Annexure-I

Details of action taken by the respondent units for the directions issued by the TNPCB and remarks of TNPCB during the subsequent inspection:

Sl. No	Directions Issued by the TNPCB vide Proc. Dated 11.03.2021/15.04.2021	Unit's Reply	Remarks of TNPCB
1.	**M/s. Manali Petrochemicals Ltd Plant-I, Manali.** a) The unit shall remove the Lime sludge dumped outside the earmarked area immediately.	As per Board advice removed the Lime sludge from outside the Lime storage earmarked area. We are strictly using Lime sludge yard only for storage and disposal of lime.	**Complied.** The unit has removed the lime sludge dumped outside the earmarked area. The unit is now using the earmarked area for the temporary storage of lime sludge being generated from the unit.
	b) The unit shall store the lime sludge generated from the rotary drum vacuum filter and un-burnt lime from lime slacker unit in the earmarked area only and sent to brick kiln for further beneficial use.	As per Board advice we are storing the lime sludge generated from the rotary drum vacuum filter and un burnt lime from lime slacker unit in the earmarked area only and sent to brick kiln for further beneficial use.	**Complied.** The unit is storing the lime sludge generated from the rotary drum vacuum filter and un-burnt lime from lime slacker unit in the earmarked area and disposing the same to brick kiln units for further beneficial use.
	c) The unit shall maintain records on the quantity of generation and disposal of lime sludge for further beneficial use.	We are maintaining the records for the quantity of generation and disposal of lime sludge for further beneficial use.	**Complied.** The unit is maintaining log book for the generation and disposal of lime sludge for further beneficial use.
	d) The unit shall ensure that the temporary lime storage yard and its leachate collection	Lime storage yard and its leachate collection arrangements are provided and are properly maintained. If any water is	**Complied.** The unit is now maintaining the

	arrangements provided are properly maintained, so as to avoid any groundwater pollution.	collected, the water will be pumped to ETP for further treatment. so as to avoid any groundwater pollution.	temporary lime storage yard and its leachate collection arrangements properly so as to avoid any groundwater pollution.
	e) The unit shall ensure that the OCEMS installed in the Boiler stack and the continuous ambient air quality monitoring (CAAQM) sensors provided are calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers.	As per Board advice the OCEMS installed in the Boiler Stack for (SPM,SO2,NOX,CO) and the continuous ambient air quality monitoring(CAAQM) sensors(PM2.5, PM 10. VOC, Cl2) provided are calibrated regularly and operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** The OCEMS (Online Continuous Emission Monitoring Sensors) installed in the Boiler Stack for the parameters SPM, SO2, NOX & CO and the Continuous Ambient Air Quality Monitoring (CAAQM) sensors (PM2.5, PM10. VOC & Cl2) are calibrated regularly and operated continuously by the unit which is connected to the CAC (Care Air Centre) of the Board and CPCB servers.
	f) The unit shall ensure that the OCEMS installed at the outlet of the treated trade effluent holding tank (ETP) for the parameters TOC (BOD & COD), TSS, pH & Temperature and flow sensors provided are calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers .	As per Board advice that the OCEMS installed at the outlet of the treated trade effluent holding tank (ETP) for the parameters TOC (BOD & COD),TSS, PH & Temperature and flow sensors provided are calibrated regularly and operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** The OCEMS (Online Continuous Effluent Monitoring Sensors) installed at the outlet of the treated trade effluent holding tank of ETP for the parameters TOC (BOD & COD),TSS, PH & Temperature and flow sensors are calibrated regularly and operated continuously and connected to the CAC of the TNPC Board

			and CPCB servers.
	g) The unit shall ensure for the continuous data transmission from the OCEMS and CAAQM sensors to the CAC and WQW of the Board and CPCB servers.	We are ensuring the continuous data transmission from the OCEMS and CAAQM sensors to the CAC and WQW of the Board and CPCB servers. Dedicate Link for TNPCB form Airtel 10 MBPS on RF for Plant 1 Secondary link from LAN with below Links Provided via Load Balancer with auto Switching in 30 Secs <u>LAN Link Details :</u> Primary Link 20 Mbps BSNL – Fibber Link Secondary Link 10 Mbps Airtel – RF Link DedicatedUPS power supply is provided for the system and equipment's.	**Complied.** The unit is ensuring the transmission of data from the OCEMS and CAAQM sensors to the CAC and WQW(Water Quality Watch) of the Board and CPCB servers continuously.
	h) The unit shall comply with the minutes of the meeting held on 09.02.2021.	Based on 09.02.2021 minutes of the meeting all the points complied and feedback letter submitted.	The compliance details are submitted below.

Sl. No.	**Points mentioned in the TNPCB minutes of the meeting dated 09.02.2021 for compliance**	**Action taken by the unit**
i.	The unit shall conduct marine impact study at the point where the treated trade effluent is being discharged into sea and furnish the report once in a year (since 2016) conducted through a reputed institution. The recently conducted study report shall be furnished within 28.02.2021.	**Partially Complied.** Marine water quality study carried out through NIOT, Chennai in the year 2020 as stated by the unit is based on the joint committee decision as per Hon'ble Tribunal, Southern Zone, Chennai order dated 08.02.2020, 11.06.2020 & 07.09.2020 in OA nos. 19/2013, 224/2016, 248/2016 and Appeal nos. 51/2017 & 52/2017. NIOT has suggested long term study in both the report (2015 & 2020) to assess the

			marine water quality and flora & fauna marine life as well as indicated the pollution from other sources also. All the three units (M/s.TPL, M/s.Kothari Petrochemical & M/s.MPL) have now accepted to carry out the marine impact study every year for which these units have given undertaking and it was reported that the impact study will be conducted from the year 2021-22.
	ii.	The unit shall improve the temporary lime storage yard and its leachate collection arrangements provided and shall also take steps to ensure that they are properly maintained so as to curtain ground water pollution.	**Complied.** The unit has improved the temporary lime storage yard and its leachate collection arrangements and needs to be continuous maintenance.
	iii.	The unit shall furnish the compliance of Environmental Clearance conditions with third party audit every year.	**Partially Complied.** The unit has engaged M/s.Glense Lab, Chennai to carry out the third party audit for the EC conditions compliance and the same is in progress.
	iv.	The unit shall apply and obtain Authorization under Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.	**Complied.** The unit has obtained Hazardous waste Authorization vide Board's Proc. dated.28.05.2020 for 5 years.
	v.	The unit shall comply with the long term and short term action plan with respect to CEPI and to carry out all the mitigation measures for improvement of Air, Water, land environment as per the mechanism evolved by CPCB vide letter dated.25.10.2019 for environmental management of critically Polluted Areas. If the land area is not adequate within the premises to develop green belt, the unit may tie-up with local body & develop green belt up to 40% as per CEPI norms.	**Partially Complied.** The unit has replaced the furnace oil usage in a Boiler with LNG and to be replaced for standby Boiler. The unit shall continue to develop green belt to attain an area of 40% of the total area with indigenous native tree species either within the unit premises or outside the premises in consultation with the Zonal Officer, GCC.

2.	**M/s. Manali Petrochemicals Ltd Plant -II, Manali.** a) The unit shall maintain records on the quantity of generation and disposal of lime sludge for further beneficial use.	We are maintaining the records for the quantity of generation and disposal of lime sludge for further beneficial use.	**Complied.** The unit is maintaining log book for the generation and disposal of lime sludge for further beneficial use.
	b) The unit shall ensure that the temporary lime storage yard and its leachate collection arrangements provided are properly maintained, so as to avoid any groundwater pollution.	Lime storage yard and its leachate collection arrangements provided are properly maintained, and any water collected, will be pumped to ETP for further treatment, so as to avoid any groundwater pollution. Photo copy enclosed in the	**Complied.** The unit is maintaining the temporary lime storage yard and its leachate collection arrangements properly so as to avoid any groundwater pollution.
	c) The unit shall ensure that the OCEMS installed in the Boiler stack and the continuous ambient air quality monitoring (CAAQM) sensors provided are calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers.	As per Board advice the OCEMS installed in the Boiler Stack for (SPM,SO2,NOX,CO) and the continuous ambient air quality monitoring(CAAQM) sensors(PM2.5, PM 10. VOC, Cl2) provided are calibrated regularly and operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** The OCEMS installed in the Boiler Stack for the parameters SPM, SO2, NOX, & CO and the Continuous Ambient Air Quality Monitoring (CAAQM) sensors (PM2.5, PM10, VOC & Cl2) are calibrated regularly and operated continuously by the unit which are connected to the CAC of the Board and CPCB servers.
	d) The unit shall ensure that the OCEMS installed at the outlet of the treated trade effluent holding tank (ETP) for the parameters TOC (BOD & COD), TSS, pH & Temperature and flow sensors provided are calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers.	As per Board advice that the OCEMS installed at the outlet of the treated trade effluent holding tank (ETP) for the parameters TOC (BOD & COD),TSS, PH & Temperature and flow sensors provided are calibrated regularly and operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** The OCEMS installed at the outlet of the treated trade effluent holding tank of ETP for the parameters TOC (BOD & COD),TSS, PH & Temperature and flow sensors are calibrated regularly and operated continuously and connected to the CAC of the Board and CPCB servers.
	e) The unit shall ensure for the continuous data transmission from the OCEMS and CAAQM sensors to the CAC of the Board and CPCB servers.	We are ensuring the continuous data transmission from the OCEMS and CAAQM sensors to the CAC and WQW of the Board and CPCB servers. Dedicate Link for TNPCB form Airtel 10 MBPS on RF for Plant 2 Secondary link from LAN with below Links Provided via	**Complied.** The unit is ensuring the transmission of data from the OCEMS and CAAQM sensors to the CAC and WQW of the Board and CPCB servers continuously.

		Load Balancer with auto Switching in 30 Secs LAN Link Details : Primary Link 20 Mbps BSNL – Fibber Link Secondary Link 10 Mbps Airtel – RF Link Dedicate power supply UPS were provided for the system and equipment's.	
	f) The unit shall furnish time bound action plan to remove/clear the old accumulated lime sludge stored in the backyard of the unit.	As per Board advice we have moved approx. 6000Mt of old accumulated lime sludge for beneficial use to develop low lying area. Continuously taking steps for further disposal of old sludge for beneficial use. Lime sludge Quantity moved details submitted to TNPCB in the monthly report.	**Partially Complied.** The unit has reported that the unit has removed about 6000 MT of old accumulated lime sludge for further beneficial use. The unit has to remove the remaining accumulated sludge early for further beneficial use.
	g) The unit shall take immediate action to get supply of LNG from IOCL to switch over the fuel from furnace oil to LNG for the boiler.	MPL side LNG burners procurement action taken and ready for despatch for LNG firing. Awaiting LNG supply from IOCL. We are closely following with IOCL for pipe line laying and supply of LNG.	**Partially Complied.** The unit is yet to complete the fuel replacement from furnace oil to LNG for the boiler.
	h) The unit shall comply with the minutes of the meeting held on 09.02.2021.	Based on 09.02.2021 minutes of the meeting all the points were complied and feedback letter was submitted.	The compliance details are submitted below.

Sl. No.	**Points mentioned in the minutes of the meeting dated 09.02.2021 for compliance**	**Action taken by the unit**
i.	The unit shall conduct marine impact study at the point where the treated trade effluent is being discharged into sea and furnish the report once in a year (since 2016) conducted through a reputed institution. The recently conducted study report shall be furnished within 28.02.2021.	**Partially Complied.** Marine water quality study carried out through NIOT, Chennai in the year 2020 as stated by the unit is based on the joint committee decision as per Hon'ble Tribunal, Southern Zone, Chennai order dated 08.02.2020, 11.06.2020 & 07.09.2020 in OA nos. 19/2013, 224/2016, 248/2016 and Appeal nos. 51/2017 & 52/2017. NIOT has suggested long term study in both the report (2015 & 2020) to assess the marine water quality and flora & fauna

			marine life as well as indicated the pollution from other sources also. All the three units (M/s.TPL, M/s.Kothari Petrochemical & M/s.MPL) have now accepted to carry out the marine impact study every year for which these units have given undertaking and it was reported that the impact study will be conducted from the year 2021-22.	
	ii.	The unit shall improve the temporary lime storage yard and its leachate collection arrangements provided and shall also take steps to ensure that they are properly maintained so as to curtain ground water pollution.	**Complied.** The unit has improved the temporary lime storage yard and its leachate collection arrangements and needs to be continuous maintenance.	
	iii.	The unit shall furnish the compliance of Environmental Clearance conditions with third party audit every year.	**Partially Complied.** The unit has engaged M/s.Glense Lab, Chennai to carry out the third party audit for the EC conditions compliance and the same is in progress.	
	iv.	The unit shall apply and obtain Authorization under Hazardous and Other Wastes (Management & Transboundary Movement) Rules, 2016.	**Complied.** The unit has obtained Hazardous waste Authorization vide Board's Proc. dated.28.05.2020 for 5 years.	
	v	The unit shall comply with the long term and short term action plan with respect to CEPI and to carry out all the mitigation measures for improvement of Air, Water, land environment as per the mechanism evolved by CPCB vide letter dated.25.10.2019 for environmental management of critically Polluted Areas. If the land area is not adequate within the premises to develop green belt, the unit may tie-up with local body & develop green belt up to 40% as per CEPI norms.	**Partially Complied.** The unit has replaced the furnace oil usage in a Boiler with LNG and to be replaced for standby Boiler. The unit shall continue to develop green belt to attain an area of 40% of the total area with indigenous native tree species either within the unit premises or outside the premises in consultation with the Zonal Officer, GCC.	

3.	**<u>M/s. Chennai Petroleum Corporation Limited Refinery I, II and III,</u>**	All the three ETP's are commissioned with American Petroleum Institute (API)	**Complied.** The unit has reported that the unit is

	Manali. a) The unit shall improve oil water separation in the ETP for effective removal of oil.	separator, Tilted Plate Interceptors (TPI) and Dissolved Air Floatation unit for separation of both free oil & emulsified oil. In addition to the above, in the upstream of the above said system, free oil removal is done in the feed tanks wherein the effluent water is allowed to settle and the top oil layer is removed through pipes connected to the tanks at different levels. CPCL is checking Oil & Grease in the Effluent Treated water on daily basis and are within the limits (<3ppm).	operating and maintaining the oil separation units provided in all ETPs for effective removal of oil. The report of analysis of treated trade effluent samples collected from the ETPs by the TNPCB revealed that the oil & grease parameter is within the treated trade effluent standards notified for oil refinery under the Environment (Protection) Rules, 1996 vide SR.186 (E) dated 18.03.2008.
	b) The unit shall quantify the amount of water received from each source, Utilization of that water in process and treated water utilization and their distribution system.	Water balance diagram indicating the sources & distribution of water for the year 2019-20 and also for the month of Feb'21 are attached.	-
	c) The unit shall provide EMFM to all the inlets and outlets of STPs, ETPs, and all the treated sewage/effluent distribution system.	EMFM & Orifice meter with recorder facility is provided at the inlet & outlet of STPs and ETPs.	**Partially Complied.** The unit has provided EMFMs at the inlet and outlet of Sewage Reclamation Plant I&II and OCEMS at the outlet of the ETPs (except in ETP IV)
	d) The unit shall expedite the provision of online analyser at the outlet of ETP IV and connect the same to the WQW, TNPCB, Guindy.	CPCL has issued work order to supply online analyzer for measuring ETP-IV outlet. The work will be completed before June '21. It is to be noted that the ETP-IV effluent water is treated thro 'RO and ION Exchange process and the water is reused at CPCL Boilers.	**Partially Complied.** The unit has reported that the work order for the installation of OCEMS at the outlet of ETP-IV has been issued and the same will be installed and commissioned before

			November 2021.
	e) The unit shall furnish details on wet slop oil collection and utilization since it is not known whereabouts of wet slop oil from ETP.	CPCL is having a closed circuit wet slop collection system to receive slop oil from ETPs. The slop tank is closed tank and after preparation, the 100% of the oil is pumped to process unit along with Crude Oil & reprocessed. PFD/P&ID of ETP-III and ETP-IV**,** depicting the removal of oil in ETP and subsequent transfer to slop tank for processing with crude. The slop recovered from ETP's from Oct'20 to Feb'21 is furnished below. ➢ Oct' 20 – 2137 KL ➢ Nov'20 – 4644 KL ➢ Dec' 20 – 3434 KL ➢ Jan' 21 – 4790 KL ➢ Feb' 21 – 3832 KL	**Complied.** The slop oil is collected in a closed tank and the same is pumped to process unit along with crude oil and reprocessed. The unit has been instructed to maintain the records for the slop oil generation and reuse.
	f) The unit shall take necessary action to improve the existing APC measures or provide new control measures to achieve the standards prescribed by the Board as the parameters CO, PM, SO_2 and NO_x have exceeded many times over a period of 2 years.	CPCL has implemented the following Air Pollution Control (APC) Measures: ➢ Only low Sulphur fuel oil is used as internal fuel for reducing SO2 emission. ➢ Low NOx burners are installed in all the major process heaters, Boilers & Gas Turbines to control NOx emission. ➢ Excess Oxygen control is provided in the Digital Distribution System (DCS) for complete combustion and this will suppress the formation of CO. As a major leap, CPCL has recently installed Re-gasified Liquefied Natural Gas (RLNG) in all the major process heaters, Boilers & Gas Turbines from March 2019 in a phased manner. Presently CPCL is using 30,000 MT of RLNG per month.	**Partially Complied.** The unit has implemented the following improvement measures. Low Sulphur fuel oil is used as internal fuel for reducing SO2 emission. Low NOx burners have been installed in all the major process heaters, Boilers & Gas Turbines to control NOx emission. Excess Oxygen control is provided in the Digital Distribution System (DCS) for complete combustion and to reduce the formation of CO. The unit has installed Re-gasified Liquefied

		Few excursions in stack parameters noticed are predominantly during unforeseen plant upset, during startup & due to instrument fault. Timely action is being done by CPCL to attend the instrument fault.	Natural Gas (RLNG) in all the major process heaters, Boilers & Gas Turbines. The unit is using 30,000 MT of RLNG per month. However, the unit shall replace the fuel with Re-gasified Liquefied Natural Gas (RLNG) in all process and utility stacks.
	g) The unit shall conduct studies regarding the emission level inside and outside the premises and take necessary effective steps to reduce the emission load let out from the premises and maintain records for the same.	In addition to the regular NABL accredited Lab survey on stack monitoring and Ambient Air Quality Monitoring, the stack emission survey and Ambient Air quality monitoring inside and outside CPCL has been entrusted to Indian Institute of Technology (IIT), Madras on 09.01.2021 vide P.O.No.26758469. IIT has completed survey of 41 stacks out of 45 and completed Ambient Air Quality monitoring at 10 stations for 4 weeks, out of which one is at CPCL Polytechnic near to Manali Bus stand. All the values are within the limit.	**Complied.** The unit has reported that the unit has conducted Ambient Air Quality (AAQ) / Stack Emission Monitoring survey through IIT, Chennai.

<table>
<tr><td>4.</td><td colspan="3"><u>M/s. North Chennai Thermal Power Station-I, Puzhuthivakam village, Ponneri Taluk, Tiruvallur District.</u></td></tr>
<tr><td>1.</td><td colspan="3">The unit shall comply with the following findings of the committee constituted by the Hon’ble National Green Tribunal order dated.20.05.2019, communicated and agreed by the Hon’ble NGT within the time limit as reported.</td></tr>
<tr><td></td><td colspan="2">a. The unit shall remove the fly ash deposited on the land in and around the ash carrying pipeline and ash disposed inside the premises for quantity of 3,95,979 Tonnes and shall store in temporary storage area and/or sent directly for beneficial purposes.</td><td></td></tr>
<tr><td></td><td colspan="2">
<table>
<tr><th rowspan="2">Action plan</th><th colspan="2">Time period of work</th><th rowspan="2">Present Status</th></tr>
<tr><th>Commencement</th><th>Completion</th></tr>
<tr><td>The Ash Deposited on the land in and around the Ash carrying pipe lines will be temporarily stored by the NCTPS in the following areas with geo thermal lining at the bottom and Bunds will be formed around the temporary storage areas as detailed below.</td><td></td><td></td><td rowspan="3">M/s. Tamil Nadu Polymer Industries Park Limited have been permitted to lift 15 lakhs m^3 of wet ash from NCTPS-I ash dyke to develop a Polymer Industries Park Project at Voyalur and Puzhudivakkam villages in Thiruvallur district in Phase-I to an extent of 180.91 acres adjacent to Ennore SEZ Project site.

It has been agreed by M/s.TPIPL for lifting of 1,67,241 m^3 from the land area (Zone I, II & III) directly at free of cost. The order for lifting the wet ash</td></tr>
<tr><td><u>Zone:(i)</u>
Southern and Northern side of Ash pipe lines from Harbor road to Pulicat bridge area.
On the southern side fly Ash spread in area of 108549 m^2 to a volume of 58508 m^3.
On the Northern side fly Ash spread in area of 28890 m^2 to a volume of 6247 m^3.</td><td></td><td></td></tr>
<tr><td><u>Zone:(ii)</u>
Southern and Northern side of Ash</td><td></td><td></td></tr>
</table>
</td><td>Partially Complied.

The unit committed to comply before September 2022.</td></tr>
</table>

		pipe lines from Pulicat Bridge to Railway crossing Bridge area. On the southern side fly Ash spread in area of 108428 m^2 to a volume of 34697 m^3. On the Northern side fly Ash spread in area of 122107 m^2 to a volume of 25032m^3.			has been issued vide Lr.No.SE/C/CM/NCTPS-I/F.WA/D.60/20, Dt.16.05.2020 and work has been commenced on 01.06.2020 in Zone (I,II & III) area and lifted 1,94,543 m^3 ash till 30.06.2021.	
		Zone:(iii) Southern and Northern side of Ash pipe lines from NCTPS stage-II pipe line to Railway crossing area. On the southern side fly Ash spread in area of 23770 m^2 to a volume of 5943m^3. On the Northern side fly Ash spread in area of 62265 m^2 to a volume of 36814m^3.				
		Zone:(iv) A). Southern and Northern side of Ash pipe lines at adjacent side of NCTPS stage-II Recovery Pump House area. On the adjacent side of recovery water pump house fly Ash spread in area of 50028 m^2 to a volume of 54530 m^3. B). Western side of Ash dyke adjacent to Ash slurry pipe lines area. On the western side of Ash dyke adjacent to Ash slurry pipe line fly Ash spread in area of 141858 m^2 to a volume of 18442 m^3. C). Western side dyke Cheppakkam ramp area. On the western side			Total ash to be removed a. 54530 m^3 b. 18442 m^3 c. 150166 m^3 Total 223138 m^3 ➢ 18,500 m^3ash removed in Zone IV area till date. ➢ Estimate submitted for removal of balance quantity of 2,04,638 m^3. Vide Lr.No. CE/NCTPS-I/ SE/M.I/EE/AHP/F.Dkt 120105/d.360/20, Dt.02.03.20 and revised proposal	

	of Ash dyke adjacent to Cheppakkam ramp area fly Ash spread in area of 219221m^2 to a volume of 150166m^3.			is also submitted vide Lr.No.CE/NCTPS-I/ SE/M.I/EE/AHP/F.NGT, D.995/20,Dt.27.05.2020 to an amount of Rs.3,32,14,500/- ➢ Further 22,000 m^3 wet ash removed in zone IV area during the month of Sep'2020	
	<u>zone-1,2,3,4</u> a. Estimation, Approval, Tendering and awarding of work:				
	1. Preparation of Estimate	Aug - 2020			
	2. Sanction at Head Quarters	Sep-2020	Aug-2021		
	3. Technical Sanction	Sep-2021			
	4. Tendering				
	i) BQR Approval	Oct-2021			
	ii) Specification Approval	Oct-2021			
	iii) Call for Tender	Nov-2021			
	5. Price Bid opening and awarding of work.	Dec-2021	Jan-2022		
	b. Formation of Temporary storage at North eastern area of 90^0bend of the pipelines in front of Zuari cement factory of size. (length 60mXWidth 40m X Height 3m)= 7200m^3	Feb-2022	March -2022		
	C. Removal of Ash from the above Zone.(iv), Storing in the	March -2022	Sep-2022		

	temporary storage, Lifting and utilization by beneficiaries.				
	➢ The TNRDC and NHAI have been addressed and also contacted in person to utilize the fly Ash generated from NCTPS-I and they have obliged their request. TNRDC have assured to lift 10-15 Lakh Tonnes of Ash for their upcoming project of Minjur to Kattupalli and the Ash will be utilized by June 2021. The Chief Engineer State Highways &The Project Director, Chennai peripheral ring road were also addressed for lifting the fly Ash and it will be followed up by NCTPS. Competent Agency /Institution will be addressed to test the soil quality after removal of the Ash and the remedial measures will be taken as per the suggestions of the Agency /Institution.			➢ In this regard, the Project Director, Tamil Nadu Road Sector Project-II, R.A.puram, Chennai-28 have also been addressed from CE/NCTPS-I vide Lr.no.D.1026/20, dt.07.02.20 regarding the quantity of wet ash required, details of the project and duration of time. ➢ In the meantime the lifting of wet ash is under progress from June-20 for NH 5 road work by the M/s.Keeran Traders agencies.	
	Work completion		**Sep'**		
	b. The unit shall completely remove the ash deposited in Buckingham canal for a quantity of 93,096 m^3 Tonnes and shall store in temporary storage area and/or sent directly for beneficial purposes.				

	Action plan	**Time period of work**		**Present Status**	**Partially Complied.** The unit committed to comply before May 2022.
		Commencement	**Completion**		
	The PWD has already commenced the dredging of the Buckingham canal and deposited the dredged Ash and silt in the Banks of the canal. Technical sanction has been accorded by NCTPS for an amount of Rs.16 lakhs for removing the deposited Ash from the banks of the Buckingham canal for a quantity of 9667m^3. Administrative approval has been accorded to transfer an amount Rs.66 lakhs to PWD on Deposit Contributory Works (DCW basis) for desilting the Buckingham canal. Fund was transferred to PWD on 13.12.2019. After the dredging work is carried out by PWD, the Ash removal work will be carried out by M/s.TANGEDCO				
	Removal of 9667 m^3Ash includes storing in a temporary storage area in existing Ash dyke and used for beneficial purposes (tendering, awarding, commencement and completion).	02.03.2020	May-20	➢ For removal of 9,667 m^3 ash, work have been completed.	
	(a) Desilting the balance quantity of 83429 $m^3$for length of			➢ Rs.66.23lakhs paid to PWD during December 2019,	

	2.6km at a cost of Rs.66 Lakhs by PWD (Tendering, awarding, commencement and completion).			PWD commenced the work and work in progress . ➢ In the mean time, on 02.11.2020 the PWD furnished additional estimate for an amount of rupees 18 lakhs for additional quantity of Ash to be de-silted in the same area.	
	i) Tendering	Sep-2020	Oct-2020		
	ii) Awarding	Nov-2020			
	iii)Commencement	Jan-2021			
	iv)Completion		June-2021		
	Work completion		**June-2021**	Desilting Work Completed	
	Removal of desilted Ash of 83429m^3 including storing in existing Ash dyke and used for beneficial purposes. (Estimate sanction, tendering, awarding, commencement and completion).			➢ The work of removal of desilting ash is under process	
	i)Estimate Sanction	April-2021	May-2021		
	ii) Tendering	May-2021			
	iii) Awarding	June-2021			
	iv)Commencement	June-2021			
	v)Completion		Sep-2021		
	(b) <u>For removing silt from NCTPS-1 main</u>			➢ Estimate has been requested	

		gate to Ennore creek (1.67km), Letter has been addressed to PWD for carrying the work on DCW basis vide letter dated 16.12.19.			from PWD vide letter references as furnished below, 1. Lr.No:CE/NCTPS/SE/CM/DB/EA/JE/F.NGT/D.881/19, dt:16.12.19 addressed to CE/PWD/WRO/Palar Basin/ Chennai-05. 2. Lr.No:EE/CM-II/NCTPS-I /F.NGT/D.403/19, dt:20.12.19 addressed to EE/PWD/ Chennai-05. 3. Lr.No:EE/CM-II/NCTPS-I/ F.NGT/D.433/19, dt:10.01.20 addressed to EE/PWD/ Chennai-05. 4. Now M/s.CMWSSB is carrying out the work of laying TTRO water supply line under the back waters of Ennore Creek. For this work, dredging is being done along the pipeline route and the dredged materials are pumped through pipeline and dumped in the Buckingham canal and this flow is mingled with Kosasthalaiyar river also, because Buckingham canal and Kosasthalaiyar river is joining	

					each other. This has been informed to the CE/PWD vide letter dt.14.08.2020 (Copy enclosed) with a copy marked to the JCE/TNPCB. 5. Further a letter has been addressed to JCEE/TNPCB vide Lr.No.CE/NCTPS-I/SE/ CM/DB/EA/JE/F. NGT/D.486/20, DT.22.09.2020 inturn the JCEE/TNPCB addressed a letter to CE/O&M-II/ CMWSSB vide Lr.No.048/ GMP/JCEE(M)/TNPCB/CHN ZONE/2020, dt.05.10.2020 stating that "to remove the dredged materials already pumped in the Buckingham canal and in Kosasthalaiyar river from Ennore creek to NCTPS-I main gate immediately".	
		Removal of desilted Ash of 15765m^3 by PWD for the above estimated quantity and kept on the banks of Buckingham canal including storing in existing Ash dyke and used for beneficial purposes. (Estimate sanction,				

tendering, awarding, commencement and completion).				
i)Estimate Sanction		Aug-2021		
ii) Tendering	Sep-2021			
iii) Awarding	Oct-2021			
iv)Commencement	Nov-2021			
v)Completion		May-2022		
Work completion		**May-2022**		

c. The unit shall completely remove the ash deposited in Kosathaliyar River for a quantity of 3,25,000 Tonnes from NCTPS main gate to KPL main gate for a length of 2.4Kms for a average width of 130m and depth of 1m and shall store in temporary storage area and/ or sent directly for beneficial purposes.

Action plan	**Time period of work**		**Present Status**
	Commencement	**Completion**	
Administrative approval has been accorded to transfer of amount Rs.28.5 crores to PWD on Deposit Contributory Works (DCW basis) for dredging of Kosasthalaiyar river for a quantity of 325000 Tonnes (2400 meters length and various width of 130-140 meters and depth of 1 meter) Fund was transferred to PWD on 13.12.2019.			Eventhough an amount of Rs 28.50 Crores paid to PWD during December - 2019, PWD have commenced the work only on 15.06.2020 and the work under progress.

Partially Complied.

The unit committed to comply before December 2021.

Desilting by PWD sanction of working estimate, Tendering, Awarding, commencement and completion Reach(i) (Ch 0 to 1.2km) and Reach (ii) (Ch 1.2 km to 2.4 km)				
i) Tendering	Mar-2020		Completed	
ii) Awarding	Jun-2020		Completed.	
iii)Commencement	Jun-2020			
iv)Completion				
Work completion				
Removal of desilted ash of 325000 m^3 including storing in existing ash dyke and used for beneficial purpose.(Estimate, Sanction, tendering, awarding, commencement and completion.			➢ The work of removal of dredged ash form the banks of kosasthalaiyar river is under progress.	
iii) Awarding				
iv)Commencement	May-2021			
v)Completion		Dec-2021		
Work completion		**Dec-**		

d. The unit shall completely remove the ash deposited in Kosathaliyar river for a quantity of 4,68,000 Tonnes form Ennore creek to NCTPS-I main gate for a distance of 1.7Km and from KPL main gate to Kattupalli downstream for a distance of 1.9 Km for a average width of 130m and depth 1m and shall store in temporary storage area and/or sent directly for beneficial purposes.

Action plan	**Time period of work**		**Present Status**
	Commenc	**Compl**	

Partially Complied.

The unit committed to comply before December 2022.

			emen t	**etion**		
		For removing silt from Ennore creek to NCTPS-I for a distance of 1.7 Km and a width of 130m and depth of 1m for a approximate quantity of 4,68,000 m^3. A letter has been addressed on 06.12.2019 to PWD for carrying out the work on Deposit Contributory Works (DCW basis). After the receipt of detailed estimate from PWD and approval from our headquarters, the funds will bearranged and transferred to PWD by NCTPS			➢ Estimate received from PWD to an amount of Rs.28 Crores for desilting the ash from Kosasthalaiyar river for a quantity of 4,68,000 m^3 from Ennore Creek to NCTPS-I main gate for a distance of 1.7 Km and submitted to TANGEDCO Head Quarters for administrative approval. Reply to remarks of Head Quarters is submitted fromCE/NCTPS-I vide Lr.No.CE/NCTPS-1/SE/CM/EE/CM2/F.NGT/D.483/20/dated: 18.09.2020 ➢ Now M/s.CMWSSB is carrying out the work of laying TTRO water supply line under the back waters of Ennore Creek. For this work, dredging is being done along the pipeline route and the dredged materials are pumped through pipeline and dumped in the Buckingham canal and this flow is mingled	

					with Kosasthalaiyar river also, because Buckingham canal and Kosasthalaiyar river is joining each other. This has been informed to the CE/PWD vide letter dt.14.08.2020 (Copy enclosed) with a copy marked to the JCE/TNPCB. ➢ Further a letter has been addressed to JCEE/TNPCB vide Lr.No.CE/NCTPS-I/SE/ CM/DB/EA/JE/F.NGT/D.486/20, DT.22.09.2020 inturn the JCEE/TNPCB addressed a letter to CE/O&M-II/ CMWSSB vide Lr.No.048/ GMP/JCEE(M)/TNPCB/CHN ZONE/2020, dt.05.10.2020 stating that "to remove the dredged materials already pumped in the Buckingham canal and in Kosasthalaiyar river from Ennore creek to NCTPS-I main gate immediately".	
		Receipt of estimate from PWD	10.03.20			
		Administrative approval by	Oct-2020	Aug-2021		
		Payment		Sep-2021		

	Desilting by PWD 1700m length sanction of working estimate Tendering				
	i) Tendering	Oct-2021	Nov-2021		
	ii) Awarding	Dec-2021			
	iii)Commencement	Jan-2022			
	iv)Completion		Oct-2022		
	Work completion		**Oct-2022**		
	Removal of desilted ash of 4,68,000 m^3including storing in existing ash dyke and used for beneficial purpose (Estimate sanction, tendering, awarding, commencement and completion).				
	i)Estimate Sanction	Sep-2021			
	ii) Tendering	Oct-2021	Dec-2021		
	iii) Awarding	Jan-2022			
	iv)Commencement	Feb-2022			
	v)Completion		Dec-		
	But the Ash and silt formation deposited in the upstream of the Kosasthalaiyar river i.e from KPL main gate to kattupalli to a distance of1.9 Km is very far away from the NCTPS-I Ash slurry pipeline crossing of the river. This area is 1.1km away from slurry line crossing on upstream side. Hence the Ash carry over in this stretch will be minimum. So, the unit is requesting restudy so as to assess the				

exact length, width, depth and volume of Ash deposit Accumulated Ash will be removed based on the Findings.				
Work completion		**Dec-**		

e. The unit shall replace the existing Ash Slurry pipe lines No.1,2,3&4 with new Cast Basalt Lined pipe lines for a total length of 20523m length.

Action Plan	**Time period of the work**		**Present status**
	Commencement	**Completion**	
<u>5A) Ash slurry disposal line No:1</u> For line No.1 entire length of 5129 metres of Ash Slurry Disposal Line is being replaced. At present, erection of 3510metres was completed and work is under progress for the balance length of 1619 metres and it will be completed by Jan'2020.	Oct' 2019	Aug-2020.	At present, erection of 5129metres was completed and line is in service.
<u>5B-1) Ash slurry disposal line Nos:2 & 3</u> For procurement of new Ash slurry pipe lines and consumables purchase order (P.O) have been placed for a length of 10452metres vide P.O.No:174/30.11.2019 for an value of Rs.8.36 Crores&175/30.11.2019 for an value of Rs.13.88 Lakhs with a delivery period of			

Partially Complied.

i) The pipelines of Stage-1 were commissioned during 1994-95 and hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks. There are total 8 Nos. of series of pipelines of which 5 Nos. carry ash slurry and 3 Nos. being used for recycling the filtered water.

ii) Out of the above 5 Nos. of pipelines, Line 1 & 5 were replaced and got completed during August 2020. These pipes are old used pipelines brought from Ennore Thermal Power Station (ETPS). They are Cast Basalt-lined having an outer diameter of 406 mm and Inner diameter of 356mm.

	10 months.				Replacement of Line 2 & 3 is in progress with new Cast Basalt pipes, but for Line 4,the unit is yet to procure new pipes. The TANGEDCO has committed a timeline for replacement of all the 5 Nos. of pipelines by December 2021. Though the unit has replaced pipeline no.1 & 5 with old pipes retrieved from ETPS, leakage may happen within short period of time. Hence, the unit shall replace all the pipelines (1 to 5) with new cast basalt pipes to arrest complete leakage of ash into B canal & back waters of Kosasthalaiyar River.
	5B-2) Delivery period of pipe lines	Jan-2020	Mar - 2021 (Including 6 months Delay due to Covid 19)	7392 Metres New pipe Lines supplied as on 31.05.2021. 70% of supply completed.	
	5B-3) The Erection and Commissioning of pipe lines	Sep-2020	Jun-2021 (Including 6 months Delay due to Covid 19)	ASDL line no 2&3 was awarded to M/s RamuEnterprises ,Chennai ASDL no.3 Pipe replacement erection work is under progress and up to 3892meters was replaced. ASDL No.2 pipe erection work is under process	
	<u>5C) Ash slurry disposal line No:4</u> For procurement of new Ash slurry pipe lines for a length of 4944metres for a value of Rs. 4.32 Crores. Tender floating is under process.		6 months Delay due to Covid-19	The tender has been put up for lodging due to non-acceptance of validity by thebidders, exorbitant steel rice hike and non acceptance of LD terms of TANGEDCO. Hence, fresh proposal for administrative approval is sent to TANGEDCO Head quarters on 05.03.2021	

			CMD Approval proceeding No.75 dt; 07.05.2021 .Procurement of pipe is under process.	
Tender processing and placing P.O.	July-2021	Aug-2021		
Delivery period for pipes (4-8 months).	Aug - 2021	Dec-2021		
The Erection and Commissioning of pipe lines	Dec-2021	Mar-2022	Erection expectedto commence in Dec'-2021	
Work completion		**Dec-2021**		

f. The unit shall provide impervious Toe drain around the Ash dyke for a length of 6000m for the collection of seepage water and to be connected to the existing Recovery Water sump and reuse for Ash slurry making.

Action Plan	**Time period of the work**		**Present status**	**Not Complied.** The unit committed to comply before June 2023.
	Commencement	**Completion**		
An amount of Rs 18.17 Lakhs has already been paid to IITM on 25.06.2019 towards the technical consultancy for the Comprehensive / Rehabilitation/Re-construction and raising of NCTPS Ash dyke. The team of IITM has visited the site on			➢ It is confirmed from the Ennore SEZ TPP wing that the preliminary report received from IITM on 28.08.2020 and final report expected	

	31.08.2019 and the soil exploration test also completed and IITM have confirmed to furnish the report by Dec-2019. (a) Receipt by study report from IITM/ Chennai within 31.12.2019. IITM have stated that the detailed report will be submitted on the Ash dyke strengthening works. (b) Estimation, Approval, tender specification approval ,E-tendering ,and awarding of work (c) Execution of agreement and getting necessary approvals from statutory agencies. (d) Execution of bund raising and strengtheningworks in accordance with IITM/Chennai recommendation complete including impervious Toe drain around the Ash dyke for length of 6000m.	May - 2021 Sep-2021 Nov-2021	Sep-2021 Oct-2021 June-2023		
	Work completion		**June-2023**		
	g. The unit shall provide 6000 Nos. of trees in and around the ash dykes and grow it well so as to prevent the dust emission from the ash dyke.				
	Action Plan	**Time period of the work**		**Present status**	**Not Complied.** The unit committed to comply before December 2023.
		Commenc	**Compl**		

	ement	**etion**		
In the Ash dyke area 2540 Nos. of sapling have been planted till 28.12.2020 by NCTPS-I .For further plantations, M/s. Swaminathan Foundation have been addressed for suggesting suitable plants and they have inspected the site on 07.12.19 and they have informed to furnish the report during January 2020. However, proposal received only for management of Mangrove Bioshield in the river Kosasthalaiyar, Ennore Estuary. Based on the report, after strengthening of bund the plantation of tree will be taken up. Every year during the summer period water sprinkling arrangements was carried out through the tractor (7 trips per day, 4000 Litres per trip. Estimate amount 1 Lakh per month).	Jan-2021	Dec-2023	For the work of mangroves bio shield in the Kosasthalaiyar river and other areas for an amount of Rs.43,24,450/- is submitted to the Head quarters vide letter no. CE/NCTPS-I/SE/CM/EE/CM-II/D.1146/ dt.18.03.2020 and approval awaited. Quotation has been called from Annamalai University and the District Forest Officer for the above work vide Lr.No:CE/ NCTPS-I/SE/CM/DB/EA/JE/ F.NGT/D.121/20,Dt. 04.06.2020&Lr.No: CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/D.120/20, Dt.04.06.2020. Further reminders also sent vide Lr.No. CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/D.1002/21, Dt.22.01.2021 and Lr.No. CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/D.1003/21, Dt.22.01.2021	
Work completion		**Dec-**		
h. The unit shall make existing ash pond impervious so as to prevent the seepages as per the technical consultancy of IITM, Chennai.				

		Action Plan	**Time period of the work**		**Present status**	**Not Complied.** The unit committed to comply before June 2023.
			Commencement	**Completion**		
		An amount of rupees 18.17 Lakhs has already paid to IIT Madras on 25.06.2019 towards the technical consultancy for the Comprehensive / Rehabilitation/Re-construction and raising of NCTPS Ash dyke. The team of IIT Madras has visited the site on 31.08.2019 and the soil exploration test also completed and they have confirmed to furnish their report by Dec 2019 (a) Receipt by study report from IITM/ Chennai within 31.12.2019. IITM have stated that the detailed report will be submitted on the Ash dyke strengthening works. (b) Estimation, Approval, tender specification approval, E-tendering and awarding of work (C) Execution of agreement and getting necessary approvals from statutory agencies.	May-2021 Sep-2021 Nov-2021	Sep-2021 Oct-2021 June-2023	➢ It is confirmed from the Ennore SEZ TPP wing that the preliminary report received from IITM on 28.08.2020 and final report is expected.	

	(D) Execution of bund raising and strengthening works in accordance with IITM/Chennai recommendations				
	Work completion		**June-2023**		

i. The unit shall obtain technical study report from IITM Chennai for the remedial measures such as strengthening of Ash Dyke and other related works in Ash dyke and implement the recommendations.

Action Plan	**Time period of the work**		**Present status**	**Partially Complied.** The unit committed to comply before June 2023.
	Commencement	**Completion**		
After receipt of the consultancy report from IITM, Chennai, the bund will be made impervious and other related work will be implemented as per the directions. An amount of rupees 18.17 Lakhs has already paid to IITM on 25.06.2019 towards the technical consultancy for the Comprehensive / Rehabilitation/Re-construction and raising of NCTPS Ash dyke. The team of IITM has visited the site on 31.08.2019 and the soil exploration test also completed and the report is expected by Dec-2019. Detailed report will be submitted latter on.			➢ It is confirmed from the Ennore SEZ TPP wing that the preliminary report received from IITM on 28.08.2020 and final report is expected.	

(a) Receipt by study report from IITM/ Chennai within 31.12.2019. IITM have stated that the detailed report will be submitted on the Ash dyke strengthening works within two weeks. A copy of the mail dt: 30.12.2019 from IITM is submitted (b) Estimation, Approval, tender specification approval, E-tendering and awarding of work (C) Execution of agreement and getting necessary approvals from statutory agencies. (D) Execution of bund raising and strengthening works in accordance with IITM/Chennai recommendations	Sep-2021 Nov-2021	Sep-2021 Oct-2021 June-2023		
Work completion		**June-2023**		

j. The unit shall provide sufficient number of piezometric wells/monitoring wells around the dykes and upstream of the industry to monitor the ground water quality.

Action Plan	**Time period of the work**		**Present status**	**Complied.**
	Commencement	**Completion**		

The Piezometric wells have been provided at 12 locations around the ask dyke area as per the CPCB Guidelines	Work fully Completed on 09.12.2019.	Work completed Ground water tests carried out.	
Work completed	**Dec'2019**		

k. The unit shall bring back Recovery water Pump No.3 in to service and to replace the existing worn-our Recover water pipe Line.1 for a entire length of 2815 m.

Complied.

Action Plan	**Time period of the work**		**Present status**
	Commencement	**Completion**	
A).Recovery Water Pump No:3 Budgetary offer for a spares pump is being obtained for Administrative approval.	Apr-2021	June-2021	Procurement of spares under process
Indent & Tender Processing.	June-2021	Aug-2021	
Purchase order and supply.	Aug-2021	Sep-2021	
Erection & Testing and commissioning.	---	**Oct-2021**	
B).Recovery Water Pump No:2 In recovery water pump no.2 minor repairs have to be attended. Purchase Order (P.O) of the above pump have been placed with a delivery period of 4 months. Delivery period of	Dec-2019	Mar-2020	Completed

spares.				
Erection & Testing and Commissioning.	Apr-2020	Jun-2020	Completed and pump No.2 is in service now	
C).Recovery Water pipe line No:1(R1) The existing worn out Recovery Water Pipe line no.1 is proposed to be replaced with fabricated MS pipe of 362mm outer diameter and 12mm thickness out of 12mm thickness MS plate for the entire length of 2815 metres. For the above work, Tender was finalized and K2 Agreement has been entered with a contractor. 12mm thick MS plates are required for the above works,P.O. have been placed. Supply of MS Plates.	May-2020	Aug-2020	150 Tonnes of 12 mm thick MS plates have been supplied and received at NCTPS-I stores	
Fabrication of MS pipes.	Apr-2021	July-2021		
Erection & commissioning of Recovery Water Pipeline No.1.	July-2021	Sep-2021		
Work completion		**Sep-2021**		
l. The unit shall modify existing three Electrostatic precipitator attached to the 3 No. boilers vide MoEF&CC notification				

dated 07.12.2015.

Action Plan	Time period of the work		Present status
	Commencement	Completion	
Administrative Approval is accorded for Renovation & Modernization (R&M) of Electro Static Precipitators (ESP) in Units I, II & III to achieve the desired PM level below 100 mg/Nm^3. So as to achieve the norms as per MOEF&CC.			As per the recommendation of consultant M/s. MECON, the semi dry FGD system will take care of additional dust burden. However all necessary steps are being taken to maintain the SPM level with in Norms. Tender was floated for installation of FGD and due date of tender opening on 12.08.2021

Not complied.

It is reported that the preliminary works for tender opening for the installation of FGD is in progress.

MoEF&CC vide notification dated 31.03.2021 has given time limit for the installation of FGD for this type of power plant till 31.12.2022.

m. The unit shall replace the worn-out boiler roof tubes in Unit-II and Unit-III so as to arrest the discharge of fugitive emission.

Action Plan	Time period of the work	
	Commencement	Completion
In Unit I and II Boiler, radiant roof tubes along with skin casing sheets were renewed. In each unit 120 Nos of tubes of size Ø51 mm x 5mm thick, of length - 11 metres grade SA213T11 were renewed. The work was commenced on 02.01.19 and completed on 26.02.19 in Unit I and in Unit II the work was commenced on 01.08.19 and completed on	Work fully Completed and now there is no fugitive emission in all three units.	

Complied.

20.08.19. In unit III, the Boiler radiant roof tubes were found intact and hence only renewal of skin casing sheets was commenced on 14.09.19 and completed on 30.09.19. Now there is no discharge of fugitive emission in all the three units.		
➢ **Work completed**	**Sep'2019**	

n. The unit shall develop Mangroves plantations and other costal vegetation in both sides Kosasthalaiyar river banks, Buckingham canal and nearby by affected coastal areas, in consultation with M.S.Swaminathan foundation (or) Annamalai University.

Action Plan	**Time period of the work**		**Present status**	**Not Complied.** The unit committed to comply before December 2022.
	Commencement	**Completion**		
Only after removal of Ash from Kosasthalaiyar River and B'Canal area, the plantation of mangroves and other vegetation's will be taken up on both sides of Kosasthalaiyarriver and Buckingham canal. M.S Swaminathan Foundation, Taramani Chennai, have been addressed to suggest suitable plants and they inspected the site on 07.12.2019 and they informed to furnish the report during Jan-2020 based on the report, the plantation of trees will be carried out to an extent of 15 Hectares along Kosasthalaiyarriver	Oct-2021 Oct-2021	Jan-2022	➢ M.S.Swaminathan Foundation have inspected the site on 07.12.2019 and have given a proposal for plantation of Mangrove trees along Kosasthalaiyar river and Buckingham canal. ➢ Proposal was submitted vide Lr.No.CE/NCTPS-I/SE/CM/EE/CM-II/D.1146/20,dt. 18.03.2020 for getting administrative	

	and Buckingham Canal. Buckingham canal Kosasthalaiyar river (NCTPS-I main gate to KPL main gate)	May-2022	Jan - 2022 Dec-2022	approval from the competent authority for the same. ➢ Quotation has been called from Annamalai University and the District Forest Officer for the above work vide Lr.No:CE/ NCTPS-I/SE/CM/DB/EA/JE/ F.NGT/D.121/20,Dt.04.06.2020&Lr.No:CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/ D.120/20, Dt.04.06.2020. ➢ Further reminders also sent vide Lr.No. CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/ D.1002/21, Dt.22.01.2021 and Lr.No. CE/ NCTPS-I/SE/CM/DB /EA/JE/F.NGT/ D.1003/21, Dt.22.01.2021	
	Work completion		**Dec-**		
	o. The unit shall ensure complete utilization of fly ash as per the Ministry of Environment, Forest & Climate Change fly ash notification of 2016.				

ACTION PLAN	**Time period of the work**		**Present status**	**Being Complied.**
	Commenc	**Completion**		

			emen t		
		NOTE Orders have been issued for lifting of 12lakhs tonnes of fly Ash to 8 major cement companies and 6 other fly Ash based product manufactures and ready mix concrete plants and lifting of fly Ash is under progress from Feb-2019. During the year 2018-19 the fly Ash utilization is 3.19 lakh tonnes out of the total fly Ash generation of 6,05 lakh tonnes which is about 52.85%. A quantity of 6.72 lakh tonnes of total Ash utilized including the wet Ash lifted from Ash dyke have been utilized against the total Ash generation of 10.16 lakhs tonnes which is about 66%. The cement companies have been requested to increase their off take of fly Ash from NCTPS-I in order to achieve 100% fly Ash utilization. During the year 2019-20 up to March-2020 the fly Ash utilization is 3.42 lakh tonnes out of the total fly Ash generation of 4.90 lakhtonnes which is about 69.74%. A quantity of 10.0 lakh tonnes of total Ash (fly ash+ wet ash) have been utilized against the total Ash generation of 8.23 lakhs tonnes. which is more than 100% Efforts are on to maintain the fly Ash utilization to 100% in the coming months. In the current year 2020-21 up to Feb-2021the total Ash utilized/removed is 21.40 lakhs tones out of the stock available at ash dyke.It inclusive of all units ash generation of 7.82 lakh tonnes in the currentyear 2020-21! which is more than 100% Remarks submitted regarding Hon'ble NGT observations during the hearing held on 20.01.2020 regarding 100% fly Ash utilization or otherwise of NCTPS-I - Court Case 08 of 2016 With reference to the above, and pertained with subject, it is stated that in the matter of O.A No. 117/2014 as per directions of Honorable NGT, Principle Bench, New Delhi , The Central pollution control board , computed and levied Environmental compensation	**Complied.**	

		amount of Rs 91,36,815/-(Rupees Ninety one lakhs thirty six thousand eight hundred and fifty only) for non-utilization of fly ash 100% by the Thermal Power plant of NCTPS-1 for the period of 2018-19. Against this compensation claim NCTPS-I has sent a letter vide No. Lr.No.CE/SE/NCTPS-1/M.I/EE/AEE-II/AHP/F. /D.1691 /20, Dt. 25.08.2020 to central pollution control board requesting to drop the claim. Since for the same subject and period the Tamil Nadu Pollution Control Board is its proceedings No T2/TNPCB /NGT F.31005/RC/2019-20 dated 25.11.2019 have levied 16.461 crores as Environmental compensation for fly ash pollution to the water bodies and surroundings area. In response to the order, NCTPS-I has remitted a cheque for a value of Rs. 16.461 crores. The Central pollution control board has sent a reply vide B.330/7/2020/IPC-II/TPP date : 04.08.2020/ SL.NO 73 and informed that these remarks have been submitted by CPCB Hon'ble NGT , Principle Bench ,New Delhi during the hearing in September 2020 .The case is pending. Further NCTPS-I have submitted that already orders have been issued to 14companies for lifting 12 lakh tones of fly Ash for 2 years from Feb'2019 and work under progress to extended the time period by one more year due to COVID – 19 pandemic condition to enable the cement companies to lift the balance quantity of fly Ash (short fall due to COVID pandemic and less unit generation on account of backing down as per instructions of load dispatch center) **Wet Ash Utilization:** From 01.04.2020 upto 31.03.2021, the quantity of wet from the ash dyke and in the		

land areas are about 21,79,326m^3. The split up details are given below.

Details of wet ash lifted from Ash dyke and land area (from 01.04.2020 to 31.03.2021)

Details of lifting contractors	From Ash dyke	From l area
Local Contractors (Transporters)	810243 m^3	-
M/s TPIPL	11,86540 m^3	182543m^3
Total	19,96,783 m^3	182543m^3
Grand Total	21,79,326m^3	

The total wet ash lifted by M/s TPIPL is 13,69,083m^3 out of 15,00,000 m3 which was approved by TANGEDCO vide Lr.No.SE/C/CM/NCTPS-I/F.WA/F.230/20 dt: 13.07.2020

The total wet ash lifted in ash dyke and land areas by all the agencies are 21,79,326m^3.It is expected that a quantity of about 1.6 lakhs m^3 will be lifted by all the agencies from the ash dyke .Further for the year 2021-22, about 6.00 lakhs m3 of wet ash will be lifted from the ash dyke for road works and other filling works.

With the details stated above it is noted that adequate efforts are put forth by NCTPS-I to dispose of Fly ash for the current year and next year. The stock in the Ash dyke has been reduced by around 13 lakhs which is in positive side in disposing the accumulated ash from the ash dyke.

p. The unit shall carry out ground water, surface water monitoring once in six months through any NABL accredited laboratory in the affected areas. Further detailed study may be carried out by Ground water department or any reputed institution on the status of ground water, surface water quality once in year.

Action Plan	Time period of the work		
	Commencement	Completion	
Ground water and surface water analysis conducted by M/s. Chennai Testing Lab, Chennai NABL accredited lab during September-2020. Test Report received.	Work Completed for the year 2020 study report already submitted.	Sep-2021 (Periodical) Under progress	**Not Complied.** The unit is yet to furnish the report for the year 2021.

q. The unit shall adhere to the latest consent order conditions dated 25.06.2014 issued by Tamil Nadu Pollution Control Board.

	Conditions stipulated	Time period of the work			Remarks of the TNPCB
		Commencement	Present Status	Date of Completion	
Under Air Act					
i)	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of coal handling conveyor and junction towers.	**Complied**	-	-	**Complied.** The unit has maintained the coal handling conveyer system and junction towers and ensures that no coal dust is accumulated in the adjacent area of coal handling conveyor and junction towers.
ii)	The unit shall operate and maintain water sprinkling and cyclone separators provided at junction towers	**Complied**	-	-	**Complied.** The unit has operated and maintained water sprinkling and cyclone separators provided at junction towers to control the dust emission at junction towers.

			to control the dust emission.				
		iii)	The unit shall ensure the APC measures provided in the coal crushing area shall be under working condition so as to control the dust emission.	**Complied.**	-	-	**Complied.** The unit has ensured the APC measures provided in the coal crushing area is under working condition so as to control the dust emission.
		iv)	The unit shall install On line Stack monitoring system for SO_2 &NOx and CO and to connect the same to CARE Air Centre, TNPCB, Chennai within three months.	**Complied.**	-	-	**Partially Complied.** The unit has provided Online Continuous Emission Monitoring System (OCEMS) for unit I, II, III of three stacks to monitor the parameters PM, SOx, NOx and the same is connected with CAC, TNPCB, Guindy and CPCB server. The unit shall ensure that the connectivity of OCEMS to TNPCB and CPCB server is at all times and regular calibration to be done in this regard.

		v)	The Unit shall provide continuous ambient air quality monitoring station and the same shall be connected to Care Air Centre TNPCB, Chennai within three months.	**Partially Complied.** CAAQMS 2 Nos provided at NCTPS-ICAAQMS 1 No is in continuous service and partly uploading data due to nil tech. support from supplier. The other CAAQMS station met with fire accident and not in service.(Tech. support not available from the supplier. Tender has been called for rectification and it also lodged after poor response from the supplier.	Under Progress	Feb-2021	**Partially Complied.** The unit has provided Continuous Ambient Air Quality Station (2Nos) for the parameters PM10, PM 2.5, SOx & NOx at the following locations which are connected with the CAC, TNPCB, Guindy and CPCB server. NCTPS – Stage-I Substation which is under operation from 05.03.2018. TNEB Staff Quarters (Vallur Camp) –Not in operation due to fire incident.
		vi)	The unit shall operate the Air Pollution Control measures efficiently and continuously to achieve the National Ambient Air Quality Standards as per MOEF Notification.	**Complied.**	-	-	**Complied.** The unit has provided the air pollution control measures such as Electrostatic Precipitator for Boiler, Dust Extraction and Dust Suppression for coal handling area which are being operated and maintained by the unit regularly so as to achieve the NAAQ standards. The unit has provided sampling port hole for the Boiler stacks to carry out the

						stack monitoring.
	vii	The unit shall conduct AAQ/SM survey through TNPC Board and furnish the survey report to Board within 3 months.	**Complied.**	-	-	**Complied**.
	viii	The unit shall develop green belt in and around the unit premises at the rate of 400 trees / hectare.	**Complied.**	-	-	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.
	Under Water Act					
	i)	The unit shall complete and commission the common sewage treatment plant for Stage-I & Stage-II within a month time.	**Complied.**	-	-	**Complied.** STP provided at Stage-I is under operation.
	ii)	The unit shall ensure that no water shall be discharged from the Ash pond or through the canal linking the pump house and ash pond to Ennore creek either directly or indirectly under any	Details already furnished in Point No: 11.	-	-	**Partially Complied.** Ash pond recovery water is being utilized for bottom ash slurry preparation. The unit has to improve the bottom ash slurry collection, recovery and disposal of recovery water including ash ponds as recommended by the Joint Committee constituted by the NGT.

			circumstances.				
		iii)	The unit shall reconstruct/revamp the existing spillway structure to ensure uniform distribution of water from the cooling water canal in to Ennore creek to preserve the marine eco system within 6 months time.	**Partially Complied.** The following works are being carried out to maintain the cooling water effluent temperature. The work for widening of the cooling water channel for an amount of Rs.9,20,46,378/-has been awarded vide Lr.no.CE /P/SE/C /TP/E2/A2/F. widening/WC .No.2/D.495/ 14,dt.26.04.2014,and the work .About 95% has been completed. The temperature at the outfall is maintained within the standards prescribed less than 5^{o} Degree. A study has been conducted at the marine outfall by engaging IIT Chennai, and the design for construction of the spillway with	Jan-2020 Oct-2020	Nov-2020 April - 2022	**Not Complied.** Tender has been awarded by Stage II for widening of Hot water channel. Proposal to reconstruct the existing spillway structure to ensure uniform distribution of water has been evolved by stage II which is under progress.

				energy dissipation including compound wall has been finalized and reported. **Tender for Rs.14 Crores,** for construction of new spillway and compound wall, as recommended by IIT Chennai has been floated and the work has been awarded. The construction of new spill way would enable in wide and equal distribution of water with reduced temperature at the discharge point (Marine outfall).			
			Work completion			**April - 2022**	
		iv)	The unit shall reconstruct/revamp the pipe line carrying the ash slurry to the ash pond and to ensure that no ash slurry shall be discharged in to creek area under any	➢ Details already furnished in Point No: 5.	-	-	**Partially Complied.** i) The pipelines of Stage-1 were commissioned during 1994-95 and hence more than 25 years old. They have become rustic, corroded and brittle with numerous cracks. There are total 8

			circumstance.				Nos. of series of pipelines of which 5 Nos. carry ash slurry and 3 Nos. being used for recycling the filtered water. ii) Out of the above 5 Nos. of pipelines, Line 1 & 5 were replaced and got completed during August 2020. These pipes are old used pipelines brought from Ennore Thermal Power Station (ETPS). They are Cast Basalt-lined having an outer diameter of 406 mm and Inner diameter of 356mm. Replacement of Line 2 & 3 is in progress with new Cast Basalt pipes, but for Line 4,the unit is yet to procure new pipes. The TANGEDCO has committed a timeline for replacement of all the 5 Nos. of pipelines by December 2021. Though the unit has replaced pipeline no.1 & 5 with old pipes retrieved from ETPs, leakage may happen within short period of time. Hence, the unit shall replace all the pipelines (1 to 5) with new cast basalt pipes to arrest complete leakage of ash into B canal & back waters of Kosasthalaiyar River.	
		v)	The unit shall take immediate action for the removal of fly ash accumulated over the roads	Details already furnished in Point No: 1.	-	-	**Not Complied.** The unit has to remove the fly ash accumulated as per the Joint Committee findings.	

			and around the ash dyke area.				
		vi)	The unit shall conduct Marine Impact Study at where the cooling water is being discharged in to creek/sea and furnish the report within three months.	Tendering for the study is under progress.	Jan-2021	Aug-2021	**Not Complied.** Marine Impact Study not yet conducted.
		vii	The unit shall maintain the coal handling conveyer system and junction towers and ensure that no coal dust shall be accumulated in the adjacent area of coal handling conveyor and junction towers.	**Complied.**	-	-	**Complied.** The coal accumulation in the adjacent areas of coal handling conveyor and junction towers of ICHS are being cleared then and there on regular basis.
		viii	The unit shall obtain renewal of authorization under the Hazardous Waste (MH&T) Rules 2008.	Authorization applied to TNPCB for renewal and got returned due to pending CTO.	-	-	**Not Complied.** Authorization for Hazardous waste obtained is valid up to April'2020, renewal application is yet to file.
		ix)	The unit shall remit the balance Water cess immediately.	As per MOEFCC notification dated 28.10.2020 Lr no. 6604/A1/2020-1 remitting of Water cess balance dropped.	-	-	The unit has not remitted the balance water cess.

	x)	The unit shall develop green belt in and around the unit premises at the rate of 400 trees/hectare.	**Complied.**	-	-	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.
	2.	The unit shall install Flue Gas Desulphurisation (FGD) System based on Lime/Ammonia dosing to capture Sulphur in the flue gases to meet the SO2 emissions standard of 600mg/Nm^3 (Power Plants smaller than 500MW installed before 31st December 2003) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015.	Regarding installation of flue gas desulphurisation, it is submitted that, Administrative approval was accorded vide Per(CMD) TANGEDCO Proceeding No:92 dt: 05.03.2019 to engage a technical consultant for feasibility study. After getting feasibility report and clarifications from Consultant, Detailed project report was requested from consultant and received the same on 30.03.2020. Administrative approval was accorded for installing semi dry flue gas desulphurisation system. After receiving Tender specification on 31.01.2021, received from consultant, Tender was floated and published on 23.02.2021.The pre bid meeting was conducted and the due date of tender has been fixed as 12.08.2021.		**Not Complied.** The unit committed to comply by December 2022 as the timeline (31.12.2022) was given by the MoEF&CC for completion of FGD for these type of power plants.
	3.	The unit shall install Selective Catalytic Reduction (SCR) system or the Selective Non-Catalytic Reduction (SNCR) system or Low NOx Burners with Over Fire Air (OFA) system to achieve NOx emission	As NOx emission level in Unit I, II and Unit III of NCTPS I are well within the norms of 600 mg/Nm3 all the time and not exceeded even a single instant as per MoEF & CC's Notification S.O.3305(E) dated 07.12.2015, Combustion Modification/measures for control			**Not Complied.** The unit committed to comply by December 2022 as the timeline (31.12.2022) was given by the MoEF&CC for completion of Low

	standard of 600 mg/Nm^3 (Power Plants smaller than 500MW installed before 31st December 2003) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015.	of NOx have not been proposed . A letter was sent to CPCB on 02.01.2020 in this regard.	NOx Burners for these type of power plants.
	4. The unit shall ensure that the Particulate Matter (PM) emission in each 3 boiler stacks is within the standard of 100mg/ Nm^3 at all times (Power Plants smaller than 500MW installed before 31st December 2002) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015.	All necessary steps are being taken at NCTPS-I Meticulously such as Overhauling of ESP and rectification works if any needed then and there to maintain Emission level within norms. It has also been proposed for refurbishment of ESP.	**Partially Complied.** The unit has to improve the operation & maintenance of ESPs to achieve the PM Emission in each boiler stacks consistently.
	5. The unit shall ensure that the OCEMS for the emission parameters SPM, SO2 & NOx are provided to each three Boiler stacks which are calibrated regularly and operated at all times and ensure that the output of the sensors are connected to CAC, TNPCB & CPCB server at all times.	Online Continuous Emission Monitoring system for Emission parameters of SPM, SOx and NOx have been provided in all the three Boiler stacks. It is also submitted that SOx & NOx analysers are being calibrated periodically using sample cylinders. SPM analysers are being calibrated using NABL accredited external Lab facility. The stack emission data have been connected to TNPCB server.	**Complied.** The unit has to calibrate the sensors periodically so as to ensure the continuous transmission of data to TNPCB & CPCB servers.
	6. The unit shall ensure that the sensors for the parameters PM10, PM2.5, SO2 & NO2 installed in 2 Continuous Ambient Air Quality Monitoring Station (CAAQMS) are calibrated regularly and operated effectively and ensure that the output of the sensors are	2 Nos. CAAQMS have been commissioned at NCTPS-I during the year 2018. Fire accident occurred on 11.07.2018 in one no. CAAQMS installed at Vallur camp site and the other one no.CAAQMS installed at 33/11 KV SS NCTPS-I location have got some repairs and need rectification works. The indent was raised for required spares for rectification of CAAQMS and the	**Partially Complied.** The unit has provided Continuous Ambient Air Quality Station (2Nos) for the parameters PM10, PM 2.5, SOx & NOx at the following locations which are connected with the CAC, TNPCB, Guindy and CPCB

	connected to CAC,TNPCB at all times.	enquiry was sent to the OEM M/s.Environment SA India Pvt.Ltd.,Mumbai- 400705 but the OEM has not responded our requests. Hence the tender was lodged and further process is this matter is underway. In this regard, it was also intimated the non response of the OEM to JCEE, Chennai – 106. Mean while, Arrangements have been made for testing Ambient Air quality in various locations in and around NCTPS-I premises by enagaging a NABL accredited external agency.	server. NCTPS – Stage-I Substation which is under operation from 05.03.2018. TNEB Staff Quarters (Vallur Camp) –Not in operation due to fire incident.
	7. The unit shall continue to develop green belt either within or outside the premises to attain an area of 33% of the total area with indigenous native tree species and the green belt shall inter – alia cover an entire periphery of the unit.	2540 Nos. of saplings have been planted so far.	**Not Complied.** The total area of the unit is 549.10 Acres and it was reported that the unit has planted tree sapling to an extent of 130 Acres. The green belt to be developed by the unit is 181 Acres (33% of the total area), hence, the unit shall further develop green belt of remaining 51 Acres.

5.	**<u>M/s. NTPC Tamilnadu Energy Company Ltd, Vellivoil village, Ponneri Taluk, Tiruvallur District</u>** a) The unit shall install Flue Gas Desulphurisation (FGD) System based on Lime/Ammonia dosing to capture Sulphur in the flue gases to meet the SO2 emissions standard of 200mg/Nm^3	The FGD contract is already awarded to M/s TATA Projects Ltd and the construction works are in progress at NTECL. As per our earlier commitment the FGD for all the three units will be installed by Nov 2022.	**Partially Complied.** The unit has reported that the work order for the installation of Flue Gas Desulphurisation (FGD) System has been awarded, works are in progress and the same will be completed in all three units before November 2022.

		(500MW and above power plants installed after 1st January 2003 up to 31st December 2016) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015 as reported. (Before November 2022).		
	b)	The unit shall install Selective Catalytic Reduction (SCR) system or the Selective Non-Catalytic Reduction (SNCR) system or Low NOx Burners with Over Fire Air (OFA) system to achieve NOx emission standard of 300 mg/Nm^3 (500MW and above power plants installed after 1st January 2003 up to 31st December 2016) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015 as reported. (Before November 2022).	The Low NO Burner with Over Fire Damper is being installed Through M/S GE Power India Ltd. Installation was completed in Unit 1 in Dec 2020 and NOx levels of Unit 1 are within limit. Installation in Unit2 and Unit3 will be completed before Nov'22. (As per MoEF&CC's Notification S.O. 3305 (E) dated 07.12.2015 the limit for NO is 450mg/Nm3 which is applicable to to NTECL Vallur)	**Partially Complied.** The unit has reported that the installation of Low NOx Burner with Over Fire Damper has been installed in unit-1 and for the remaining units (2&3), same will be completed before November 2022.
	c)	The unit shall ensure that the Particulate Matter (PM) emission in each 3 boiler stacks is within the standard of 50mg/ Nm^3 at all times (Power Plants installed after 1st January 2003 up to 31st December 2016) as per MoEF&CC's Notification S.O. 3305(E) dated: 07.12.2015.	**Complied.** The emission level in all three units of NTECL are maintained within the applicable limit value of 50mg/Nm3	**Complied.** The unit is generally complying the PM emission level in each 3 boiler stacks.
	d)	The unit shall ensure that the online continuous effluent monitoring sensors (OCEMS) provided for	**Complied.** The OCEMS is already operational and parameters pH, TSS, BOD, COD, Conductivity,	**Complied.** The OCEMS installed for the parameters pH, TSS,

	the parameters pH, TSS, BOD, COD, Conductivity, Turbidity & Temperature at the outlet of Central Monitoring Basin are connected to WQW, TNPCB Chennai & CPCB server at all times and calibrated regularly and also ensure the continuous online data transfer.	Turbidity & Temperature at the outlet of Central Monitoring Basin are connected to WQW, TNPCB Chennai & CPCB server at all times continuously.	BOD, COD, Conductivity, Turbidity & Temperature at the outlet of Central Monitoring Basin are calibrated regularly and connected to WQW, TNPCB Chennai & CPCB server and ensuring continuous data transfer.
	e) The unit shall ensure that the OCEMS for the emission parameters SPM, SO2 & NOx provided to each three Boiler stacks are calibrated regularly and operated at all times and ensure that the output of the sensors are connected to CAC, TNPCB & CPCB server at all times.	**Complied.** The OCEMS for the emission parameters SPM, SO2 & NO„ provided at all the three Boiler stacks and values are connected to CAC, TNPCB & CPCB server.	**Complied.** The OCEMS for the emission parameters SPM, SO2 & NOx provided at all the three Boiler stacks are calibrated regularly and connected to CAC, TNPCB & CPCB server and ensuring continuous data transfer.
	f) The unit shall ensure that the EMFMs are provided at the inlet & outlet of the Sewage Treatment Plant I & II and at the outlet of Central Monitoring Basin and connected to WQW, TNPCB, Chennai for continuous monitoring.	The flow meter readings of Continuous Monitoring Basin are already connected to WQW TNPCB. STP flow meters will be installed and the reading will be connected with in the stipulated period of six months.	**Partially Complied.** The unit is yet to provide EMFMs at the inlet and outlet of STPs and it was reported that the same will be installed and commissioned within six months. The EMFMs installed at the outlet of Central Monitoring Basin is connected to WQW, TNPCB, Chennai for continuous monitoring.
	g) The unit shall ensure that the sensors for the parameters PM10, PM2.5, SO2 & NO2 installed in 4	**Complied.** Instruments are installed at installed in 4 Continuous Ambient Air Quality Monitoring	**Complied.** The sensors for the parameters PM10, PM2.5, SO2 & NO2

		Continuous Ambient Air Quality Monitoring Station (CAAQMS) are calibrated regularly and operated effectively and ensure that the output of the sensors are connected to CAC,TNPCB at all times.	Station (CAAQMS) for parameters PM10, PNA2.5, SO2 & NO2 and the output of sensors are connected to CAC, TNPCB at all times.	installed in 4 Continuous Ambient Air Quality Monitoring Station (CAAQMS) are calibrated regularly and connected to CAC,TNPCB for continuous data transfer.
	h)	The unit shall ensure that the sewage including canteen waste water arising from the unit and colony is completely collected and treated through the STP I&II and it shall operate and maintain the Sewage Treatment Plant I&II components efficiently and continuously so as to achieve the treated sewage standards prescribed by the Board consistently and ensure that the treated sewage is completely utilized for gardening / tree plantation within the unit/colony premises without any stagnation.	The STP I & II are operated efficiently and the treated water values are maintained within the TNPCB prescribed limits. The output water is being used for horticulture purpose within the unit / colony	**Complied.** The unit is operating the maintaining the STP I&II to satisfy the treated sewage standards prescribed by the Board.
	i)	The unit shall ensure that the trade effluent discharged from the Central Monitoring Basin is meeting the marine disposal standards prescribed by the Board at all times.	**Complied.** The effluent parameters of trade effluent discharged from the Central Monitoring Basin are maintained well within the standards prescribed by the Board. The values are continuously transmitted to TNPCB online.	**Complied.** The effluent parameters of trade effluent discharged from the Central Monitoring Basin are maintained well within the standards prescribed by the Board.
	j)	The unit shall ensure that no water is discharged from the ash	**Complied.**	**Complied.** The unit is ensuring that no water is

	pond to creek nearby either directly and indirectly under any circumstances.		discharged from the ash pond to creek nearby either directly and indirectly under any circumstances.
	k) The unit shall handle the ash from ash dyke with utmost care and ensure that there shall not be any spillages of ash around the ash dyke area.	**Complied.**	**Complied.** The unit is taking utmost care and ensure that there is no spillages of ash around the ash dyke area.
	l) The unit shall ensure that the fly ash is completely collected in dry form and disposed 100% for beneficial use in cement industries and hollow block brick manufacturing industries, without any accumulation within the unit premises.	NTECL has 3 ash silos where fly ash is collected in dry form and given to cement, bricks and tiles industries. Ash utilization of NTECL for the year 2020 - 21 is 122.80 %.	**Complied.** The unit has 3 ash silos where fly ash is collected in dry form and disposed to cement, bricks and tiles industries.
	m) The unit shall continue to develop green belt either within or outside the premises to attain an area of 33% of the total area with indigenous native tree species and the green belt shall inter –alia cover an entire periphery of the unit.	NTECL has planted a total of 16,260 trees inside and 23,500 trees outside NTECL area till now through Tamilnadu Forest Department. Mangrove plantation in 14 hectares of land is done through M/s M.S.Swaminthan Research Foundation, Chennai (M/s. MSSRF). NTECL shall continue to develop green belt including along the periphery of the Unit.	**Complied.** The unit has planted a total of 16,260 trees inside and 23,500 trees outside area till now through Tamilnadu Forest Department. Mangrove plantation in 14 hectares of land has been done through M/s M.S.Swaminthan Research Foundation, Chennai (M/S MSSRF). The unit has further instructed to continue to develop green belt both within and outside the unit premises.

6.	**<u>M/s. Madras Fertilizers Limited, Manali.</u>** a) The unit shall provide Flow meter at the inlet and outlet of STP. Provide Flow meter at the inlet and outlet of NPK plant- ETP connect the readings of flow meters at the inlet and outlet of NPK plant-ETP to the WQW centre of TNPCB.	Job initiated. There are 12 points where the new EMFMs are going to be installed – (i) CWBD plant I/L and O/L (2 No.s), (ii) RO Main I/L, Permeate O/L and Reject O/L (3 No.s), (iii) ETP I/L and O/L (2 No.s) (iv) CETP I/L and O/L (2 No.s), (v) TTP I/L and O/L (2 No.s) and (vi) TTRO supply (1 No.) **Details:** Tender floated for supply & installation on 21.12.2020. Due to the non-fulfilment of pre-bid criteria by all the vendors, the tender had to be cancelled and subsequently tender was re-floated on 09.04.2021. Technical evaluation is completed. Price bid will be opened and AOW given to the selected vendor. Due to Covid-19, procurement process is getting delayed. Expected to be completed by Dec 2021.	**Not Complied.** The unit committed to comply by December 2021.
	b) The unit shall provide flow metres, energy meters and monitoring sensors for the parameters DO, TDS pH, pressure and levels to the RO plants as per CPCB guidelines and connect the readings to the WQW centre of TNPCB.	**Job completed.** **Details:** One of the existing RO stream dedicated to treat CWBD. **New Plant:** Proposed RO plant for Cooling water Blow Down Treatment plant equipment erection job is in progress in which instruments like Flow meter, monitoring sensors for TDS and pH are part of the project. **Expected completion: Dec 31, 2021.**	**Not Complied.** Installation of RO plant is under progress. The unit is having three RO system for treatment of secondary treated sewage procured from Kodungaiyur STP. At present, the unit is partially procuring Tertiary Treated RO permeate (TTRO water) from Kodungaiyur STP, so one RO system (line A) is in standby, this line A is presently used to treat the above said wastewater generated from the unit until commencement of new dedicated RO

			plant. **The unit committed to comply by December 2021**.
	c) The unit shall complete the conversion of fuel from Furnace oil to LNG in the 55 TPH boilers (2 Nos.).	**Job initiated.** **Details:** Tender floated in Feb 2021 and Bid submission time was extended based on Bidder's request. Bids opened on 30.03.2021. AOW issued on June 16, 2021 to M/s Thermax, Pune. Material supply and Installation period is 8 months. Hence, the entire process will be completed by Feb 2022.	**Not Complied.** The unit committed to comply by February 2022.
	d) The unit shall install, commission and connect the Analyser for PM, SOx & NOx for the common stack attached with Boilers 1 & 2 (55T/hr each) early.	**Job completed for** Process Condensate and 110 ATA boilers stack PM data connected to care air centre and CPCB. For boiler 1 & 2 CEMS analyser, Installation was under progress. The erection Engineer got affected with Covid-19 and work got suspended. Now with the Covid-19 situation being at ease, installation has been resumed and in progress. Expected to be completed by August 2021.	**Partially Complied.** The unit has installed PM analyser (CEMS) for the common stack attached with process condensate boiler 70T/hr & 110T/hr boiler and connected to CAC, TNPCB & CPCB servers. CEMS for the parameters PM, SOx & NOx analyser for the common stack attached with boiler 1 & 2 (55T/ hr each) installed and connectivity to CAC, TNPCB & CPCB server is yet to be established and committed to comply before November 2021.
	e) The unit shall restore the remaining 4 CAAQMS stations and connect to CAC before June 2021, as committed.	ETP station (Southwest) made ready with all the 6 parameters ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO and O_3) working. Meteorology parameters are also included in this station.	**Complied.** One CAAQM station near North gate with the sensors for parameters such as PM10, PM2.5, SOx, NOx, CO & O3 is in

		Details: Regarding the installation of remaining three new stations at i) Near workshop (North East) ii) South Gate (South East) and iii) Ammonia watch Tower (South West), Installation of all the analysers ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO , O_3 and NH_3) including Ammonia completed and calibration is in progress by the vendor M/s Environment SA. Communication to TNPCB / CPCB to be established. Expected to be completed by August 2021.	operation and connected to CAC, Chennai. Another CAAQM station near ETP in Southwest direction is made ready with all the 6 parameters ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO and O_3) and is working now. Meteorology parameters are also included in this station. Regarding the installation of remaining three new CAAQM stations at i) Near workshop (North East) ii) South Gate (South East) and iii) Ammonia watch Tower (South West), Installation of all the analysers ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO , O_3 and NH_3) have been completed, commissioned and connected to TNPCB & CPCB server.
	f) The unit shall plant green belt by planting native & local specific species in the old SEPs (lagoons) area.	Lagoon is being filled up with available debris inside our company premises and also action is being initiated to fill the entire lagoon area with sand. **Expected completion: Dec 2021.**	**Not Complied.** The unit committed to comply before December 2021.
	g) The unit shall dispose the accumulated hazardous wastes to the authorized facilities immediately as per the conditions stipulated in the authorization order issued under the Hazardous Waste	As suggested by TNPCB, HW disposal agreements made with SPCB authorized recyclers and resubmitted the application on 08.03.2021. Application was returned back on 29.03.2021 and asked MFL to contact TNPCB office**.** MFL contacted TNPCB officials for necessary	**Complied.** The unit has applied for authorization and processing of application is in progress. However, the unit is disposing the hazardous waste to

	(Management, Handling & Transboundary Movement) Rules 2008 and comply with the provisions of Hazardous & Other Wastes (Management, & Transboundary Movement) Rules, 2016.	clarification.	the authorized recyclers.
	h) The unit shall ensure that the OCEMS installed for the parameters NH_3 in Urea Prill Tower, HF & PM in NPK train C, PM analyser installed for the common stack attached with process condensate boiler 70T/hr & 110T/hr Boiler, 11 Ammonia sensors within the premises and the continuous ambient air quality monitoring (CAAQM) sensors are calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** All the data are uploaded continuously to both TNPCB and CPCB servers. All the analyzers are under AMC with the OEMs to avoid any disruption the data uploading.	**Complied.** The unit has provided OCEMS for the emission parameters NH3 in Urea prill tower and HF & PM in NPK train and maintaining regularly & calibrated periodically to ensure that the output of the sensors are connected to TNPCB & CPCB server at all times. One CAAQM station near North gate with the sensors parameters such as PM10, PM2.5, SOx, NOx, CO & O3 is in operation and connected to CAC, Chennai. Another CAAQM station near ETP in Southwest direction is made ready with all the 6 parameters ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO and O_3) and is working now. Meteorology parameters are also included in this station. Regarding the installation of remaining three new

			CAAQM stations at i) Near workshop (North East) ii) South Gate (South East) and iii) Ammonia watch Tower (South West), Installation of all the analysers ($PM_{10,}$ $PM_{2.5}$, SO_2, NOx, CO , O_3 and NH_3) have been completed, commissioned and connected to TNPCB & CPCB server. Also, the unit has installed 11 ammonia sensors to monitor the ammonia level in the ambient air.
	i) The unit shall ensure that the OCEMS installed for the EMFM in the HSP Plant is calibrated regularly, operated continuously and connected to the CAC of the Board and CPCB servers.	**Complied.** The EMFM is in line continuously and data are streamed online in TNPCB and CPCB servers by TNPCB authorised vendor M/s TransTech solutions.	**Complied.**
	j) The unit shall ensure for the continuous data transmission from the OCEMS and CAAQM sensors to the CAC and WQW of the Board and CPCB servers.	**Complied.** MFL will ensure the data transmission to TNPCB and CPCB servers without any interruption.	**Being Complied.**

7.	**<u>M/s. Taminadu Petroproducts Ltd-ECH Plant, Manali.</u>** a) The unit shall ensure that the online continuous effluent monitoring sensors(OCEMS)	Online Continuous Effluent Monitoring Sensors (OCEMS) were installed at the ETP Outlet for the parameters pH, TSS, COD, & BOD and monitoring data connected to WQW, TNPCB Chennai & CPCB server. Sensors are calibrated as per the	**Complied.** The Online Continuous Effluent Monitoring Sensors (OCEMS) provided for the parameters pH, TSS, COD & BOD at the outlet ETP are

	provided for the parameters pH, TSS, COD & BOD at the outlet ETP are connected to WQW, TNPCB Chennai & CPCB server and calibrated regularly and also ensure the continuous online data transfer.	schedule and being ensured for continuous online data transfer.	connected to WQW, TNPCB Chennai & CPCB server and calibrated regularly and also ensuring the continuous online data transfer.
	b) The unit shall ensure that the online continuous emission monitoring sensors (OCEMS) for the parameters PM, Sox, NOx & CO provided with a Boiler stack and Chlorine provided with a stack attached to scrubber in chlorine handling area are calibrated regularly and operated and also to ensure that the output of the sensors are connected to CAC of TNPCB/CPCB server at all times.	Online Continuous Emission Monitoring Sensors (OCEMS) were provided in the stacks attached with Boiler for the parameters PM, SOx, NOx, & CO and scrubber in chlorine handling area for the parameter Chlorine are calibrated regularly and operated at all times and being ensured. The output of the sensors is connected to CAC of TNPCB / CPCB server at all times.	**Complied.** The Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters PM, SOx, NOx & CO provided with a Boiler stack and for the parameter Chlorine provided with a stack attached to scrubber in chlorine handling area are calibrated regularly and operated and also ensuring that the output of the sensors are connected to CAC of TNPCB/CPCB server at all times.
	c) The EMFMs installed at the inlet to the ETP & RO reject from LAB Plant along with the HCD Plant treated effluent reuse to ECH Plant process shall be connected to WQW of TNPCB/CPCB web portal.	Electro Magnetic Flow Meters (EMFM) were installed at the following locations • Inlet to ETP from WTP • Inlet to ETP from Process • RO Reject from LAB Plant along with the HCD Plant treated effluent reuse to ECH plant process The above installed EMFMs will be connected to WQW of TNPCB / CPCB wed portal by September 2021.	**Complied.**

	d) The unit shall ensure that the EMFMs are provided at the inlet & outlet of the Common Sewage Treatment Plant, inlet to STP from ECH Plant, inlet to STP from HCD Plant and inlet to STP from LAB Plant and connected to WQW, TNPCB, Chennai for continuous monitoring.	Electro Magnetic Flow Meter (EMFM) is provided at the following locations • Inlet to STP from HCD Plant • Inlet to STP from LAB Plant • Outlet of the Common Sewage Treatment Plant. EMFM will be provided at the Inlet to STP from ECH Plant and all the flow meters will be connected to WQW, TNPCB by September 2021.	**Complied.**
	e) The unit shall ensure that the sensors for the parameters PM2.5, PM10, Chlorine and VOC installed in 1 Continuous Ambient Air Quality Monitoring Station (CAAQMS) are calibrated regularly and operated effectively and ensure that the output of the sensors are connected to CAC,TNPCB at all times.	The sensors installed in 1 Continuous Ambient Air Quality Monitoring station (CAAQMS) for the parameters PM2.5, PM10Chlorine and VOC are calibrated regularly and operated effectively and the output of the sensors are connected to CAC, TNPCB at all times and being ensured.	**Complied.** The sensors installed in 1 Continuous Ambient Air Quality Monitoring station (CAAQMS) for the parameters PM2.5, PM10, Chlorine and VOC are calibrated regularly and operated continuously and the output of the sensors are connected to CAC, TNPCB at all times and being ensured.
	f) The unit shall ensure that the temporary lime storage yard and its leachate collection arrangements provided are properly maintained so as to curtail ground water pollution. The unit shall collect and dispose the lime sludge generated then and there to brick kilns for further beneficial.	Temporary lime storage yard with the leachate collection arrangements was provided to store lime sludge and is being properly maintained to curtail ground water pollution. The lime sludge generated is being disposed then and there to brick manufacturer for further beneficial.	**Complied.** The unit is properly maintaining the temporary lime storage yard with the leachate collection arrangements to store lime sludge to curtail ground water pollution. The lime sludge generated is being disposed then and there to brick manufacturers for further beneficial use.
	g) The unit shall continue to develop green belt	Green Belt is being developed in the available area within the	**Partially Complied.**

	outside the premises by approaching Zonal Officer (Zone-II), Greater Chennai Corporation/Highways Department to attain an area of 40% of the total area with indigenous native tree species and the green belt shall inter-alia cover an entire periphery of the unit.	premises. Further to the above, Green Belt is being developed in the land available in the adjacent plant M/s. TPL – Polymer plant. Total Plant Area – 38.72 Acres. Inside the plant – 12 Acres. Proposed GB Area – 5 Acres Total area - 17 Acres. Additionally, we will approach Zonal Officer (Zone II) Greater Chennai Corporation / Highways Department to allocate area outside the premises to develop green belt.	The unit is yet to develop green belt outside the premises by approaching Zonal Officer (Zone-II), Greater Chennai Corporation/ Highways Department to attain an area of 40% of the total area.

8.	**M/s. Taminadu Petroproducts Ltd -LAB Plant, Manali.** a) The unit shall ensure that the online continuous effluent monitoring sensors (OCEMS) provided for the parameters pH, TSS, COD & BOD at the outlet of ETP are connected to WQW, TNPCB Chennai & CPCB server at all times and calibrated regularly and also ensure the continuous online data transfer.	Online Continuous Effluent Monitoring Sensors (OCEMS) were installed at the ETP Outlet for the parameters pH, TSS, COD, & BOD and monitoring data connected to WQW, TNPCB Chennai & CPCB server. Sensors are calibrated as per the schedule and being ensured for continuous online data transfer.	**Complied.** The Online Continuous Effluent Monitoring Sensors (OCEMS) provided for the parameters pH, TSS, COD & BOD at the outlet ETP are connected to WQW, TNPCB Chennai & CPCB server and calibrated regularly and also ensuring the continuous online data transfer.
	b) The unit shall ensure that the online continuous emission monitoring sensors (OCEMS) provided for the parameters PM, Sox, NOx & CO for stack attached with Hot	Online Continuous Emission Monitoring Sensors (OCEMS) were provided in the stacks attached with Hot oil heater, PACOl heater, Hydrotreater, DG sets and Boiler for the parameters PM, SOx, NOx, & CO are calibrated regularly and	**Complied.** The Online Continuous Emission Monitoring Sensors (OCEMS) for the parameters PM, Sox, NOx & CO provided with Hot Oil Heater,

	Oil Heater, PACOL Heater, Hydro Treater, DG sets and Boilers are calibrated regularly and operated at all times and also to ensure that the output of the sensors are connected to CAC of TNPCB/CPCB server at all times.	operated at all times and being ensured. The output of the sensors is connected to CAC of TNPCB / CPCB server at all times.	PACOL Heater, Hydro Treater, DG sets and Boilers are calibrated regularly and operated and also ensuring that the output of the sensors are connected to CAC of TNPCB/CPCB server at all times.
	c) The EMFMs installed at the RO-I feed, RO-I permeate, RO-II permeate, RO-II reject and RO-II reject & HCD Plant treated effluent reuse to ECH Plant process shall be connected to the WQW of TNPCB/CPCB web portal immediately.	Electro Magnetic Flow Meters (EMFM) were installed at the following locations • RO – 1 feed, • RO – Permeate (I & II). • RO – II Reject, • RO II Reject & HCD plant treated effluent reuse to ECH - PO plant process. The above installed EMFMs will be connected to WQW of TNPCB / CPCB portal by September 2021.	**Complied.**
	d) The unit shall ensure that the EMFMs are provided at the inlet & outlet of the Common Sewage Treatment Plant, inlet to STP from ECH Plant, inlet to STP from HCD Plant and inlet to STP from LAB Plant and connected to WQW, TNPCB, Chennai for continuous monitoring.	Electro Magnetic Flow Meter (EMFM) is provided at the following locations • Inlet to STP from HCD Plant • Inlet to STP from LAB Plant • Outlet of the Common Sewage Treatment Plant. EMFM will be provided at the Inlet to STP from ECH Plant and all the flow meters will be connected to WQW, TNPCB by September 2021.	**Complied.**
	e) The unit shall ensure that the sensors for the parameters PM2.5, PM10, SO2, NOx, CO and Benzene installed in 1 Continuous Ambient Air Quality	The sensors installed in Continuous Ambient Air Quality Monitoring station (CAAQMS) for the parameters PM2.5, PM10, SO2, NOx, CO and Benzene are calibrated regularly and operated effectively and the output of the	**Complied.** The sensors installed in 1 Continuous Ambient Air Quality Monitoring station (CAAQMS) for the

	Monitoring Station (CAAQMS) are calibrated regularly and operated effectively and ensure that the output of the sensors are connected to CAC,TNPCB at all times.	sensors are connected to CAC, TNPCB at all times and being ensured.	parameters PM2.5, PM10, SO2, NOx, CO and Benzene installed are calibrated regularly and operated continuously and the output of the sensors are connected to CAC, TNPCB at all times and being ensured.
	f) The unit shall continue to develop green belt outside the premises by approaching Zonal Officer (Zone-II), Greater Chennai Corporation/Highways Department to attain an area of 40% of the total area with indigenous native tree species and the green belt shall inter-alia cover an entire periphery of the unit.	Green Belt is being developed in the available area within the premises. Further to the above, Green Belt will be developed in the TPL land at the back side of ECH plant. Total Plant Area – 40 Acres. Inside the plant – 3 Acres. Proposed GB Area – 18 Acres. Total green belt area (existing & proposed) – 21 Acres. Additionally, we will approach Zonal Officer (Zone II) Greater Chennai Corporation / Highways Department to allocate area outside the premises to develop green belt.	**Partially Complied.** The unit is yet to develop green belt outside the premises by approaching Zonal Officer (Zone-II), Greater Chennai Corporation/ Highways Department to attain an area of 40% of the total area.

***

By Speed Post

ANNEXURE - II

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-1, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Chennai Petroleum Corporation Limited, Refinery I,II and CPP, Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.3696/AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Chennai Petroleum Corporation Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80.

N = Number of days of violation took place = 334 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

26/8/2021

For Chairman

To:

The Director,
M/s. Chennai Petroleum Corporation Limited,
Manali Village, Thiruvottiyur Taluk
Chennai District, Pin:6000 68

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region
2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.
3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-2, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Chennai Petroleum Corporation Limited Refinery III, Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.3696/AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Chennai Petroleum Corporation Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas, it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80.

N = Number of days of violation took place = 418 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

26/8/2021

For Chairman

To:

The Director,
M/s. Chennai Petroleum Corporation Limited Refinery III,
Manali Village,
Thiruvottiyur Taluk
Chennai District Pin:6000 68

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region
2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.
3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-3, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Chennai Petroleum Corporation Limited (Propylene Plant), Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and its order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.3696/AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Chennai Petroleum Corporation Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Telephone : 22353134 to 141, Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : www.tnpcb.gov.in

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80.

N = Number of days of violation took place = 161 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

g. Jayaram 23/5/24

For Chairman

To:
The Director,
M/s. Chennai Petroleum Corporation Limited (Propylene Plant),
Manali Village, Thiruvottiyur Taluk
Chennai District, Pin:6000 68

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region

2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.

3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-4, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Chennai Petroleum Corporation Limited (DHDS Plant), Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.3696/AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Chennai Petroleum Corporation Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas, it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 121 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

26/12/2020

For Chairman

To:
The Director,
M/s. Chennai Petroleum Corporation Limited (DHDS Plant), Manali
Manali Village,
Thiruvottiyur Taluk
Chennai District Pin: 6000 68

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region
2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.
3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-5, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Chennai Petroleum Corporation Limited (Resid Upgradation Plant), Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.3696/AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Chennai Petroleum Corporation Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Telephone : 22353134 to 141, Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : www.tnpcb.gov.in

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas, it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 352 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

26/8/2021

For Chairman

To:
The Director,
Chennai Petroleum Corporation Limited (Resid Upgradation Plant),
Manali Village,
Thiruvottiyur Taluk
Chennai District Pin:6000 68

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region
2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.
3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T6 /TNPCB/F. 017544/Chennai Zone /Misc/2021-6, dt: 25.08.2021

Sub: TNPCB – Directions under section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of M/s. Tamilnadu Petro products Limited-LAB Plant, S.F.No.267,Manali Village, Thiruvottiyur Taluk and Chennai District – Reg.

Ref:
1. SUO MOTU case filed by Hon'ble NGT in O.A.No.256 of 2020 (SZ) and order dated: 15.12.2020 & 15.04.2021
2. Bd proc. T5/TNPCB/F.200AMB/17category/2021 dated:11.03.2021
3. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
4. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Tamilnadu Petro products Limited-LAB Plant, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases including others as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017:

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 4th cited has assessed the Environmental compensation based on the exceedance of emission parameters as observed during the period 1.04.2019 to 26.12.2020 in the online

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Telephone : 22353134 to 141, Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : www.tnpcb.gov.in

continuous emission monitoring system which is connected to Care Air Centre, TNPCB, Chennai.

Whereas, it is evident that the unit has caused environmental damage by not operating the air pollution control measures properly and emitting air pollutants more than the standard prescribed by the Board. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

Environmental Compensation (EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 228 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

26/8/2021

For Chairman

To

The Director,
M/s. Tamilnadu Petro products Limited-LAB Plant,
Manali Express highway
Manali
Chennai 600068

Copy to

1. The Joint Chief Environmental Engineer (Monitoring),
   Tamil Nadu Pollution Control Board,
   Chennai Region
2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.
3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc. No: T1/TNPCB/F.214/ AMB/RL/17 Category/2021 Dated: 25.08.2021

Sub: TNPCB – Industries – M/s. Madras Fertilizers Limited, S.F. No. R.S. No.212 to 248, Manali Village, Thiruvottiyur Taluk, Chennai District - SUO MOTU case by Hon'ble NGT in O.A.No.256 of 2020 (SZ) – Non-compliance of emission norms- Levy of Environmental compensation under section 5 of the Environment (Protection) Act, 1986 as amended – Show cause notice - Issued - Regarding – Reg

Ref: 1. SUO MOTU case filed by Hon'ble NGT in O.A.No 256 of 2020 (SZ) dated 15.12.2020 & 15.04.2021

2. Bd Proc. No: T1/TNPCB/F.214/ AMB/17 Category/2021 dated: 11.03.2021
3. CPCB Methodology for assessing Environmental Compensation
4. JCEE(M). Lr No. F.214/ JCEE(M)/ TNPCB/ CHN.ZONE/ Misc/ 2021, dt 16.08.2021

Whereas, a SUO MOTU case has been taken up by the Hon'ble NGT in O.A.No.256 of 2020 (SZ) based on the news item in News Desk Magazine Dated 11.11.2020, under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" and also directed to form a Joint committee to inspect the area in question and submit a factual as well as action taken report, if there is any violation found.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries which includes the unit of M/s. Madras Fertilizers Limited, Manali.

Whereas, the Board has issued directions under Section 33A of Water (Prevention and Control of Pollution) Act, 1974 as amendment & under Section 31A of the Air (Prevention and Control of Pollution) Act 1981 as amended to the said unit to comply with certain conditions as stated therein vide reference 2nd cited.

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases as per the NGT(PB) order dated 03.08.2018 in OA No. 593/2017 -

a) Discharges in violation of consent conditions mainly prescribed standards/consent limits.

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Telephone: 22353130 to 141, Fax - 044-22353068
Email - tnpcb-chn@gov.in Web : www.tnpcb.gov.in

CS: 100

b) Not complying with the directions issued such as direction for closure due to non installation of OCEMS, non adherence to the action plans submitted etc.,

c) Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission/Effluent Monitoring systems

d) Accidental discharges lasting for short durations resulting into damage to the environment.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

f) Injection of treated/partially treated/untreated effluents to ground water.

Whereas, Joint Chief Environmental Engineer, Chennai vide reference 3rd cited has assessed the Environmental compensation based on the Online Continuous Emission Monitoring System (OCEMS) data, monitored during April 2019 to December 2020 obtained from the Care Air Centre (CAC), TNPC Board, Chennai for the exceedance of stack emission levels prescribed by the Board. It was found that the PM emission from the stack attached to NPK has exceeded once on 08/11/2019, thereby not complied with the emission norms as prescribed by the Board

Whereas, it is evident that the unit has caused environmental damage by not operating the Air pollution control measures properly and therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows.

As per the CPCB guidelines, the Environmental Compensation shall be calculated based on the following formula.

(EC) = PI x N x R x S x LF

Where,

PI = Pollution index of Industrial sector - 60

N = Number of days of violation took place = 1 (based on the available OCEMS data for the period from 1.4.2019 to 26.12.2020 for the exceedance)

R = A factor in Rupees for EC - 250

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

TAMIL NADU POLLUTION CONTROL BOARD

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

For Chairman

To

The Director Technical,
M/s. Madras Fertilizers Limited,
Manali,
Thiruvottiyur Taluk,
Chennai - 600068

Copy to

1. The Joint Chief Environmental Engineer (M),
   Tamil Naidu Pollution Control Board,
   Chennai Region

2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Ambattur.

3. Technical file.

No. 76, MOUNT SALAI GUINDY, CHENNAI - 600 032.
Telephone : 22353134 to 141, Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : www.tnpcb.gov.in

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T4 /TNPCB/F.0048GMP/RL/2021, dated: 25.08.2021

Sub: TNPCB – Directions under Section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of **M/s. North Chennai Thermal Power Station, Stage-I, (3x210 MW) , SF. No. 44, 45 etc Puzhuthivakam Village, Ponneri Taluk, Tiruvallur District** – Reg.

Ref: 1. Report on POISON IN THE AIR -The Regulatory black hole over Ennore Manali Industries Zone By Chennai Climate Action Group- November 2020.

2. Board's.Proc.No.T2/TNPCB/F.0048GMP/17CATEGORY/2021, dt15.04.2021
3. Hon'ble NGT order in O.A No.256 of 2020 (SZ) dated:15.04.2021 & 05.07.2021
4. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
5. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

****

Whereas Chennai Climate Action Group has published a report in News Desk Magazine "Poison in the Air- The Regulatory Black hole over Ennore Manali Industrial Zone" during November 2020.Based on the above report of Climate Action Group, the Hon'ble NGT SUO MOTU taken up the case vide O.A.No.256 of 2020 (SZ) and formed a Joint Committee to furnish a report on the above.

Whereas, the news paper report published in News Desk Magazine dated, 11.11.2020 under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" is based on the stack emissions data recorded at the CAC, TNPCB for the period from 01.01.2019 to 15.12.2019.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries.

Whereas, based on the JCEE(M), Chennai recommendation, the unit was issued with certain directions under Section 33 A of Water (P&CP) Act1974 as amended in 1988 & Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended vide Board Proc 2nd cited above to comply with.

No. 76, MOUNT SALAI, GUINDY, CHENNAI - 600 032.
Telephone : 22353134 to 141, Fax : 044-22353068
Email : tnpcb-chn@gov.in Web : www.tnpcb.gov.in

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017 :

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.
b) Not complying with the directions issued such as direction for closure due to non installation of OCEMS, non adherence to the action plans submitted etc.,
c) Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission/Effluent Monitoring systems.
d) Accidental discharges lasting for short durations resulting into damage to the environment.
e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.
f) Injection of treated/partially treated/untreated effluents to ground water.

Whereas based on the Hon'ble NGT order in O.A No.256 of 2020 (SZ) reference third cited above, JCEE(M), Chennai vide reference fifth above has furnished a report based on the exceedance of online monitored parameters observed for the period 1.04.2019 to 26.12.2020 from the report of Care Air Centre, TNPCB, Chennai-32, to levy environmental compensation.

From the available OCEMS data for the period 01.04.2019 to 26.12.2020 the exceedance of parameter (particulate matter), it is evident that the unit has caused environmental damage by not operating the Air pollution control measures properly. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

As per the CPCB guidelines, the Environmental Compensation shall be calculated based on the following formula:

$$(EC) = PI \times N \times R \times S \times LF$$

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 273 (based on the **available OCEMS data** for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

TAMIL NADU POLLUTION CONTROL BOARD

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

25/10/13

For Chairman

To

The Chief Engineer,
M/s. North Chennai Thermal Power Station, Stage-I, (3x210 MW)
SF. No. 44, 45 etc
Puzhuthivakam Village,
Ponneri Taluk,
Tiruvallur District

25/10/13 am

Copy to:

1. The Joint Chief Environmental Engineer (M),
   Tamil Nadu Pollution Control Board,
   Chennai Region

2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Gummidipoondi.

3. Technical file.

By Speed Post

TAMIL NADU POLLUTION CONTROL BOARD

Proc No.: T4 /TNPCB/F.0318GMP/RL/2021, dated: 25.08.2021

Sub: TNPCB – Directions under Section 5 of Environment Protection Act, 1986 to show cause as to why Environmental Compensation should not be imposed for the violation caused by the unit of **M/s. NTPC Tamilnadu Energy Company Limited, SF. No. 1556, Vellivoyal Village , Ponneri Taluk, Tiruvallur District** – Reg.

Ref: 1. Report on POISON IN THE AIR -The Regulatory black hole over Ennore Manali Industries Zone By Chennai Climate Action Group- November 2020.
2. Board's.Proc.No.T2/TNPCB/F.0318GMP/RL/2021, dated:15.04.2021
3. Hon'ble NGT order in O.A No.256 of 2020 (SZ) dated:15.04.2021 & 05.07.2021
4. CPCB Methodology for assessing Environmental Compensation and Action Plan to Utilize the fund vide circular dated 24/05/2019
5. JCEE(M) Lr.No.F.214/JCEE(M)/TNPCB/CHN Zone/Misc/ 2020, dt.16.08.2021

****

Whereas Chennai Climate Action Group has published a report in News Desk Magazine "Poison in the Air- The Regulatory Black hole over Ennore Manali Industrial Zone" during November 2020.Based on the above report of Climate Action Group, the Hon'ble NGT SUO MOTU taken up the case vide O.A.No.256 of 2020 (SZ) and formed a Joint Committee to furnish a report on the above.

Whereas, the news paper report published in News Desk Magazine dated, 11.11.2020 under the caption "These Six Industries in North Chennai are polluting the air for more than half the year" is based on the stack emissions data recorded at the CAC, TNPCB for the period from 01.01.2019 to 15.12.2019.

Whereas, it is alleged in the news paper report that air quality in Ennore – Manali region has been seriously affected on account of the emission made by some of the industries.

Whereas, based on the JCEE(M), Chennai recommendation, the unit was issued with certain directions under Section 33 A of Water (P&CP) Act1974 as amended in 1988 & Section 31A of the Air (Prevention and Control of Pollution) Act, 1981 as amended vide Board Proc 2nd cited above to comply with.

Whereas, Central Pollution Control Board has formulated the methodology to assess and recover compensation under "CPCB Methodology for assessing Environmental Compensation and Action Plan to utilize the fund" for the following cases as per the NGT(PB) order dated:03.08.2018 in OA No. 593/2017 :

a) Discharges in violation of consent conditions, mainly prescribed standards/consent limits.

b) Not complying with the directions issued such as direction for closure due to non installation of OCEMS, non adherence to the action plans submitted etc.,

c) Intentional avoidance of data submission or data manipulation by tampering the Online Continuous Emission/Effluent Monitoring systems.

d) Accidental discharges lasting for short durations resulting into damage to the environment.

e) Intentional discharges to the environment – land, water and air resulting into acute injury or damage to the environment.

f) Injection of treated/partially treated/untreated effluents to ground water.

Whereas based on the Hon'ble NGT order in O.A No.256 of 2020 (SZ) reference third cited above, JCEE(M), Chennai vide reference fifth above has furnished a report based on the exceedance of online monitored parameters observed for the period 1.04.2019 to 26.12.2020 from the report of Care Air Centre to levy environmental compensation.

From the available OCEMS data for the period 01.04.2019 to 26.12.2020 the exceedance of parameters (Particulate matter), it is evident that the unit has caused environmental damage by not operating the Air pollution control measures properly. Therefore, coming under the case (a) & (e) as per the CPCB Methodology for assessing Environmental Compensation.

Under these circumstances, as per the CPCB methodology for assessing Environmental Compensation, you are liable to pay the Environmental Compensation computed as follows:

As per the CPCB guidelines, the Environmental Compensation shall be calculated based on the following formula:

(EC) = PI x N x R x S x LF

Where,

PI = Pollution index of industrial sector - 80 .

N = Number of days of violation took place = 124 (based on the **available OCEMS data** for the period from 1.4.2019 to 26.12.2020 for the exceedance.)

R = A factor in Rupees for EC - 250.

S = Factor for scale of operation -1.5

LF = Location factor - 1.5.

TAMIL NADU POLLUTION CONTROL BOARD

Now, therefore, in view of the above facts, you are hereby directed to show cause within 15 days from the date of receipt of this notice as to why Environmental Compensation computed as above should not be imposed against your unit under Section 5 of the Environmental Protection Act, 1986 as per the guidelines issued by the Hon'ble NGT & CPCB for the violations caused by the unit as mentioned above.

It is informed that non receipt of any reply within 15 days from the date of receipt of this notice will be construed that you have no satisfactory explanation to offer for the above said contraventions and action will be initiated on merits in accordance with law.

The receipt of the proceedings shall be acknowledged.

For Chairman

To

The Chief Executive Engineer,
M/s. NTPC Tamilnadu Energy Company Limited ,
SF. No. 1556, Vellivoyal Village ,
Ponneri Taluk, Tiruvallur District

Copy to:

1. The Joint Chief Environmental Engineer (M),
   Tamil Nadu Pollution Control Board,
   Chennai Region

2. The District Environmental Engineer,
   Tamil Nadu Pollution Control Board,
   Gummidipoondi.

3. Technical file.

Annexure-III

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s. NORTH CHENNAI THERMAL POWER STATION - 1

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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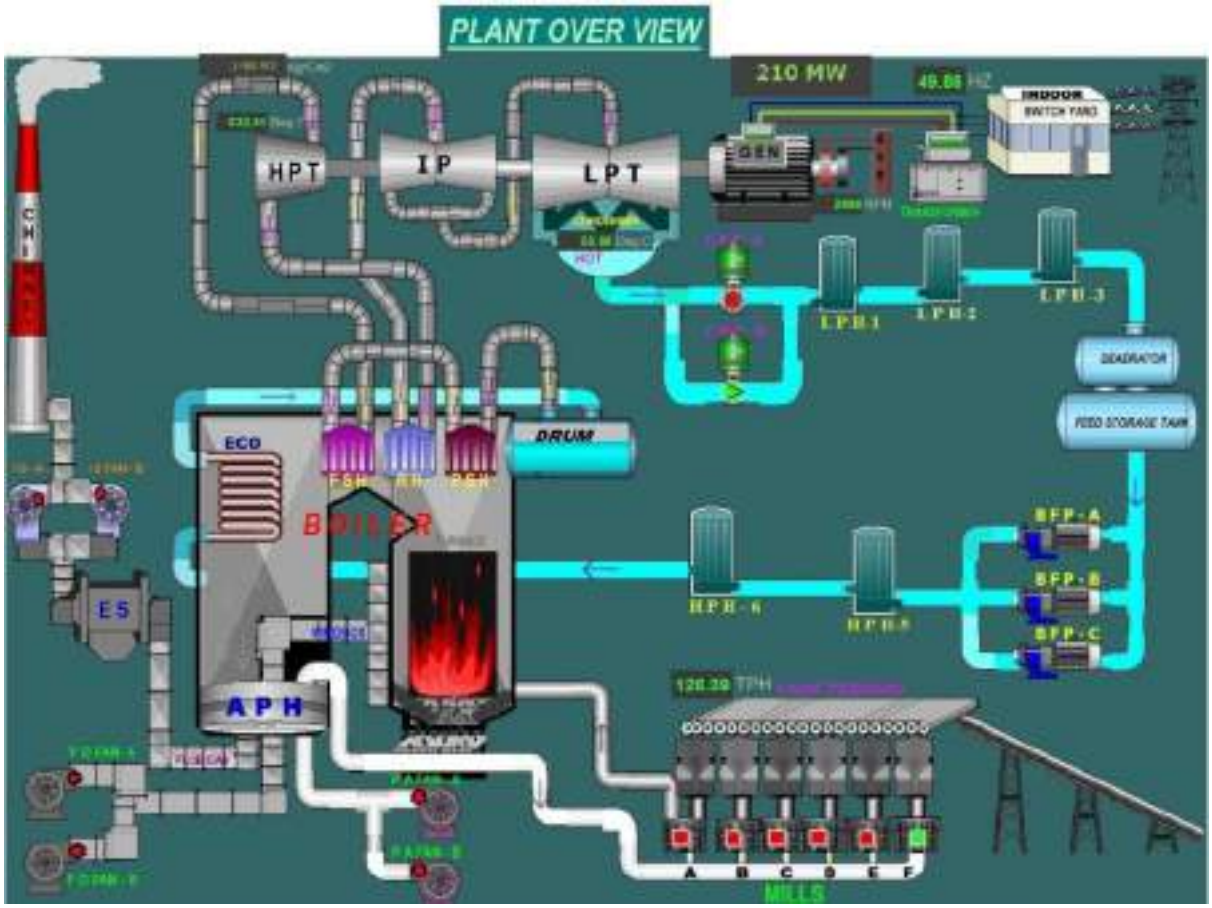
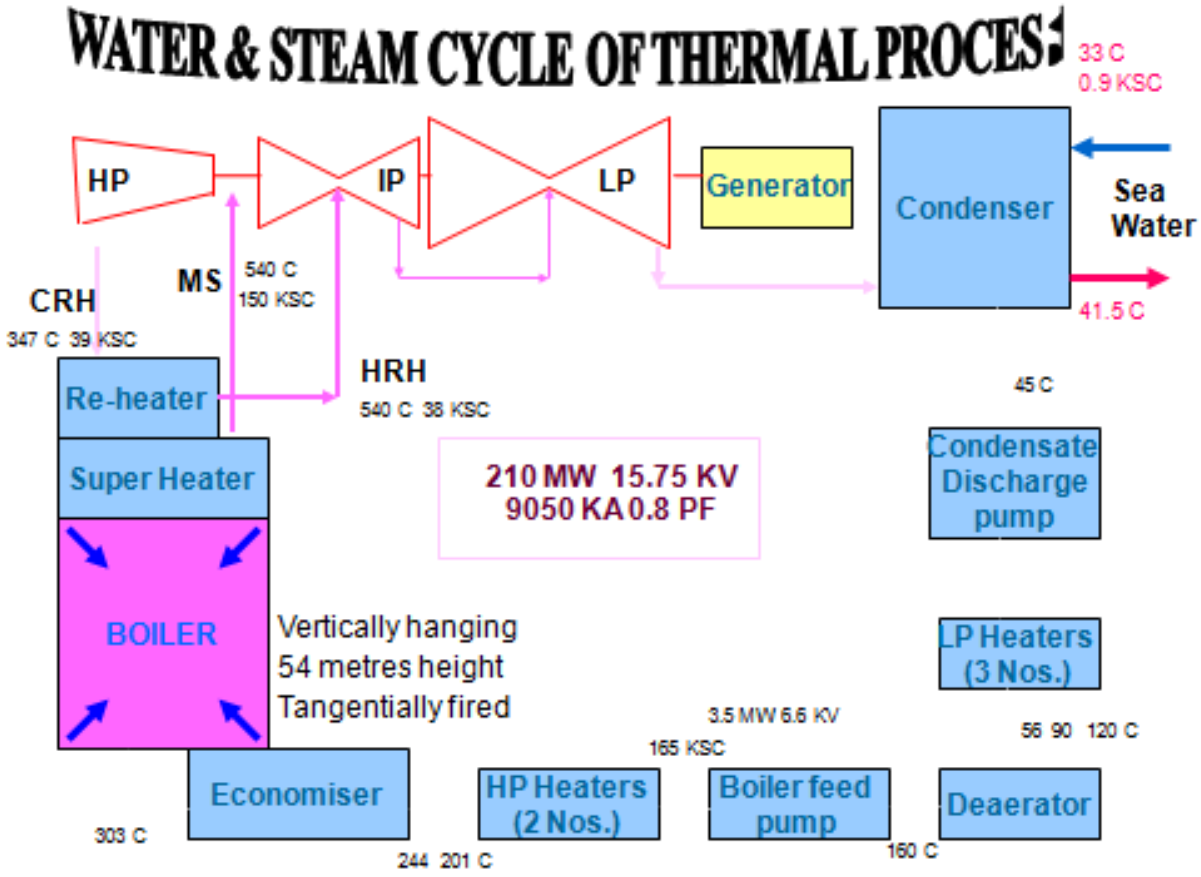
1. ABOUT INDUSTRY

- Capacity of 3X210 MW coal fired Thermal Power Plant.
- BHEL Boiler capacity 155 kg/cm^2 SH outlet pressure, 540°C max temperature, flow 693.6 tonnes per hour, type –water tube boiler.
- Tandem compound Turbine KWU (German) type – Surface Condenser type.
- ESP attachment type FAA-6X37.5 – 2X96135-2 for emission control with gas flow rate 326.6 m^3/sec, temperature 130°C.



1.1. Plant Layout:

1.3. Process details:



(i) ***Process of Coal handling***:- Coal is continuously feeding from coal yard to bunker and to milling system for powdering coal and supply to boiler for combustion

(ii) ***Air and Flow Gas System***

Required air flow 779 tonnes per hour (max) has been given to boiler for combustion by using FD, PA fans and evacuated flue gas system by ID fan.

(iii) ***Steam Generating System***

Continuously generating steam and supplying to turbine by combustion of coal powder inside the boiler, heating by convection and radiation, conduction through water walls, super heater, and reheater various stages etc.

(iv) ***Feed water system***

Required feed water supplied 720 tonnes per hour to boiler for generating steam in boiler continuously by using boiler feed pump.

(v) ***Process of ESP***

The outlet of boiler flue gas travelled through ESP and to Stack by controlling emission of Suspended Particulate Matter (SPM), SOx, NOx,

ELECTROSTATIC PRECIPITATOR

Technical Data:

1. Design Conditions:
   a) Gas flow rate : 326.6 cu.m/sec.
   b) Temperature : 130 deg.c
   c) Dust concentration : 78.3 gms/cu.Nm
2. Type of precipitator : FAA-6x37.5-2x96135-2
3. No. of precipitators : 2 (4 paths)
4. No. of fields in series/path : 6
5. Guaranteed collection efficiency : 99.81%
6. Pr. drop across EP : 20mmwc
7. Velocity of gas : 0.63 m/sec.
8. Treatment time : 35.7 sec.
9. Collecting Electrode:
   a) No. of rows of collecting electrodes per field : 65
   b) No. of collecting electrode plates in each row : 5
   c) No. of collecting electrode plates per field : 65 x 5 = 325
   d) Total No. of collecting plates per boiler : 325 x 12 = 3900
   e) Nominal height of collecting plates : 13.5 m
   f) Nominal width of collecting plates : 750 mm
   g) Spacing between plates : 300 mm
   h) Specific collecting area : 238 sq.m/cu.m/sec.
10. Emitting Electrodes:
   a) Type : Spiral with hooks
   b) Size of each electrode : 2.7 mm dia.
   c) No. of electrodes in the frame forming one row. : 45 fields
   d) No. of electrodes in each field. : 2880
   e) Total No. of electrodes per

boiler.	: 2880 x 12 = 34560
f) Total length of electrodes per field.	: 16156.8 m
g) Plate/wire spacing	: 150 mm

11. Rappers for collecting electrodes:

a) No. and type of rapper	: One drop hammer per row of collecting electrodes.
b) Rapper weight	: 4.9 Kgs.
c) Drive	: Geared electric motor
d) Quantity	: 24 Nos.
e) Motor capacity	: 0.5 HP 3 phase 415V 50 Hz
f) Speed	: 1.1 RPM
g) Location	: On the side panel of the casing
h) Frequency	: Varying from 20 raps/hr at Inlet field to 1 rap/hr. at the exit field.

12. Rappers for emitting electrodes:

a) No. and type of rapper	: Approx. one drop hammer for two rows of electrodes.
b) Rapper weight	: 3.0 Kg.
c) Drive	: Geared electric motor.
d) Quantity	: 24 Nos.
e) Motor capacity	: 0.33 HP, 415V 3 phase 50 Hz.
f) Speed.	: 2.5 Rpm.
g) Location	: On top of EP
h) Frequency of rapper	: 10 raps/hr.

13. Hopper:

a) Type	: Pyramid
b) No. of hoppers	: 48
c) Capacity	: 8 hrs. storage
d) Heating	: Electrical heating with thermostats.
e) Heater capacity	: 6 Kw/Hopper

14. Heaters:

a) Shaft insulators	: 24 Nos.
b) Heater capacity.	: 1 Kw/insulator
c) Support insulators	: 96 Nos.
d) Heater capacity	: 1 Kw/insulator

15. High Voltage Transformer Rectifier (HVR)

a) KVA rating	: 70 KVA (Peak 1000 mA)
b) Input Voltage to primary of HV Transformer	: 0 to 373 V AC
c) Input Current	: 195 Amps. AC for 1000MA DC output.
d) Form factor Current	: 1.4 Amps. (max)

e) Output Current (rated) : 1000 mA DC (max Avg)
f) Output Voltage : 0 - 70 KV peak
g) Operating Temperature : -5 Deg. To + 50 Deg.C
h) Application : Outdoor service.
i) Size (L x W x H) : 1550 x 1720 x 1930 mm
j) Total weight with oil : 1910 Kg.
k) Bucholz relay : 25 mm dia, 2 Nos. rated at 2 Amps. 250 V AC or DC.
l) Relay setting (i) Alarm : 125 cc of Gas
(ii) trip70-130cm/ sec of oil velocity

16. AC Reactor:
a) Type : Iron core with gaps.
b) Rated Current : 195 Amps AC.
c) No. of phases : Single
d) Frequency : 50 Hz.
e) Type of Cooling : ONAN
f) Inductance : 1.6 mH (approx.)
g) Voltage : 415 volts

17. High Frequency Choke:
a) Type : Air core
b) Inductance : 30 mH at 50 Hz, 2 mH at 100 KHz.
c) Current : 800 mA DC
d) Voltage : 45 KV DC
e) Type of cooling : ONAN

18. High Voltage Rectifiers:
a) No. of modules : 7 Nos. in series per arm.
b) No. of arms/phase : 4 Nos.
c) No. of phases of full wave rectifier: Single
d) Total Nos. of modules : 28 Nos.
e) Average current at 100 Deg. C in oil : 0.65 Amps. DC
f) Cont. peak reverse voltage : 19 KV PIV
g) Operating Frequency : 5 KHz.
h) Diode Type : Fast recovery avalanche type glass pack DO 29,600 PIV, 720V, BDV, VF=1.2V

II. DIMENSIONS AND DESIGN OF THE ESP:

1. Coal Quality

Proximate Analysis Report

PROXIMATE ANALYSIS 11.03.2021		
TEST	**RESULT**	**UNIT**
TOTAL MOISTURE	11.97	%
MOISTURE	3.99	%
ASH	43.33	%
VOLATILE MATTER	25.86	%
FIXED CARBON	26.82	%
GCV(ADB)	3695	Kcal/Kg
GCV(ARB)	3388	Kcal/Kg

Ultimate Analysis Report

ULTIMATE ANALYSIS 11.03.2021		
TEST	**RESULT**	**UNIT**
CARBON	42.67	%
HYDROGEN	3.37	%
NITROGEN	0.91	%
SULPHUR	0.59	%

2. Coal Feed Rate : 125.8t/hr
3. Total Air Supplied to Boiler : 779t/hr
4. Excess Air : 20%
5. Total Flue Gas Mass Flow : 326.6 m^3/sec

Description	**Inlet**	**Outlet**
APH Flue gas (°C)	298	132
Secondary air (°C)	30	280
Primary air (°C)	30	275
Percentage of O_2 after APH	9-10%	

6. Flue Gas Temperature : 132°C
7. Flue Gas Velocity : 0.63 m/s as ESP
8. Characteristics of Ash Samples :

FLY ASH ANALYSIS (Chemical composition)for the month of JULY-2021	
TEST	RESULT
SILICA as SIO_2	58.64 %
ALUMINUM AS AlO_2	28.18 %
Iron as Feo	4.44 %
Calcium as Cao_2	1.56 %
Megnisium as MgO_2	0.64 %

9. Compartment : 2 compartments
   - Width [m] : 50 m (AB/CD pan)
   - Height [m] : 14 m
   - Length [m] : 30 m
   - Number : 2 Nos.
10. Inlet Cone
    - Width [m] : 20 m
    - Height [m] : 12 m
    - Length [m] : 5 m

11. <u>FIELDS:</u> Serial Fields

- $Width_{SF}$ [m] : 750 mm
- $Height_{SF}$ [m] : 13.5 m
- $Length_{SF}$ [m] : 30 m
- No. of Gas Passages : 2 (4 pass)
- $Width_{GP}$ [m] : 300 mm

Discharging Electrodes

- Spacing [m] : 150 mm
- Number : 34560
- Diameter [mm] : 2.7 mm
- Length [m] : 4.5 m (3 tire)
- Distance between the serial fields : 500 mm

12. FIELDS :Parallel Fields

$Width_{SF}$ [m]	:	19.5
$Height_{SF}$ [m]	:	13.5
$Length_{SF}$ [m]	:	5.5
No. of Gas Passages	:	4 pass
$Width_{GP}$ [m]	:	

Discharging Electrodes

Spacing [m]	:	150
Number	:	34560
Diameter [mm]	:	2.7
Length [m]	:	4.5

13. Hoppers

Hopper Type	:	Pyramid
Hopper – Lock Tyoe	:	48 (24x2)
No. of Hoppers	:	48
Height [m]	:	5 m

14. Electrical Supply

Voltage

Serial & Parallel Field [KV] : DC , 0-70 KV peak continuously adjustable

Current

Serial & Parallel Field [mA] : DC , 1000 milli Amps (maximum AVG)

15. Electrical Supply of the Discharging Electrodes

DC , 0-70 KV peak continuously adjustable

16. Area of the discharging electrodes in the fields [m2]

17. Specific current of the charging electrode Area [mA/m2]

18. Total Collecting Area of the ESP [m2] : $239/m^2/s$

19. Energy consumption of ESP [KW]

20. Velocities of Gas Flow : 0.63 m/s

Mean Velocity in the Gas passages

Mean velocity at the inlet of the inlet cone

Mean velocity at the outlet of the final outlet cone

21. Rapping and Cycle time

EERM for 6 fields in U I , U II & U II : 5,5,5,5,5,5 minutes

CERM for 6 fileds in U I & U II : 5,10,15,25,40,60 minutes

U III : 5,10,18,30,60,60 minutes

Parameters	Unit	TPP-1	TPP-2	TPP - 3
Boiler Rating(MCR)	TPH			
Steam Pressure at Main Steam Stop Valve Outlet from minimum Load upto MCR	Kg/cm^2 (g)	155	155	155
Steam Temperature at the Main Steam Stop valve at MCR	DegC	540	540	540
Main Steam Temperature Control range at the main Steam Stop Valve Outlet	%MCR	535	535	535
FeedWaterTemperatureatEconomiserInlet/ SpryWaterTemp(WithHPHeaterinservice)	DegC	248	248	248
Feed Water Temperature at Economiser Inlet (Without HP Heater in service)	DegC	158	157	156
Flue Gas Temperature at APH Outlet	DegC	132	134	132
Start Up Fuel		LDO/HFO	LDO/HFO	LDO/HFO

2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

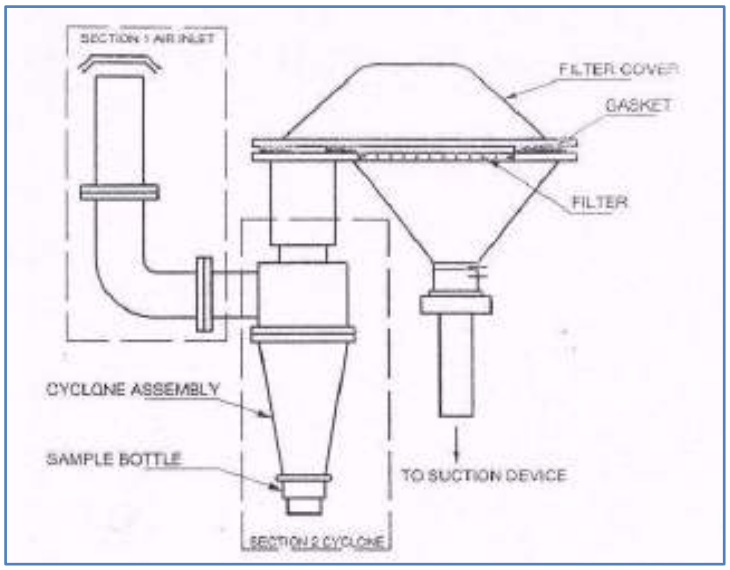
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in an envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, $\mu g/m^3$	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter

Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of $PM_{2.5}$ in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting

50 ml of stock solution to 500 ml with distilled water.

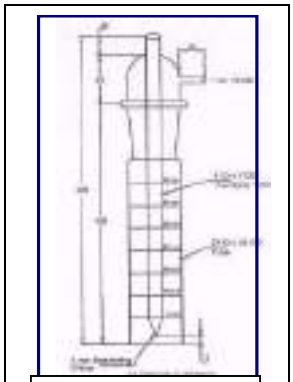
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and

transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO2 = Concentration of Nitrogen dioxide, $\mu g/m^3$

As = Absorbance of sample

Ab = Absorbance of reagent blank

CF = Calibration factor

Va = Volume of air sampled, m^3

Vs = Volume of sample, ml

Vt = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), µg/m3	8 Hours *	100	100
	1 Hour **	180	180
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 ± 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as

in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ )\ =\ (As\ -\ Ab)\ x\ CF\ /\ Va$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

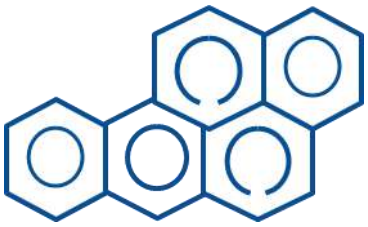
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

8 Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
⇩
Ultrasonic extraction with Toluene (50 ml × 3 times)
⇩
Filter & dry with Anhydrous Sodium Sulphate
⇩
Concentration with Rotary Evaporator
⇩
Clean up with Silica Gel Column Chromatography
⇩
Elution with Cyclo-Hexane (5 ml × 3 times)
⇩
Evaporate to nearly dryness under Nitrogen
⇩
Re-dissolved in 0.5 to 1.0 ml Toluene
⇩
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min

Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V	=	Volume of air, m^3
Q	=	Average sampling rate, m^3/min.
T	=	Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m³	20 µg/ m³	-Improved West and Gaeke method
		24 hours	80 µg/ m³	80 µg/ m³	-Ultraviolet Fluorescence
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m³	30 µg/ m³	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m³	80 µg/ m³	
3	Suspended Particulate Matter	Annual Average	60 µg/ m³	60 µg/ m³	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m³	100 µg/ m³	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m³	40 µg/ m³	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m³	60 µg/ m³	
5	Ozone (O_3)	8 hours	100 µg/ m³	100 µg/ m³	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m³	180 µg/ m³	
6	Lead	Annual Average	0.5 µg/ m³	0.5 µg/ m³	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m³	1.0 µg/ m³	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m³	2 mg/ m³	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m³	4 mg/ m³	
8	Ammonia	Annual Average	100 µg/ m³	100 µg/ m³	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m³	400 µg/ m³	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m³	5 µg/ m³	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)- particulate phase only	Annual Average	1 ng/ m³	1 ng/ m³	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m³	6 ng/ m³	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m³	20 ng/ m³	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

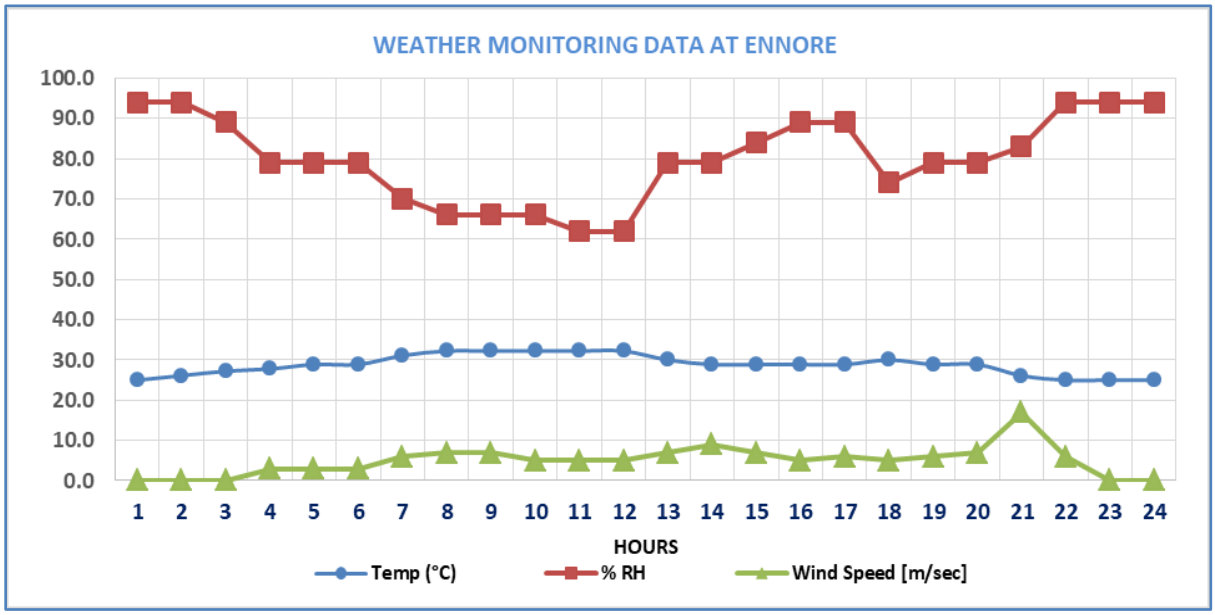
*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

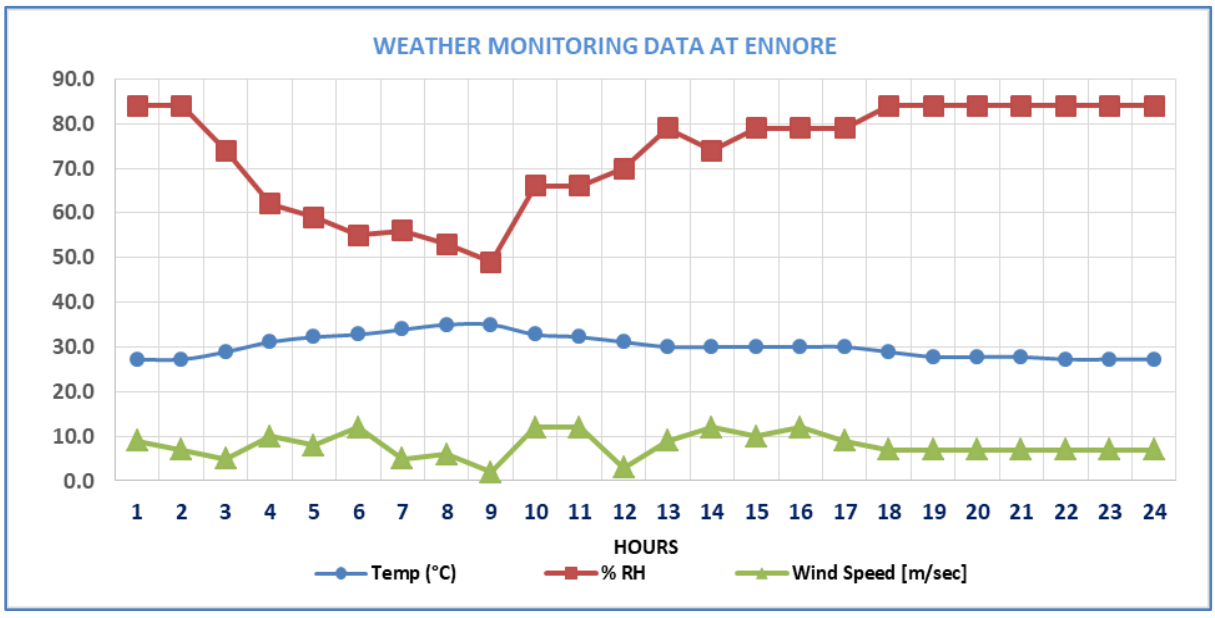
Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

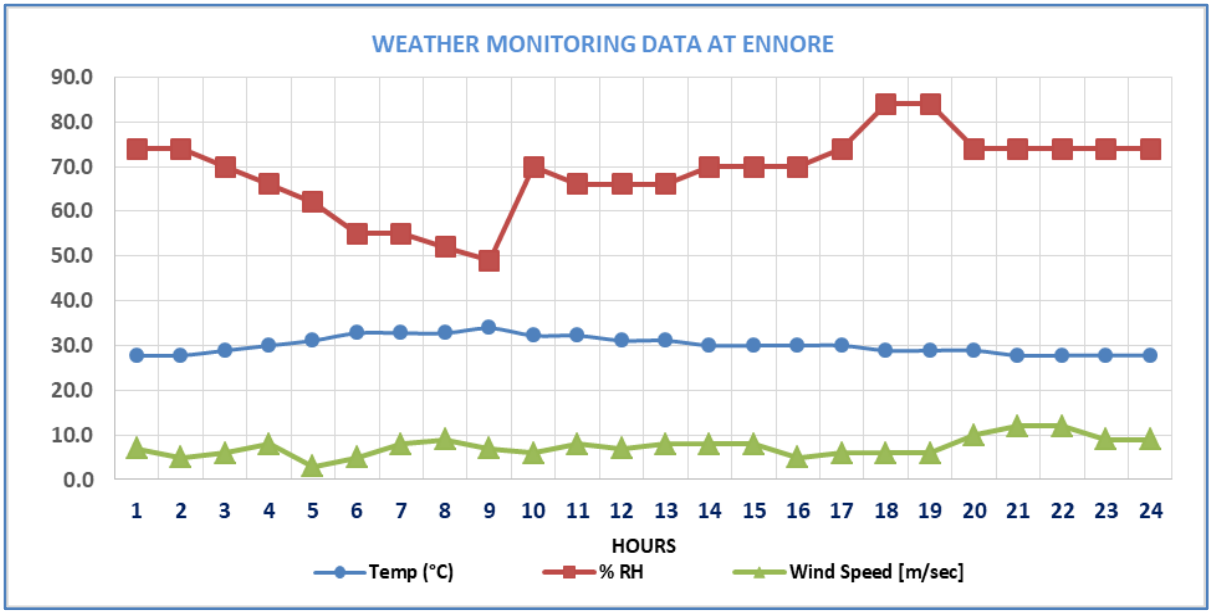
WEATHER MONITORING DATA AT NCTPS STAGE 1 - ENNORE					
Date	Time	Temp (°C)	% RH	Wind Speed [m/sec]	Wind Dir.
17.08.2021	1:00 AM	25.0	94	0	CALM
17.08.2021	2:00 AM	26.1	94	0	CALM
17.08.2021	3:00 AM	27.2	89	0	CALM
17.08.2021	4:00 AM	27.8	79	3	S
17.08.2021	5:00 AM	28.9	79	3	SSW
17.08.2021	6:00 AM	28.9	79	3	SSW
17.08.2021	7:00 AM	31.1	70	6	SW
17.08.2021	8:00 AM	32.2	66	7	W
17.08.2021	9:00 AM	32.2	66	7	W
17.08.2021	10:00 AM	32.2	66	5	W
17.08.2021	11:00 AM	32.2	62	5	W
17.08.2021	12:00 PM	32.2	62	5	S
17.08.2021	1:00 PM	30.0	79	7	SSE
17.08.2021	2:00 PM	28.9	79	9	S
17.08.2021	3:00 PM	28.9	84	7	S
17.08.2021	4:00 PM	28.9	89	5	S
17.08.2021	5:00 PM	28.9	89	6	S
17.08.2021	6:00 PM	30.0	74	5	SSW
17.08.2021	7:00 PM	28.9	79	6	SW
17.08.2021	8:00 PM	28.9	79	7	WNW
17.08.2021	9:00 PM	26.1	83	17	W
17.08.2021	10:00 PM	25.0	94	6	SW
17.08.2021	11:00 PM	25.0	94	0	CALM
17.08.2021	12:00 AM	25.0	94	0	CALM
MIN		25.0	62.0	0.0	W
MAX		32.2	94.0	17.0	
AVG		28.8	80.1	5.0	

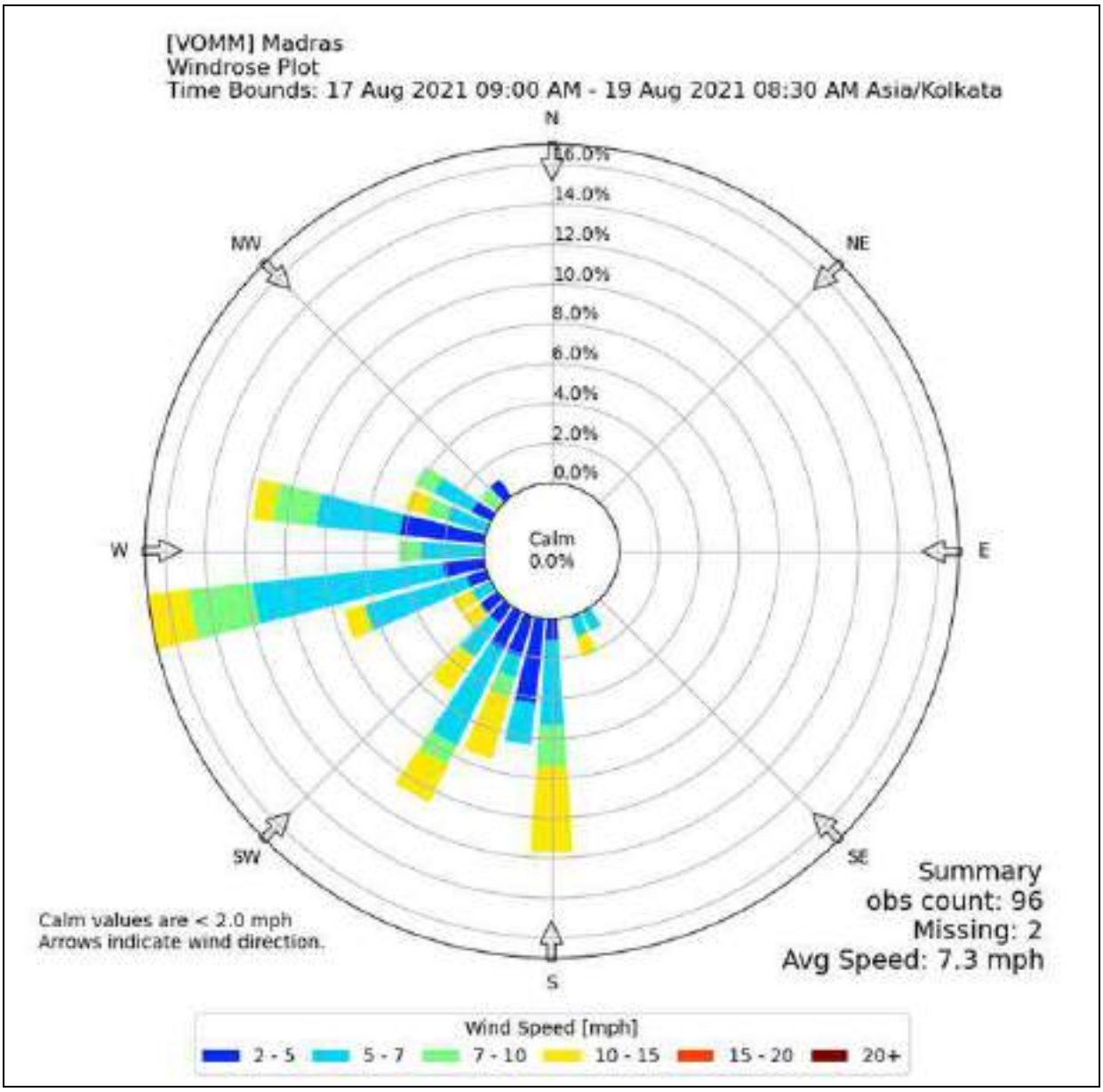


WEATHER MONITORING DATA AT NCTPS STAGE 1 - ENNORE					
Date	Time	Temp (°C)	% RH	Wind Speed [m/sec]	Wind Dir.
18.08.2021	1:00 AM	27.2	84	9	W
18.08.2021	2:00 AM	27.2	84	7	W
18.08.2021	3:00 AM	28.9	74	5	W
18.08.2021	4:00 AM	31.1	62	10	W
18.08.2021	5:00 AM	32.2	59	8	WNW
18.08.2021	6:00 AM	32.8	55	12	W
18.08.2021	7:00 AM	33.9	56	5	WSW
18.08.2021	8:00 AM	35.0	53	6	WNW
18.08.2021	9:00 AM	35.0	49	2	VAR
18.08.2021	10:00 AM	32.8	66	12	SSE
18.08.2021	11:00 AM	32.2	66	12	S
18.08.2021	12:00 PM	31.1	70	3	S
18.08.2021	1:00 PM	30.0	79	9	S
18.08.2021	2:00 PM	30.0	74	12	SSW
18.08.2021	3:00 PM	30.0	79	10	SSW
18.08.2021	4:00 PM	30.0	79	12	SSW
18.08.2021	5:00 PM	30.0	79	9	SSW
18.08.2021	6:00 PM	28.9	84	7	SSW
18.08.2021	7:00 PM	27.8	84	7	WSW
18.08.2021	8:00 PM	27.8	84	7	WSW
18.08.2021	9:00 PM	27.8	84	7	WSW
18.08.2021	10:00 PM	27.2	84	7	W
18.08.2021	11:00 PM	27.2	84	7	W
18.08.2021	12:30 AM	27.2	84	7	W
MIN		27.2	49.0	2.0	W
MAX		35.0	84.0	12.0	
AVG		30.1	73.2	8.0	



WEATHER MONITORING DATA AT NCTPS STAGE 1 - ENNORE					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
19.08.2021	1:00 AM	27.8	74	7	W
19.08.2021	2:00 AM	27.8	74	5	W
19.08.2021	3:00 AM	28.9	70	6	WNW
19.08.2021	4:00 AM	30.0	66	8	NW
19.08.2021	5:00 AM	31.1	62	3	NW
19.08.2021	6:00 AM	32.8	55	5	W
19.08.2021	7:00 AM	32.8	55	8	W
19.08.2021	8:00 AM	32.8	52	9	WSW
19.08.2021	9:00 AM	33.9	49	7	WSW
19.08.2021	10:00 AM	32.2	70	6	S
19.08.2021	11:00 AM	32.2	66	8	SSE
19.08.2021	12:00 PM	31.1	66	7	S
19.08.2021	1:00 PM	31.1	66	8	S
19.08.2021	2:00 PM	30.0	70	8	SSW
19.08.2021	3:00 PM	30.0	70	8	SSW
19.08.2021	4:00 PM	30.0	70	5	SSW
19.08.2021	5:00 PM	30.0	74	6	SSW
19.08.2021	6:00 PM	28.9	84	6	SW
19.08.2021	7:00 PM	28.9	84	6	SW
19.08.2021	8:00 PM	28.9	74	10	SW
19.08.2021	9:00 PM	27.8	74	12	WSW
19.08.2021	10:00 PM	27.8	74	12	WSW
19.08.2021	11:00 PM	27.8	74	9	W
19.08.2021	12:00 AM	27.8	74	9	W
MIN		27.8	49.0	3.0	SSW
MAX		33.9	84.0	12.0	
AVG		30.1	68.6	7.4	




[VOMM] Madras
Windrose Plot
Time Bounds: 17 Aug 2021 09:00 AM - 19 Aug 2021 08:30 AM Asia/Kolkata
N
NE
E
SE
S
SW
W
NW
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Calm
0.0%
Calm values are < 2.0 mph
Arrows indicate wind direction.
Summary
obs count: 96
Missing: 2
Avg Speed: 7.3 mph
Wind Speed [mph]
2 - 5
5 - 7
7 - 10
10 - 15
15 - 20
20+

4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Ambient Air Quality Monitoring Sampling Location

Stack Emission Monitoring Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

DAY-1 STATION- 1: M/s. NCTPS, ENNORE, 33/11 KAV SUBSTATION

LOCATION - 33/11 KAV SUBSTATION - ENNORE			
SAMPLING DATE & TIME 17.08.2021 [11:10 Hrs] – 18.08.2021 [11:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	20.7
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	27
3	Particulate Matter (PM_{10})	$\mu g/m^3$	53.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	22.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 2: M/s. NCTPS, ENNORE, ECHS CONTROL ROOM LCSS-2

LOCATION - ECHS CONTROL ROOM LCSS-2 - ENNORE			
SAMPLING DATE & TIME 17.08.2021 [12:00 Hrs] – 18.08.2021 [12:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	15
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.3
3	Particulate Matter (PM_{10})	$\mu g/m^3$	64.8
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28.5
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)

11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 3: M/s. NCTPS, ENNORE, FEED OIL PUMP HOUSE

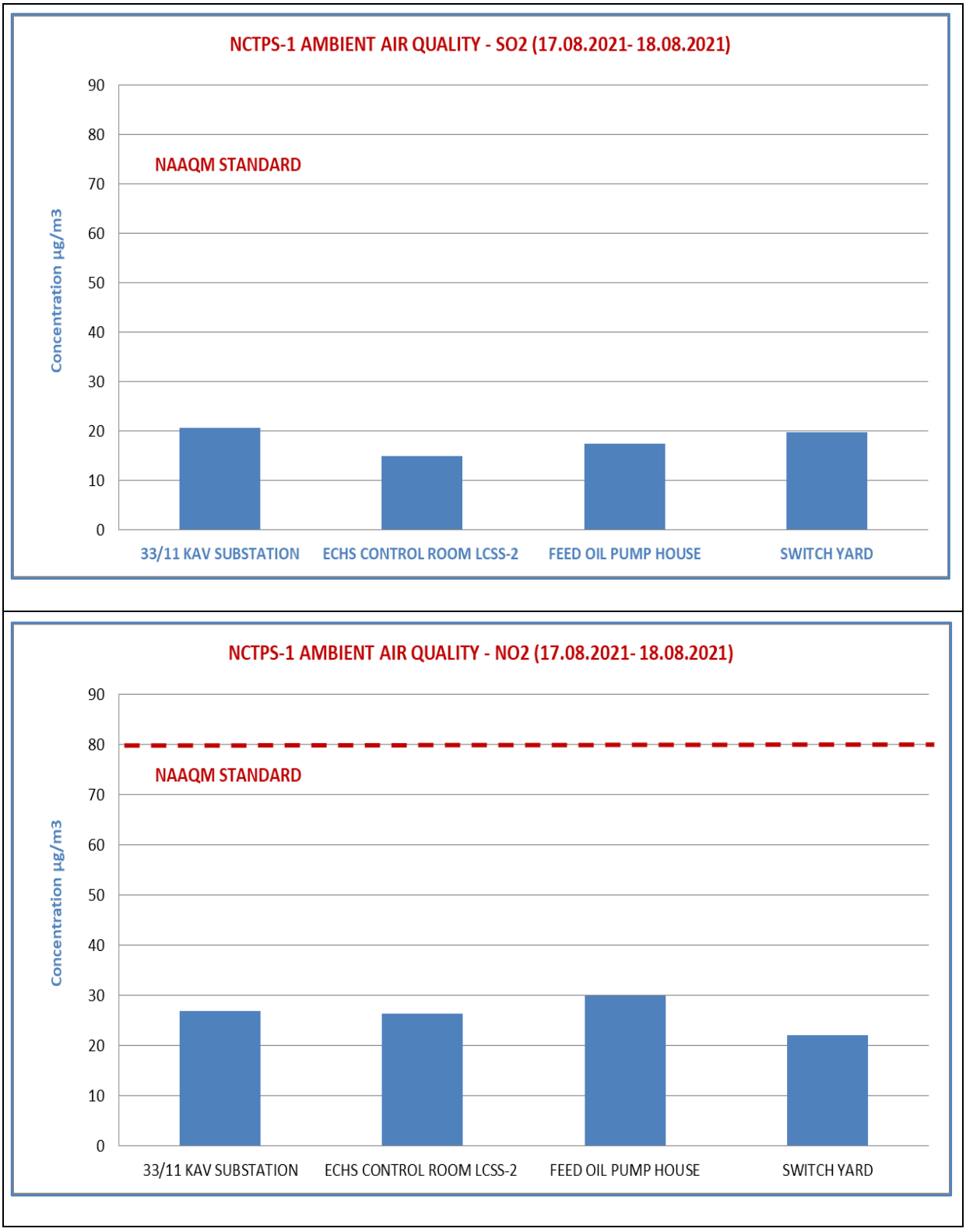
LOCATION – FEED OIL PUMP HOUSE, ENNORE			
SAMPLING DATE & TIME 17.08.2021 [12:50 Hrs] – 18.07.2021 [12:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	17.5
2	Nitrogen Dioxide as NO_2	µg/m^3	29.9
3	Particulate Matter (PM_{10})	µg/m^3	61.6
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	25.2
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

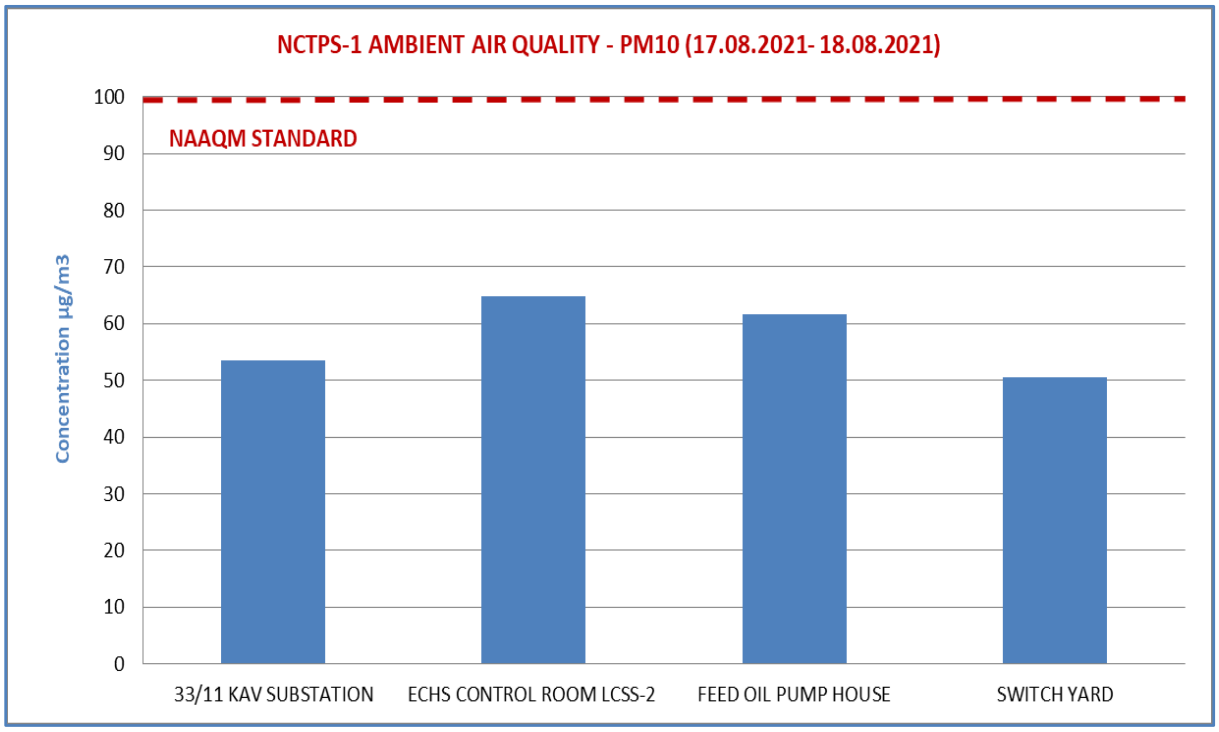
DAY-1 STATION- 4: M/s. NCTPS, ENNORE, SWITCH YARD

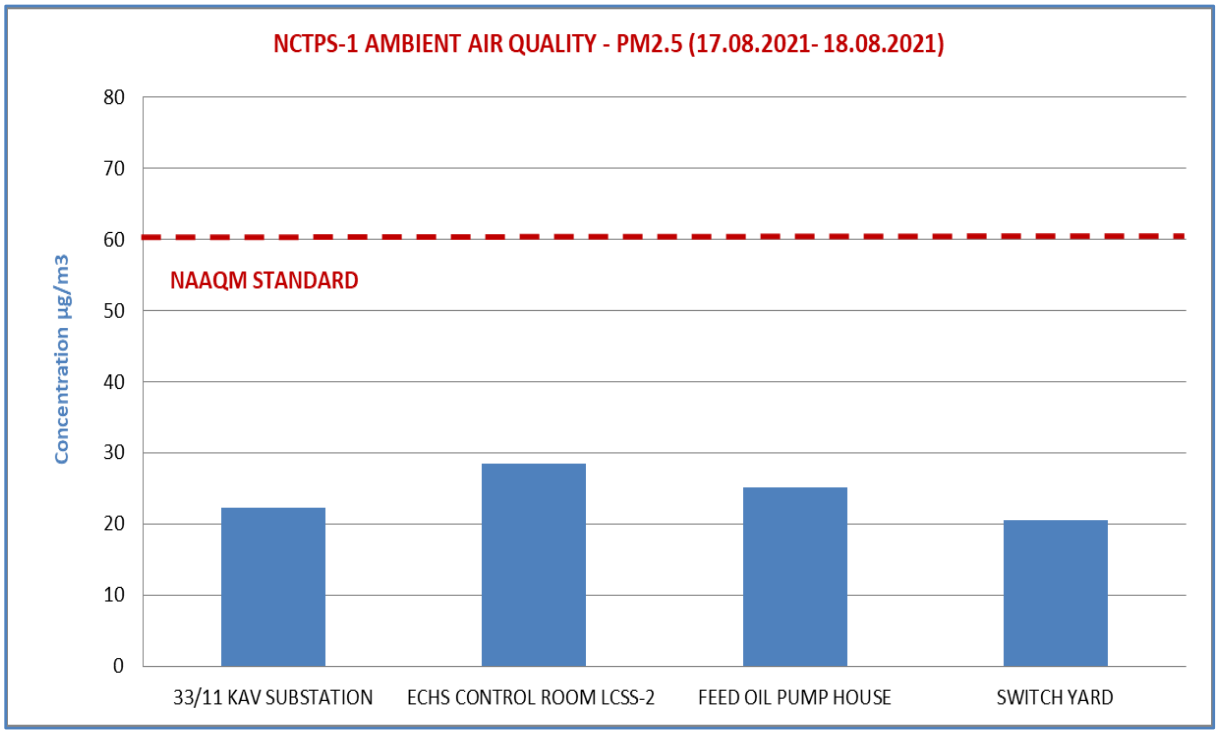
LOCATION – SWITCH YARD, ENNORE			
SAMPLING DATE & TIME 17.08.2021 [13:15 Hrs] – 18.07.2021 [13:15 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	19.7
2	Nitrogen Dioxide as NO_2	µg/m^3	22
3	Particulate Matter (PM_{10})	µg/m^3	50.5
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	20.6
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

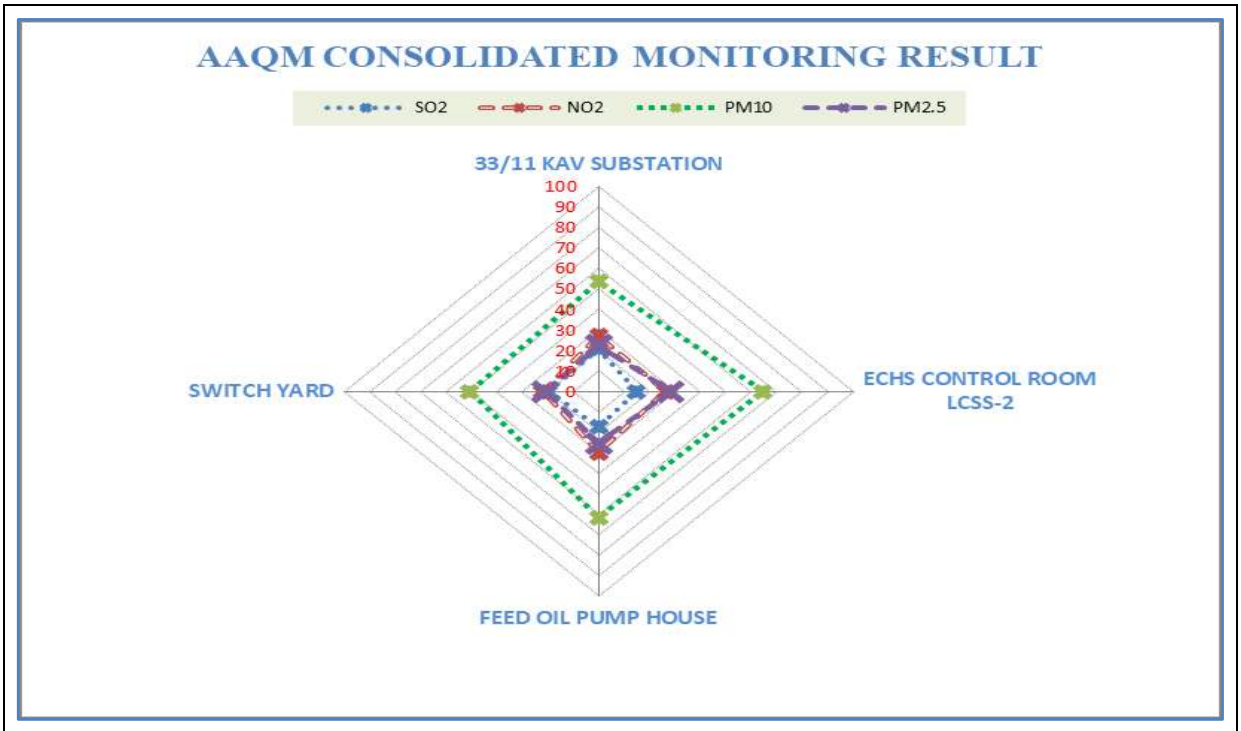
DAY-1 AAQM Consolidated Monitoring Results:

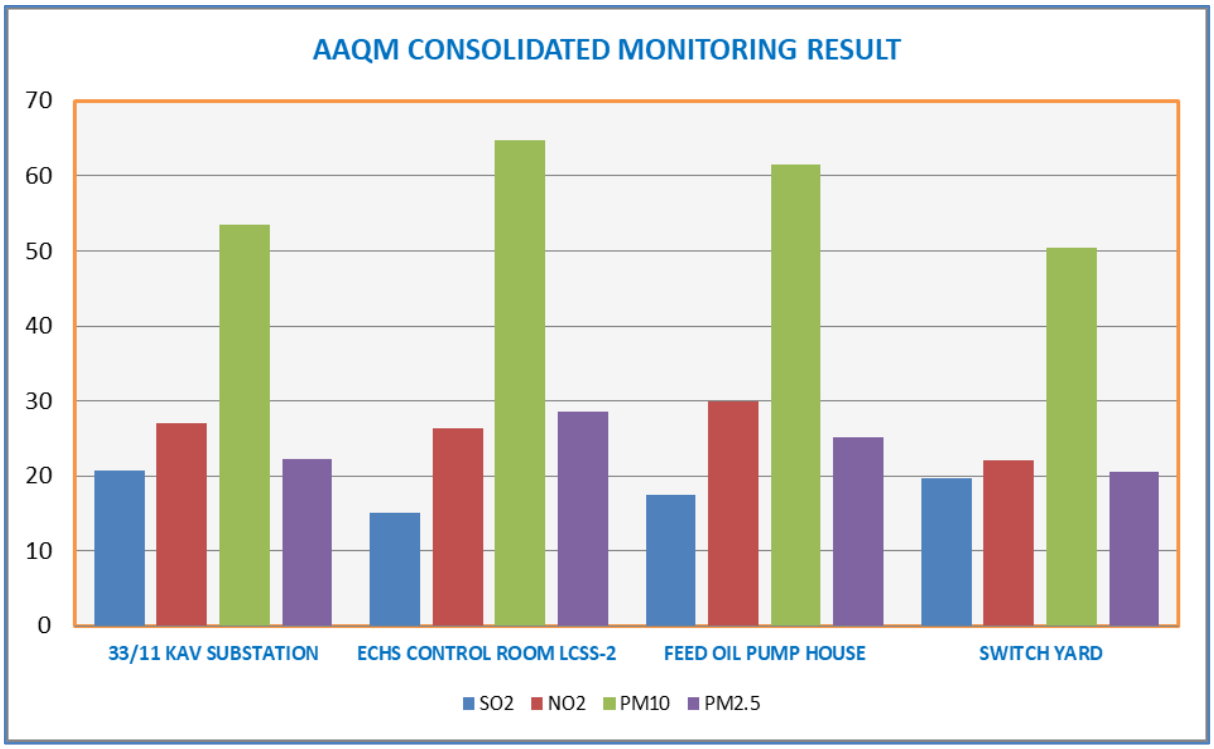
DAY-1 AAQM Consolidated Monitoring Results (µg/m3)				
[17.08.2021 to 18.08.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
33/11 KAV SUBSTATION	20.7	27	53.5	22.3
ECHS CONTROL ROOM LCSS-2	15	26.3	64.8	28.5
FEED OIL PUMP HOUSE	17.5	29.9	61.6	25.2
SWITCH YARD	19.7	22	50.5	20.6


NCTPS-1 AMBIENT AIR QUALITY - SO2 (17.08.2021- 18.08.2021)
Concentration µg/m3
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD
NCTPS-1 AMBIENT AIR QUALITY - NO2 (17.08.2021- 18.08.2021)
Concentration µg/m3
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


NCTPS-1 AMBIENT AIR QUALITY - PM10 (17.08.2021- 18.08.2021)
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


NCTPS-1 AMBIENT AIR QUALITY - PM2.5 (17.08.2021- 18.08.2021)
Concentration µg/m3
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD
100
90
80
70
60
50
40
30
20
0


AAQM CONSOLIDATED MONITORING RESULT
70
60
50
40
30
20
10
0
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD
SO2
NO2
PM10
PM2.5

CONCLUSION:

In Ambient Air Quality monitoring four sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are 33/11 KAV Substation, ECHS Control Room LCSS-2, Feed Oil Pump House and Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15 to 20.7µg/m^3. Highest value of 20.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 22 to 29.9µg/m^3. Highest value of 29.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.5 to 64.8µg/m^3. Highest value of 64.8µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.6 to 28.5µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

DAY-2 STATION- 1: M/s. NCTPS, ENNORE, 33/11 KAV SUBSTATION

LOCATION - 33/11 KAV SUBSTATION - ENNORE			
SAMPLING DATE & TIME 18.08.2021 [11:20 Hrs] – 19.08.2021 [11:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	21.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	24.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	62
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	29.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 2: M/s. NCTPS, ENNORE, ECHS CONTROL ROOM LCSS-2

LOCATION - ECHS CONTROL ROOM LCSS-2 - ENNORE			
SAMPLING DATE & TIME 18.08.2021 [12:05 Hrs] – 19.08.2021 [12:05 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	19.4
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	21.4
3	Particulate Matter (PM_{10})	$\mu g/m^3$	55.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	24.7
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 3: M/s. NCTPS, ENNORE, FEED OIL PUMP HOUSE

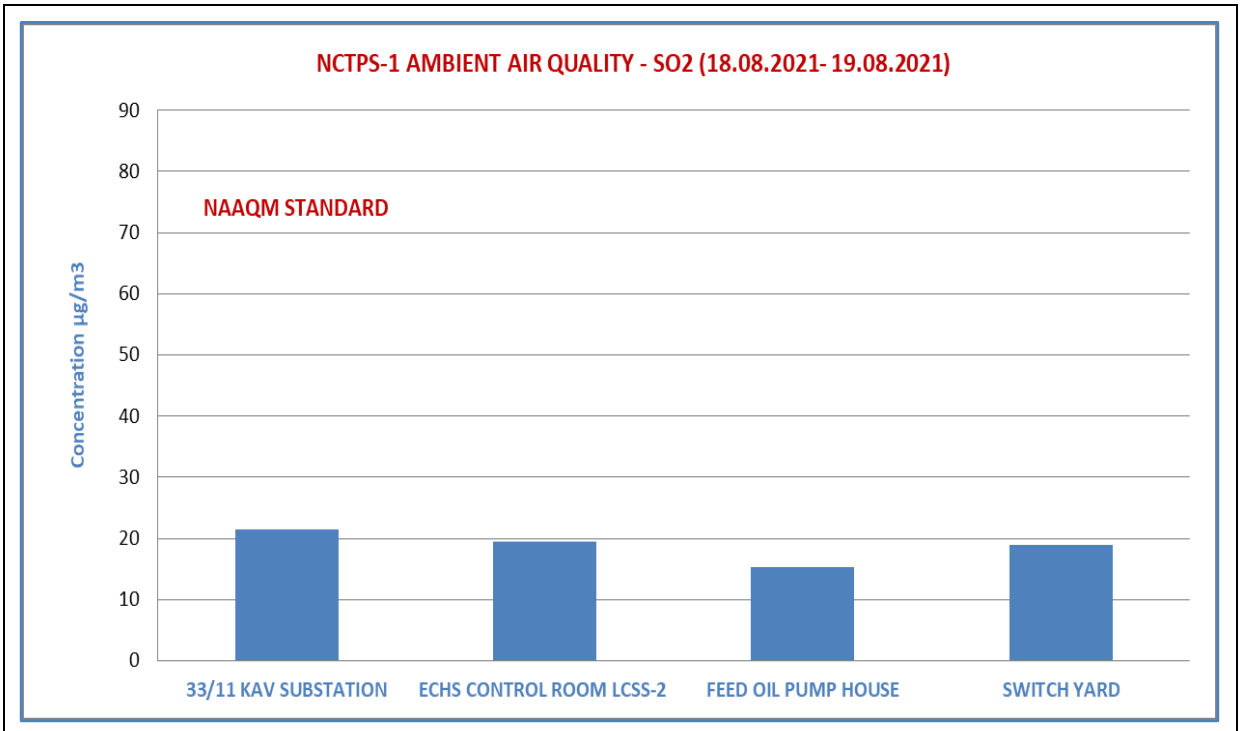
LOCATION – FEED OIL PUMP HOUSE, ENNORE			
SAMPLING DATE & TIME 18.08.2021 [13:00 Hrs] – 19.08.2021 [13:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	15.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.1
3	Particulate Matter (PM_{10})	$\mu g/m^3$	51.4
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	21.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

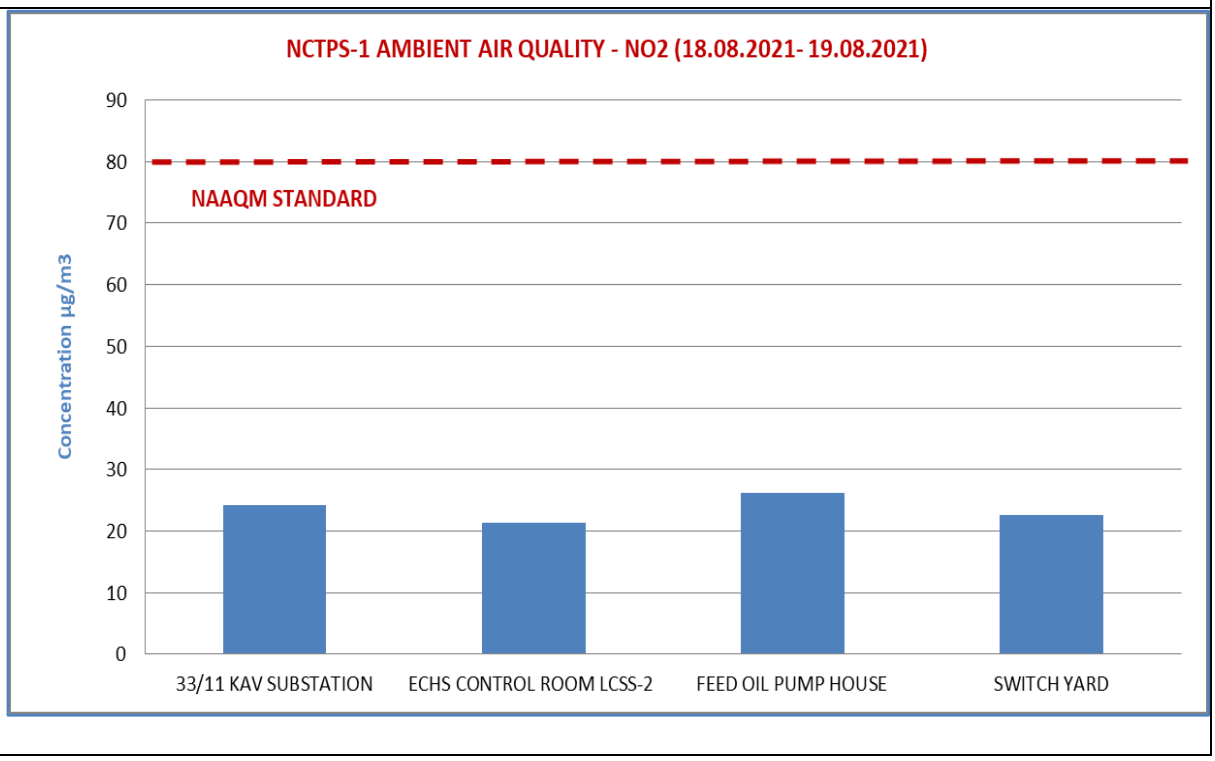
DAY-2 STATION- 4: M/s. NCTPS, ENNORE, SWITCH YARD

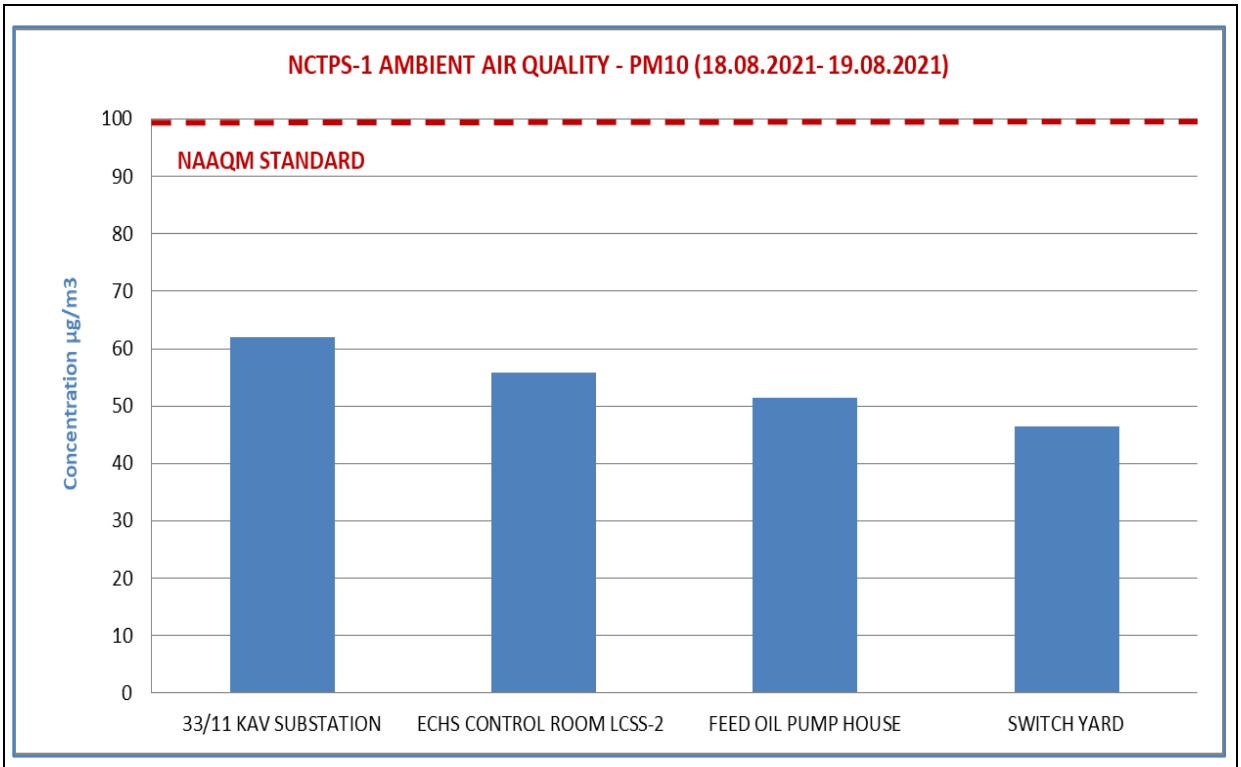
LOCATION – SWITCH YARD, ENNORE			
SAMPLING DATE & TIME 18.08.2021 [13:25 Hrs] – 19.08.2021 [13:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	18.9
2	Nitrogen Dioxide as NO_2	µg/m^3	22.6
3	Particulate Matter (PM_{10})	µg/m^3	46.5
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	20.6
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

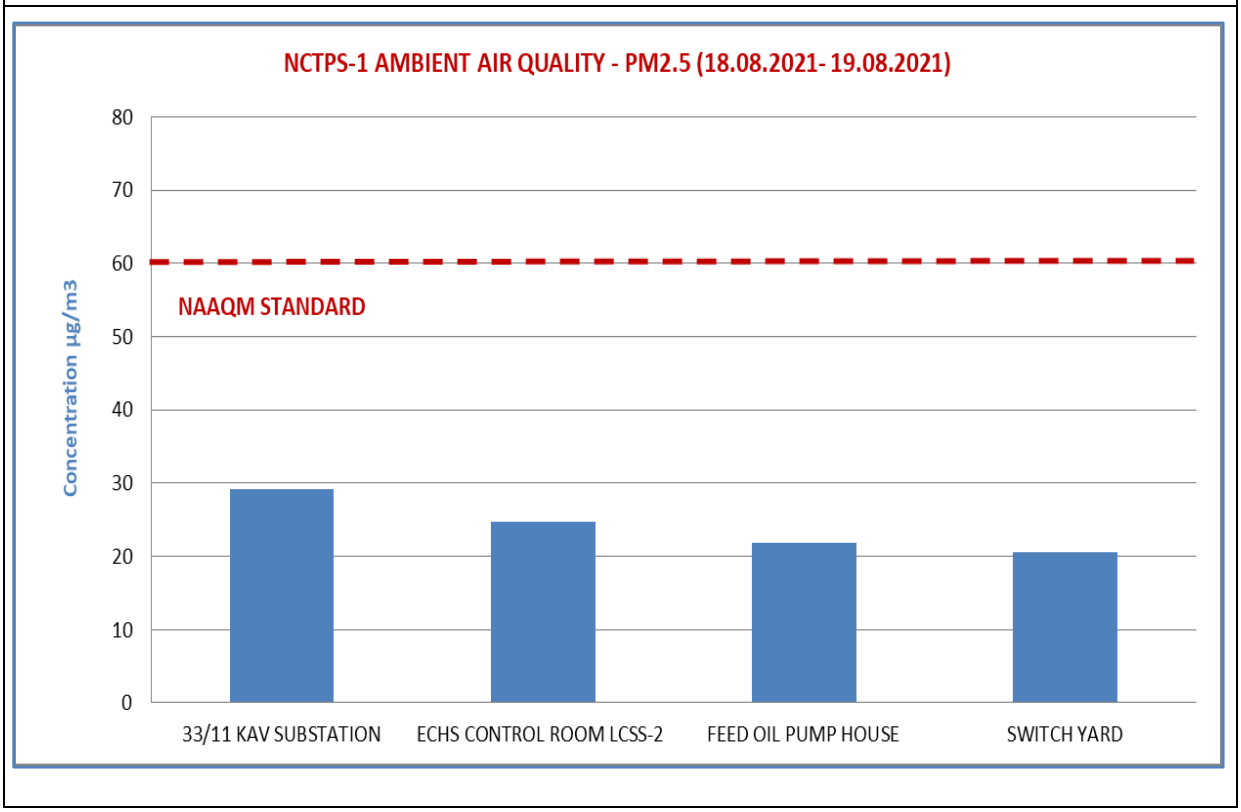
DAY-2 AAQM Consolidated Monitoring Results:

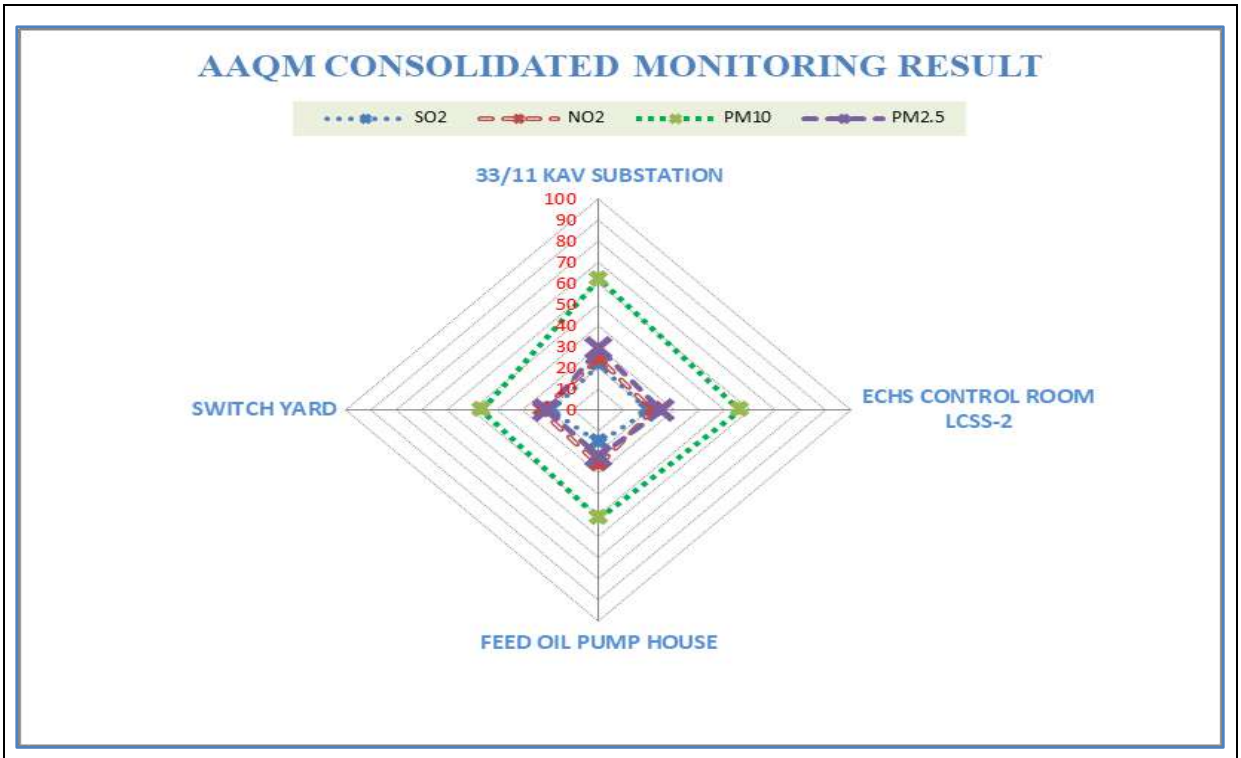
DAY-2 AAQM Consolidated Monitoring Results (µg/m3) [18.08.2021 to 19.08.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
33/11 KAV SUBSTATION	21.5	24.2	62	29.2
ECHS CONTROL ROOM LCSS-2	19.4	21.4	55.9	24.7
FEED OIL PUMP HOUSE	15.3	26.1	51.4	21.8
SWITCH YARD	18.9	22.6	46.5	20.6

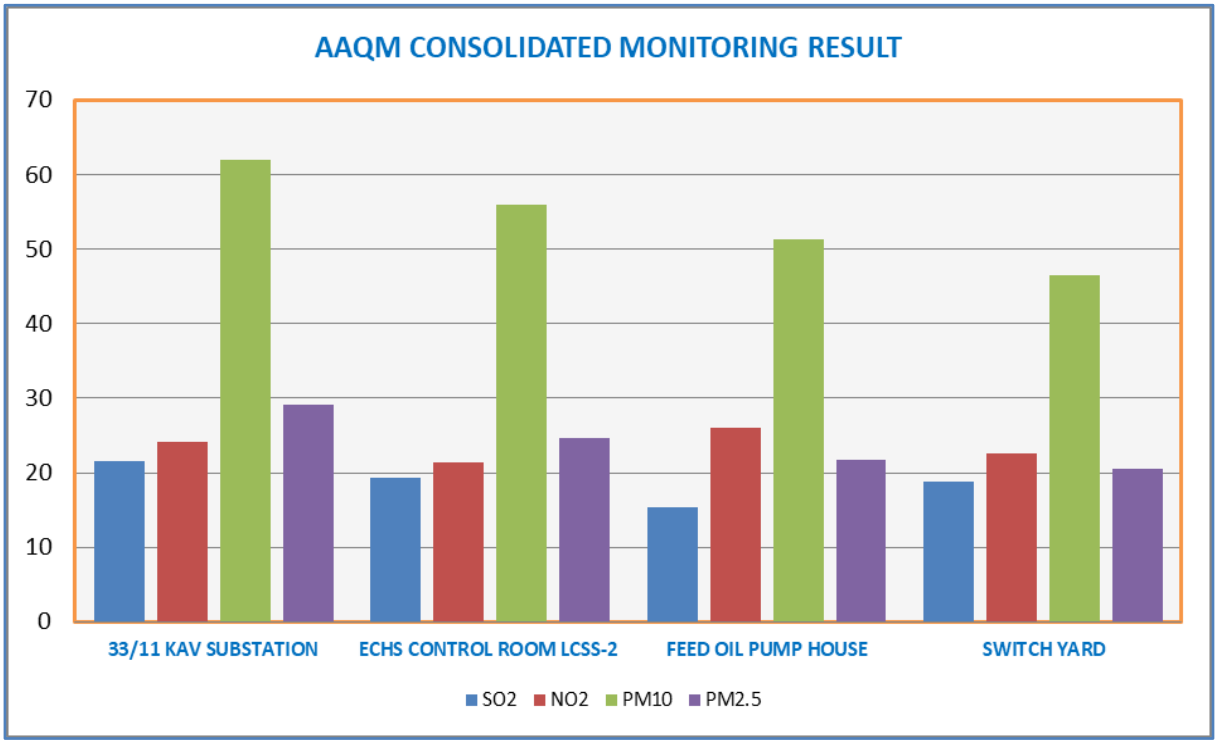

NCTPS-1 AMBIENT AIR QUALITY - SO2 (18.08.2021- 19.08.2021)
Concentration µg/m3
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


NCTPS-1 AMBIENT AIR QUALITY - NO2 (18.08.2021- 19.08.2021)
Concentration µg/m3
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


NCTPS-1 AMBIENT AIR QUALITY - PM10 (18.08.2021- 19.08.2021)
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


NCTPS-1 AMBIENT AIR QUALITY - PM2.5 (18.08.2021- 19.08.2021)
Concentration µg/m3
80
70
60
50
40
30
20
10
0
NAAQM STANDARD
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
33/11 KAV SUBSTATION
100
90
80
70
60
50
40
30
20
10
0
SWITCH YARD
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE


AAQM CONSOLIDATED MONITORING RESULT
70
60
50
40
30
20
10
0
33/11 KAV SUBSTATION
ECHS CONTROL ROOM LCSS-2
FEED OIL PUMP HOUSE
SWITCH YARD
SO2
NO2
PM10
PM2.5

FINDINGS:

In Ambient Air Quality monitoring four sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are 33/11 KAV Substation, ECHS Control Room LCSS-2, Feed Oil Pump House and Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.3 to 21.5 µg/m^3. Highest value of 21.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 21.4 to 26.1µg/m^3. Highest value of 26.1µg/m^3 is obtained and however the values are within the NAAQM standards.

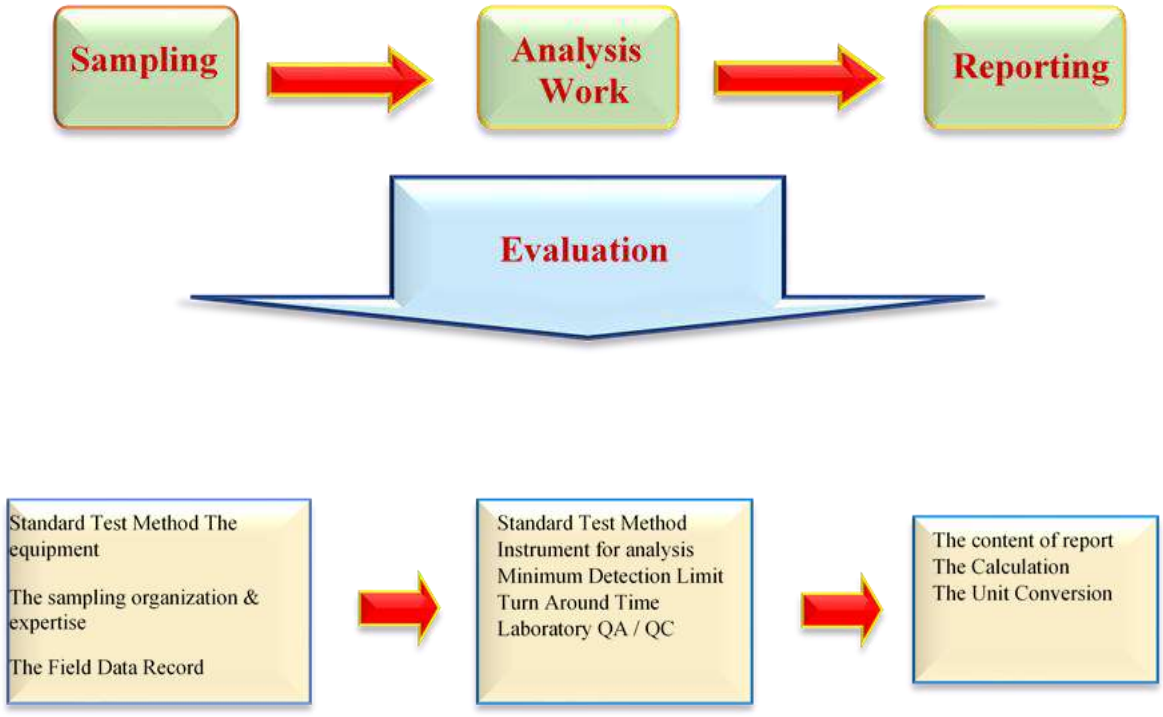
- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 46.5 to 62µg/m^3. Highest value of 62µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.6 to 29.2µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

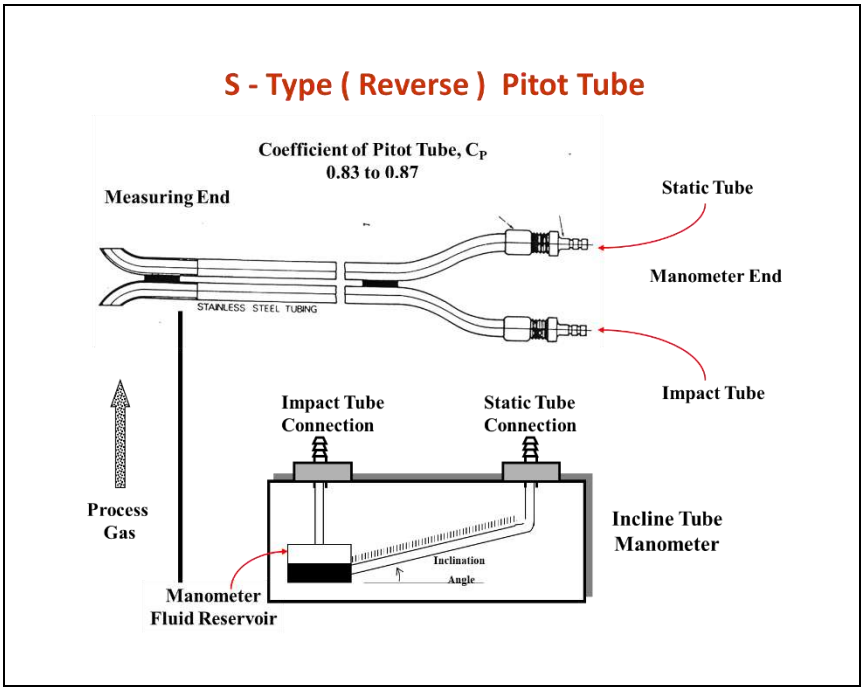


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points :

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

5. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

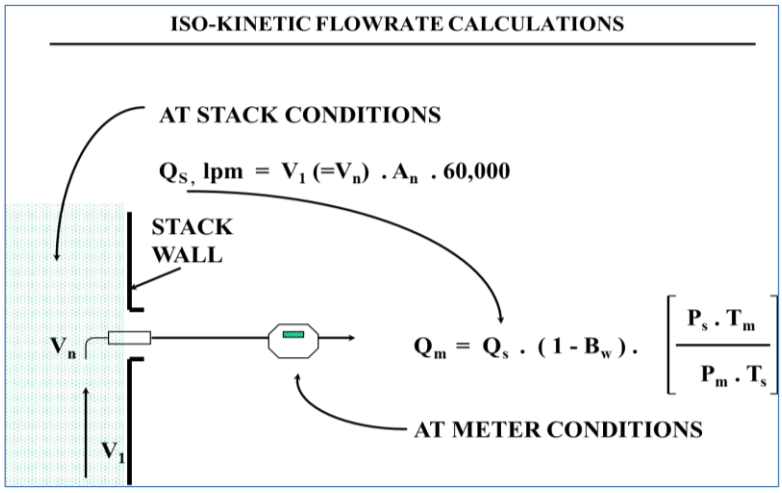
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

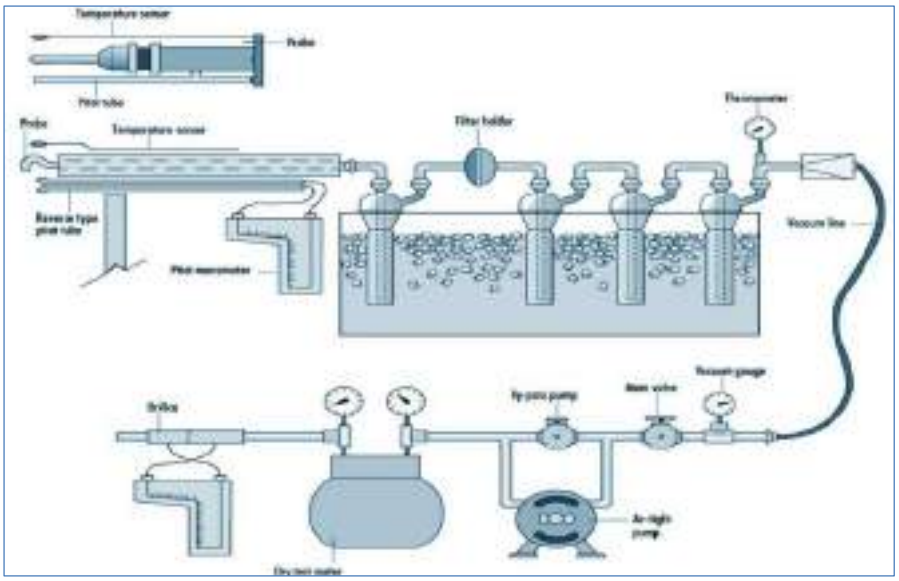
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the

isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading, meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

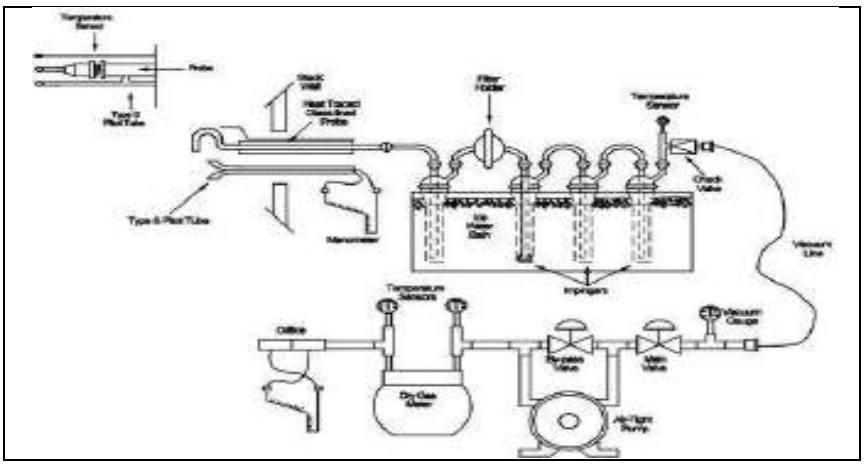
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

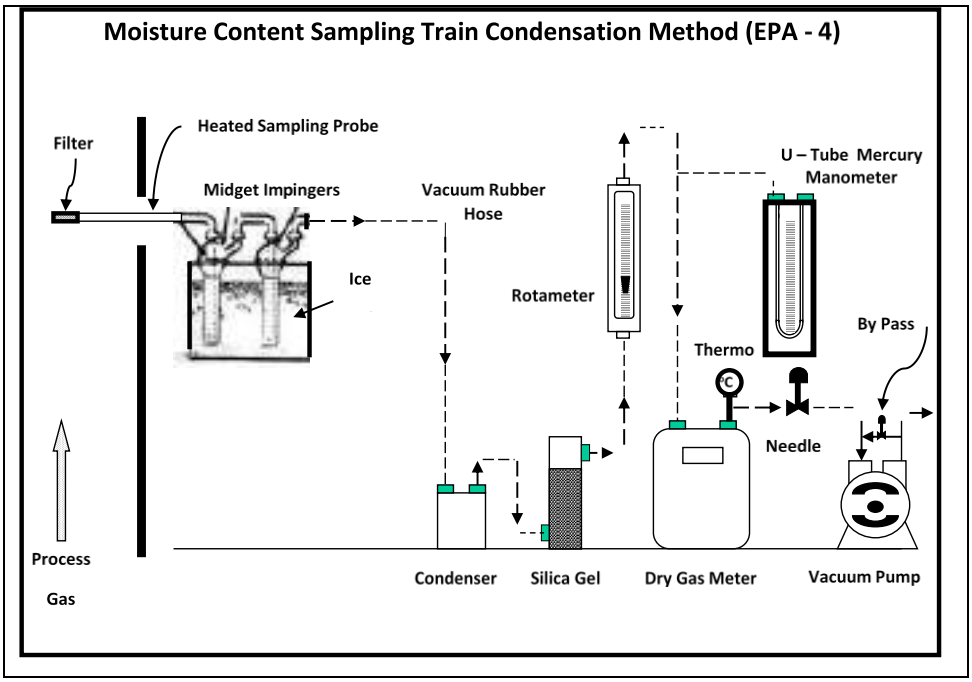
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS: NCTPS - ENNORE

STACK- 1: M/s. NCTPS, ESP UNIT-1 (TPP 210 MW) STACK INLET AND OUTLET

LOCATION - ESP UNIT-1 (TPP 210 MW) STACK INLET AND OUTLET, ENNORE					
S.NO	**POLLUTANT**	**UNIT**	**ESP UNIT-1 (TPP210 MW) INLET**	**ESP UNIT-1 (TPP210 MW) OUTLET**	**EFFICIENCY (%)**
1	Stack Temperature	K	389	383	NA
2	Oxygen as O_2	%	13.7	13.7	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	BDL	NA
4	Carbon Dioxide as CO_2	%	7.6	6.8	NA
5	Particulate Matter	mg/Nm^3	19668	2196	88.83
6	Sulphur Dioxide as SO_2	mg/Nm^3	995	906	NA
7	Oxides of Nitrogen as NO_2	mg/Nm^3	265	253	NA

Particulate Matter concentration ESP UNIT-1 TPP 210 MW Stack inlet is 19668 mg/Nm^3 and Outlet are 2196 mg/Nm^3. The mass emission flow rate on the ESP UNIT-1 TPP 210 MW Stack Outlet is 66634 kg/day. The Efficiency of ESP connected to Boiler is 88.83 %.

STACK- 2: M/s. NCTPS, ESP UNIT-3 (TPP 210 MW) STACK INLET AND OUTLET

LOCATION - ESP UNIT-3 (TPP 210 MW) STACK INLET AND OUTLET, ENNORE					
S.NO	**POLLUTANT**	**UNIT**	**ESP UNIT-3 (TPP210 MW) INLET**	**ESP UNIT-3 (TPP210 MW) OUTLET**	**EFFICIENCY (%)**
1	Stack Temperature	K	393	388	NA
2	Oxygen as O_2	%	11.7	13	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	BDL	NA
4	Carbon Dioxide as CO_2	%	8.5	7.3	NA
5	Particulate Matter	mg/Nm^3	17747	710	96
6	Sulphur Dioxide as SO_2	mg/Nm^3	1112	1000	NA
7	Oxides of Nitrogen as NO_2	mg/Nm^3	301	301	NA

Particulate Matter concentration ESP UNIT-3 TPP 210 MW Stack inlet is 17747 mg/Nm^3 and Outlet are 710 mg/Nm^3. The mass emission flow rate on the ESP UNIT-3 TPP 210 MW Stack inlet is outlet 21775 kg/day. The Efficiency of ESP connected to Boiler is 96 %.

Stack Consolidated Monitoring Results:

S.NO	Compound Method	UNIT	ESP UNIT-1 (TPP210 MW) OUTLET	ESP UNIT-3 (TPP210 MW) OUTLET	CPCB LIMIT
1	Stack Temperature	K	383	388	NA
2	Oxygen as O_2	%	13.7	13	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	BDL	NA
4	Carbon Dioxide as CO_2	%	6.8	7.3	NA
5	Particulate Matter	mg/Nm^3	2196	710	50
6	Sulphur Dioxide as SO2	mg/Nm^3	906	1000	200
7	Oxides of Nitrogen as NO_2	mg/Nm^3	253	301	450

In Stack Emission monitoring at ESP UNIT-1 (TPP210 MW) OUTLET and ESP UNIT-3 (TPP210 MW) OUTLET the stacks are not complying for Particulate Matter Concentration of 2196mg/Nm^3 and 710mg/Nm^3 against the CPCB Emission Limit value of 50mg/Nm^3 and Sulphur Dioxide Concentration of 906mg/Nm^3 and 1000 mg/Nm^3 against the CPCB Emission Limit value of 200mg/Nm^3 and Oxides of Nitrogen parameter are complying with the CPCB Limit.

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

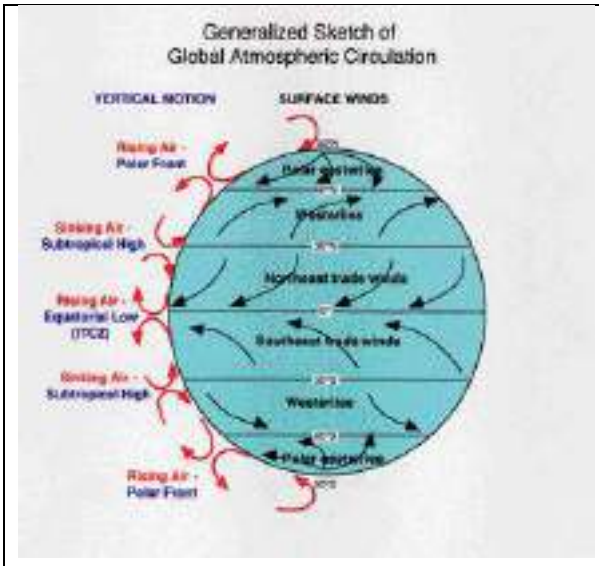
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from NTECL, Athipattu Pudhnager. For our simulations, the required

source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

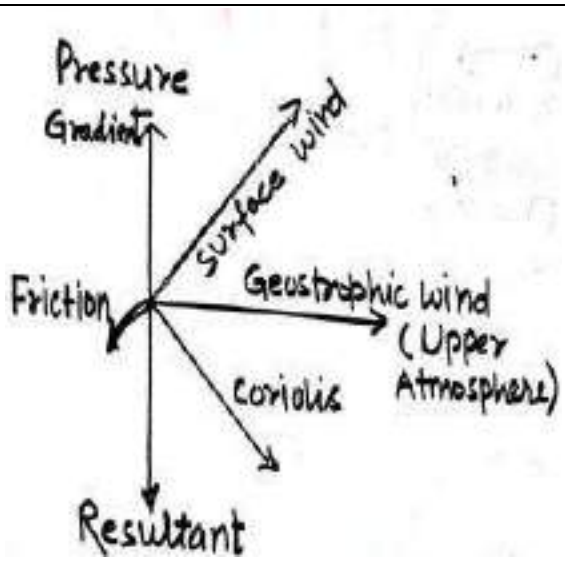
The AERMOD model was applied to study the diffusion of pollutants from NTECL, Athipattu Pudhnager and other sources in three days from 26.07.2021 to 28.07.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

NCTPS ENNORE ESP Unit 1 (TPP 210 MW) Outlet

Particulate matter:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	32.77
PM Concentration, mg/m3	-	2196
Emission load, gm/Sec	-	771.2
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	32.77
NOx Concentration, mg/m3	-	253
Emission load, gm/Sec	-	88.9
Plume rise, m	-	4

Sulphur dioxide as SO2

Stack Height, m	-	275
Exit Velocity, m/Sec	-	32.77
SO2 Concentration, mg/m3	-	906
Emission load, gm/Sec	-	318.2
Plume rise, m	-	4

Carbon Monoxide as CO

Stack Height, m	-	275

Exit Velocity, m/Sec	-	32.77
CO Concentration, mg/m3	-	6.8
Emission load, gm/Sec	-	2.4
Plume rise, m	-	4

ESP Unit 3 (TPP 210 MW) Outlet

Particulate matter:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	33.57
PM Concentration, mg/m3	-	710
Emission load, gm/Sec	-	252
Plume rise, m	-	4

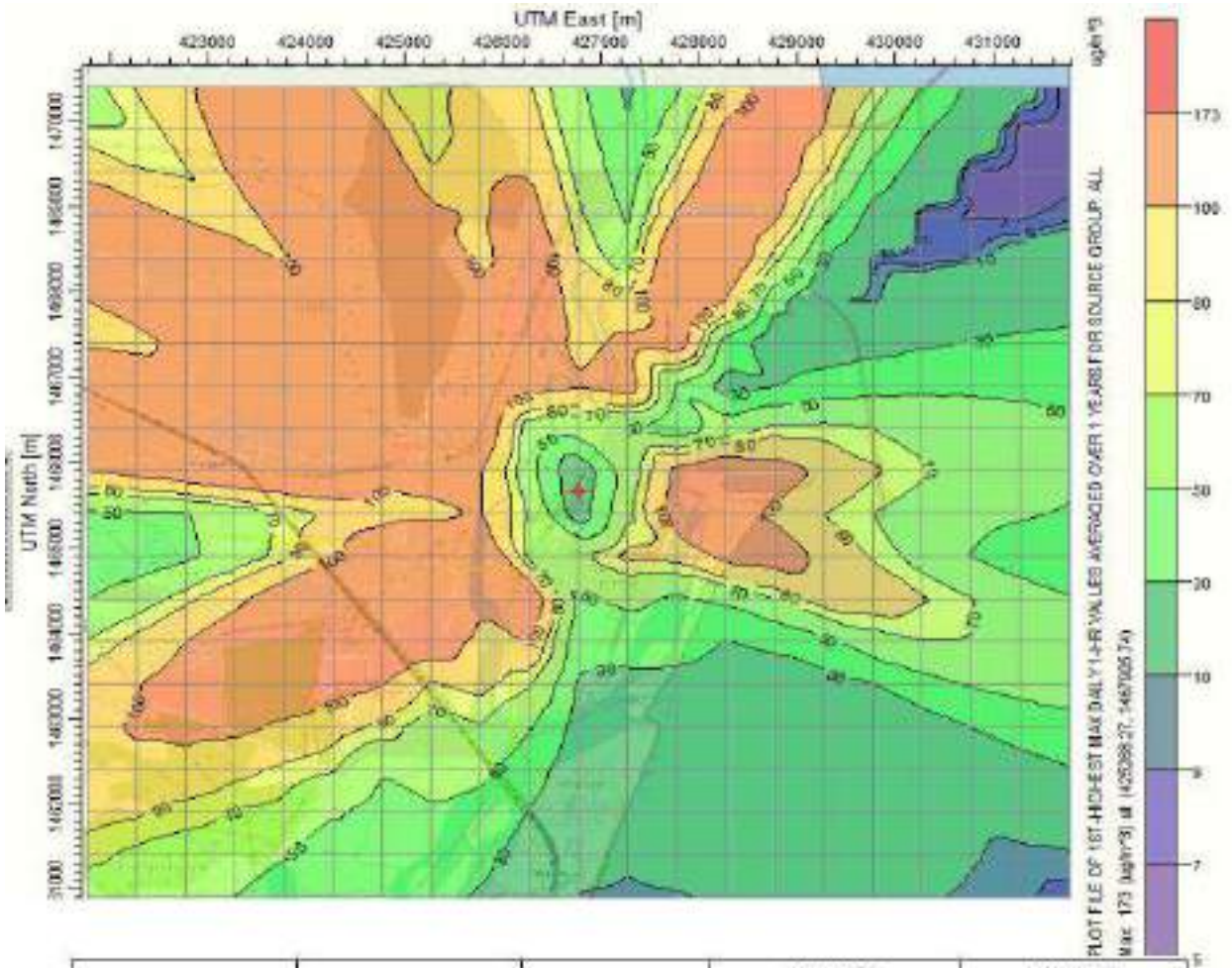
Oxides of Nitrogen as NO2:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	33.57
NOx Concentration, mg/m3	-	301
Emission load, gm/Sec	-	106.8
Plume rise, m	-	4

Sulphur dioxide as SO2

Stack Height, m	-	275
Exit Velocity, m/Sec	-	33.57
SO2 Concentration, mg/m3	-	1000
Emission load, gm/Sec	-	355
Plume rise, m	-	4

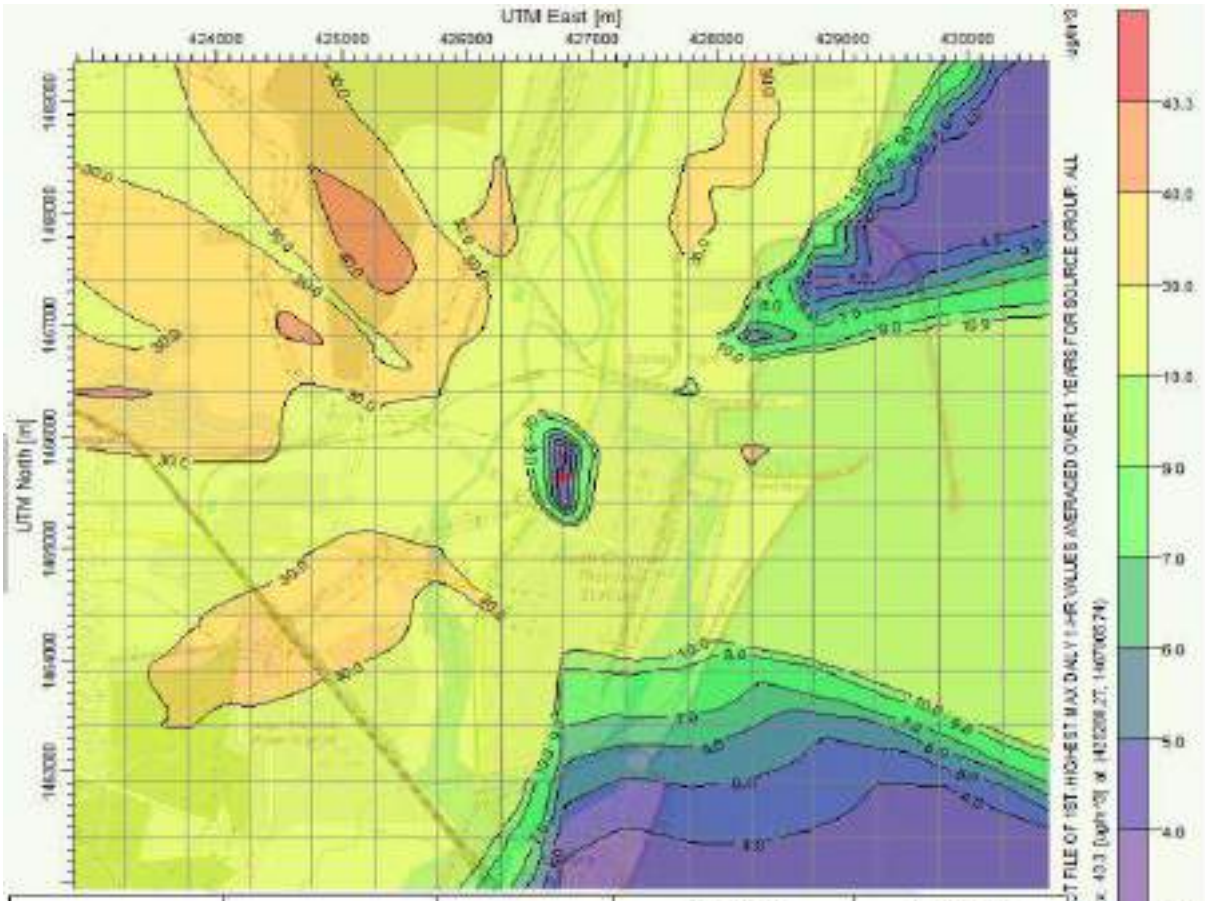
STACK EMISSION DISPERSION MODELLING – ESP UNIT-1 (210 MW) OUTLET@ 2 & 5KM – PARTICULATE MATTER



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
2196	2.45	173	206	0.4671

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Particulate matter concentration is 2196mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.45 km at the concentration of 173 µg/m^3 at 2km dispersion Particulate matter is 206 µg/m^3 and at 5km dispersion Particulate matter is 0.4671 µg/m^3 and the predominant wind direction is SW.

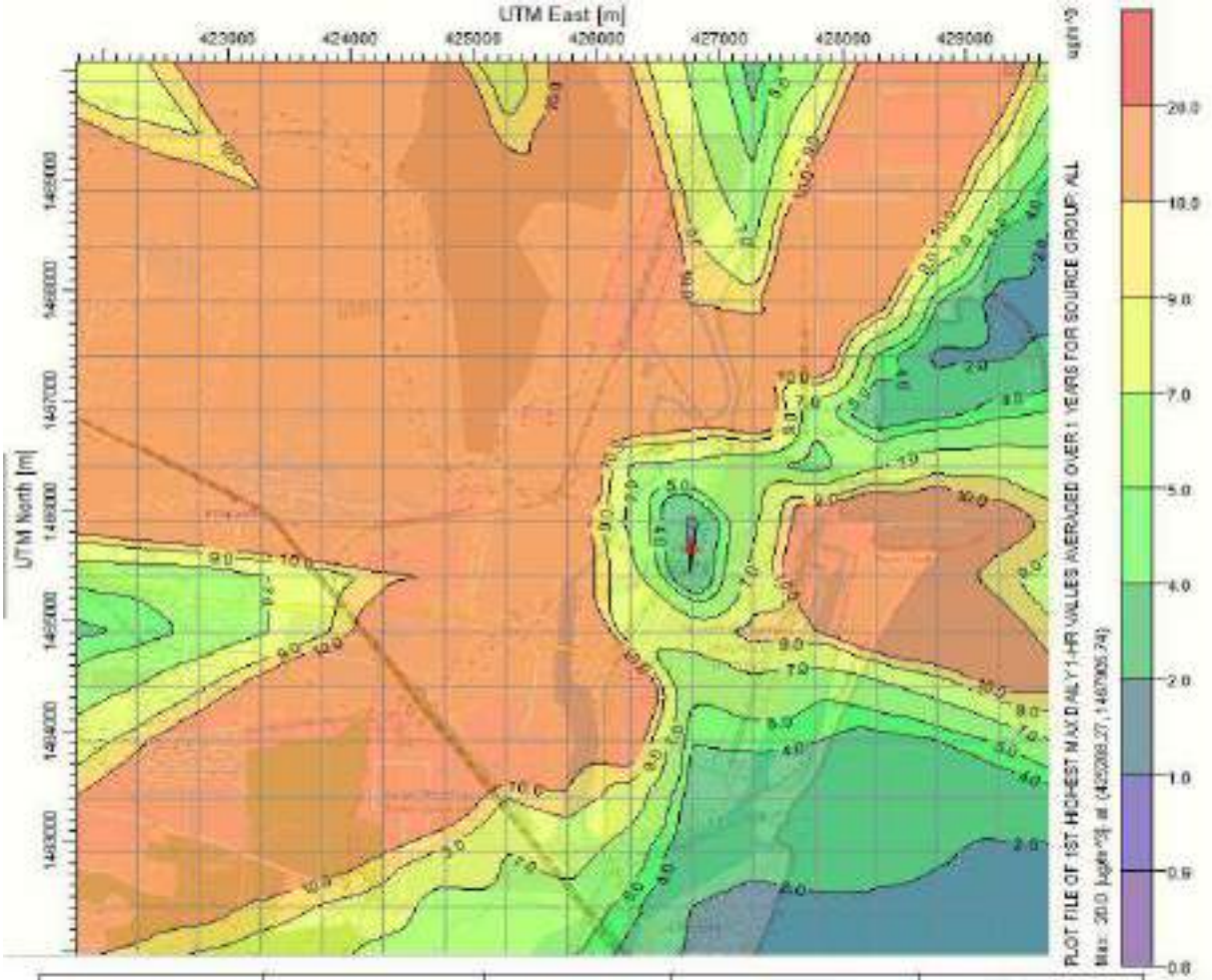
STACK EMISSION DISPERSION MODELLING – ESP UNIT-1 (210 MW) OUTLET@ 2 & 5KM- Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
906	2.16	43.3	1.76	0.123

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Sulphur dioxide concentration is 906mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.16km at the concentration of 43.3µg/m^3 at 2km dispersion Sulphur dioxide is 1.76µg/m^3 and at 5km dispersion Sulphur dioxide is 0.123µg/m^3 and the predominant wind direction is SW.

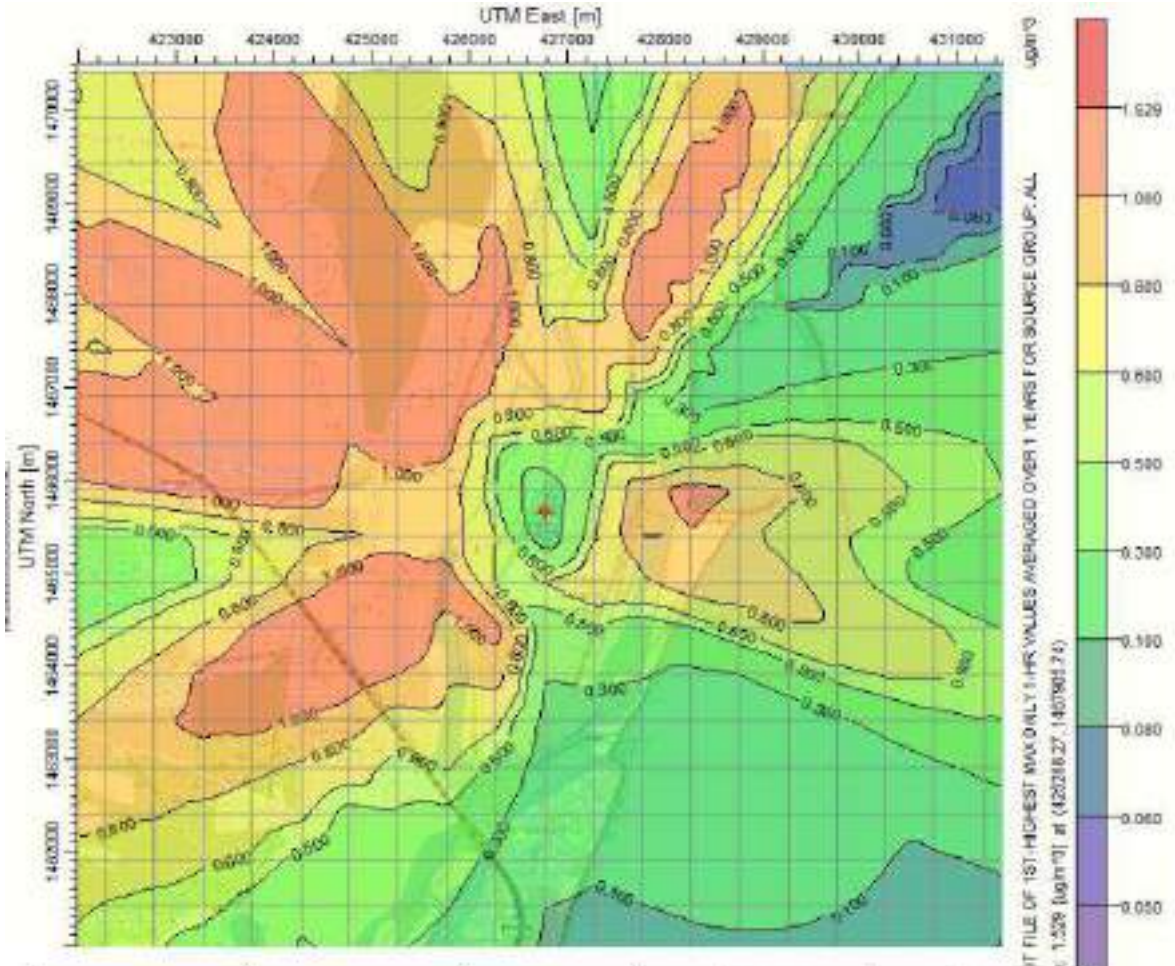
STACK EMISSION DISPERSION MODELLING – ESP UNIT-1 (210 MW) OUTLET@ 2 & 5KM- Oxides of Nitrogen



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
253	2.05	20	0.977	0.0689

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Oxides of Nitrogen concentration is 253mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.05km at the concentration of 20µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.977µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0689µg/m^3 and the predominant wind direction is SW.

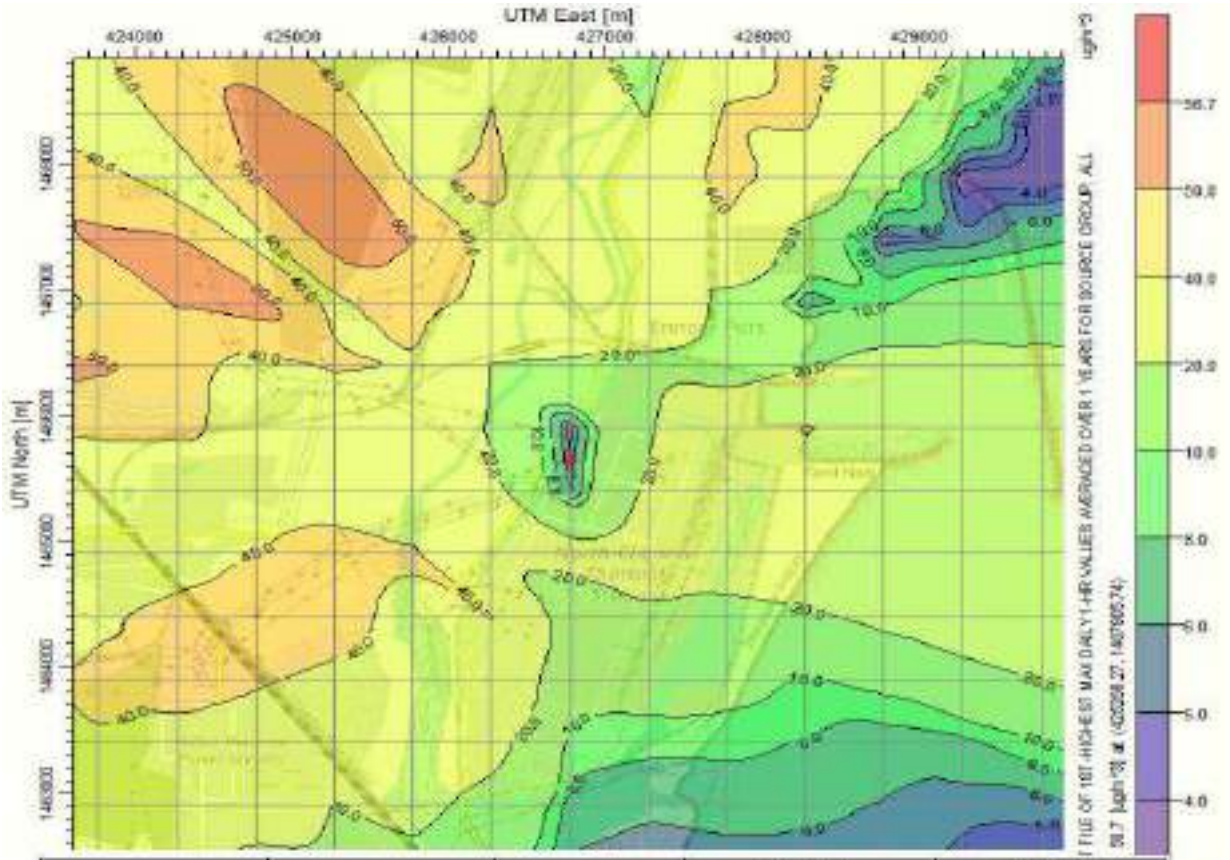
STACK EMISSION DISPERSION MODELLING – ESP UNIT-1 (210 MW) OUTLET@ 2 & 5KM- Carbon Monoxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
6.8	2.33	1.529	0.588	0.8976

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Carbon Monoxide concentration is 6.8mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.33km at the concentration of 1.529µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.588µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.8976µg/m^3 and the predominant wind direction is SW.

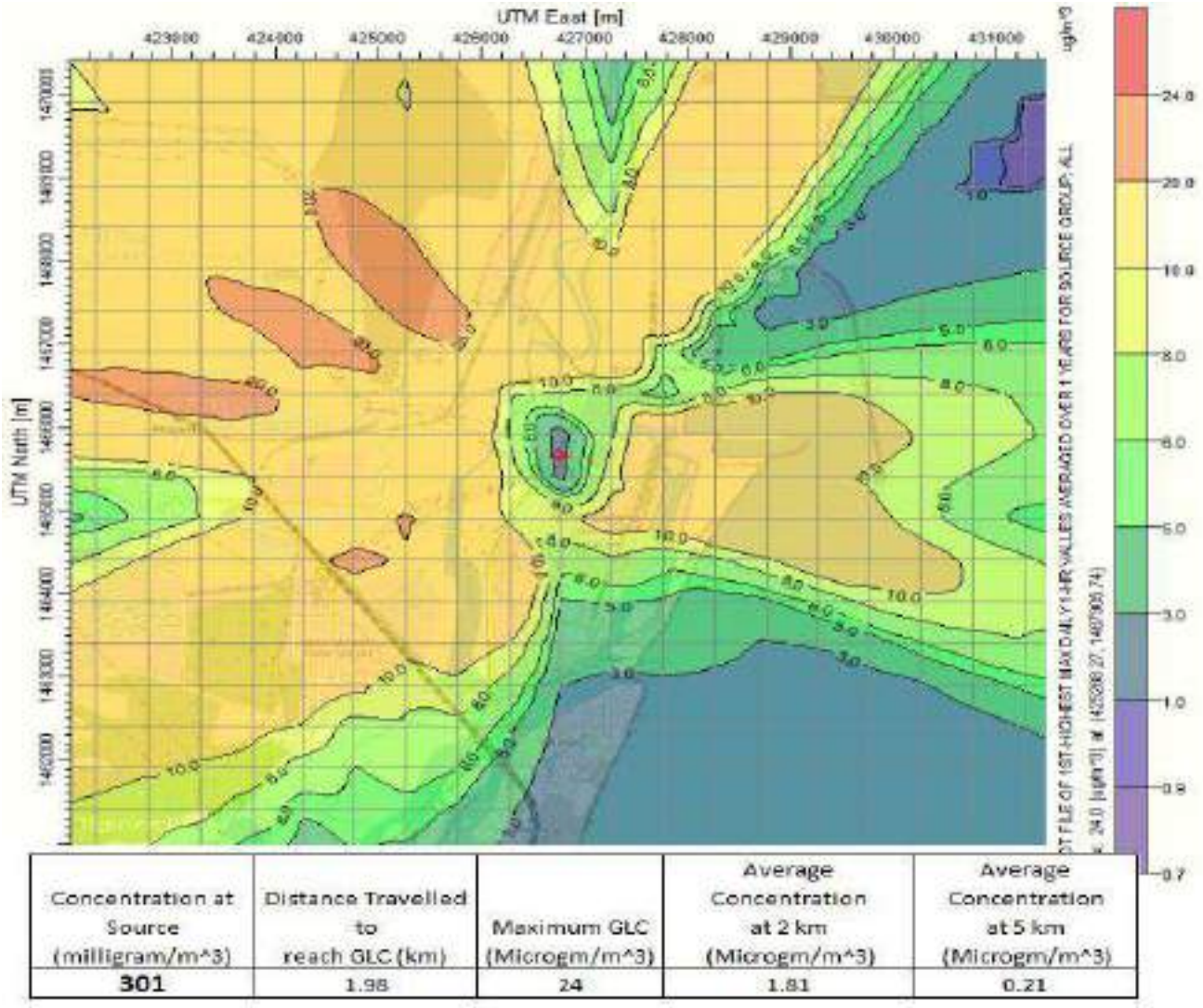
STACK EMISSION DISPERSION MODELLING – ESP UNIT-3 (210 MW) OUTLET@ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
710	1.99	56.7	1.11	0.86

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Particulate matter concentration is 710mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.99km at the concentration of 56.7µg/m^3 at 2km dispersion Particulate matter is 1.11µg/m^3 and at 5km dispersion Particulate matter is 0.86µg/m^3 and the predominant wind direction is SW.

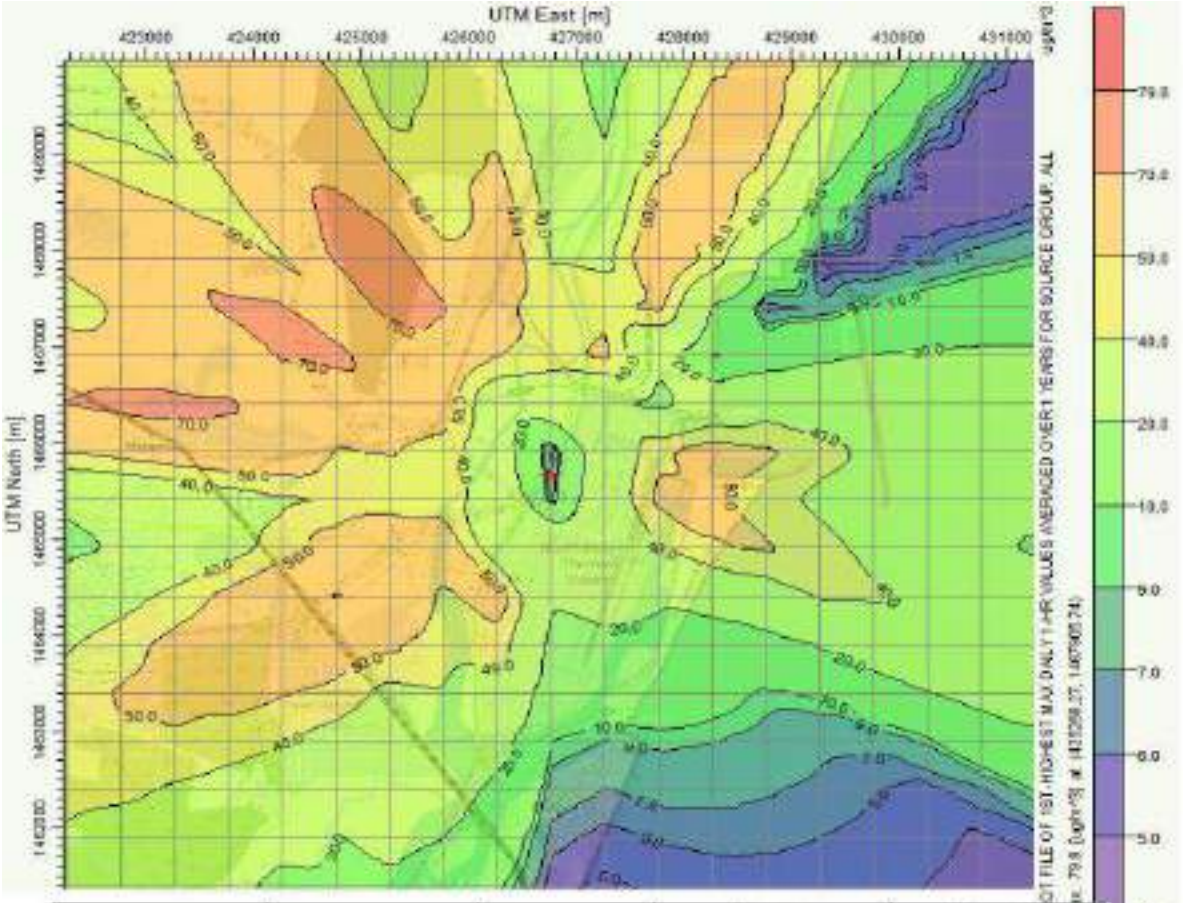
STACK EMISSION DISPERSION MODELLING – ESP UNIT-3 (210 MW) OUTLET@ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
301	1.98	24	1.81	0.21

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Oxides of Nitrogen concentration is 301mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.98km at the concentration of 24µg/m^3 at 2km dispersion Oxides of Nitrogen is 1.81µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.21µg/m^3 and the predominant wind direction is SW.

STACK EMISSION DISPERSION MODELLING – ESP UNIT-3 (210 MW) OUTLET@ 2 & 5KM – Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
1000	2.16	79.8	2.67	0.87

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Sulphur dioxide concentration is 1000 mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.16km at the concentration of 79.8µg/m^3 at 2km dispersion Sulphur dioxide is 2.67µg/m^3 and at 5km dispersion Sulphur dioxide is 0.87µg/m^3 and the predominant wind direction is SW.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)
ESP Unit 1	PM	2196	2.45	173	206	0.4671
ESP Unit 1	SO2	906	2.16	43.3	1.76	0.123
ESP Unit 1	NOX	253	2.05	20	0.977	0.0689
ESP Unit 1	CO	6.8	2.33	1.529	0.588	0.8976
ESP UNIT-3	PM	710	1.99	56.7	1.11	0.86
ESP UNIT-3	NOx	301	1.98	24	1.81	0.21
ESP UNIT-3	SO2	1000	2.16	79.8	2.67	0.87

10. FINDINGS ON AIR POLLUTION MONITORING:

10.1 Ambient Air Quality –DAY-1

In Ambient Air Quality monitoring four sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are 33/11 KAV Substation, ECHS Control Room LCSS-2, Feed Oil Pump House and Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15 to 20.7µg/m^3. Highest value of 20.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 22 to 29.9µg/m^3. Highest value of 29.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.5 to 64.8µg/m^3. Highest value of 64.8µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.6 to 28.5µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

10.2 Ambient Air Quality –DAY-2

In Ambient Air Quality monitoring four sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are 33/11 KAV Substation, ECHS Control Room LCSS-2, Feed Oil Pump House and Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.3 to 21.5µg/m^3. Highest value of 21.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 21.4 to 26.1µg/m^3. Highest value of 26.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 46.5 to 62µg/m^3. Highest value of 62µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.6 to 29.2µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

10.3 Stack monitoring

Particulate Matter concentration ESP UNIT-1 TPP 210 MW Stack inlet is 19668 mg/Nm^3 and Outlet are 2196 mg/Nm^3. The mass emission flow rate on the ESP UNIT-1 TPP 210 MW Stack Outlet is 66634kg/day. The Efficiency of ESP connected to Boiler is 88.83 %.

Particulate Matter concentration ESP UNIT-3 TPP 210 MW Stack inlet is 17747 mg/Nm^3 and Outlet are 710mg/Nm^3. The mass emission flow rate on the ESP UNIT-3 TPP 210 MW Stack inlet is outlet 21775kg/day. The Efficiency of ESP connected to Boiler is 96 %.

In Stack Emission monitoring at ESP UNIT-1 (TPP210 MW) OUTLET and ESP UNIT-3 (TPP210 MW) OUTLET the stacks are not complying for Particulate Matter Concentration of 2196mg/Nm^3 and 710mg/Nm^3 against the CPCB Emission Limit value of 50mg/Nm^3 and Sulphur Dioxide Concentration of 906mg/Nm^3 and 1000 mg/Nm^3 against the CPCB Emission Limit value of 200mg/Nm^3 and Oxides of Nitrogen parameter are complying with the CPCB Limit.

10.4 ESP UNIT-1

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Particulate matter concentration is 2196mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.45km at the concentration of 173µg/m3 at 2km dispersion Particulate matter is 206µg/m^3 and at 5km dispersion Particulate matter is 0.4671µg/m^3 and the predominant wind direction is SW.

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Sulphur dioxide concentration is 906mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.16km at the concentration of 43.3µg/m^3 at 2km dispersion Sulphur dioxide is 1.76µg/m^3 and at 5km dispersion Sulphur dioxide is 0.123µg/m^3 and the predominant wind direction is SW

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Oxides of Nitrogen concentration is 253mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.05km at the concentration of 20µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.977µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0689µg/m^3 and the predominant wind direction is SW.

ESP UNIT-1 (210 MW) OUTLET BOILER emission of Carbon Monoxide concentration is 6.8mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 32.77 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.33km at the concentration of 1.529µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.588µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.8976µg/m^3 and the predominant wind direction is SW.

10.5 ESP UNIT-3

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Particulate matter concentration is 710mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and

contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.99km at the concentration of 56.7µg/m^3 at 2km dispersion Particulate matter is 1.11µg/m^3 and at 5km dispersion Particulate matter is 0.86µg/m^3 and the predominant wind direction is SW.

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Oxides of Nitrogen concentration is 301mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.98km at the concentration of 24µg/m^3 at 2km dispersion Oxides of Nitrogen is 1.81µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.21µg/m^3 and the predominant wind direction is SW.

ESP UNIT-3 (210 MW) OUTLET BOILER emission of Sulphur dioxide concentration is 1000 mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.57m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.16km at the concentration of 79.8µg/m^3 at 2km dispersion Sulphur dioxide is 2.67µg/m^3 and at 5km dispersion Sulphur dioxide is 0.87µg/m^3 and the predominant wind direction is SW.

10.6 Cumulative Particulate Matter Emissions from All Stacks:

Stack Consolidate emission of Particulate matter concentration is 2906 mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 4.0m) with exit velocity of 33.17m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.22km at the concentration of 114.85µg/m^3 at

2km dispersion Particulate matter is 2.215µg/m^3 and at 5km dispersion Particulate matter is 0.664µg/m^3 and the predominant wind direction is ESE.

Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from NCTPS Stage-1 to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit values. The NCTPS Stage-1 plant is surrounded by residential areas like 1. Ennore fish Market, 2.Attipattu pudu Nagar, 3.NTECL Township, 4.Athipet and 5.L&T Vinayaga Temple. From NCTPS Stage-2 to Ennore fish Market aerial distance is 3.24km, to Attipattupudu Nagar is 2.9km, to NTECL Township is 4.02km, to Athipet is 4.02km and to L&T Vinayaga Temple is 4.3km.

The cumulative particulate matter emissions from NCTPS Stage-1 through stacks is 2906 mg/m^3. The average ground level concentration achieves at an average distance of 2.22km and the sum of PM concentration at GLC is 114.85 µg/m^3 which includes all the stacks at NCTPS Stage-1. It clearly indicates the PM contribution to the nearby communities is exceeding the ambient air quality standards and carrying capacity in this area is exceeding.

The cumulative Sulphur Dioxide emissions from NCTPS Stage-1 through stacks is 1906 mg/m^3. The average ground level concentration achieves at an average distance of 2.16km and the sum of Sulphur Dioxide concentration at GLC is 61.55 µg/m^3 which includes all the stacks at NCTPS Stage-1. It clearly indicates the SO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from NCTPS Stage-1 through stacks is 554 mg/m^3. The average ground level concentration achieves at an average distance of 2.015km and the sum of Nitrogen Oxides concentration at GLC is 22 µg/m^3 which includes all the stacks at NCTPS Stage-1. It clearly indicates the NOx contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

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Annexure-IV

Report on

Environmental Monitoring and Analysis and Source Dispersion Modelling at Manali

NTECL, ATHIPATTU PUDHUNAGAR, CHENNAI

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. ABOUT

GENERAL INFORMATION ABOUT THE NTECL VALLUR THERMAL POWER PLANT

NTPC Tamil Nadu Energy Company Ltd (NTECL) is a joint venture company between TANGEDCO (a Tamil Nadu state government undertaking and NTPC Ltd (a Central govt Undertaking) operating 3x 500 MW Vallur Thermal Power Station. NTECL has installed the Power station in two phases namely Phase 1 and Phase 2. Phase 1 comprises of 2 x 500 MW plant called Unit 1 and Unit 2. Phase 2 comprises of 1 x 500 MW plant called Unit 3. NTECL had obtained

S.No	Description	Reference No	date
1.	Environmental Clearance for Phase -1 (2*500MW)	NO.J-13011/33/2006-IA.II(T)	18.04.2007
2.	Environmental Clearance for Phase -II (1*500MW)	NO.J-13011/62/2008-IA.II(T)	03.06.2009
3.	CRZ Clearance for the project	NO.11-22/2009-IA. III	14.07.2009
4.	CTO Air	1908212404647	25.01.2019
5	CTO Water	1908112404647	25.01.2019

The synopsis of the NTECL Vallur are as below

Name of the Factory	NTPC Tamilnadu Energy Company Limited, (A 50:50 Joint venture company of NTPC and TANGEDCO) Vallur Thermal Power Project, P.O. Villvoyal Chavadi, Ponneri Taluk –600103 District : Tiruvallur, Chennai (Tamilnadu)
Nature of Industry Capacity	Coal based 'Thermal Power Plant' having generation capacity of 1500 MW (3 units of 500 MW each). Phase-I: 1000 MW (2x500) Phase-II: 500MW (1x500) Total : 1500MW
Location	Plant is spread over in 1139 acres land Major portion of land acquired from salt pan area (Main Plant in 470 Acres, Ash Dyke in 524 acres

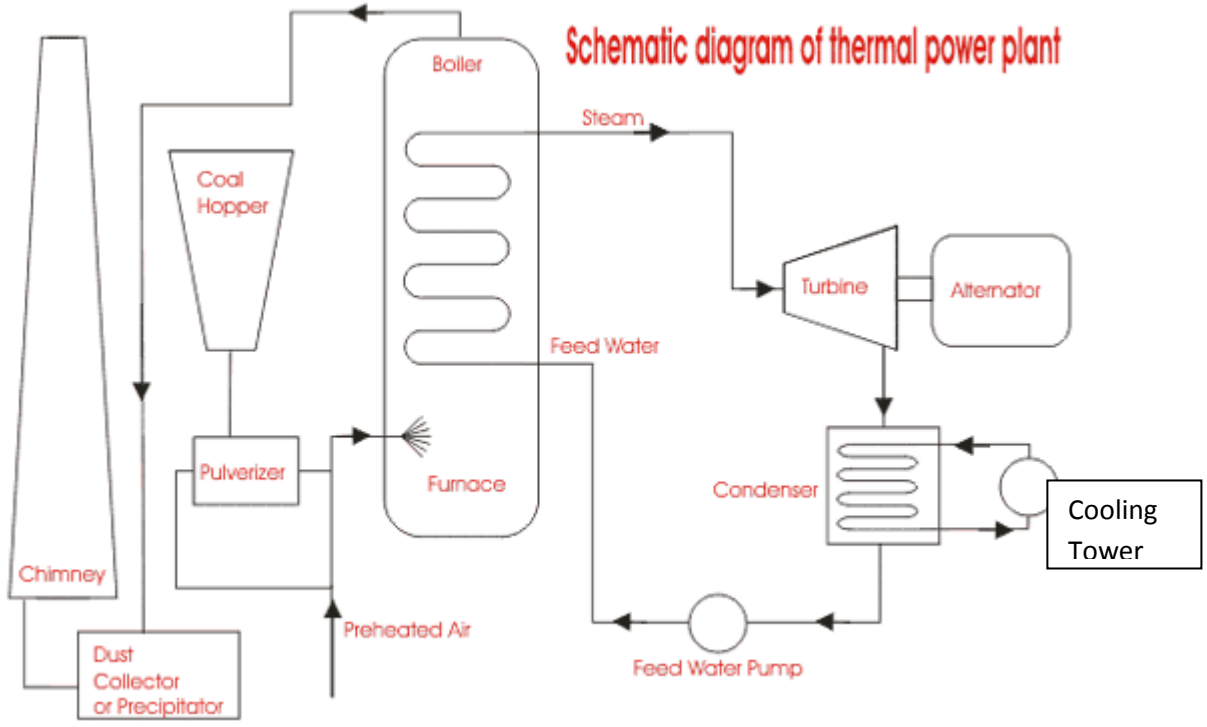
	Balance conveyor corridor and township etc) Distances: i) 25KMs.(approx) - Chennai Central Rly Station on South side near Attipattu Pudunagar Rly. Station. ii) 50 KMs from 'Chennai Air Port' towards north.
Beneficiary States	The majority of the power generated from power station is supplied to Tamil Nadu (70.74%) and the rest of power is supplied to other Southern states (AP, Telangana, Karnataka, Kerala and Puducherry).
FUEL REQUIREMENT	*Raw Coal* – Requirement is 24000 MT/day.
STARTUP FUEL	LIGHT DIESEL OIL (LDO) – is stored in surface tanks for start-up and to maintain temperature in boilers as and when required.
Fuel Transportation	Domestic coal-By rail from MCL/CCL/ECL to Paradip Port / Dhamra Port, Odisha. From Paradip port to Ennore Port in Chennai by Ship & from Ennore Port to Plant by conveyor system(5 km long including 4.35km of single stream pipe conveyor.)
Water source	Sea water drawn from NCTPS , to meet the requirement of desalination plant for sweet water requirement , CW and Ash handling plant.
Steam generation	1715 T / Hour Per Boiler
ESP	Each boiler is provided with ESP The ESP specifications are 4 pass per unit 80 fields / unit Efficiency 99.9%
FGD and combustion modification	The work awarded and target completion by Dec 2022
Chimney	Flue gases are let out through chimney of height 275 meter. The stack parameters are transmitted on line to TNPCB
Associated Transmission system (ATS)	▪ Total outgoing 6 feeders ▪ 2 tie-feeders to NCTPS/TANGEDCO, owned by TANTRANSCO ▪ 2 feeders to Alamaty, owned by TANTRANSCO

	▪ 2 feeders to Kalivanthapattu ,owned by PGCIL
DG set for 5Emergency back up	▪ 1250 KVA – 4 NOS provided with 25 meter height stack
STP	▪ Plant is provided with STP of cap 75 KLD ▪ Township is provided with STP of cap 1.2 MLD
Effluent	▪ Effluents from the system are collected in central monitoring basin and discharged to NCTPS lagoon as per the EC conditions. The effluent water quality are monitored on continuous basis and maintained within the prescribed limit. The effluent parameters are transmitted on line to TNPCB
Ambient Air Quality Monitoring System	▪ The ambient air quality monitoring systems are located at four places in nearby villages, and the air quality parameters are transmitted online to TNPCB. ▪ The locations are as follows ▪ Athipattu ▪ Kondakarai ▪ Kathivakkam ▪ Vichur

Principle of operation of thermal power plant

A Thermal **power generation plant** mainly consists of alternator runs with help of steam turbine. The steam is obtained from high pressure boilers. The bituminous coal is used in the boiler in powder form by using the coal pulverizer. In **thermal power plant**, the steam is produced in high pressure in the steam boiler due to burning of fuel (pulverized coal) in boiler furnace. This steam is further supper heated in a super heater. This superheated steam then enters into the turbine and rotates the turbine blades. The turbine is mechanically coupled with alternator that its rotor will rotate with the rotation of turbine blades. The high pressure steam after passes through the turbine blades the steam pressure falls and corresponding volume of the steam increases. After imparting energy to the turbine rotor, the steam passes out of the turbine blades into the condenser. In the condenser, the cooling water is circulated with the help of a pump which condenses the low-pressure wet steam . This condensed water is again sent to boiler

Line Diagram of Power Plant



Water source at NTECL :

Vallur Thermal Power station is an entirely sea water based plant. The sea water taken from the intake channel at North Chennai thermal power station owned by TANGEDCO. The sea water pumped is used for cooling water makeup and desalination. The plant uses a closed cycle cooling water system with Induced draft cooling towers and hence the water intake is for only make up of losses. The cooling Water is blowed down from the system for maintaining salt concentration within prescribed operational limits. The cooling water blowdown is tapped from cold basin thus only the cooled water goes as effluent.

The DM water and the permeate water required for the plant is produced from sea water through reverse osmosis process. The service The DM water is used in power generation as a makeup in the cycle and the permeate water is used as service water and for fire water . The service water used in the coal handling plant area gets collected in the drains around the CHP which is sent to the coal settling pond. After settling in the coal settling pond the the clear water is pumped into the central monitoring basin. The effluents from the systems like desalination plant, cooling water blowdown and from the coal settling pond are collected in central monitoring basin from where it is pumped to the discharge point at the NCTPS outlet lagoon from there it flows down to sea as per the EC condition. The TSS, BOD, COD, pH and temperature of the effluent discharged are being is monitored and transmitted online to TNPCB and CPCB.

The sewage generated in the plant is processed in the sewage treatment plant. The effluent from the sewage treatment plant is used for horticulture in the industry's own land.

Fuel supply at NTECL

The coal required for NTECL Vallur is being supplied from domestic coal fields of mahanadhi coal fields , Central coal fields, and Eastern coal fields .

Domestic coal is transported by rail from MCL/CCL/ECL to Paradip Port/Dhamra Port, Odisha. From Paradip port to Ennore Port in Chennai by Ship & from Ennore Port to Plant by conveyor system(5 km long including 4.35km of single stream pipe conveyor.)

Coal is transported through closed conveyor belts and stored in the bunker from where it is taken to the pulverizer for crushing and grinding to the required size then transported to coal burner through coal pipes through primary air . An emergency stock of coal required fro 15 days operation of the plant is normally kept as reserve and stored inside the plant. The coal is stocked over the area which is covered with impervious layer of sheet so that the ground water pollution is avoided.

Fugitive emission control at NTECL

Electrostatic precipitator.

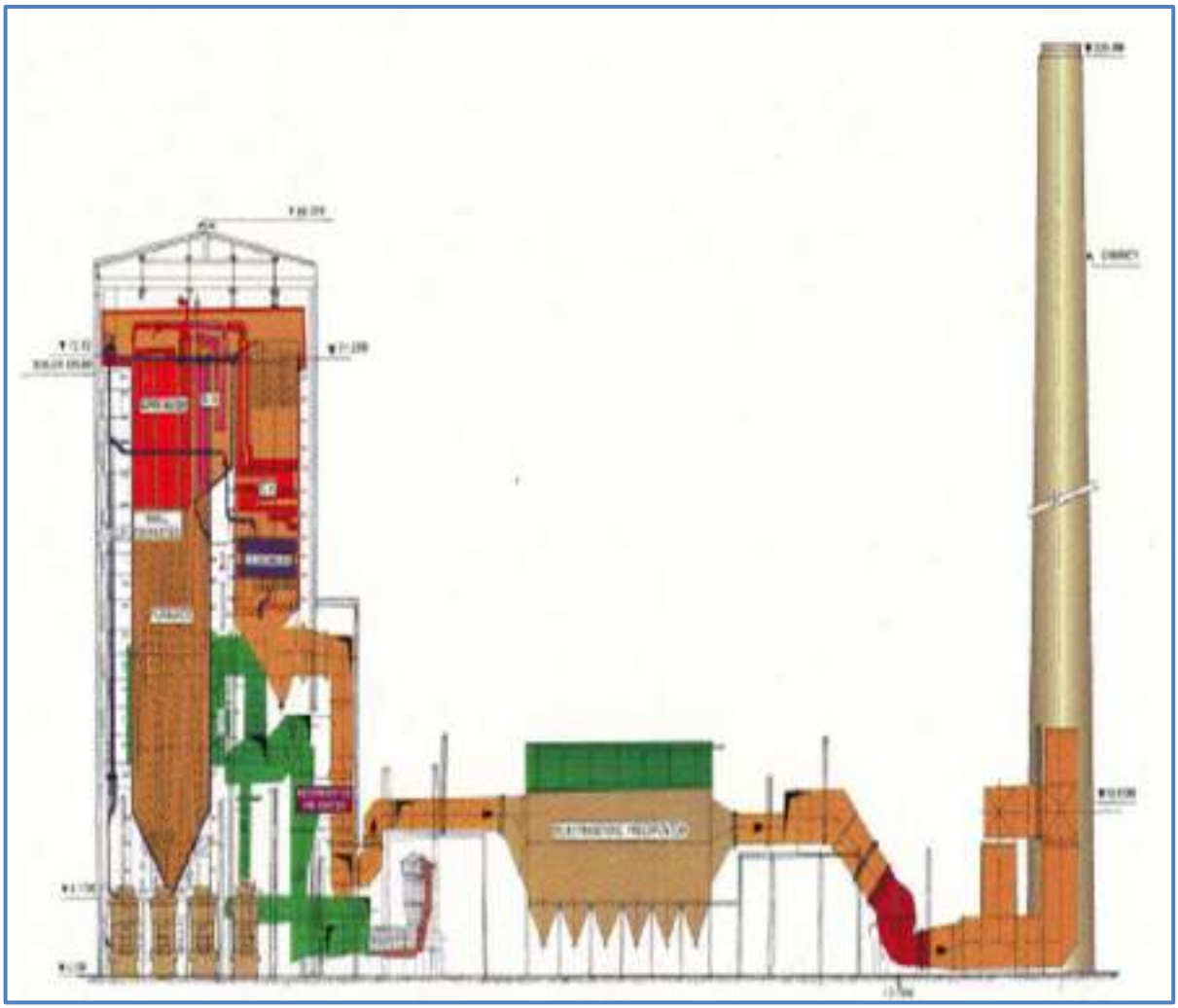
The flue gas from the boiler is sent to chimney through electrostatic precipitator where the suspended ash particles are removed and the clean flue gas is sent to atmosphere through chimney at 275 meter height. The flue gas discharged outside is monitored for the parameter of Particulate matter , So2 and Nox and maintained within the prescribed limits. These parameters are sent online to the TNPCB care air centre

The working principle of electro static precipitator

The Electrostatic precipitator essentially consists of two sets of electrodes called ' Collecting Electrodes ' and ' Emitting Electrodes' and (also called discharge electrodes). The collecting electrode is made up of steel sheet pressed to a special profile and the emitting electrode is a thin wire draw in to a helical form. A unidirectional high voltage is applied between these electrodes, connecting its negative polarity to the emitting electrodes and the positive polarity to collecting electrodes, which are also earthed. The dust laden flue gas from boiler passes between rows of collecting and discharge electrodes. The high voltage induces ionization of gas molecules adjacent to the negatively charged emitting electrodes. The positive charges of the ions created travel towards the discharge electrodes and the negative charges towards the collecting electrodes. On their way to the collecting electrodes, the negative charges get deposited on the dust particles. Thus the dust particles are electrically charged. In the presence of high electric field between the electrodes the charged dust particles experience a force which causes the particles to move towards the collecting electrodes and finally get deposited on them. Minor portions of the dust particles, which have acquired positive charges, get deposited on the emitting electrodes also. Periodically these are dislodged from the electrodes by a process called ' rapping '. The particles then fall into the hoppers at the bottom

The de dusted ash particles are collected in ESP the hopper which is later disposed through DRY/ wet ash evacuating system.

GENERAL ARRANGMENT OF 500 MW UNIT



Athipallu
NTPC Tamilnadu Energy

2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

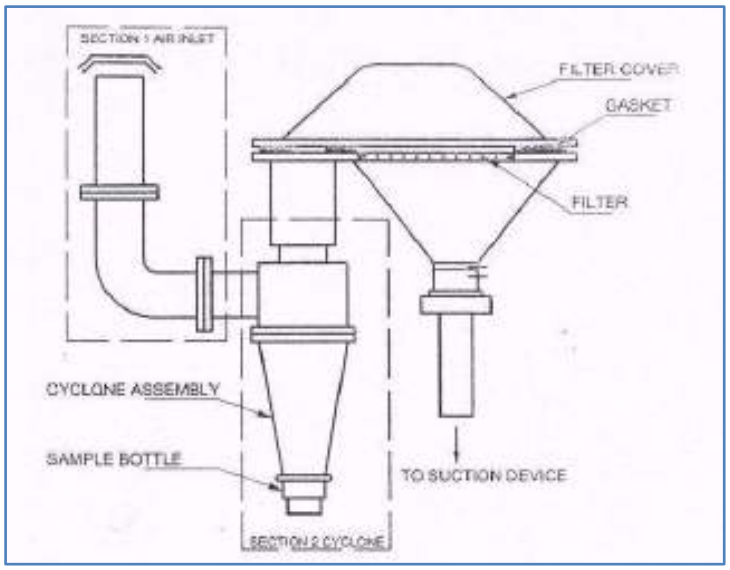
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, µg/m^3	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter

Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine PM2.5 mass concentration:

$PM_{2.5} = M2.5 / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (µg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting

50 ml of stock solution to 500 ml with distilled water.

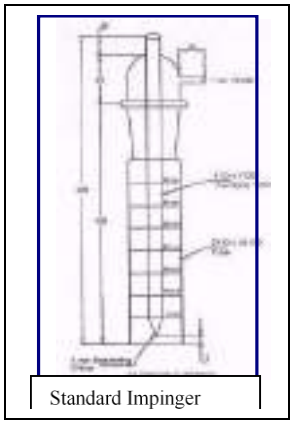
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{o}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml

V1 = Volume of thiosulfate for blank, ml

V2 = Volume of thiosulfate for sample, ml

N = Normality of thiosulfate

K = 32000 (Milliequivalent weight SO_2/µg)

V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO_2 = Concentration of Nitrogen dioxide, µg/m^3

A_s = Absorbance of sample

A_b = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m^3

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
Draw air at a sampling rate of 0.5 lpm for 8 hours
Check the volume of sample at the end of sampling and record it
Transfer the exposed samples in storage bottle and preserve
Prepare calibration graph as recommended in method
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
Add 1ml hydrogen peroxide,
Add 10ml Sulphanilamide
Add 1.4 ml NEDA
Make up to mark (50 ml.) with distilled water.
Keep it 10 minutes for reaction
Set Zero of spectrophotometer with Distilled water
Measure absorbance at 540 nm
Calculate concentration using calibration graph
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as

in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ )\ =\ (As\ -\ Ab)\ x\ CF\ /\ Va$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

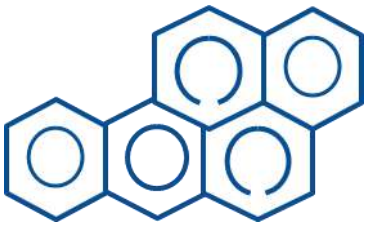
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

8 Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various

PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
Ultrasonic extraction with Toluene (50 ml × 3 times)
Filter & dry with Anhydrous Sodium Sulphate
Concentration with Rotary Evaporator
Clean up with Silica Gel Column Chromatography
Elution with Cyclo-Hexane (5 ml × 3 times)
Evaporate to nearly dryness under Nitrogen
Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H_2SO_4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.

Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples

Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V	=	Volume of air, m^3
Q	=	Average sampling rate, m^3/min.
T	=	Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

ATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Geek method -Ultraviolet Flurorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

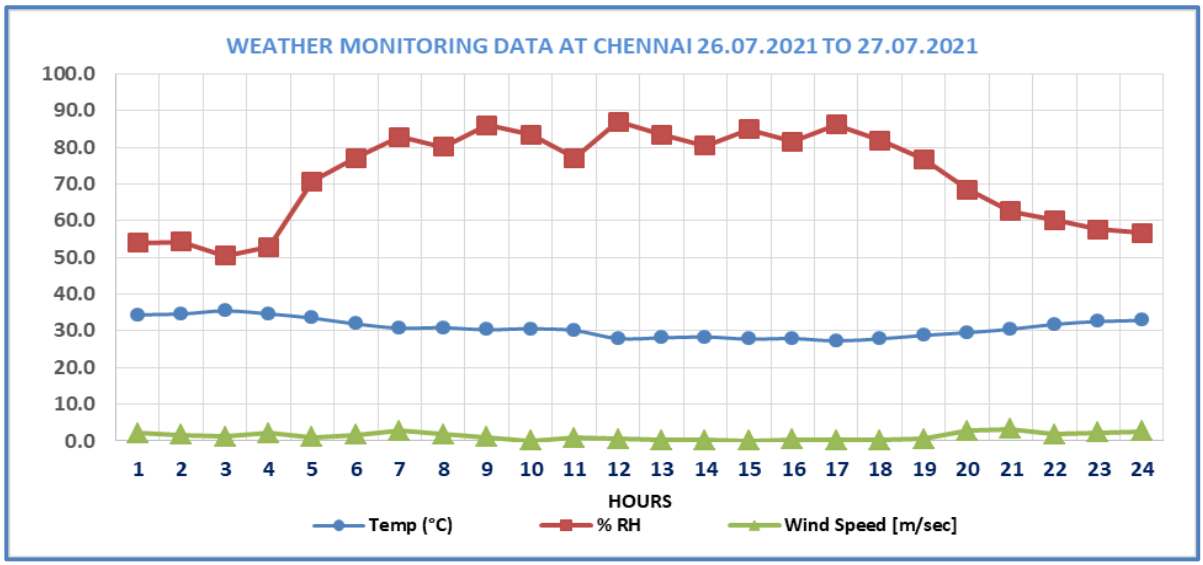
*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

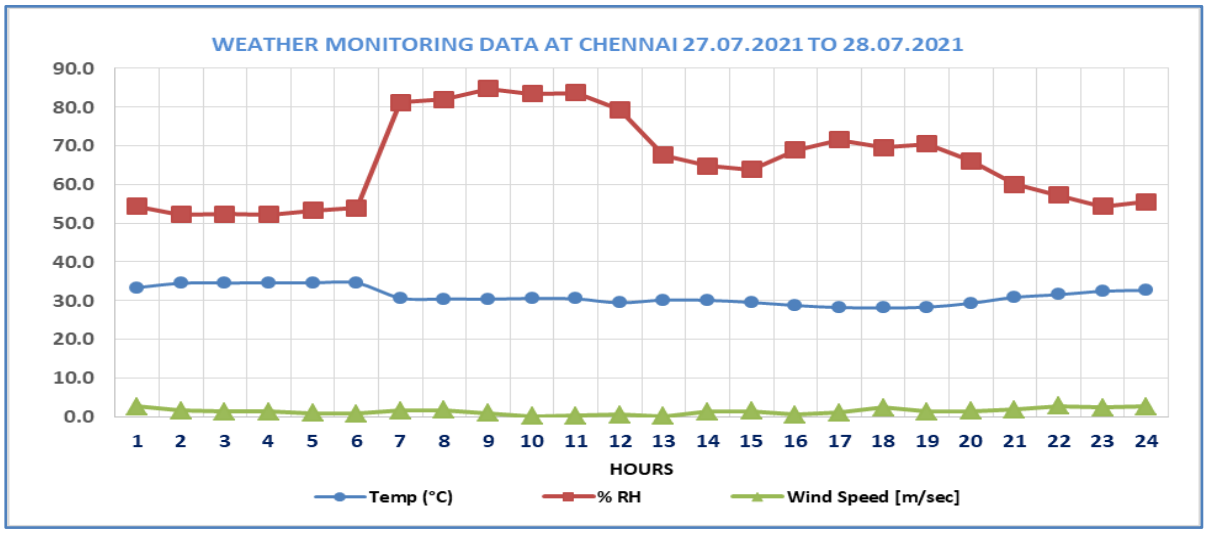
Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

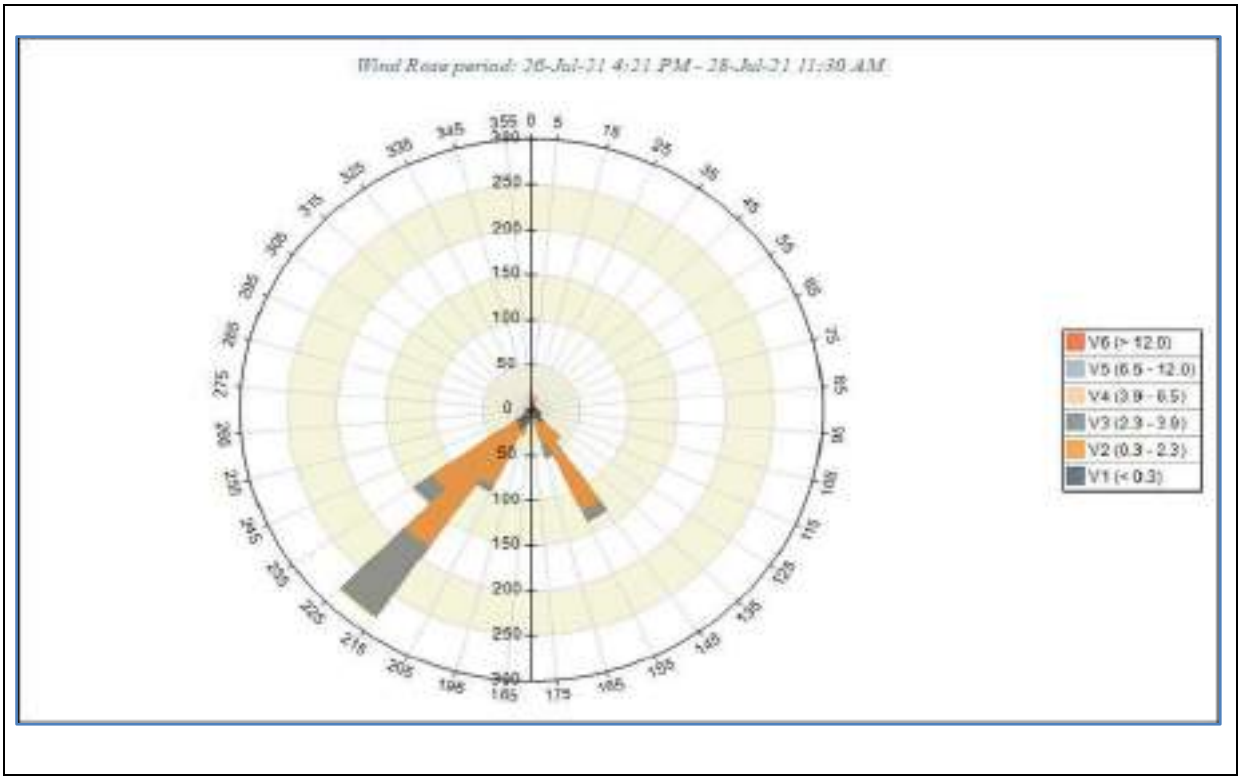
3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT NTECL - 26.07.2021 to 27.07.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
26.07.2021	1:00 PM	34.4	53.9	2.1	WSW
26.07.2021	2:00 PM	34.6	54.3	1.6	WSW
26.07.2021	3:00 PM	35.5	50.5	1.2	SW
26.07.2021	4:00 PM	34.7	52.8	2.1	SW
26.07.2021	5:00 PM	33.5	70.7	1.1	SW
26.07.2021	6:00 PM	31.9	77.1	1.7	SW
26.07.2021	7:00 PM	30.8	82.8	2.8	WSW
26.07.2021	8:00 PM	30.9	80.1	1.9	SSW
26.07.2021	9:00 PM	30.3	86	1.1	SSW
26.07.2021	10:00 PM	30.6	83.4	0.1	SW
26.07.2021	11:00 PM	30.1	77	0.9	SW
26.07.2021	12:00 AM	27.9	86.9	0.6	SW
27.07.2021	1:00 AM	28.1	83.5	0.2	SW
27.07.2021	2:00 AM	28.4	80.5	0.3	SW
27.07.2021	3:00 AM	27.8	84.9	0.1	SSW
27.07.2021	4:00 AM	27.9	81.5	0.4	SSW
27.07.2021	5:00 AM	27.3	86.2	0.2	SW
27.07.2021	6:00 AM	27.9	81.8	0.3	W
27.07.2021	7:00 AM	28.8	76.8	0.6	WSW
27.07.2021	8:00 AM	29.5	68.5	2.8	WNW
27.07.2021	9:00 AM	30.5	62.5	3.2	SW
27.07.2021	10:00 AM	31.8	60.1	1.9	SW
27.07.2021	11:00 AM	32.6	57.6	2.3	SSE
27.07.2021	12:00 PM	32.8	56.7	2.6	SSE
MIN		27.3	50.5	0.1	SW
MAX		35.5	86.9	3.2	
AVG		30.8	72.3	1.3	



WEATHER MONITORING DATA AT NTECL - 27.07.2021 to 28.07.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
27.07.2021	1:00 PM	33.4	54.3	2.7	SSE
27.07.2021	2:00 PM	34.5	52.2	1.6	SSW
27.07.2021	3:00 PM	34.6	52.3	1.3	SW
27.07.2021	4:00 PM	34.6	52.2	1.3	SW
27.07.2021	5:00 PM	34.6	53.3	0.9	WSW
27.07.2021	6:00 PM	34.6	54	0.8	SW
27.07.2021	7:00 PM	30.7	81.2	1.6	SW
27.07.2021	8:00 PM	30.4	82	1.7	SSW
27.07.2021	9:00 PM	30.4	84.8	0.9	SW
27.07.2021	10:00 PM	30.6	83.4	0.1	SE
27.07.2021	11:00 PM	30.5	83.7	0.2	SSE
28.07.2021	12:00 AM	29.5	79.4	0.5	SSW
28.07.2021	1:00 AM	30.2	67.6	0.1	SW
28.07.2021	2:00 AM	30.1	64.8	1.3	SW
28.07.2021	3:00 AM	29.6	63.9	1.4	SSW
28.07.2021	4:00 AM	28.8	68.9	0.5	SSW
28.07.2021	5:00 AM	28.2	71.5	1	SW
28.07.2021	6:00 AM	28.1	69.6	2.4	SW
28.07.2021	7:00 AM	28.3	70.5	1.3	WSW
28.07.2021	8:00 AM	29.3	66.1	1.5	SW
28.07.2021	9:00 AM	30.9	60.1	1.8	WSW
28.07.2021	10:00 AM	31.6	57.2	2.8	WSW
28.07.2021	11:00 AM	32.5	54.4	2.4	WSW
28.07.2021	12:00 PM	32.7	55.6	2.7	SW
MIN		28.1	52.2	0.1	SW
MAX		34.6	84.8	2.8	
AVG		31.2	66.0	1.4	




Wind Rose period: 26-Jul-21 4:21 PM - 28-Jul-21 11:30 AM
V6 (> 12.0)
V5 (6.5 - 12.0)
V4 (3.9 - 6.5)
V3 (2.3 - 3.9)
V2 (0.3 - 2.3)
V1 (< 0.3)

4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Ambient Air Quality Monitoring Sampling Location

Stack Emission Monitoring Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. NTECL, KATHIVAKKA (SE)

LOCATION - KATHIVAKKA(SE),ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 26.07.2021 [12:45 Hrs] – 27.07.2021 [12:45 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	9.3
2	Nitrogen Dioxide as NO_2	µg/m^3	16.35
3	Particulate Matter (PM_{10})	µg/m^3	57.29
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	22.54
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. NTECL, NTPC TOWN SHIP – STP PANT (NW)

LOCATION – NTPC TOWN SHIP – STP PANT (NW), ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 26.07.2021 [13:50 Hrs] – 27.07.2021 [13:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	11.86
2	Nitrogen Dioxide as NO_2	µg/m^3	21.04
3	Particulate Matter (PM_{10})	µg/m^3	51.7
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	20.54
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)

10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. NTECL, KONDAKARAI PLANT- MAIN GATE

LOCATION – KONDAKARAI PLANT- MAIN GATE, ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 26.07.2021 [17:25 Hrs] – 27.07.2021 [17:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	17.44
2	Nitrogen Dioxide as NO_2	µg/m^3	27.05
3	Particulate Matter (PM_{10})	µg/m^3	65.1
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	26.62
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. NTECL, NTECL PLANT - MAIN GATE (N)

LOCATION – NTECL PLANT - MAIN GATE (N), ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 26.07.2021 [19:10 Hrs] – 27.07.2021 [19:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	23.23
2	Nitrogen Dioxide as NO_2	µg/m^3	32.7
3	Particulate Matter (PM_{10})	µg/m^3	75.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	33.66
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. NTECL, ATHIPATTU TNEB CAMP

LOCATION – ATHIPATTU TNEB CAMP, ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 27.07.2021 [17:05 Hrs] – 28.07.2021 [19:05 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	11.49
2	Nitrogen Dioxide as NO_2	µg/m^3	21.14
3	Particulate Matter (PM_{10})	µg/m^3	58.98
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	25.03
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)

8			
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. NTECL, ENNORE CARGO CONTAINER TERMINAL PVT LTD

LOCATION – ENNORE CARGO CONTAINER TERMINAL PVT LTD, ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 27.07.2021 [18:30 Hrs] – 28.07.2021 [18:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	10.5
2	Nitrogen Dioxide as NO_2	µg/m^3	17.19
3	Particulate Matter (PM_{10})	µg/m^3	53.81
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	22.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 7: M/s. NTECL, NTECL STP PLANT-(CSSP-MCP)

LOCATION – NTECL STP PLANT-(CSSP-MCP), ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 27.07.2021 [18:30 Hrs] – 28.07.2021 [18:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	15.2
2	Nitrogen Dioxide as NO_2	µg/m^3	21.43
3	Particulate Matter (PM_{10})	µg/m^3	60.89
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	25.12
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)

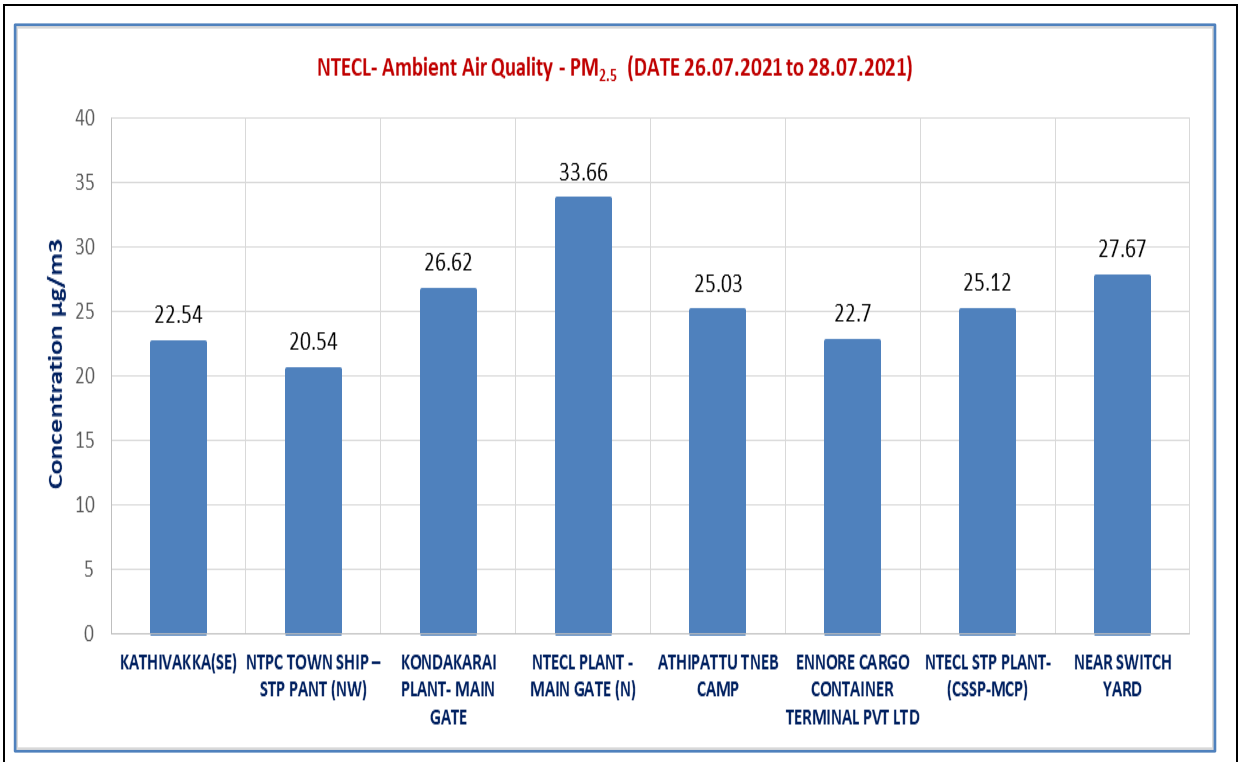
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

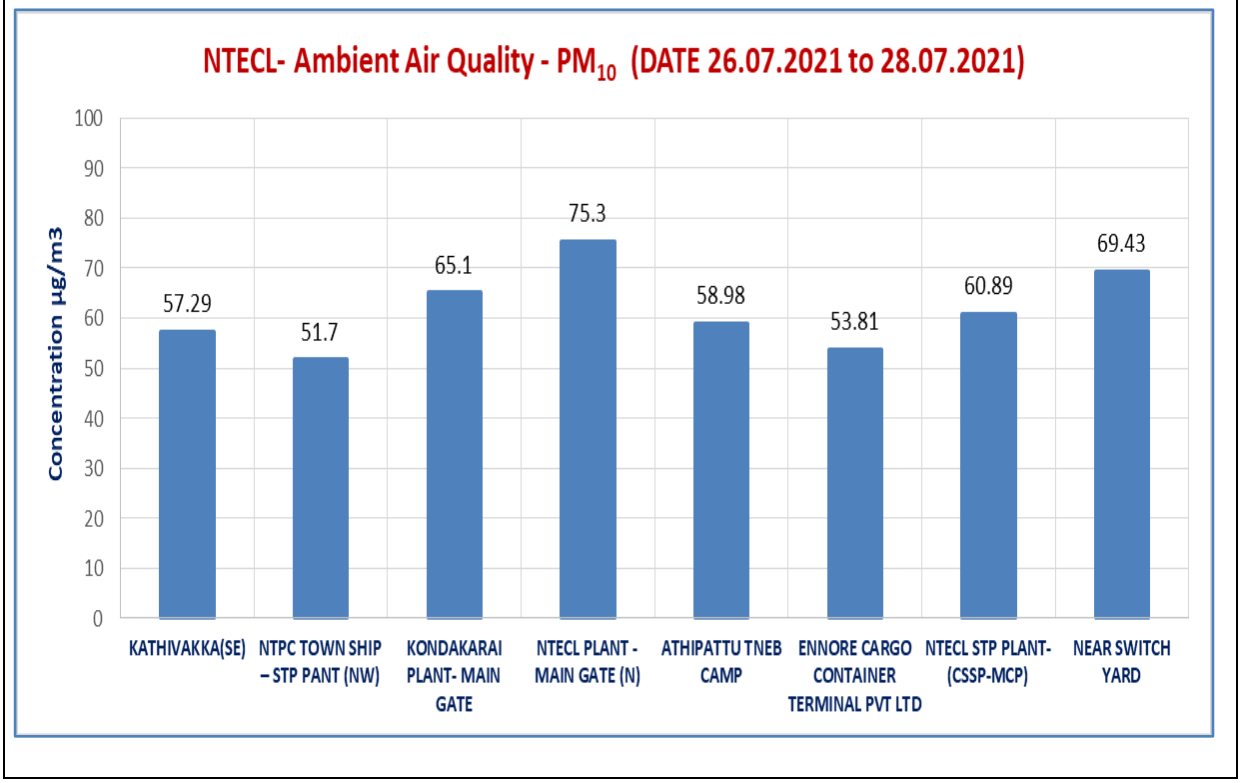
AAQ- 8: M/s. NTECL, NTECL – NEAR SWITCH YARD

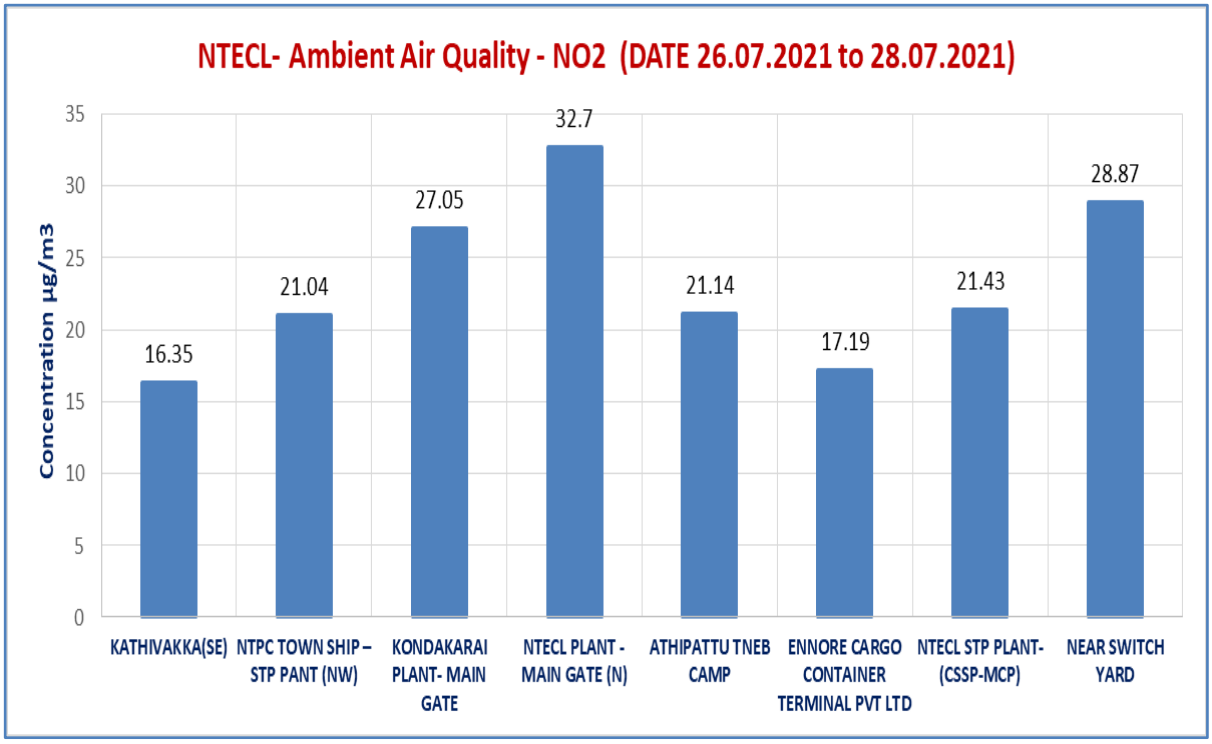
LOCATION – NEAR SWITCH YARD,ATHIPATTU PUDHUNAGAR			
SAMPLING DATE & TIME 27.07.2021 [18:30 Hrs] – 28.07.2021 [18:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	19.79
2	Nitrogen Dioxide as NO_2	µg/m^3	28.87
3	Particulate Matter (PM_{10})	µg/m^3	69.43
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	27.67
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

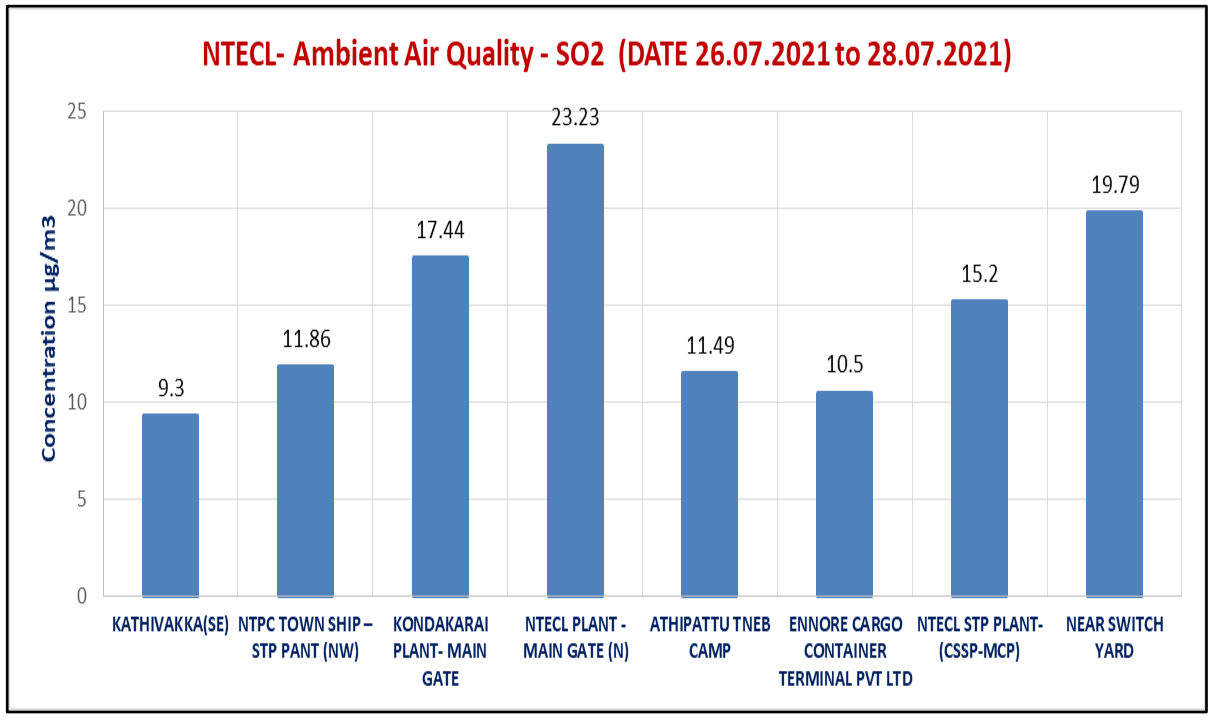
AAQM Consolidated Monitoring Results:

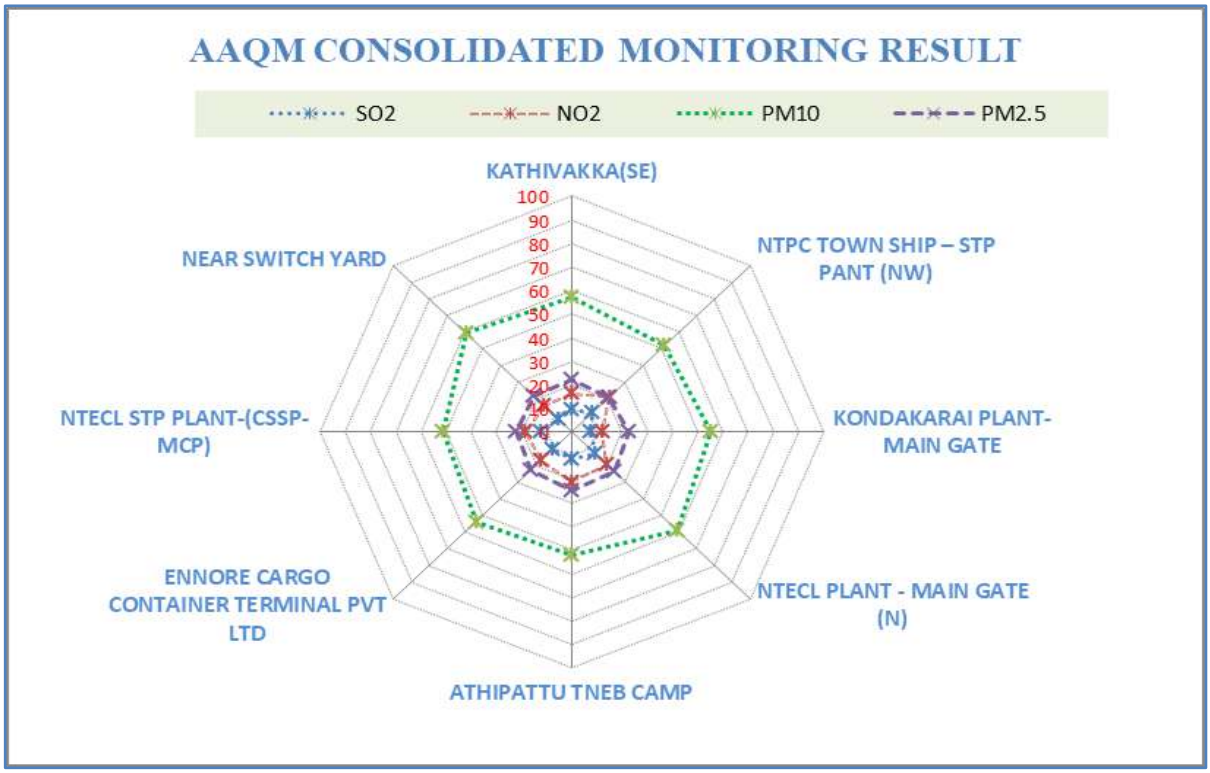
AAQM Consolidated Monitoring Results (µg/m3) [26.07.2021 to 28.07.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
KATHIVAKKA(SE)	9.3	16.35	57.29	22.54
NTPC TOWN SHIP – STP PANT (NW)	11.86	21.04	51.7	20.54
KONDAKARAI PLANT- MAIN GATE	17.44	27.05	65.1	26.62
NTECL PLANT - MAIN GATE (N)	23.23	32.7	75.3	33.66
ATHIPATTU TNEB CAMP	11.49	21.14	58.98	25.03
ENNORE CARGO CONTAINER TERMINAL PVT LTD	10.5	17.19	53.81	22.7
NTECL STP PLANT-(CSSP-MCP)	15.2	21.43	60.89	25.12
NEAR SWITCH YARD	19.79	28.87	69.43	27.67

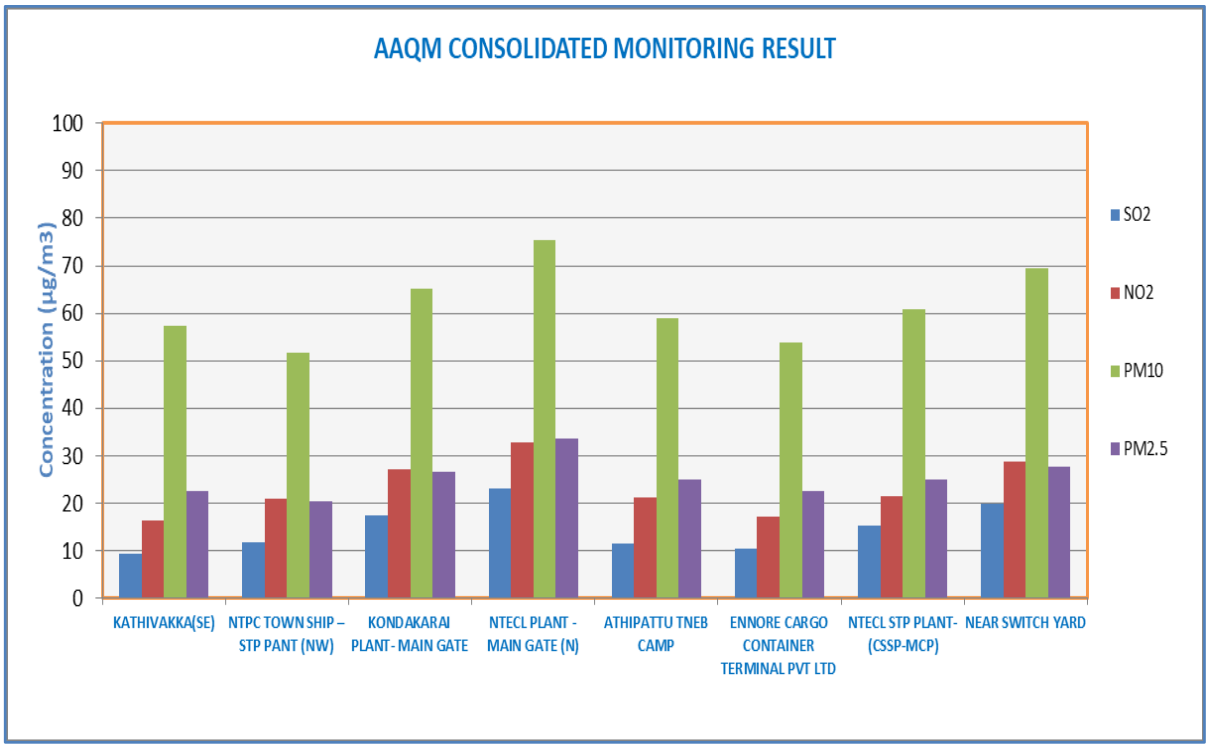

NTECL- Ambient Air Quality - PM2.5 (DATE 26.07.2021 to 28.07.2021)
Concentration µg/m3
40
35
30
25
20
15
10
5
0
22.54
20.54
26.62
33.66
25.03
22.7
25.12
27.67
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT- (CSSP-MCP)
NEAR SWITCH YARD


NTECL- Ambient Air Quality - PM10 (DATE 26.07.2021 to 28.07.2021)
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
57.29
51.7
65.1
75.3
58.98
53.81
60.89
69.43
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT- (CSSP-MCP)
NEAR SWITCH YARD


NTECL- Ambient Air Quality - NO2 (DATE 26.07.2021 to 28.07.2021)
Concentration µg/m3
35
30
25
20
15
10
5
0
16.35
21.04
27.05
32.7
21.14
17.19
21.43
28.87
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT- (CSSP-MCP)
NEAR SWITCH YARD


NTECL- Ambient Air Quality - SO2 (DATE 26.07.2021 to 28.07.2021)
Concentration µg/m3
25
20
15
10
5
0
9.3
11.86
17.44
23.23
11.49
10.5
15.2
19.79
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT- (CSSP-MCP)
NEAR SWITCH YARD


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT-(CSSP-MCP)
NEAR SWITCH YARD
100
90
80
70
60
50
40
30
20
10
0


AAQM CONSOLIDATED MONITORING RESULT
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
SO2
NO2
PM10
PM2.5
KATHIVAKKA(SE)
NTPC TOWN SHIP – STP PANT (NW)
KONDAKARAI PLANT- MAIN GATE
NTECL PLANT - MAIN GATE (N)
ATHIPATTU TNEB CAMP
ENNORE CARGO CONTAINER TERMINAL PVT LTD
NTECL STP PLANT- (CSSP-MCP)
NEAR SWITCH YARD

CONCLUSION:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Kathivakka(SE), NTPC Town Ship – STP Pant (NW), Kondakarai Plant- Main Gate, NTECL Plant - Main Gate (N), Athipattu TNEB Camp, Ennore Cargo Container Terminal Pvt Ltd, NTECL STP PLANT-(CSSP-MCP) and Near Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 9.3 to 23.2µg/m^3. Highest value of 23.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 16.4 to 32.7µg/m^3. Highest value of 32.7µg/m^3 is obtained and however the values are within the NAAQM standards.

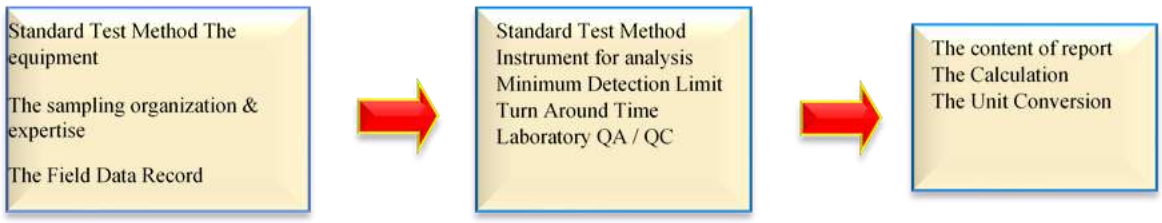
- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 51.7to 75.3µg/m^3. Highest value of 75.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.5 to 33.7µg/m^3. Highest value of 33.7µg/m^3 is obtained and however the values are within the NAAQM standards.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

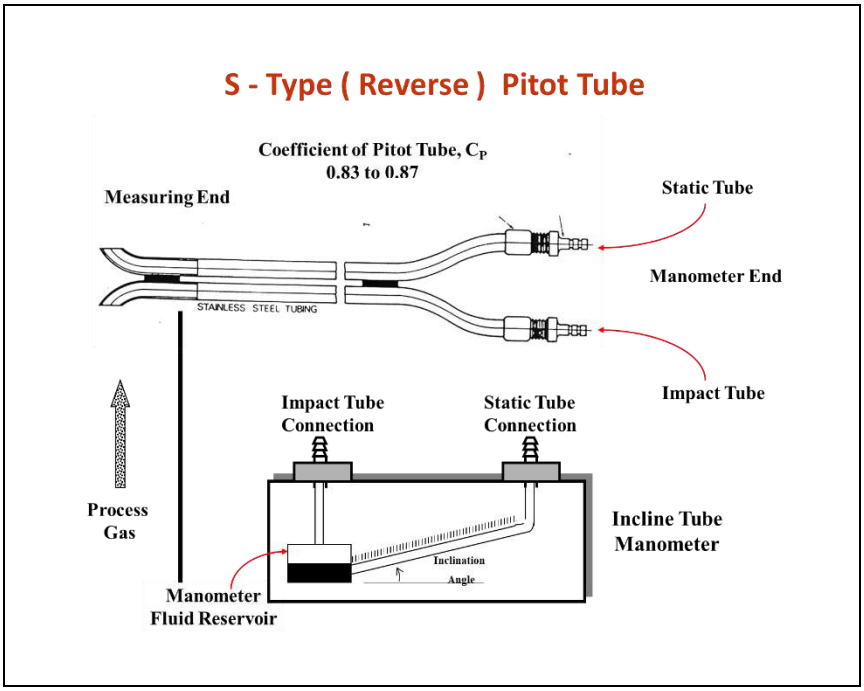


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points :

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

5. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

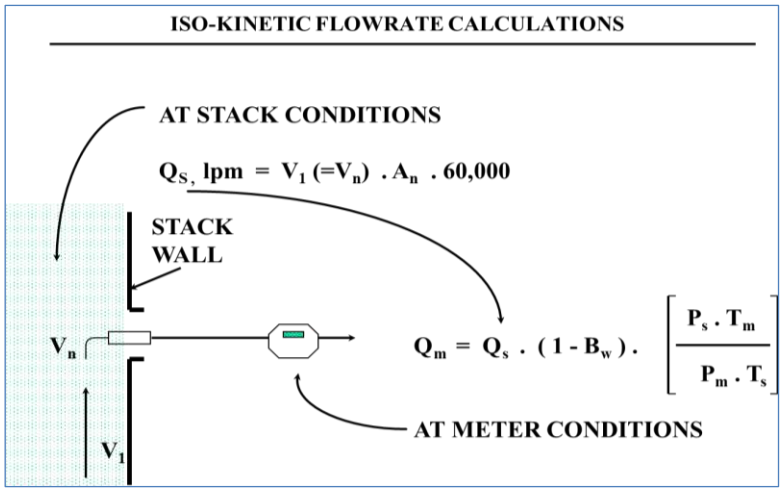
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

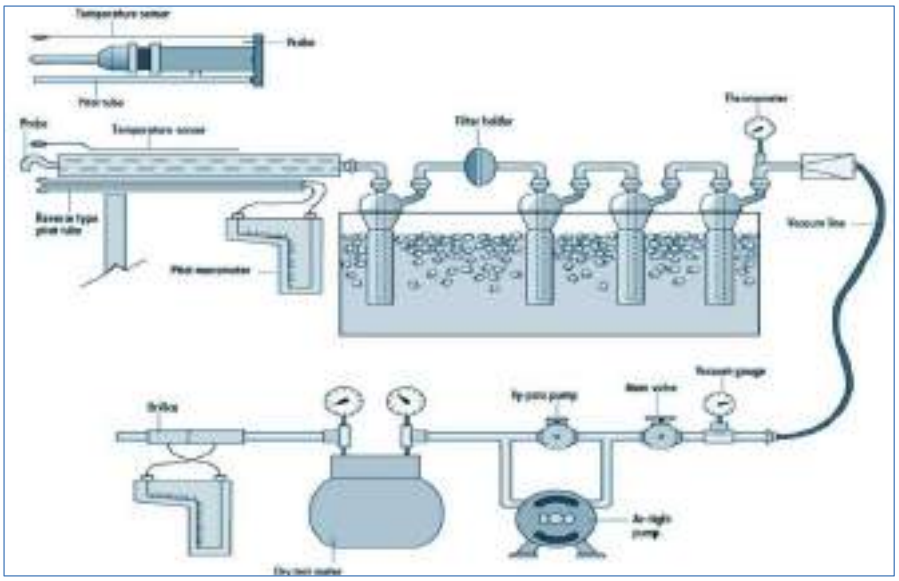
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The SO_2 is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. SO_2 is absorbed in the impingers and converted to form H_2SO_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_2O_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(ClO_4)_2$ $3H_2O$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_2O$, in 200 ml deionized water and then dilute to 1 liter with the

isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading, meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

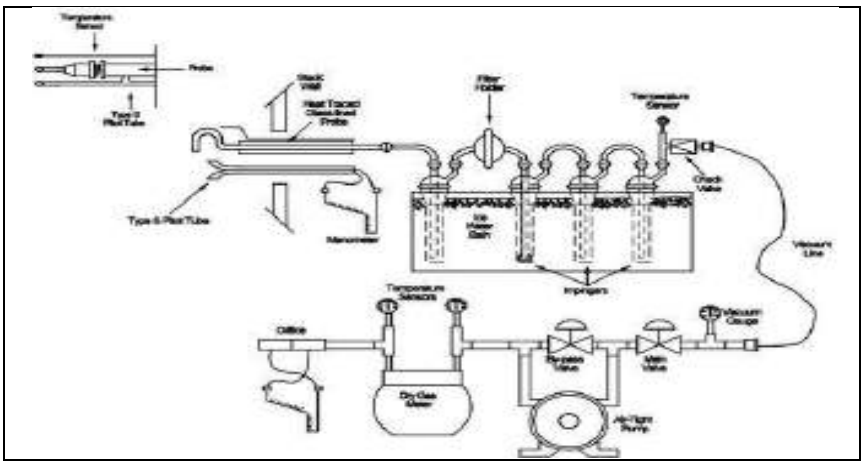
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

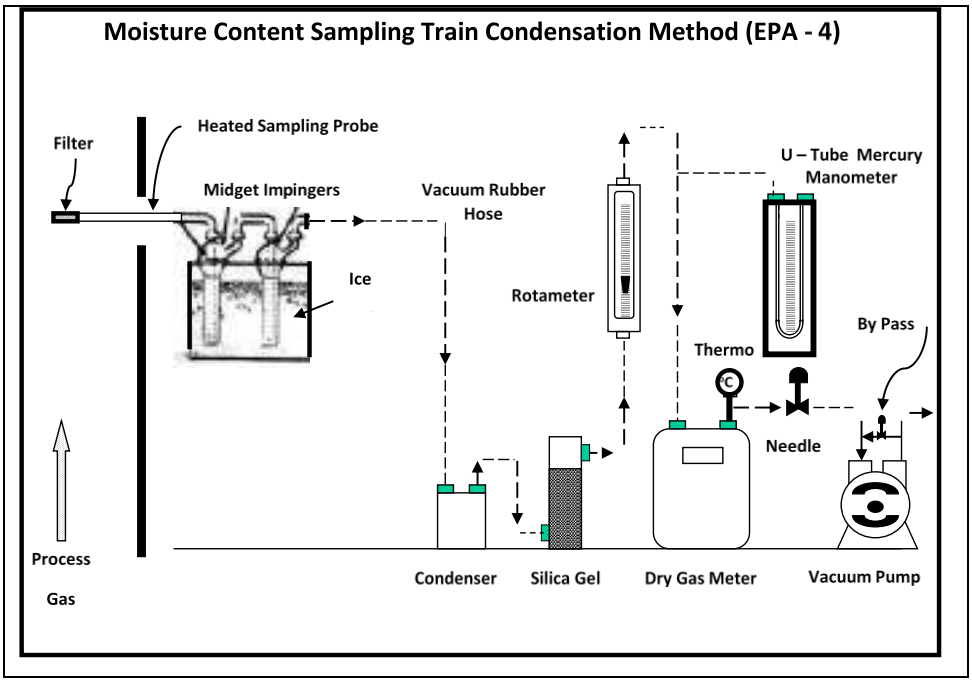
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS: NTECL - ATHIPATTU PUDHUNAGAR

STACK- 1: M/s. NTECL, TPP-1 STACK INLET AND OUTLET

LOCATION - TPP-1 STACK INLET AND OUTLET, ATHIPATTU PUDHUNAGAR					
S.NO	**POLLUTANT**	**UNIT**	**TPP-1 STACK INLET**	**TPP-1 STACK OUTLET**	**EFFICIENCY (%)**
1	Stack Temperature	K	399	385	NA
2	Oxygen as O_2	%	7.9	7.0	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	2.2	NA
4	Carbon Dioxide as CO_2	%	10.5	12	NA
5	Particulate Matter	mg/Nm^3	42604	23.7	99.94
6	Sulphur Dioxide as SO_2	mg/Nm^3	925	872	NA
7	Oxides of Nitrogen as NO_2	mg/Nm^3	217	206	NA

Particulate Matter concentration TPP-1 Boiler inlet is 42604 mg/Nm^3 and Outlet are 23.7 mg/Nm^3. The mass emission flow rate on the TPP-1 boiler inlet is 226442 kg/day and outlet are 1028kg/day. The Efficiency of ESP connected to Boiler is 99.94 %.

STACK- 2: M/s. NTECL, TPP-2 STACK INLET AND OUTLET

LOCATION - TPP-2 STACK INLET AND OUTLET, ATHIPATTU PUDHUNAGAR					
S.NO	**POLLUTANT**	**UNIT**	**TPP-2 STACK INLET**	**TPP-2 STACK OUTLET**	**EFFICIENCY (%)**
1	Stack Temperature	K	409	399	NA
2	Oxygen as O_2	%	8	7.6	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	2.2	NA
4	Carbon Dioxide as CO_2	%	10.8	11.9	NA
5	Particulate Matter	mg/Nm^3	56492	25.5	99.95
6	Sulphur Dioxide as SO_2	mg/Nm^3	1655	1379	NA

7	Oxides of Nitrogen as NO_2	mg/Nm^3	278	317	NA

Particulate Matter concentration TPP-2 Boiler inlet is 56492 mg/Nm^3 and Outlet are 25.5 mg/Nm^3. The mass emission flow rate on the TPP-2 boiler inlet is 299636 kg/day and outlet are 975kg/day. The Efficiency of ESP connected to Boiler is 99.95 %.

STACK- 3: M/s. NTECL, TPP-3 STACK INLET AND OUTLET

LOCATION - TPP-3 STACK INLET AND OUTLET, ATHIPATTU PUDHUNAGAR					
S.NO	**POLLUTANT**	**UNIT**	**TPP-3 STACK INLET**	**TPP-3 STACK OUTLET**	**EFFICIENCY (%)**
1	Stack Temperature	K	401	382	NA
2	Oxygen as O_2	%	9.4	9.47	NA
3	Carbon Monoxide as CO	mg/Nm^3	BDL	2.2	NA
4	Carbon Dioxide as CO_2	%	11	11.5	NA
5	Particulate Matter	mg/Nm^3	52726	23	99.96
6	Sulphur Dioxide as SO_2	mg/Nm^3	1434	1269	NA
7	Oxides of Nitrogen as NO_2	mg/Nm^3	285.7	289	NA

Particulate Matter concentration TPP-3 Boiler inlet is 52726 mg/Nm^3 and Outlet are 23 mg/Nm^3. The mass emission flow rate on the TPP-3 boiler inlet is 279526kg/day and outlet are 1001kg/day. The Efficiency of ESP connected to Boiler is 99.96 %.

STACK- 4: M/s. NTECL, DG-1 1250 KVA STACK

LOCATION – DG-1 1250 KVA STACK , ATHIPATTU PUDHUNAGAR				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**Limit as per MoEF (CPCB) Standard**
1	Stack Temperature	K	455	NA
2	Velocity	m/sec	8.83	NA
3	Volume of Gas Discharge	Nm^3/hr	2602	NA
4	Oxygen as O_2	%	16	NA
5	Carbon Monoxide as CO (at 15% O2) mg/Nm3	mg/Nm^3	108	150
6	Carbon Dioxide as CO_2	%	4.6	NA
7	Particulate Matter (at 15% O2) (Diesel fuels HSD&LDO) mg/Nm3	mg/Nm^3	59.9	75
8	Sulphur Dioxide as SO_2	mg/Nm^3	77.6	NA
9	Oxides of Nitrogen as NO2 (at 15% O2) on dry basis in ppmv	ppmv	269	710

- DG Stack greater than1000KVA Complies as per MoEF (CPCB) DG Stack Emission Standards.

STACK- 5: M/s. NTECL, DG-2 1250 KVA STACK

LOCATION – DG-2 1250 KVA STACK , ATHIPATTU PUDHUNAGAR				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**Limit as per MoEF (CPCB) Standard**
1	Stack Temperature	K	461	NA
2	Velocity	m/sec	9.06	NA
3	Volume of Gas Discharge	Nm^3/hr	2635	NA
4	Oxygen as O_2	%	15.8	NA
5	Carbon Monoxide as CO (at 15% O2) mg/Nm3	mg/Nm^3	100	150

6	Carbon Dioxide as CO_2	%	4.8	NA
7	Particulate Matter (at 15% O2) (Diesel fuels HSD&LDO) mg/Nm3	mg/Nm^3	54.9	75
8	Sulphur Dioxide as SO_2	mg/Nm^3	97	NA
9	Oxides of Nitrogen as NO2 (at 15% O2) on dry basis in ppmv	ppmv	262	710

- DG Stack greater than1000KVA Complies as per MoEF (CPCB) DG Stack Emission Standards.

STACK- 6: M/s. NTECL, DG-3 1250 KVA STACK

LOCATION – DG-2 1250 KVA STACK , ATHIPATTU PUDHUNAGAR				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**Limit as per MoEF (CPCB) Standard**
1	Stack Temperature	K	457	NA
2	Velocity	m/sec	8.98	NA
3	Volume of Gas Discharge	Nm^3/hr	2634	NA
4	Oxygen as O_2	%	15.7	NA
5	Carbon Monoxide as CO (at 15% O2) mg/Nm3	mg/Nm^3	100	150
6	Carbon Dioxide as CO_2	%	4.9	NA
7	Particulate Matter (at 15% O2) (Diesel fuels HSD&LDO) mg/Nm3	mg/Nm^3	51.6	75
8	Sulphur Dioxide as SO_2	mg/Nm^3	108	NA
9	Oxides of Nitrogen as NO2 (at 15% O2) on dry basis in ppmv	ppmv	173	710

- DG Stack greater than1000KVA Complies as per MoEF (CPCB) DG Stack Emission Standards.

STACK- 7: M/s. NTECL, DG-4 1250 KVA STACK

LOCATION – DG-2 1250 KVA STACK , ATHIPATTU PUDHUNAGAR				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**Limit as per MoEF (CPCB) Standard**
1	Stack Temperature	K	459	NA
2	Velocity	m/sec	8.88	NA
3	Volume of Gas Discharge	Nm^3/hr	2594	NA
4	Oxygen as O_2	%	16.1	NA
5	Carbon Monoxide as CO (at 15% O2) mg/Nm3	mg/Nm^3	111	150
6	Carbon Dioxide as CO_2	%	3.7	NA
7	Particulate Matter (at 15% O2) (Diesel fuels HSD&LDO) mg/Nm3	mg/Nm^3	52.4	75
8	Sulphur Dioxide as SO_2	mg/Nm^3	103	NA
9	Oxides of Nitrogen as NO2 (at 15% O2) on dry basis in ppmv	ppmv	263	710

- DG Stack greater than1000KVA Complies as per MoEF (CPCB) DG Stack Emission Standards.

Stack Consolidated Monitoring Results:

S.NO	Compound Method	TPP-1	TPP-2	TPP-3	CPCB LIMIT
1	Stack Temperature	385	399	382	NA
2	Velocity	18.41	19.47	18.3	NA
3	Volume of Gas Discharge	1808003	1593182	1813056	NA
4	Oxygen as O_2	7	7.6	9.47	NA
5	Carbon Monoxide as CO	2.2	2.2	2.2	NA
6	Carbon Dioxide as CO_2	12	11.9	11.5	NA
7	Particulate Matter	23.7	25.5	23	50
8	Sulphur Dioxide as SO2	872	1379	1269	200
9	Oxides of Nitrogen as NO_2	206	317	289	450

In Stack Emission monitoring at thermal boiler the stacks are not complying for Sulphur Dioxide Concentration of 872mg/Nm^3, 1379 &mg/Nm^3 1269mg/Nm^3 against the CPCB Emission Limit value of 200mg/Nm^3 and rest all the parameters are complying with the CPCB Limit

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential preprocessed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modeling system consists of two preprocessors and a core dispersion model. AERMET is the meteorological preprocessor for the AERMOD while AERMAP is the terrain preprocessor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

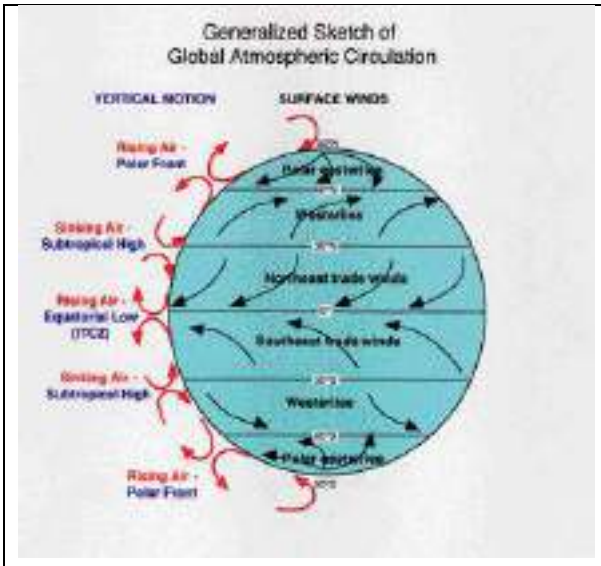
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from NTECL, Athipattu Pudhnager. For our simulations, the required

source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

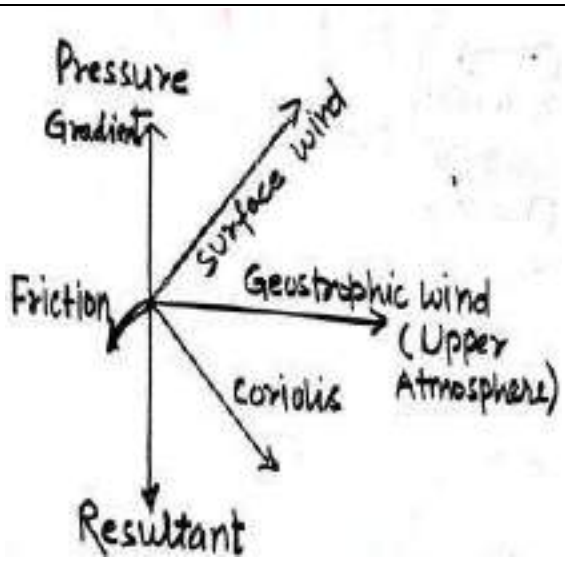
The AERMOD model was applied to study the diffusion of pollutants from NTECL, Athipattu Pudhnager and other sources in three days from 26.07.2021 to 28.07.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

NTECL ATHIPATTU PUDHNAGAR

TPP-1

Particulate matter:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.41
PM Concentration, mg/m3	-	23.7
Emission load, gm/Sec	-	11.9
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.41
NOx Concentration, mg/m3	-	206
Emission load, gm/Sec	-	103.46
Plume rise, m	-	3

Sulphur dioxide as SO2

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.41
SO2 Concentration, mg/m3	-	872
Emission load, gm/Sec	-	437.94
Plume rise, m	-	3

TPP-2

Particulate matter:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	19.47
PM Concentration, mg/m3	-	25.5
Emission load, gm/Sec	-	11.29
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	19.47
NOx Concentration, mg/m3	-	317
Emission load, gm/Sec	-	140.29
Plume rise, m	-	3

Sulphur dioxide as SO2

Stack Height, m	-	275
Exit Velocity, m/Sec	-	19.47
SO2 Concentration, mg/m3	-	1379
Emission load, gm/Sec	-	610
Plume rise, m	-	3

TPP-3

Particulate matter:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.3
PM Concentration, mg/m3	-	23
Emission load, gm/Sec	-	11.58
Plume rise, m	-	3

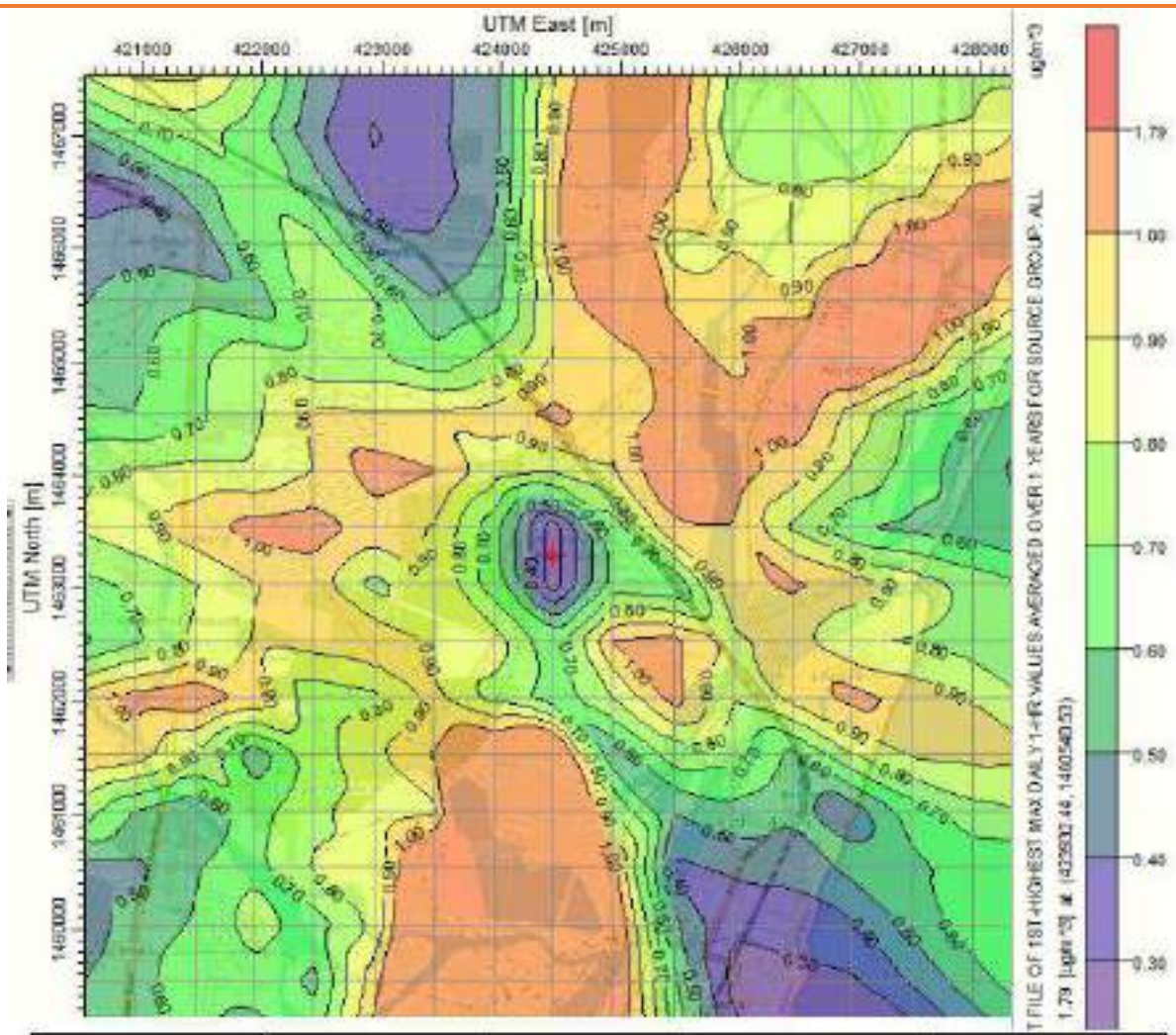
Oxides of Nitrogen as NO2:

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.3
NOx Concentration, mg/m3	-	289
Emission load, gm/Sec	-	145.55
Plume rise, m	-	3

Sulphur dioxide as SO2

Stack Height, m	-	275
Exit Velocity, m/Sec	-	18.3
SO2 Concentration, mg/m3	-	1269
Emission load, gm/Sec	-	639
Plume rise, m	-	3

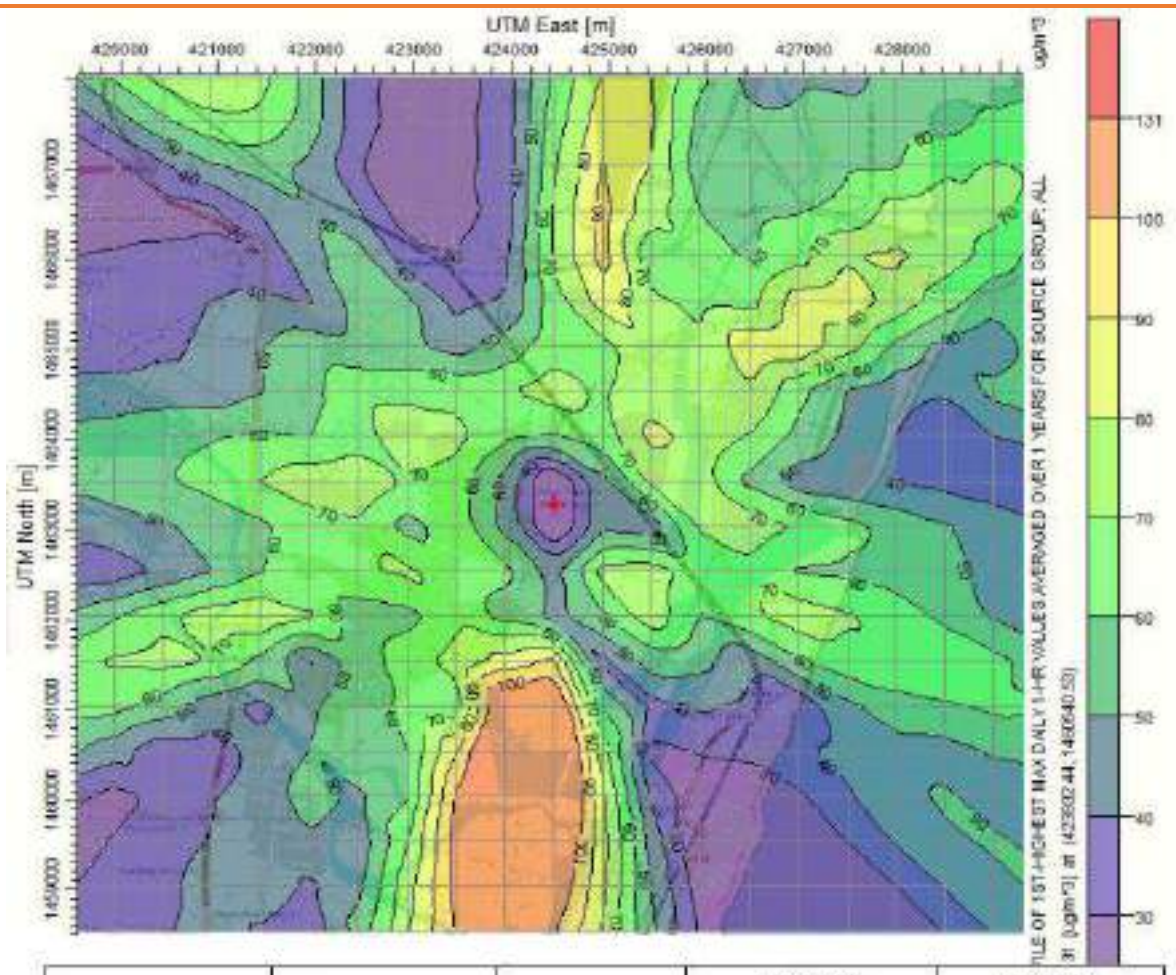
STACK EMISSION DISPERSION MODELLING – TPP-1 BOILER @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
23.7	2.04	1.79	0.578	0.177

TPP-1 BOILER emission of Particulate matter concentration is 23.7mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.04km at the concentration of 1.79µg/m3 at 2km dispersion Particulate matter is 0.578µg/m3 and at 5km dispersion Particulate matter is 0.177µg/m3 and the predominant wind direction is SW.

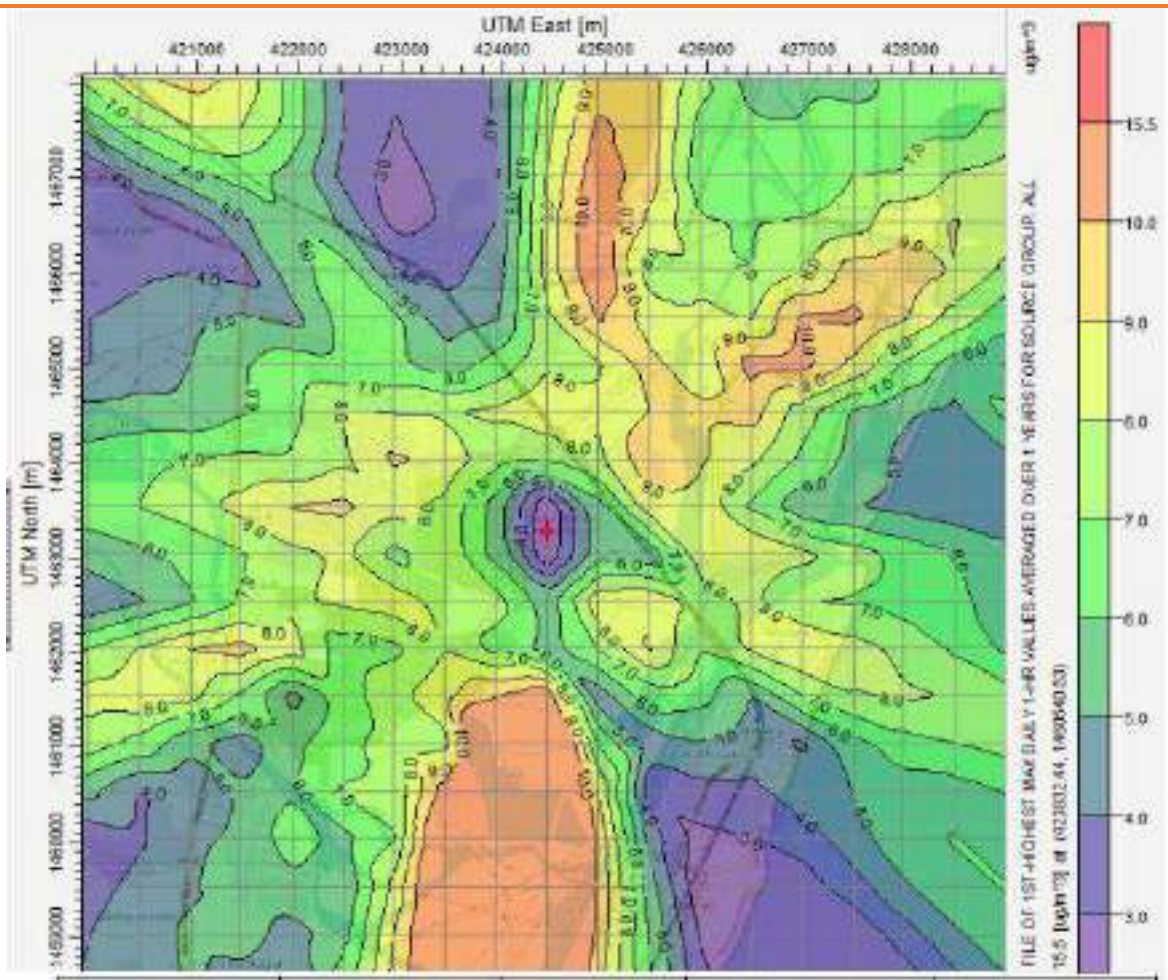
STACK EMISSION DISPERSION MODELLING – TPP-1 BOILER @ 2 & 5KM – Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
872	1.97	131	9.976	0.677

TPP-1 BOILER emission of Sulphur dioxide concentration is 872mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.97km at the concentration of 131µg/m3 at 2km dispersion Sulphur dioxide is 9.976µg/m3 and at 5km dispersion Sulphur dioxide is 0.677µg/m3 and the predominant wind direction is SW.

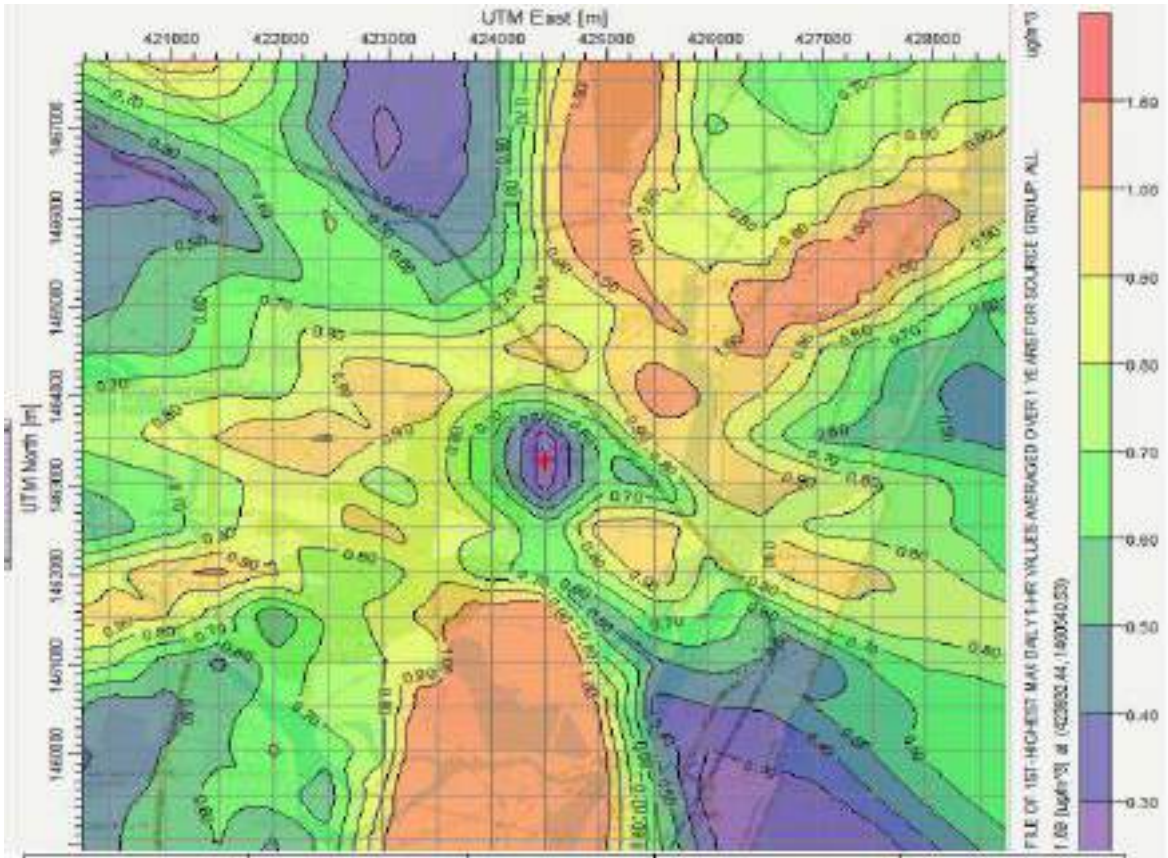
STACK EMISSION DISPERSION MODELLING – TPP-1 BOILER @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
206	1.98	15.5	2.123	0.976

TPP-1 BOILER emission of Oxides of Nitrogen concentration is 206mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.98km at the concentration of 15.5µg/m3 at 2km dispersion Oxides of Nitrogen is 2.123µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.976µg/m3 and the predominant wind direction is SW.

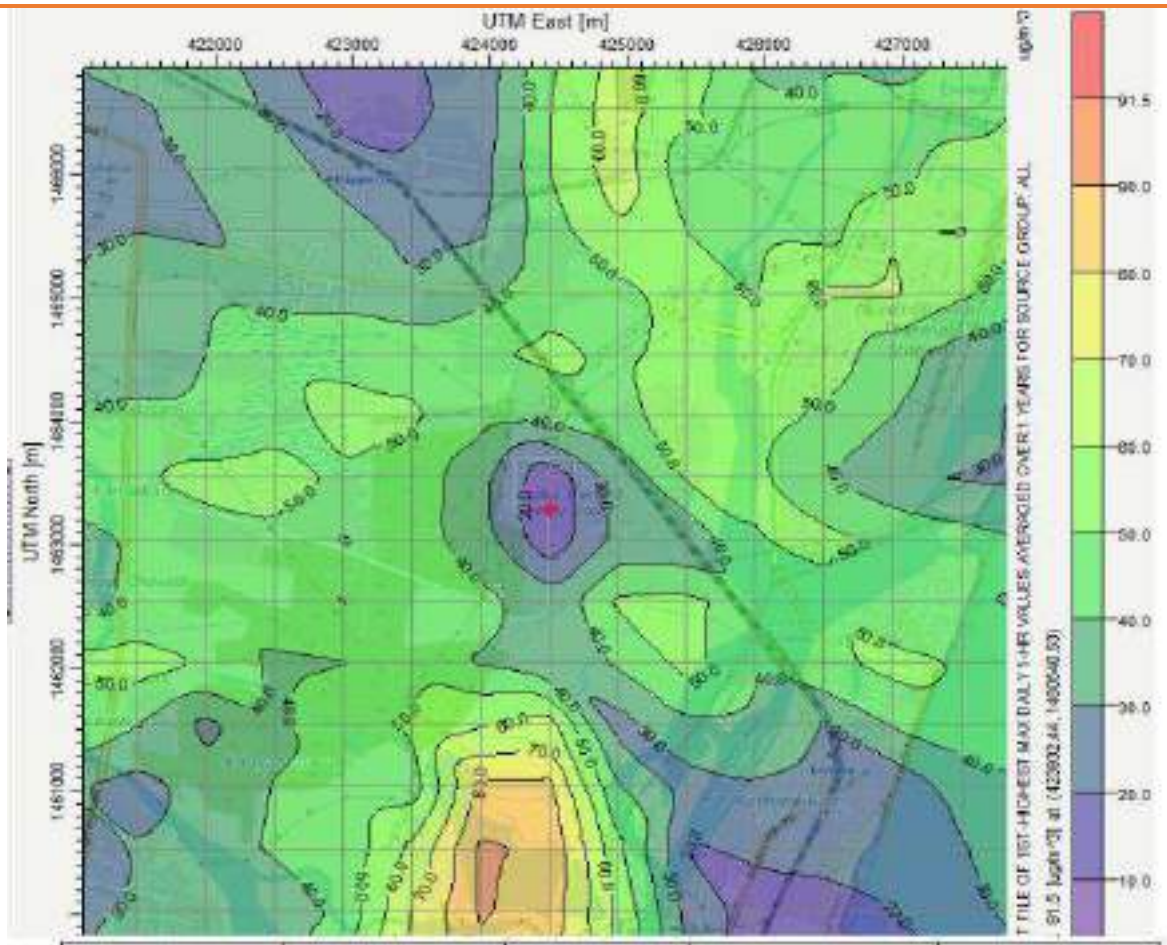
STACK EMISSION DISPERSION MODELLING – TPP-2 BOILER @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
25.5	1.99	1.69	0.234	0.0876

TPP-2 BOILER emission of Particulate matter concentration is 25.5mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.99km at the concentration of 1.69µg/m3 at 2km dispersion Particulate matter is 0.234µg/m3 and at 5km dispersion Particulate matter is 0.0876µg/m3 and the predominant wind direction is SW.

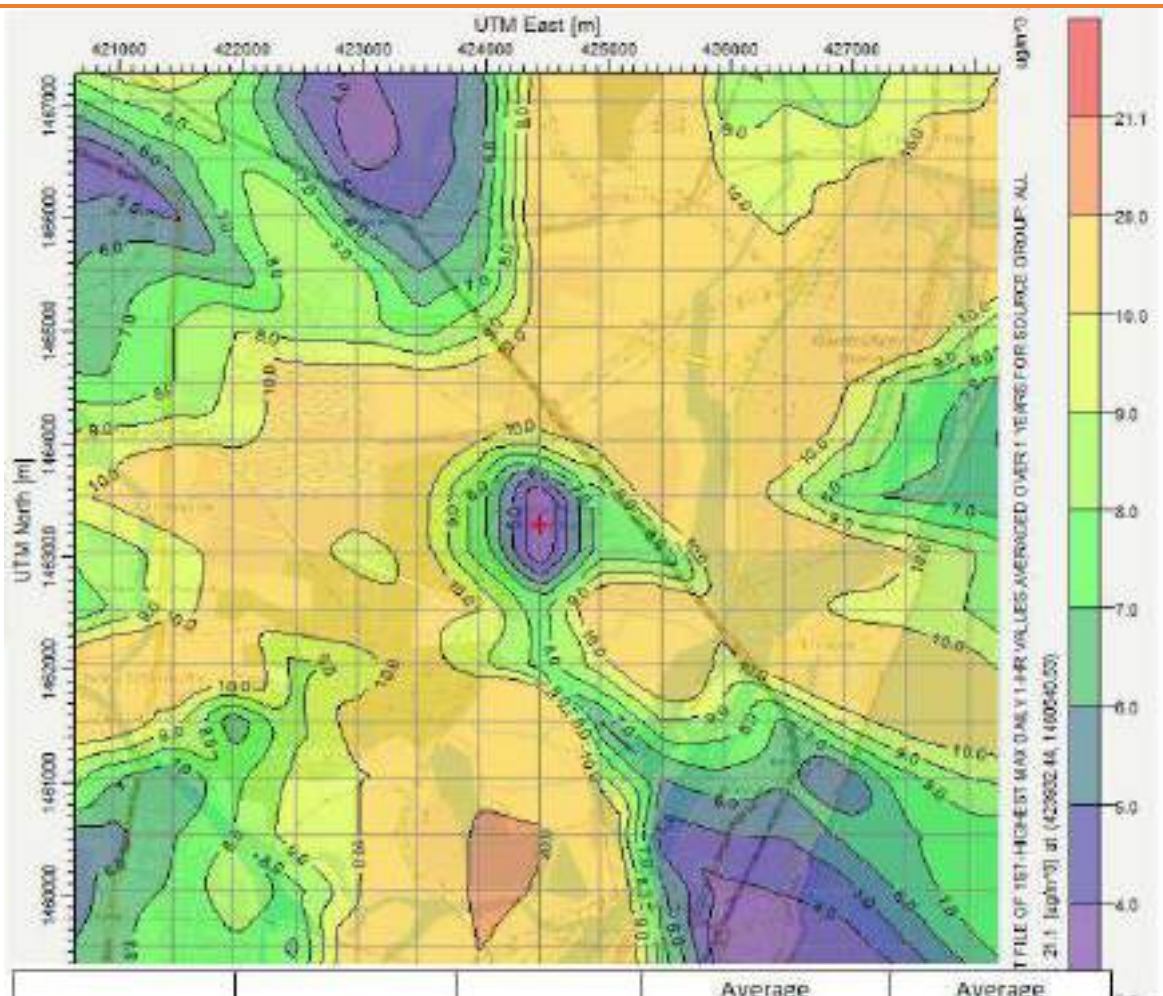
STACK EMISSION DISPERSION MODELLING – TPP-2 BOILER @ 2 & 5KM – Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
1379	2.08	91.5	8.97	6.34

TPP-2 BOILER emission of Sulphur dioxide concentration is 1379mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.08km at the concentration of 91.5µg/m3 at 2km dispersion Sulphur dioxide is 8.97µg/m3 and at 5km dispersion Sulphur dioxide is 6.34µg/m3 and the predominant wind direction is SW.

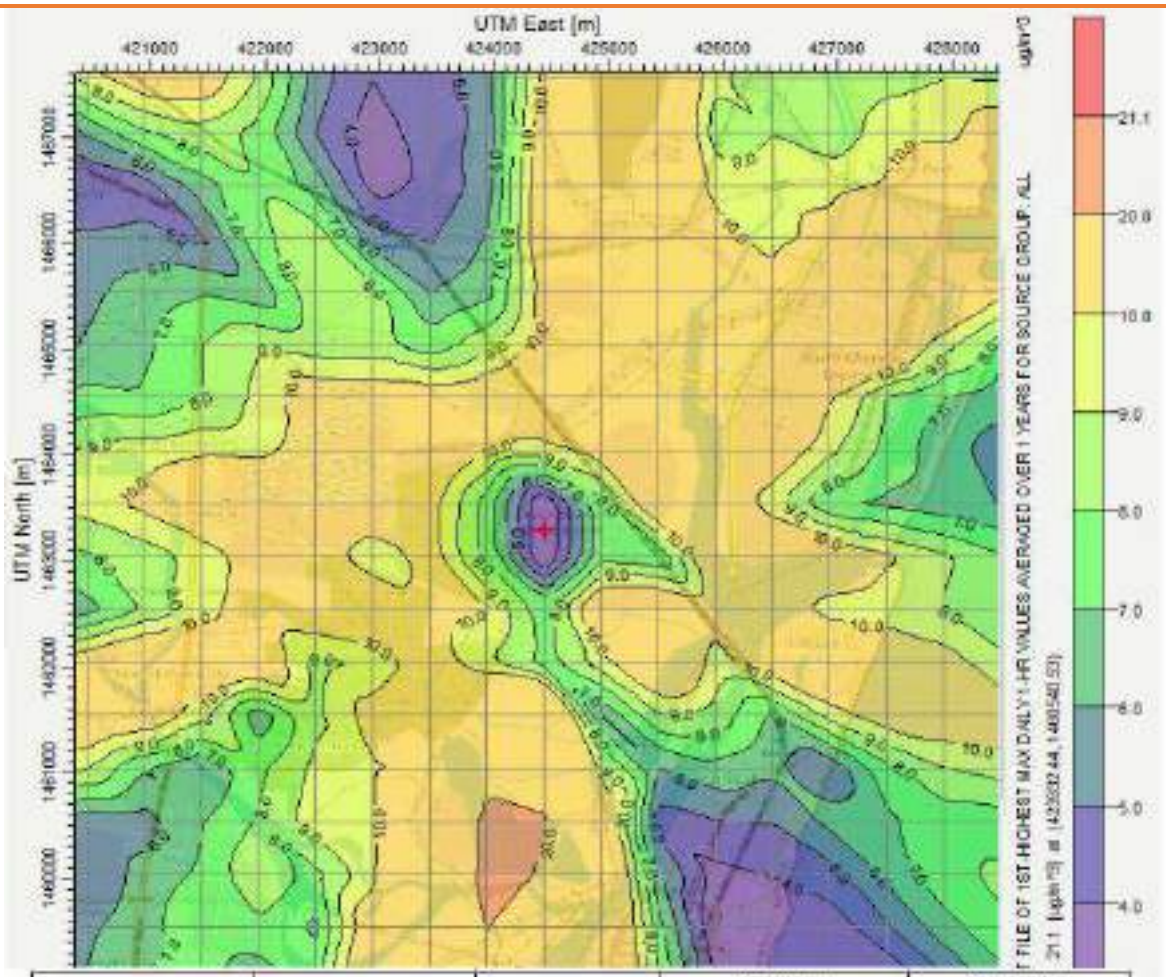
STACK EMISSION DISPERSION MODELLING – TPP-2 BOILER @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
317	2.01	21.1	1.977	0.678

TPP-2 BOILER emission of Oxides of Nitrogen concentration is 317mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.01km at the concentration of 21.1µg/m3 at 2km dispersion Oxides of Nitrogen is 1.977µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.678µg/m3 and the predominant wind direction is SW.

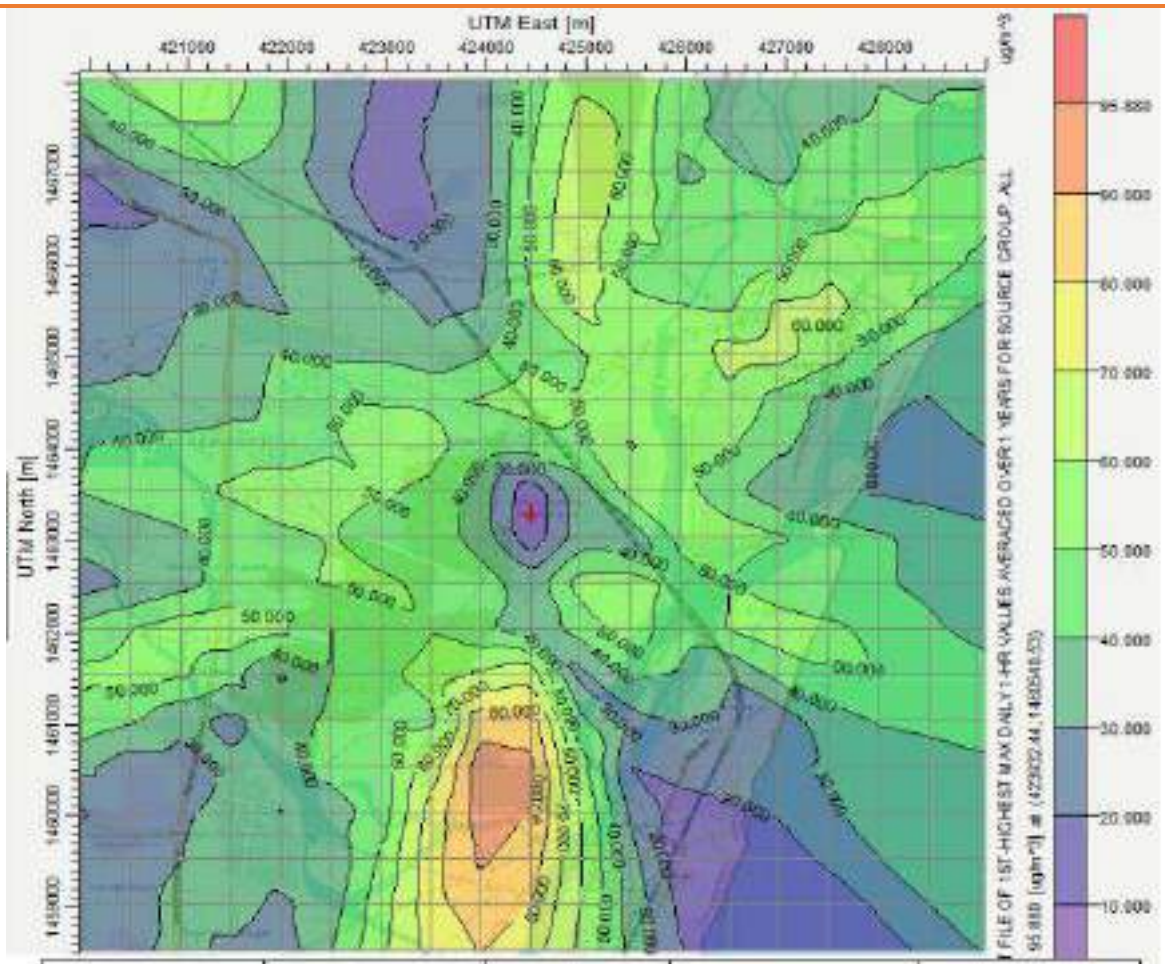
STACK EMISSION DISPERSION MODELLING – TPP-3 BOILER @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
23	2.01	21.1	2.969	0.858

TPP-3 BOILER emission of Particulate matter concentration is 23mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.01km at the concentration of 21.1µg/m3 at 2km dispersion Particulate matter is 2.969µg/m3 and at 5km dispersion Particulate matter is 0.858µg/m3 and the predominant wind direction is SW.

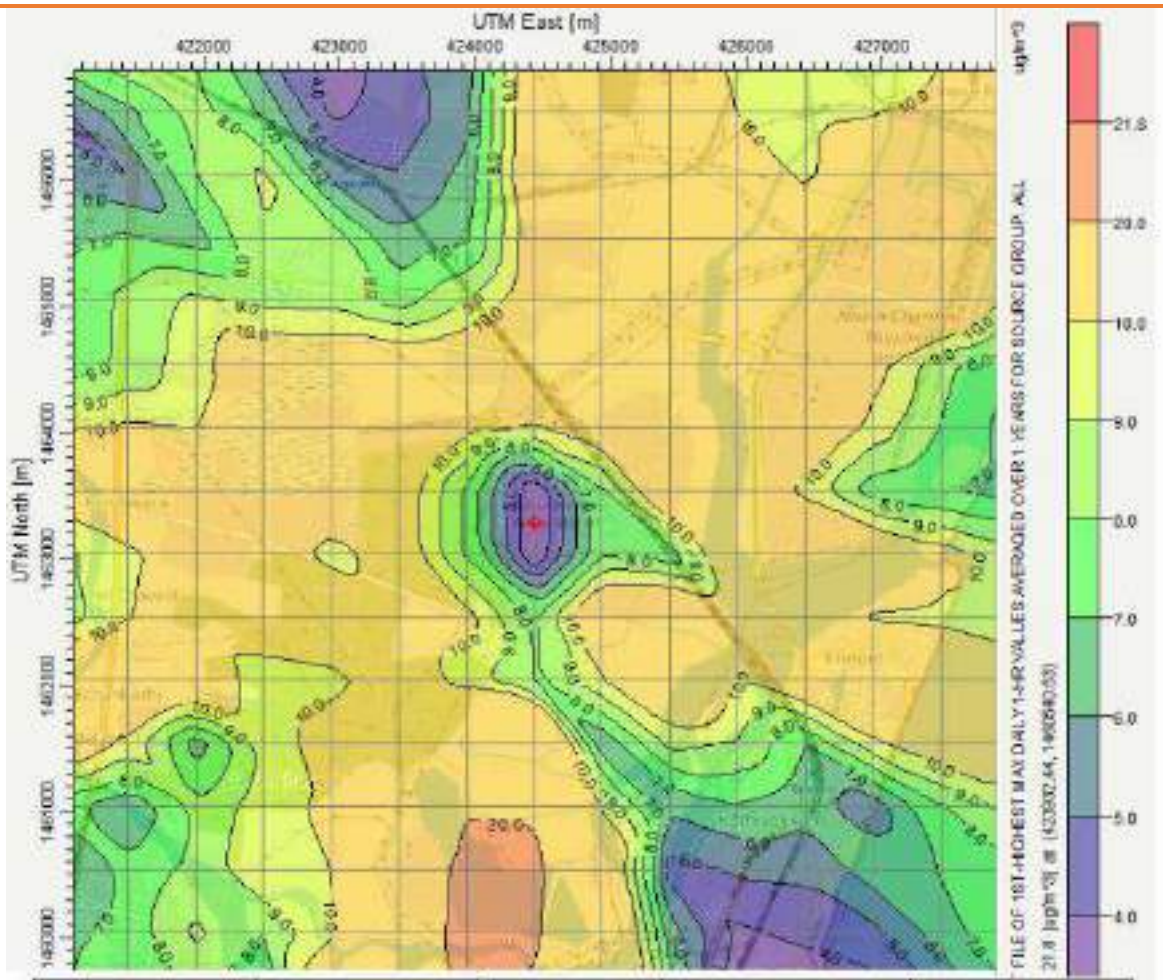
STACK EMISSION DISPERSION MODELLING – TPP-3 BOILER @ 2 & 5KM – Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
1269	2.04	95.5	5.866	4.754

TPP-3 BOILER emission of Sulphur dioxide concentration is 1269mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.04km at the concentration of 95.5µg/m3 at 2km dispersion Sulphur dioxide is 5.866µg/m3 and at 5km dispersion Sulphur dioxide is 4.754µg/m3 and the predominant wind direction is SW.

STACK EMISSION DISPERSION MODELLING – TPP-3 BOILER @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
289	2.15	95.5	13.121	1.459

TPP-3 BOILER emission of Oxides of Nitrogen concentration is 289mg/m3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.15km at the concentration of 95.5µg/m3 at 2km dispersion Oxides of Nitrogen is 13.121µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.459µg/m3 and the predominant wind direction is SW.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)
TPP-1	PM	23.7	2.04	1.79	0.578	0.177
TPP-1	SO2	872	1.97	131	9.976	0.677
TPP-1	NOx	206	1.98	15.5	2.123	0.976
TPP-2	PM	25.5	1.99	1.69	0.234	0.0876
TPP-2	SO2	1379	2.08	91.5	8.97	6.34
TPP-2	NOx	317	2.01	21.1	1.977	0.678
TPP-3	PM	23	2.01	21.1	2.969	0.858
TPP-3	SO2	1269	2.04	95.5	5.866	4.754
TPP-3	NOx	289	2.15	95.5	13.121	1.459

10. Findings:

Ambient Air Quality

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Kathivakka(SE), NTPC Town Ship – STP Pant (NW), Kondakarai Plant- Main Gate, NTECL Plant - Main Gate (N), Athipattu TNEB Camp, Ennore Cargo Container Terminal Pvt Ltd, NTECL STP PLANT-(CSSP-MCP) and Near Switch Yard.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 9.3 to 23.2µg/m^3. Highest value of 23.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 16.4 to

32.7µg/m^3. Highest value of 32.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 51.7to 75.3µg/m^3. Highest value of 75.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 20.5 to 33.7µg/m^3. Highest value of 33.7µg/m^3 is obtained and however the values are within the NAAQM standards.

Stack monitoring

Particulate Matter concentration TPP-1 Boiler inlet is 42604 mg/Nm^3 and Outlet are 23.7 mg/Nm^3. The mass emission flow rate on the TPP-1 boiler inlet is 226442 kg/day and outlet are 1028kg/day. The Efficiency of ESP connected to Boiler is 99.94 %.

Particulate Matter concentration TPP-2 Boiler inlet is 56492 mg/Nm^3 and Outlet are 25.5 mg/Nm^3. The mass emission flow rate on the TPP-2 boiler inlet is 299636 kg/day and outlet are 975kg/day. The Efficiency of ESP connected to Boiler is 99.95 %.

Particulate Matter concentration TPP-3 Boiler inlet is 52726 mg/Nm^3 and Outlet are 23 mg/Nm^3. The mass emission flow rate on the TPP-3 boiler inlet is 279526kg/day and outlet are 1001kg/day. The Efficiency of ESP connected to Boiler is 99.96 %.

TPP-1 BOILER emission of Particulate matter concentration is 23.7mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.04km at the concentration of 1.79µg/m^3 at 2km dispersion Particulate matter is 0.578µg/m^3 and at 5km dispersion Particulate matter is 0.177µg/m^3 and the predominant wind direction is SW.

TPP-1 BOILER emission of Sulphur dioxide concentration is 872mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are

considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.97km at the concentration of 131µg/m^3 at 2km dispersion Sulphur dioxide is 9.976µg/m^3 and at 5km dispersion Sulphur dioxide is 0.677µg/m^3 and the predominant wind direction is SW.

TPP-1 BOILER emission of Oxides of Nitrogen concentration is 206mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.98km at the concentration of 15.5µg/m^3 at 2km dispersion Oxides of Nitrogen is 2.123µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.976µg/m^3 and the predominant wind direction is SW.

TPP-2 BOILER emission of Particulate matter concentration is 25.5mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.99km at the concentration of 1.69µg/m^3 at 2km dispersion Particulate matter is 0.234µg/m^3 and at 5km dispersion Particulate matter is 0.0876µg/m^3 and the predominant wind direction is SW.

TPP-2 BOILER emission of Sulphur dioxide concentration is 1379mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.08km at the concentration of 91.5µg/m^3 at 2km dispersion Sulphur dioxide is 8.97µg/m^3 and at 5km dispersion Sulphur dioxide is 6.34µg/m^3 and the predominant wind direction is SW.

TPP-2 BOILER emission of Oxides of Nitrogen concentration is 317mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 19.47m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.01km at the concentration of 21.1µg/m^3 at 2km dispersion Oxides of Nitrogen is 1.977µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.678µg/m^3 and the predominant wind direction is SW.

TPP-3 BOILER emission of Particulate matter concentration is 23mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.01km at the concentration of 21.1µg/m^3 at 2km dispersion Particulate matter is 2.969µg/m^3 and at 5km dispersion Particulate matter is 0.858µg/m^3 and the predominant wind direction is SW.

TPP-3 BOILER emission of Sulphur dioxide concentration is 1269mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.04km at the concentration of 95.5µg/m^3 at 2km dispersion Sulphur dioxide is 5.866µg/m^3 and at 5km dispersion Sulphur dioxide is 4.754µg/m^3 and the predominant wind direction is SW.

TPP-3 BOILER emission of Oxides of Nitrogen concentration is 289mg/m^3 and dispersed at the effective stack height of 275m (Stack height 275m + Plume Height 3.0m) with exit velocity of 18.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 2.15km at the concentration of 95.5µg/m^3 at

2km dispersion Oxides of Nitrogen is 13.121µg/m^3 and at 5km dispersion Oxides of Nitrogen is 1.459µg/m^3 and the predominant wind direction is SW.

Cumulative Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from NTECL Athipattu Pudhunagar to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The NTECL plant is surrounded by residential areas like 1.Athipattu pudhunagar, 2.Kamaraj Nagar, 3.Ernavur, 4.Edayanchavadi, 5.NTECL Township and 6. Gounder Palayam. From NTECL to Athipattu pudhunagar aerial distance is 1.58km, to Kamaraj Nagar is 2.22km, to Ernavur is 4.38km, to Edayanchavadi is 3.56km to NTECL Township is 2.39 and to Gounder Palayam is 3.37km.

The cumulative particulate matter emissions from NTECL through stacks is 72.2 mg/m3. The average ground level concentration achieves at an average distance of 2.01km and the sum of PM concentration at GLC is 8.19 µg/m3 which includes all the stacks at NTECL. The residential areas are more than 2km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from NTECL through stacks is 812 mg/m3. The average ground level concentration achieves at an average distance of 2.05km and the sum of Nitrogen Oxides concentration at GLC is 58.9 µg/m3 which includes all the stacks at NTECL. The residential areas are more than 2km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the NO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur dioxide emissions from NTECL through stacks is 3520 mg/m3. The average ground level concentration achieves at an average distance of 2.03km and the sum of Sulphur dioxide concentration at GLC is 106 µg/m3 which includes all the stacks at NTECL. The residential areas are more than 2km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the SO_2 contribution to the nearby residential areas are maximum and it is not below within the National Ambient Air Quality Standards.

***

Annexure-V

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Chennai Petroleum Corporation Ltd, Chennai

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. About Industry

Chennai Petroleum Corporation Limited (CPCL), one of the leading group companies of Indian Oil's, was conceived in 1960s as a 2.5 million metric tonnes per annum (MMTPA) refinery designed to produce fuels and lubes base stock. At CPCL, the past five decades have an eventful, growth-oriented phase as the CPCL family built the organisation to reach the present stature of 10.5 MMTPA capacity.

Today, CPCL stands tall among the public-sector refining companies in India, with one of the most complex refineries of its kind in the country, producing an array of value-added petroleum products. It also pioneered key initiatives in several areas such as process optimisation, technology absorption, energy conservation, waste land reclamation and environment management.

The first refinery complex of CPCL was commissioned in 1969 with a capacity of 2.5 MMTPA (CDU-1). This refinery was designed to produce Lube oil based stocks (LOBS) in addition to Fuel products like LPG, MS, HSD, SKO, ATF, Naphtha and FO. Lube production includes process units like Aromatic extraction unit using NMP solvent, Dewaxing unit using MEK & Toluene solvent, Hydro-finishing unit.

The Manali refining capacity was doubled to 5.6 MMTPA in 1984 by setting up an additional Crude Distillation unit (CDU-2) with a capacity of 2.8 MMTPA. The secondary processing unit – FCC was also installed to increase the production of high value products like LPG and MS.

A Wax unit was set up to produce Paraffin and Match Wax. The capacity of CDU-2 was increased from 2.8 to 3.7 MMTPA through de-bottlenecking, taking the total refinery capacity to 6.5 MMTPA. In 1994, the Lube capacity was increased from 140 to 270 TMTPA by revamping Solvent Dewaxing unit.

CPCL implemented a 3 MMTPA refinery expansion project(Refinery-III) in 2004 with an additional crude distillation Unit (CDU-III) and increased the refining capacity of Manali refinery to 9.5 MMTPA. Refinery III revamp taken up during 2010, has further increased Manali Refining capacity to 10.5 MMTPA. The total refining capacity of CPCL (Manali + CBR) has increased to 12.1 MMTPA capacity as on 2020.

In order to maximize the distillate yield of the Manali Refinery, CPCL has implemented Resid Upgradation Project during Nov'2017. This project involved addition of new Delayed Coker Unit and Revamp of existing Hydro Cracker Unit along with other associated facilities. This project enabled improvement of Distillate yield, i.e, maximization of value added products.

Chennai Petroleum Corporation Limited (CPCL) a group company of Indian Oil Corporation Limited (IOCL) has planned to set up a grassroots refinery of capacity 9 MMTPA at Nagapattinam, Tamilnadu at the same location of the existing 1 MMTPA Cauvery Basin Refinery after dismantling the existing facilities. This new refinery which will produce the fuels of BS-VI specifications will able to meet the growing demands of fuels in southern region and nearby location. Engineers India Ltd have been retained by CPCL to provide services for the following:

(i) Preparation of Basic Engineering Design Package of CDU/VDU.

(ii) Preparation of Basic Engineering Design Package of SWS & ARU.

(iii) Preparation of Basic Engineering Design Package of Utilities & offsites facilities.

(iv) Review of Basic Engineering Design Package of all licensed units & coordination with Licensor during preparation of BDEP.

(v) Licensor selection of licensed units like VGO-HDT, MS Block, PP unit, SRU, LPG treating unit.

(vi) Preparation of Project DFR with +/- 10% accuracy, including development of Plot plan, project schedule and implementation etc.

(vii) Preparation of DFR for Desalination plant

(viii) Preparation of DFR for SPM and pipeline facilities

(ix) EIA and RRA study

CPCL Location Google Earth Map

2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.1 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100
*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM_{10} in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM_{10} in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM_{10}

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

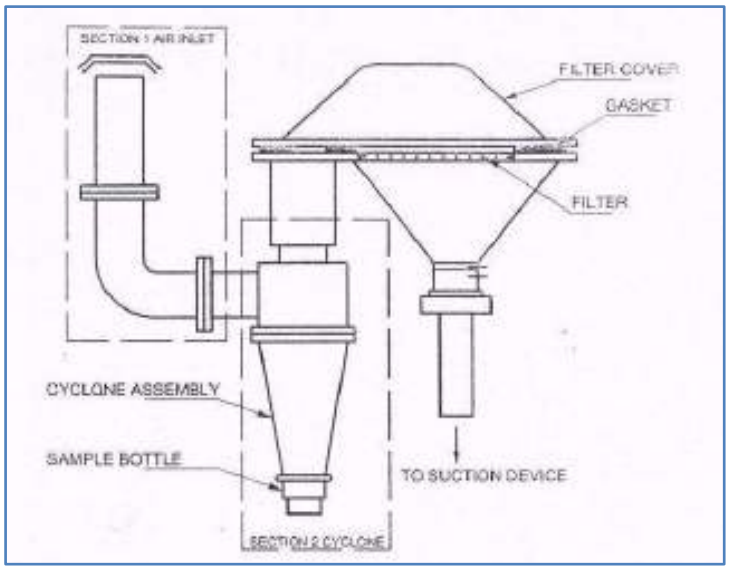
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = $(Wf - Wi) \times 10^6 / V$

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flowrate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.2 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, $\mu g/m^3$	Annual *	40	40
	24 Hours **	60	60
*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.

- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2ºC) temperature between 25ºC. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).
- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time

of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine PM2.5 mass concentration:

$PM2.5 = M2.5 / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF $PM_{2.5}$
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of $PM_{2.5}$ in µg/m3

8.0 References

40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2.0 PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.3 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80

*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) **-** Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days

(48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.

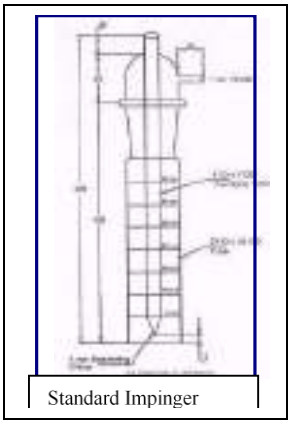
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^oC.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO_2 = Concentration of Nitrogen dioxide, µg/m^3
A_s = Absorbance of sample
A_b = Absorbance of reagent blank
CF = Calibration factor
V_a = Volume of air sampled, m^3
V_s = Volume of sample, ml
V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing

solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$C\ (NO_2\ \mu g/m^3) = (As - Ab) \times CF \times Vs / Va \times Vt \times 0.82$

Where,

$C\ NO_2$	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger ⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS) ⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours ⇩
Check the volume of sample at the end of sampling and record it ⇩
Transfer the exposed samples in storage bottle and preserve ⇩

Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O_3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I_2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25^{o}C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with

10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (NH_3\ \mu g/m^3) = (As - Ab) \times CF / Va$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

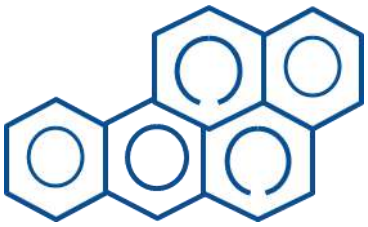
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is $C_{20}H_{12}$ having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH in

24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM- 2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

11 References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
⇩
Ultrasonic extraction with Toluene (50 ml × 3 times)
⇩
Filter & dry with Anhydrous Sodium Sulphate
⇩
Concentration with Rotary Evaporator
⇩
Clean up with Silica Gel Column Chromatography
⇩
Elution with Cyclo-Hexane (5 ml × 3 times)
⇩
Evaporate to nearly dryness under Nitrogen
⇩
Re-dissolved in 0.5 to 1.0 ml Toluene
⇩
Capillary GC-MS

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction

(Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps

Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V = Volume of air, m^3

Q = Average sampling rate, m^3/min.

T = Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C = Concentration, µg Metal/M^3.

Ms = Metal Concentration µg/ml

Mb = Blank Concentration µg/ml

Vs = Total Volume of Extraction in ml

Fa = Total Area of Exposed Filter in Cm^2

V = Volume of Air Sampled in M^3

Ft = Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	Methods of Measurement
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Gaeke method -Ultraviolet Fluorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3. Weather Data

WEATHER MONITORING DATA AT CPCL CHENNAI - 20.01.2021 to 21.01.2021					
Date	Time	Temp (°C)	% RH	Wind Speed [km/hr]	Wind Dir.
20.01.2021	10:00	27	74	11	WSW
20.01.2021	11:00	29	62	22	NNE
20.01.2021	12:00	30	55	24	NE
20.01.2021	13:00	30	55	26	NNE
20.01.2021	14:00	30	59	22	NNE
20.01.2021	15:00	30	52	19	NNE
20.01.2021	16:00	29	58	22	NE
20.01.2021	17:00	28	66	17	NE
20.01.2021	18:00	27	70	15	NE
20.01.2021	19:00	27	70	17	NE
20.01.2021	20:00	27	74	9	NE
20.01.2021	21:00	26	79	7	NE
20.01.2021	22:00	26	79	4	N
20.01.2021	23:00	25	83	4	N
21.01.2021	00:00	25	89	0	N
21.01.2021	01:00	24	94	0	N
21.01.2021	02:00	24	94	0	N
21.01.2021	03:00	24	94	4	N
21.01.2021	04:00	24	94	4	N
21.01.2021	05:00	24	94	0	N
21.01.2021	06:00	24	94	4	N
21.01.2021	07:00	24	94	4	N
21.01.2021	08:00	25	89	4	N
21.01.2021	09:00	27	84	4	N
MIN		24	52	0	
MAX		30.0	94	26.0	N
AVG		26.5	77	10.1	

WEATHER MONITORING DATA AT CPCL CHENNAI - 21.01.2021 to 22.01.2021					
Date	Time	Temp (°C)	% RH	Wind Speed [km/hr]	Wind Dir.
21.01.2021	10:00	29.0	74	7	E
21.01.2021	11:00	30.0	70	7	ESE
21.01.2021	12:00	31.0	66	9	ESE
21.01.2021	13:00	31.0	62	13	ESE
21.01.2021	14:00	30.0	66	13	ESE
21.01.2021	15:00	31.0	66	15	ESE
21.01.2021	16:00	30.0	70	15	ESE
21.01.2021	17:00	29.0	74	17	E
21.01.2021	18:00	28.0	79	15	ESE
21.01.2021	19:00	27.0	89	11	E
21.01.2021	20:00	27.0	89	11	ESE
21.01.2021	21:00	27.0	89	9	ESE
21.01.2021	22:00	27.0	89	9	E
21.01.2021	23:00	27.0	89	9	E
22.01.2021	00:00	27.0	89	7	N
22.01.2021	01:00	27.0	89	7	ESE
22.01.2021	02:00	26.0	94	0	N
22.01.2021	03:00	26.0	94	0	N
22.01.2021	04:00	26.0	94	4	N
22.01.2021	05:00	25.0	94	4	N
22.01.2021	06:00	25.0	100	4	N
22.01.2021	07:00	25.0	100	4	N
22.01.2021	08:00	25.0	100	0	N
22.01.2021	09:00	26.0	84	0	N
MIN		25.0	62	0	
MAX		31.0	100	17.0	ESE
AVG		27.6	84	7.9	

4.0 Google Earth Map – Sampling Location

Ambient Air Quality Monitoring Sampling Locations

Stack Emission Monitoring Locations

5. AMBIENT AIR QUALITY MONITORING RESULTS:

AAQ- 1 : M/S. R & D, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - R & D	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	20.17	17.99
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	34.69	32.58
3	Particulate Matter (PM_{10})	$\mu g/m^3$	58.1	56.92
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	24.45	35.62
5	Lead as Pb	$\mu g/m^3$	0.01	BLQ(LOQ:0.02)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	4.17	4.18
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

AAQ- 2: M/s. SRU, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - SRU	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	26.51	20.28
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	28.39	34.22
3	Particulate Matter (PM_{10})	$\mu g/m^3$	51.3	42.42
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	37.34	27.92
5	Lead as Pb	$\mu g/m^3$	0.008	BLQ(LOQ:0.02)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	4.25	BLQ(LOQ:4)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

AAQ- 3: M/s. CPP, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - CPP	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	µg/m^3	26.51	22.95
2	Nitrogen Dioxide as NO_2	µg/m^3	35.43	30.03
3	Particulate Matter (PM_{10})	µg/m^3	40	55.82
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	28.46	33.27
5	Lead as Pb	µg/m^3	0.009	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	µg/m^3	4.36	BLQ(LOQ:4)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

AAQ- 4: M/s. TEMPLE, MANALI, TAMIL NADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - Temple	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	µg/m^3	20.97	24.05
2	Nitrogen Dioxide as NO_2	µg/m^3	35.87	33.27
3	Particulate Matter (PM_{10})	µg/m^3	43.6	48.31
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	27.61	33.58
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)	0.016
6	Ammonia as NH3	µg/m^3	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4)	BLQ(LOQ:4)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	2.56

AAQ- 5: M/s. SS-5, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - SS-5	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	µg/m^3	17.34	16.47
2	Nitrogen Dioxide as NO_2	µg/m^3	29.84	36.38
3	Particulate Matter (PM_{10})	µg/m^3	42.13	47.86
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	36.14	34.1
5	Lead as Pb	µg/m^3	0.008	0.010
6	Ammonia as NH3	µg/m^3	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)	4.20
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	2.17	BLQ(LOQ:2)

AAQ- 6: M/s. ETP 2, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - ETP 2	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	µg/m^3	22.56	13.43
2	Nitrogen Dioxide as NO_2	µg/m^3	30.44	31.52
3	Particulate Matter (PM_{10})	µg/m^3	41.83	45.45
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	29.15	32.86
5	Lead as Pb	µg/m^3	0.008	0.016
6	Ammonia as NH3	µg/m^3	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)	4.38
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	2.25	2.5

AAQ- 7: M/s. TTP, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - TTP	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	17.48	11.93
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	28.16	32.32
3	Particulate Matter (PM_{10})	$\mu g/m^3$	45.71	54
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28.48	34.72
5	Lead as Pb	$\mu g/m^3$	0.005	0.008
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	2.18

AAQ- 8: M/s. POLYTANIC, MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - POLYTANIC	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	23.84	14.55
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	34.82	31.32
3	Particulate Matter (PM_{10})	$\mu g/m^3$	51.16	53.28
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	23.79	28.15
5	Lead as Pb	$\mu g/m^3$	0.008	0.051
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

AAQ- 9: M/s. ISOMER (CABIN), MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - ISOMER (CABIN)	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	20.8	15.61
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	31.31	31.32
3	Particulate Matter (PM_{10})	$\mu g/m^3$	50.44	48.52
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	32.79	36.45
5	Lead as Pb	$\mu g/m^3$	0.007	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	4.21	4.16
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

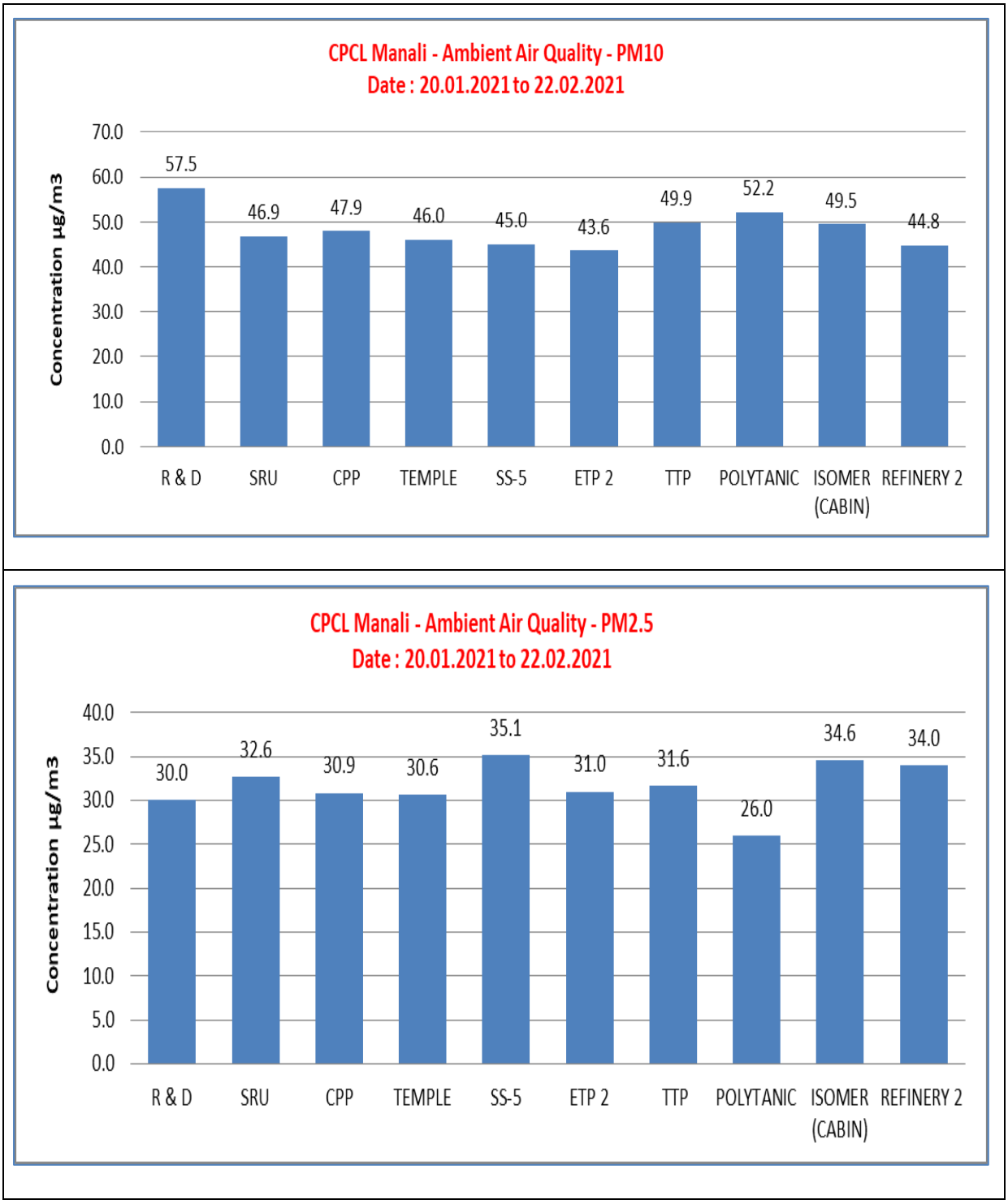
AAQ- 10: M/s. REFINERY 2 MAINTANE FIELD ROOM, MANALI, TAMILNADU

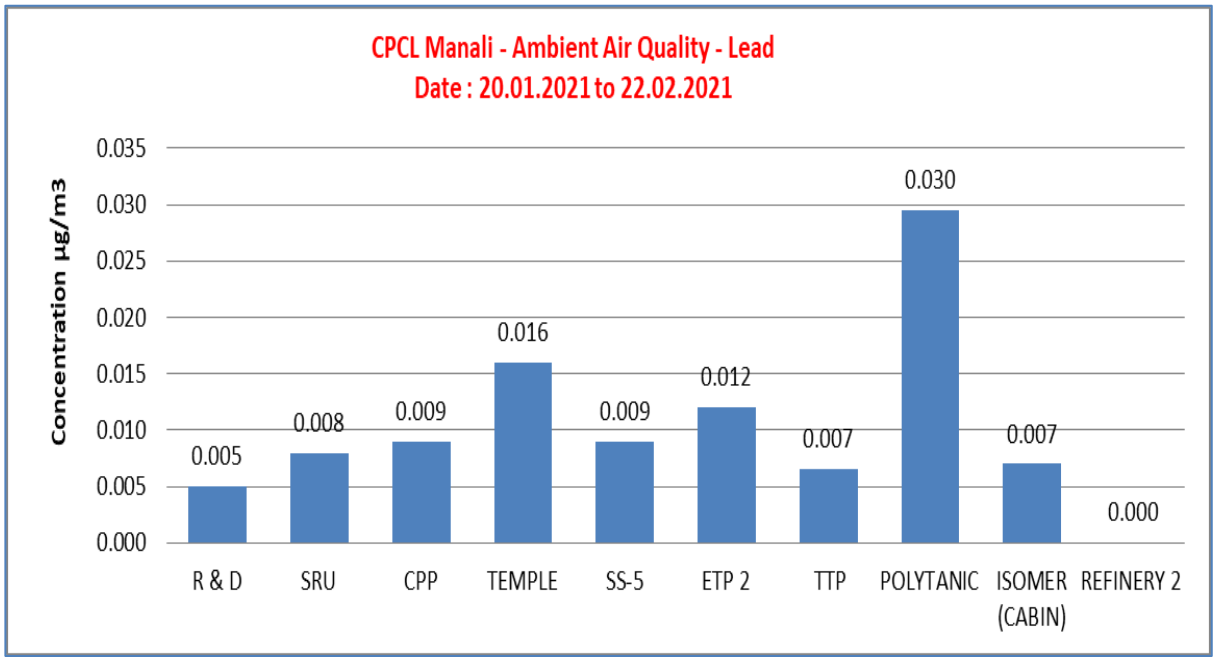
S.NO	POLLUTANT	UNIT	CHENNAI PETROLEUM CORPORATION LIMITED-MANALI LOCATION - REFINERY 2 MAINTANE FIELD ROOM	
			20 to 21 Jan 2021 DAY-1	21 to 22 Jan 2021 DAY-2
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	14.13	20.02
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	28.62	37.43
3	Particulate Matter (PM_{10})	$\mu g/m^3$	44.24	45.27
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	32.85	35.22
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.02)	BLQ(LOQ:0.02)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4)	BLQ(LOQ:4)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2)	BLQ(LOQ:2)

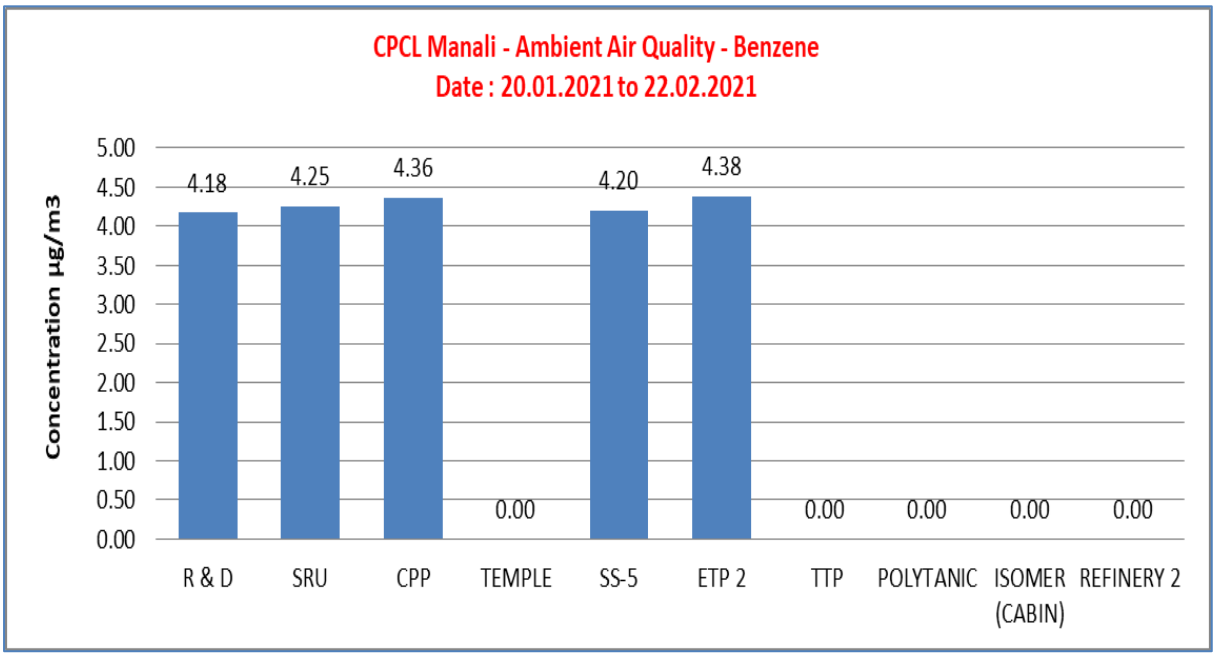
Consolidated AAQ Monitoring Results

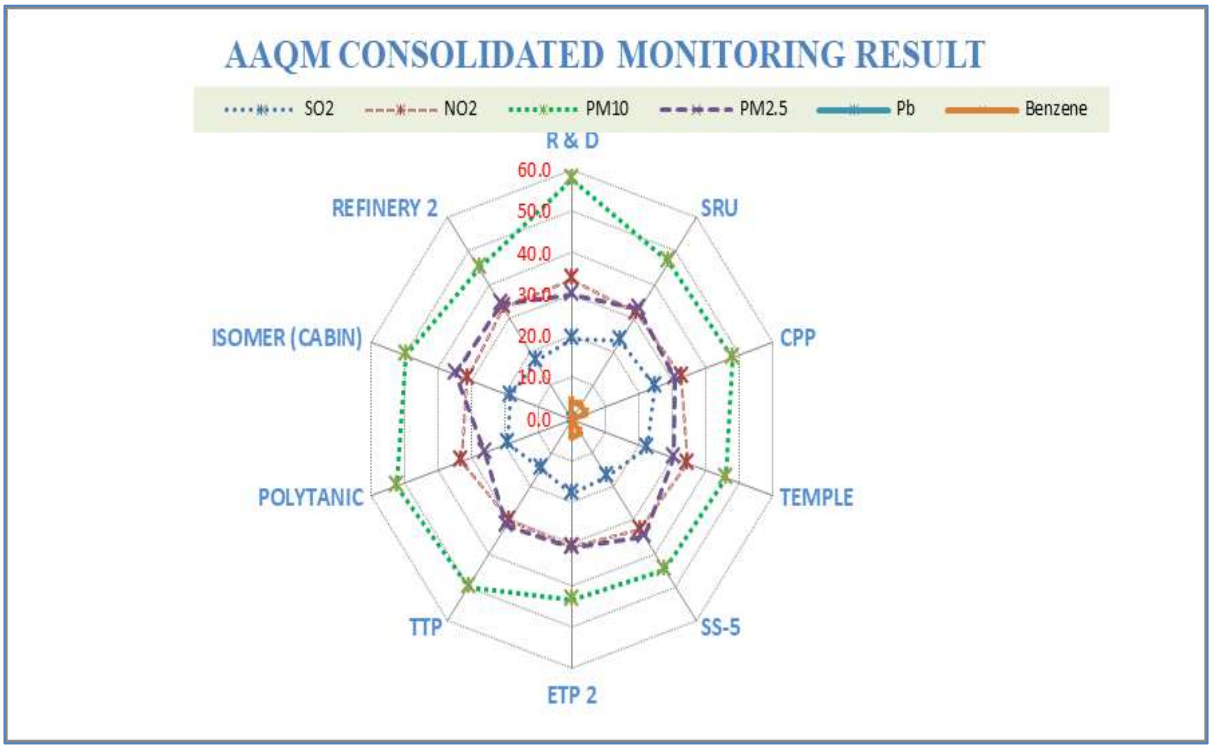
AAQM Consolidated Monitoring Results (µg/m3)						
Sampling Date [20.01.2021 to 22.01.2021]						
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**	**Pb**	**BENZENE**
R & D	19.1	33.6	57.5	30.0	0.005	4.18
SRU	23.4	31.3	46.9	32.6	0.008	4.25
CPP	24.7	32.7	47.9	30.9	0.009	4.36
TEMPLE	22.5	34.6	46.0	30.6	0.016	BDL
SS-5	16.9	33.1	45.0	35.1	0.009	4.20
ETP 2	18.0	31.0	43.6	31.0	0.012	4.38
TTP	14.7	30.2	49.9	31.6	0.007	BDL
POLYTANIC	19.2	33.1	52.2	26.0	0.030	BDL
ISOMER (CABIN)	18.2	31.3	49.5	34.6	0.007	BDL
REFINERY 2	17.1	33.0	44.8	34.0	BDL	BDL

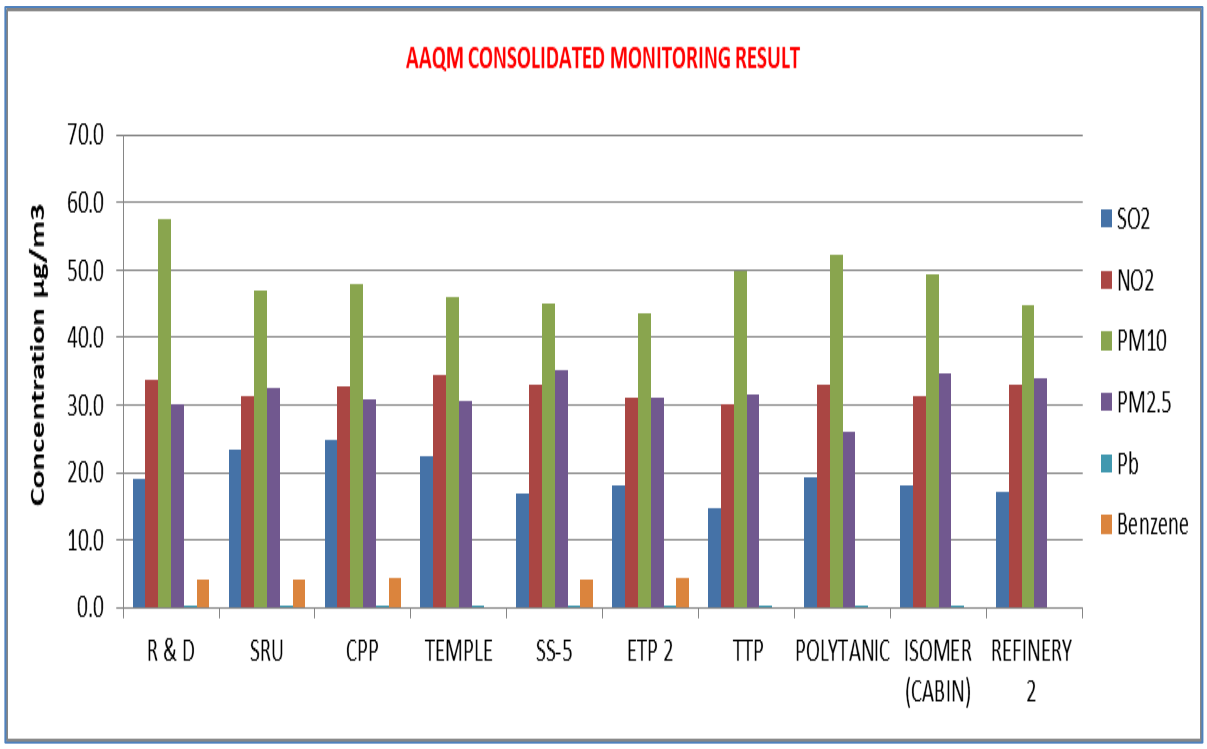
CPCL Manali - Ambient Air Quality - SO2
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
30.0
25.0
20.0
15.0
10.0
5.0
0.0
19.1
23.4
24.7
22.5
16.9
18.0
14.7
19.2
18.2
17.1
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2
CPCL Manali - Ambient Air Quality - NO2
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
35.0
34.0
33.0
32.0
31.0
30.0
29.0
28.0
33.6
31.3
32.7
34.6
33.1
31.0
30.2
33.1
31.3
33.0
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2


CPCL Manali - Ambient Air Quality - PM10
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
57.5
46.9
47.9
46.0
45.0
43.6
49.9
52.2
49.5
44.8
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2
CPCL Manali - Ambient Air Quality - PM2.5
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
30.0
32.6
30.9
30.6
35.1
31.0
31.6
26.0
34.6
34.0
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2


CPCL Manali - Ambient Air Quality - Lead
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.005
0.008
0.009
0.016
0.009
0.012
0.007
0.030
0.007
0.000
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2


CPCL Manali - Ambient Air Quality - Benzene
Date : 20.01.2021 to 22.02.2021
Concentration µg/m3
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
4.18
4.25
4.36
0.00
4.20
4.38
0.00
0.00
0.00
0.00
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
Pb
Benzene
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2
60.0
50.0
40.0
30.0
20.0
10.0
0.0


AAQM CONSOLIDATED MONITORING RESULT
Concentration µg/m3
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
R & D
SRU
CPP
TEMPLE
SS-5
ETP 2
TTP
POLYTANIC
ISOMER (CABIN)
REFINERY 2
SO2
NO2
PM10
PM2.5
Pb
Benzene

FINDINGS:

In Ambient Air Quality monitoring ten locations were identified as source of emission of Gaseous and Particulate matter. Those are, R & D, SRU, CPP, Temple, SS-5, ETP-2, TTP, Polytanic, Isomer (Cabin) & Refinery 2 Maintains Field Room.

- *Sulphur Dioxide as SO_2 :* Ambient Air Quality values of SO_2 are ranging from 14.7 to 24.7 µg/m^3. Highest value of 24.7 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Nitrogen Dioxide as NO_2 :* Ambient Air Quality values of NO_2 are ranging from 30.2 to 34.6 µg/m^3. Highest value of 37.61 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter (PM_{10}) :* Ambient Air Quality values of PM_{10} are ranging from 43.6 to 57.5 µg/m^3. Highest value of 57.5 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter ($PM_{2.5}$) :* Ambient Air Quality values of $PM_{2.5}$ are ranging from 26 to 35.1 µg/m^3. Highest value of 35.1 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Lead as Pb :* Ambient Air Quality values of Pb are ranging from 0.0 to 0.0295 µg/m^3. Highest value of 0.0295 µg/m^3 is obtained and however the value is within the NAAQ standards.

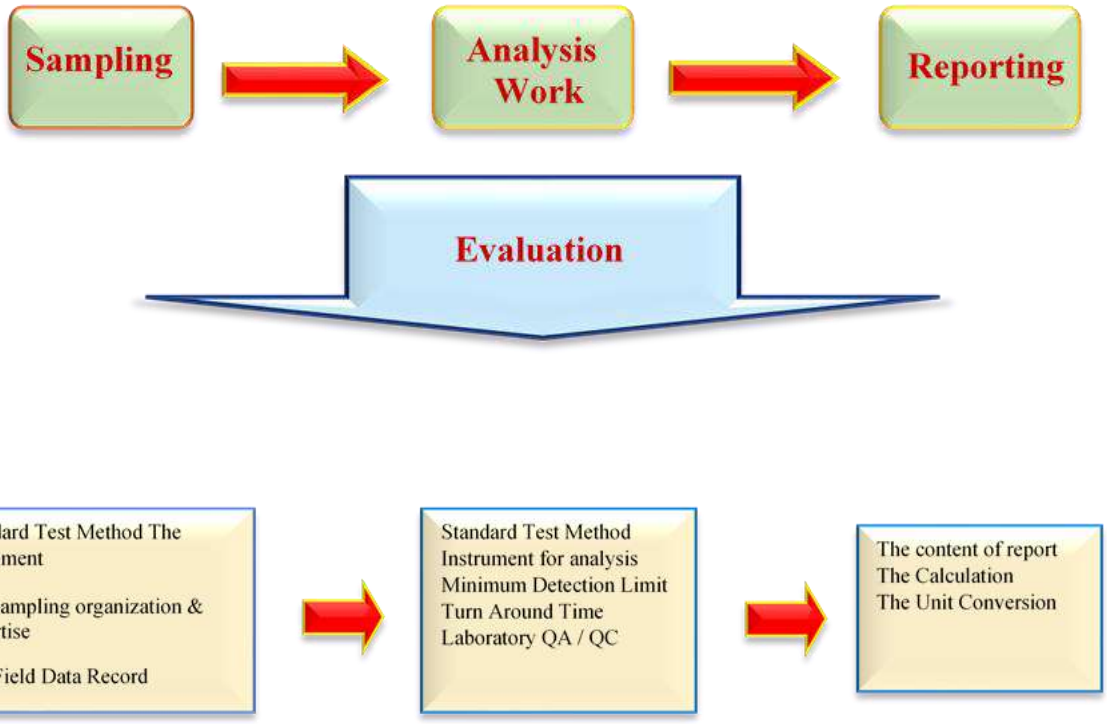
- *Benzene :* Ambient Air Quality values of Benzene are ranging from 0 to 4.4 µg/m^3.

- *Nickel as Ni:* Ambient Air Quality values of Nickel are ranging from 0 to 2.56 µg/m^3.

6. STACK EMISSION MONITORING AND ANALYSIS:

6.1 PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

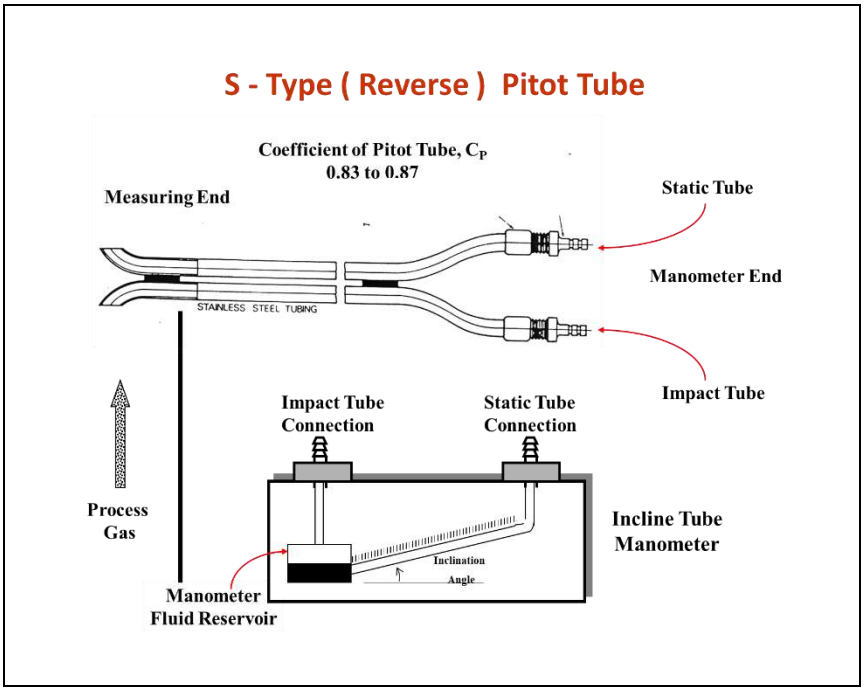


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

6.2 Exhaust Gas Volume Stream

6.2.1 Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left[\frac{\Delta P \times Ts}{Ps \times Mw} \right]^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: ***Field Sampling Procedure:***

Duct Cross section and Number of Traverse Points :

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

5. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

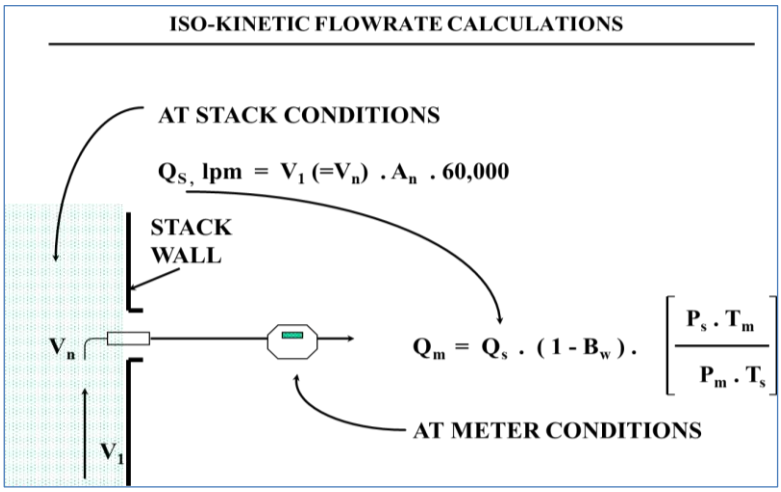
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

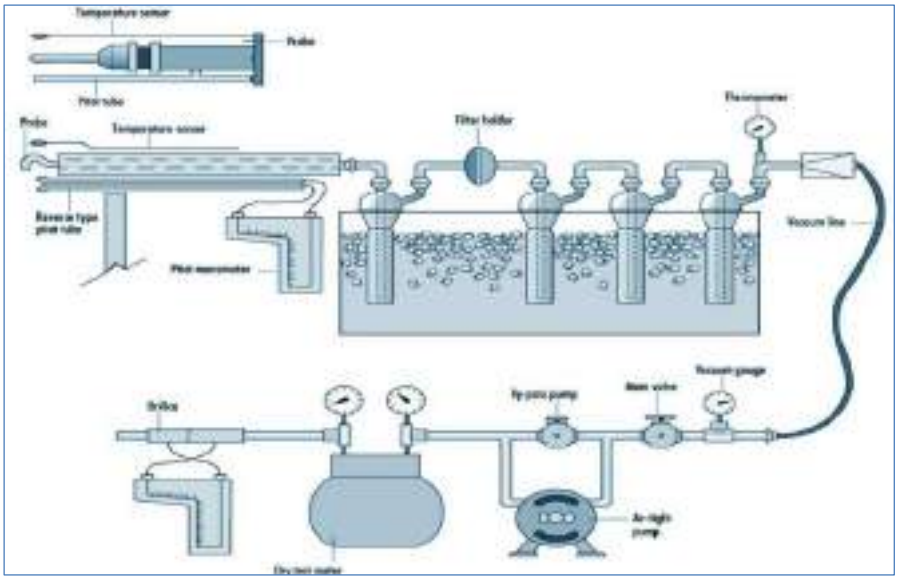
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



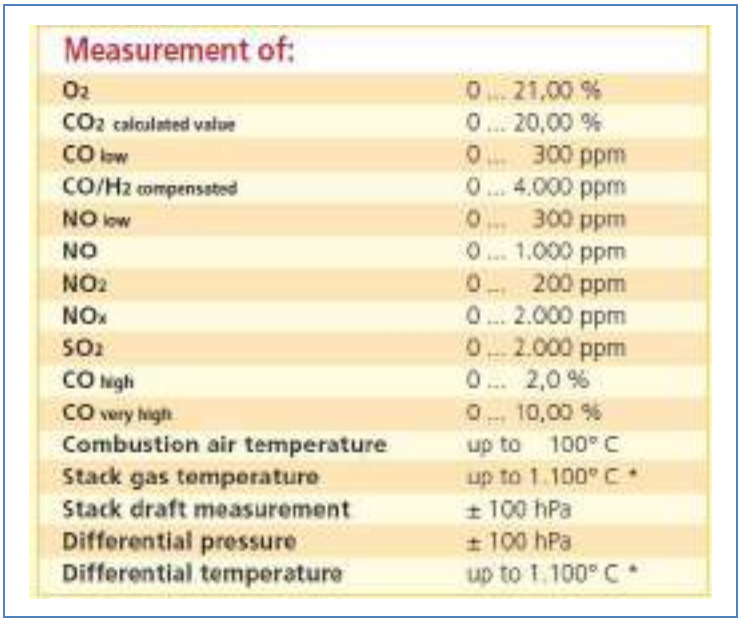
Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.



Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:
The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In

case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading, meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers. Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298^oK

Tm The absolute dry gas meter temperature, ^oK

Pn The absolute pressure at normal conditions, 760 mmHg

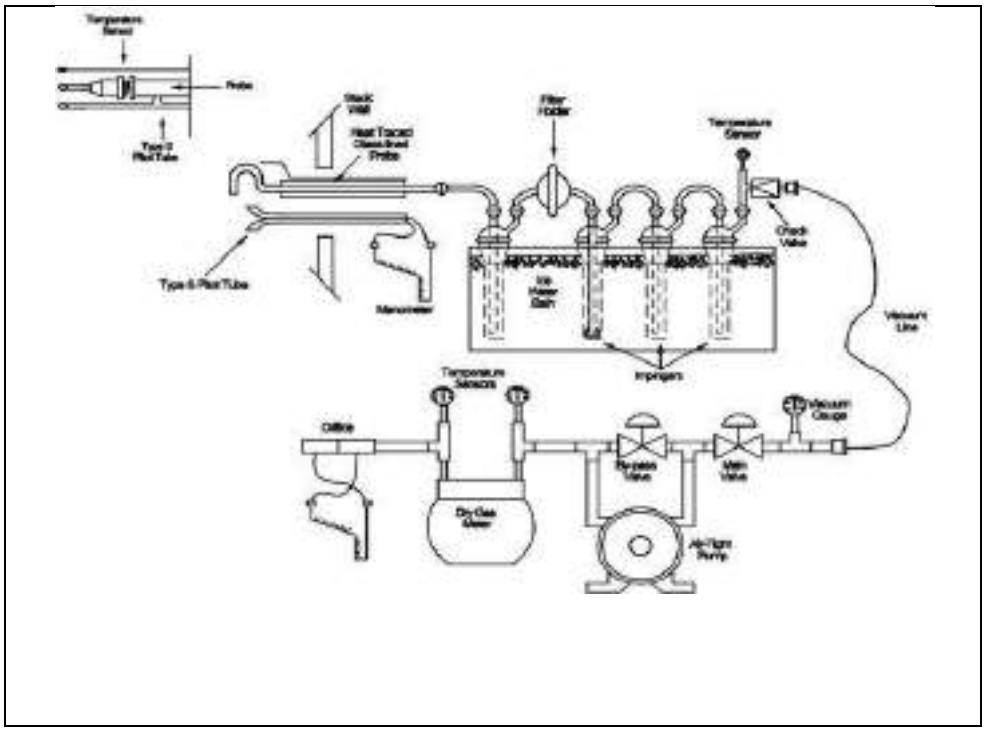
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

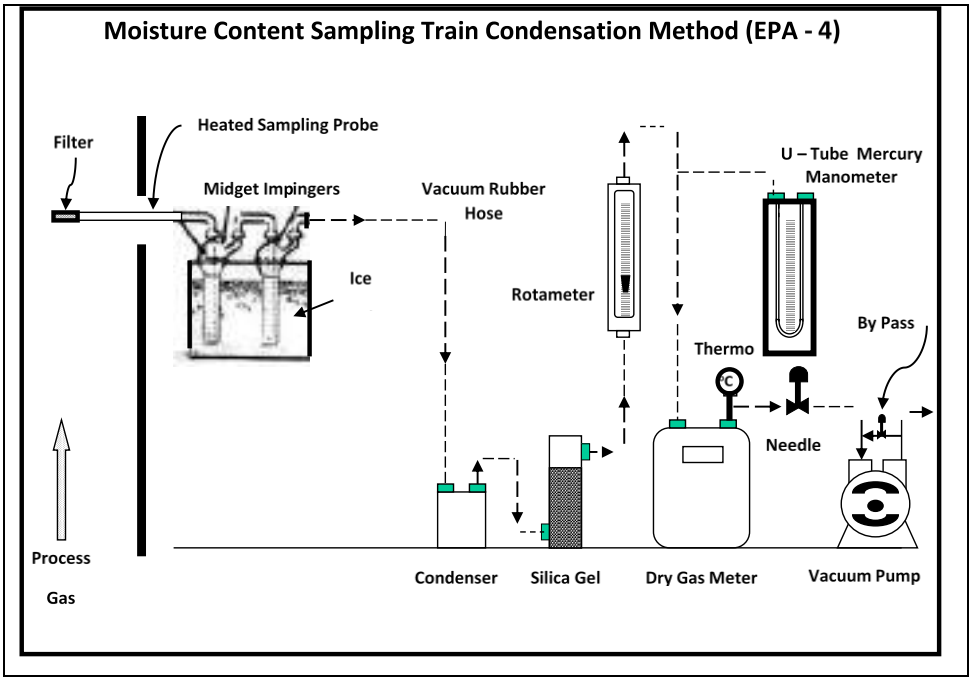
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.


Moisture Content Sampling Train Condensation Method (EPA - 4)
Filter
Heated Sampling Probe
Midget Impingers
Vacuum Rubber Hose
U – Tube Mercury Manometer
Ice
Rotameter
Thermo
By Pass
Needle
Process Gas
Condenser
Silica Gel
Dry Gas Meter
Vacuum Pump

7.0 STACK EMISSION RESULTS:

STACK- 1: M/s. 14F1, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 14F1
1	Stack Temperature	K	788
2	Velocity	m/sec	12.3
3	Volume of Gas Discharge	Nm^3/hr	20067
4	Oxygen as O_2	%	8.1
5	Carbon Monoxide as CO	mg/Nm^3	152
6	Carbon Dioxide as CO_2	%	11.6
7	Particulate Matter	mg/Nm^3	15.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	116
9	Oxides of Nitrogen as NO_2	mg/Nm^3	356

STACK- 2: M/s. 14F101, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 14F101
1	Stack Temperature	K	769
2	Velocity	m/sec	14.08
3	Volume of Gas Discharge	Nm^3/hr	21669
4	Oxygen as O_2	%	9.6
5	Carbon Monoxide as CO	mg/Nm^3	140
6	Carbon Dioxide as CO_2	%	10.5
7	Particulate Matter	mg/Nm^3	8.1
8	Sulphur Dioxide as SO_2	mg/Nm^3	42
9	Oxides of Nitrogen as NO_2	mg/Nm^3	331

STACK- 3: M/s. 15F1A, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 15F1A
1	Stack Temperature	K	431
2	Velocity	m/sec	7.3
3	Volume of Gas Discharge	Nm^3/hr	95678
4	Oxygen as O_2	%	11.2
5	Carbon Monoxide as CO	mg/Nm^3	149
6	Carbon Dioxide as CO_2	%	8.6
7	Particulate Matter	mg/Nm^3	17.9
8	Sulphur Dioxide as SO_2	mg/Nm^3	33.5
9	Oxides of Nitrogen as NO_2	mg/Nm^3	76

STACK- 4: M/s. PLANT 15 VAC, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – Plant 15 VAC
1	Stack Temperature	K	457
2	Velocity	m/sec	8.46
3	Volume of Gas Discharge	Nm^3/hr	44656
4	Oxygen as O_2	%	9.4
5	Carbon Monoxide as CO	mg/Nm^3	103
6	Carbon Dioxide as CO_2	%	11.5
7	Particulate Matter	mg/Nm^3	19.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	59
9	Oxides of Nitrogen as NO_2	mg/Nm^3	172

STACK- 5: M/s. 15F2A, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 15F2A,
1	Stack Temperature	K	630
2	Velocity	m/sec	9.95
3	Volume of Gas Discharge	Nm^3/hr	27750
4	Oxygen as O_2	%	8.3
5	Carbon Monoxide as CO	mg/Nm^3	119
6	Carbon Dioxide as CO_2	%	10.5
7	Particulate Matter	mg/Nm^3	18.5
8	Sulphur Dioxide as SO_2	mg/Nm^3	61.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	306

STACK- 6: M/s. 15F2B, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 15F2B
1	Stack Temperature	K	536
2	Velocity	m/sec	11.21
3	Volume of Gas Discharge	Nm^3/hr	36747
4	Oxygen as O_2	%	7.9
5	Carbon Monoxide as CO	mg/Nm^3	84
6	Carbon Dioxide as CO_2	%	11.3
7	Particulate Matter	mg/Nm^3	20.3
8	Sulphur Dioxide as SO_2	mg/Nm^3	186.9
9	Oxides of Nitrogen as NO_2	mg/Nm^3	192

STACK- 7: M/s. 16F1, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 16F1
1	Stack Temperature	K	456
2	Velocity	m/sec	10.74
3	Volume of Gas Discharge	Nm^3/hr	63804
4	Oxygen as O_2	%	9.4
5	Carbon Monoxide as CO	mg/Nm^3	148
6	Carbon Dioxide as CO_2	%	10.8
7	Particulate Matter	mg/Nm^3	17.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	59.1
9	Oxides of Nitrogen as NO_2	mg/Nm^3	408

STACK- 8: M/s. 16F3, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 16F3
1	Stack Temperature	K	671
2	Velocity	m/sec	14.99
3	Volume of Gas Discharge	Nm^3/hr	59179
4	Oxygen as O_2	%	6.2
5	Carbon Monoxide as CO	mg/Nm^3	142
6	Carbon Dioxide as CO_2	%	11.9
7	Particulate Matter	mg/Nm^3	9.7
8	Sulphur Dioxide as SO_2	mg/Nm^3	10.2
9	Oxides of Nitrogen as NO_2	mg/Nm^3	43

STACK- 9: M/s. 9F201, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 9F201
1	Stack Temperature	K	417
2	Velocity	m/sec	7.32
3	Volume of Gas Discharge	Nm^3/hr	32147
4	Oxygen as O_2	%	11.2
5	Carbon Monoxide as CO	mg/Nm^3	185
6	Carbon Dioxide as CO_2	%	9.4
7	Particulate Matter	mg/Nm^3	24.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	41.0
9	Oxides of Nitrogen as NO_2	mg/Nm^3	421

STACK- 10: M/s. 9F301, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 9F301
1	Stack Temperature	K	509
2	Velocity	m/sec	9.46
3	Volume of Gas Discharge	Nm^3/hr	16143
4	Oxygen as O_2	%	8.6
5	Carbon Monoxide as CO	mg/Nm^3	159
6	Carbon Dioxide as CO_2	%	10.1
7	Particulate Matter	mg/Nm^3	25.6
8	Sulphur Dioxide as SO_2	mg/Nm^3	71.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	425

STACK- 11: M/s. 10F101, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 10F101
1	Stack Temperature	K	641
2	Velocity	m/sec	9.8
3	Volume of Gas Discharge	Nm^3/hr	18099
4	Oxygen as O_2	%	11.3
5	Carbon Monoxide as CO	mg/Nm^3	111
6	Carbon Dioxide as CO_2	%	6.9
7	Particulate Matter	mg/Nm^3	19.1
8	Sulphur Dioxide as SO_2	mg/Nm^3	40.8
9	Oxides of Nitrogen as NO_2	mg/Nm^3	232

STACK- 12: M/s. 1F1A East, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 1F1A East
1	Stack Temperature	K	468
2	Velocity	m/sec	8.02
3	Volume of Gas Discharge	Nm^3/hr	97096
4	Oxygen as O_2	%	14.5
5	Carbon Monoxide as CO	mg/Nm^3	60
6	Carbon Dioxide as CO_2	%	4.8
7	Particulate Matter	mg/Nm^3	14.5
8	Sulphur Dioxide as SO_2	mg/Nm^3	164
9	Oxides of Nitrogen as NO_2	mg/Nm^3	125

STACK- 13: M/s. 1F1A West, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 1F1A West
1	Stack Temperature	K	481
2	Velocity	m/sec	8.51
3	Volume of Gas Discharge	Nm^3/hr	100204
4	Oxygen as O_2	%	14.5
5	Carbon Monoxide as CO	mg/Nm^3	56
6	Carbon Dioxide as CO_2	%	4.8
7	Particulate Matter	mg/Nm^3	12.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	149.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	101

STACK- 14: M/s. 71F1, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 71F1
1	Stack Temperature	K	589
2	Velocity	m/sec	7.79
3	Volume of Gas Discharge	Nm^3/hr	14932
4	Oxygen as O_2	%	7.8
5	Carbon Monoxide as CO	mg/Nm^3	143
6	Carbon Dioxide as CO_2	%	10.1
7	Particulate Matter	mg/Nm^3	29.7
8	Sulphur Dioxide as SO_2	mg/Nm^3	157.3
9	Oxides of Nitrogen as NO_2	mg/Nm^3	335

STACK- 15: M/s. 73F101, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 73F101
1	Stack Temperature	K	457
2	Velocity	m/sec	7.95
3	Volume of Gas Discharge	Nm^3/hr	38271
4	Oxygen as O_2	%	10.9
5	Carbon Monoxide as CO	mg/Nm^3	135
6	Carbon Dioxide as CO_2	%	9.5
7	Particulate Matter	mg/Nm^3	27.0
8	Sulphur Dioxide as SO_2	mg/Nm^3	51.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	94

STACK- 16: M/s. 73F102, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 73F102
1	Stack Temperature	K	423
2	Velocity	m/sec	6.8
3	Volume of Gas Discharge	Nm^3/hr	37144
4	Oxygen as O_2	%	12.7
5	Carbon Monoxide as CO	mg/Nm^3	15
6	Carbon Dioxide as CO_2	%	6.4
7	Particulate Matter	mg/Nm^3	15.8
8	Sulphur Dioxide as SO_2	mg/Nm^3	10.3
9	Oxides of Nitrogen as NO_2	mg/Nm^3	16

STACK- 18: M/s. 77F1, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 77F1,
1	Stack Temperature	K	578
2	Velocity	m/sec	10.21
3	Volume of Gas Discharge	Nm^3/hr	33369
4	Oxygen as O_2	%	9.6
5	Carbon Monoxide as CO	mg/Nm^3	31
6	Carbon Dioxide as CO_2	%	8.4
7	Particulate Matter	mg/Nm^3	18.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	20.7
9	Oxides of Nitrogen as NO_2	mg/Nm^3	60

STACK- 19: M/s. 201F1-F2, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 201F1-F2
1	Stack Temperature	K	628
2	Velocity	m/sec	18.5
3	Volume of Gas Discharge	Nm^3/hr	293982
4	Oxygen as O_2	%	3.6
5	Carbon Monoxide as CO	mg/Nm^3	180
6	Carbon Dioxide as CO_2	%	12.7
7	Particulate Matter	mg/Nm^3	14.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	367.1
9	Oxides of Nitrogen as NO_2	mg/Nm^3	239

STACK- 20: M/s. 205F1, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 205F1
1	Stack Temperature	K	471
2	Velocity	m/sec	5.93
3	Volume of Gas Discharge	Nm^3/hr	33448
4	Oxygen as O_2	%	11.2
5	Carbon Monoxide as CO	mg/Nm^3	56
6	Carbon Dioxide as CO_2	%	5.9
7	Particulate Matter	mg/Nm^3	8.2
8	Sulphur Dioxide as SO_2	mg/Nm^3	18.0
9	Oxides of Nitrogen as NO_2	mg/Nm^3	55

STACK- 21: M/s. 205F2, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 205F2
1	Stack Temperature	K	432
2	Velocity	m/sec	14.4
3	Volume of Gas Discharge	Nm^3/hr	88556
4	Oxygen as O_2	%	6.1
5	Carbon Monoxide as CO	mg/Nm^3	11
6	Carbon Dioxide as CO_2	%	13.5
7	Particulate Matter	mg/Nm^3	24.9
8	Sulphur Dioxide as SO_2	mg/Nm^3	7.7
9	Oxides of Nitrogen as NO_2	mg/Nm^3	25

STACK- 22: M/s. 206 F1-F2, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 206 F1-F2
1	Stack Temperature	K	571
2	Velocity	m/sec	6.28
3	Volume of Gas Discharge	Nm^3/hr	29911
4	Oxygen as O_2	%	6
5	Carbon Monoxide as CO	mg/Nm^3	23
6	Carbon Dioxide as CO_2	%	11.3
7	Particulate Matter	mg/Nm^3	15.8
8	Sulphur Dioxide as SO_2	mg/Nm^3	258.8
9	Oxides of Nitrogen as NO_2	mg/Nm^3	217

STACK- 23: M/s. 206 F3-F6, CHENNAI PETROLEUM CORPORATION LIMITED-MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 206 F3-F6
1	Stack Temperature	K	581
2	Velocity	m/sec	13.76
3	Volume of Gas Discharge	Nm^3/hr	64247
4	Oxygen as O_2	%	12.1
5	Carbon Monoxide as CO	mg/Nm^3	49
6	Carbon Dioxide as CO_2	%	7.2
7	Particulate Matter	mg/Nm^3	9.8
8	Sulphur Dioxide as SO_2	mg/Nm^3	84.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	230

STACK- 24: M/s. 207-F1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 207-F1
1	Stack Temperature	K	667
2	Velocity	m/sec	9.4
3	Volume of Gas Discharge	Nm^3/hr	34991
4	Oxygen as O_2	%	6.2
5	Carbon Monoxide as CO	mg/Nm^3	13
6	Carbon Dioxide as CO_2	%	11.4
7	Particulate Matter	mg/Nm^3	9.3
8	Sulphur Dioxide as SO_2	mg/Nm^3	7.7
9	Oxides of Nitrogen as NO_2	mg/Nm^3	31

STACK- 25: M/s. 212 F1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 212 F1
1	Stack Temperature	K	436
2	Velocity	m/sec	6.3
3	Volume of Gas Discharge	Nm^3/hr	39245
4	Oxygen as O_2	%	5.2
5	Carbon Monoxide as CO	mg/Nm^3	54
6	Carbon Dioxide as CO_2	%	11.6
7	Particulate Matter	mg/Nm^3	8.9
8	Sulphur Dioxide as SO_2	mg/Nm^3	47
9	Oxides of Nitrogen as NO_2	mg/Nm^3	27

STACK- 26: M/s. HRSG-I, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - HRSG-I
1	Stack Temperature	K	427
2	Velocity	m/sec	10.84
3	Volume of Gas Discharge	Nm^3/hr	69013
4	Oxygen as O_2	%	14.5
5	Carbon Monoxide as CO	mg/Nm^3	2
6	Carbon Dioxide as CO_2	%	5.1
7	Particulate Matter	mg/Nm^3	28.2
8	Sulphur Dioxide as SO_2	mg/Nm^3	12.9
9	Oxides of Nitrogen as NO_2	mg/Nm^3	12

STACK- 27: M/s. HRSG-II, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - HRSG-II
1	Stack Temperature	K	422
2	Velocity	m/sec	10.84
3	Volume of Gas Discharge	Nm^3/hr	69812
4	Oxygen as O_2	%	15.8
5	Carbon Monoxide as CO	mg/Nm^3	6
6	Carbon Dioxide as CO_2	%	3.7
7	Particulate Matter	mg/Nm^3	22.2
8	Sulphur Dioxide as SO_2	mg/Nm^3	10.3
9	Oxides of Nitrogen as NO_2	mg/Nm^3	10

STACK- 28: M/s. HRSG-III, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – HRSG-III
1	Stack Temperature	K	435
2	Velocity	m/sec	10.05
3	Volume of Gas Discharge	Nm^3/hr	62807
4	Oxygen as O_2	%	15.2
5	Carbon Monoxide as CO	mg/Nm^3	8
6	Carbon Dioxide as CO_2	%	4
7	Particulate Matter	mg/Nm^3	26.9
8	Sulphur Dioxide as SO_2	mg/Nm^3	15.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	16

STACK- 29: M/s. 207-F102, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 207-F102
1	Stack Temperature	K	450
2	Velocity	m/sec	5.2
3	Volume of Gas Discharge	Nm^3/hr	28718
4	Oxygen as O_2	%	6.4
5	Carbon Monoxide as CO	mg/Nm^3	17
6	Carbon Dioxide as CO_2	%	11.1
7	Particulate Matter	mg/Nm^3	15.6
8	Sulphur Dioxide as SO_2	mg/Nm^3	437.3
9	Oxides of Nitrogen as NO_2	mg/Nm^3	167

STACK- 30: M/s. 207-F201, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 207-F201
1	Stack Temperature	K	487
2	Velocity	m/sec	6.14
3	Volume of Gas Discharge	Nm^3/hr	34302
4	Oxygen as O_2	%	4.5
5	Carbon Monoxide as CO	mg/Nm^3	BDL(DL:1.14)
6	Carbon Dioxide as CO_2	%	12.9
7	Particulate Matter	mg/Nm^3	8.7
8	Sulphur Dioxide as SO_2	mg/Nm^3	BDL(DL:3.0)
9	Oxides of Nitrogen as NO_2	mg/Nm^3	BDL(DL:2.0)

STACK- 31: M/s. BOILER 1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – BOILER 1
1	Stack Temperature	K	454
2	Velocity	m/sec	15.1
3	Volume of Gas Discharge	Nm^3/hr	90370
4	Oxygen as O_2	%	8.4
5	Carbon Monoxide as CO	mg/Nm^3	40
6	Carbon Dioxide as CO_2	%	9.4
7	Particulate Matter	mg/Nm^3	57.3
8	Sulphur Dioxide as SO_2	mg/Nm^3	922.4
9	Oxides of Nitrogen as NO_2	mg/Nm^3	368

STACK- 32: M/s. BOILER 3, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – BOILER 3
1	Stack Temperature	K	465
2	Velocity	m/sec	15.7
3	Volume of Gas Discharge	Nm^3/hr	91580
4	Oxygen as O_2	%	9.8
5	Carbon Monoxide as CO	mg/Nm^3	28
6	Carbon Dioxide as CO_2	%	8.2
7	Particulate Matter	mg/Nm^3	60.5
8	Sulphur Dioxide as SO_2	mg/Nm^3	998
9	Oxides of Nitrogen as NO_2	mg/Nm^3	272

STACK- 33: M/s. BOILER 4, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – BOILER 4
1	Stack Temperature	K	453
2	Velocity	m/sec	15.6
3	Volume of Gas Discharge	Nm^3/hr	933556
4	Oxygen as O_2	%	3.1
5	Carbon Monoxide as CO	mg/Nm^3	12
6	Carbon Dioxide as CO_2	%	13.2
7	Particulate Matter	mg/Nm^3	53.0
8	Sulphur Dioxide as SO_2	mg/Nm^3	1943
9	Oxides of Nitrogen as NO_2	mg/Nm^3	400

STACK- 34: M/s. GAS TURBINE, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – GAS TURBINE
1	Stack Temperature	K	421
2	Velocity	m/sec	14.9
3	Volume of Gas Discharge	Nm^3/hr	96150
4	Oxygen as O_2	%	16.4
5	Carbon Monoxide as CO	mg/Nm^3	11
6	Carbon Dioxide as CO_2	%	3.4
7	Particulate Matter	mg/Nm^3	17.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	5.1
9	Oxides of Nitrogen as NO_2	mg/Nm^3	32

STACK- 35: M/s. DCU HEATER, CHENNAI PETROLEUM CORPORATION LIMITED- MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – DCU HEATER
1	Stack Temperature	K	445
2	Velocity	m/sec	4.8
3	Volume of Gas Discharge	Nm^3/hr	81421
4	Oxygen as O_2	%	6.4
5	Carbon Monoxide as CO	mg/Nm^3	11
6	Carbon Dioxide as CO_2	%	10.7
7	Particulate Matter	mg/Nm^3	8.6
8	Sulphur Dioxide as SO_2	mg/Nm^3	BDL(BDL:3.0)
9	Oxides of Nitrogen as NO_2	mg/Nm^3	71

STACK- 36: M/s. 211F1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 211F1
1	Stack Temperature	K	440
2	Velocity	m/sec	5.5
3	Volume of Gas Discharge	Nm^3/hr	33999
4	Oxygen as O_2	%	14
5	Carbon Monoxide as CO	mg/Nm^3	124
6	Carbon Dioxide as CO_2	%	4.9
7	Particulate Matter	mg/Nm^3	23.7
8	Sulphur Dioxide as SO_2	mg/Nm^3	49.0
9	Oxides of Nitrogen as NO_2	mg/Nm^3	29

STACK- 37: M/s. 1F1B, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION - 1F1B
1	Stack Temperature	K	482
2	Velocity	m/sec	9.4
3	Volume of Gas Discharge	Nm^3/hr	34829
4	Oxygen as O_2	%	10.8
5	Carbon Monoxide as CO	mg/Nm^3	13
6	Carbon Dioxide as CO_2	%	8.6
7	Particulate Matter	mg/Nm^3	22.9
8	Sulphur Dioxide as SO_2	mg/Nm^3	48.8
9	Oxides of Nitrogen as NO_2	mg/Nm^3	232

STACK- 38: M/s. 206 F1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 206 F1
1	Stack Temperature	K	538
2	Velocity	m/sec	5.66
3	Volume of Gas Discharge	Nm^3/hr	12714
4	Oxygen as O_2	%	6.1
5	Carbon Monoxide as CO	mg/Nm^3	BDL(DL:1.14)
6	Carbon Dioxide as CO_2	%	11
7	Particulate Matter	mg/Nm^3	9.4
8	Sulphur Dioxide as SO_2	mg/Nm^3	212
9	Oxides of Nitrogen as NO_2	mg/Nm^3	193

STACK- 39: M/s. 206 F2, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 206 F2
1	Stack Temperature	K	557
2	Velocity	m/sec	5
3	Volume of Gas Discharge	Nm^3/hr	24413
4	Oxygen as O_2	%	7.9
5	Carbon Monoxide as CO	mg/Nm^3	6
6	Carbon Dioxide as CO_2	%	9.7
7	Particulate Matter	mg/Nm^3	9.8
8	Sulphur Dioxide as SO_2	mg/Nm^3	289
9	Oxides of Nitrogen as NO_2	mg/Nm^3	272

STACK- 40: M/s. 214 F1, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 214 F1
1	Stack Temperature	K	437
2	Velocity	m/sec	21.58
3	Volume of Gas Discharge	Nm^3/hr	134818
4	Oxygen as O_2	%	4
5	Carbon Monoxide as CO	mg/Nm^3	7
6	Carbon Dioxide as CO_2	%	12.9
7	Particulate Matter	mg/Nm^3	9.1
8	Sulphur Dioxide as SO_2	mg/Nm^3	BDL(DL:3.0)
9	Oxides of Nitrogen as NO_2	mg/Nm^3	29

STACK- 41: M/s. 1F3, CHENNAI PETROLEUM CORPORATION LIMITED - MANALI, TAMILNADU

S.NO	POLLUTANT	UNIT	SAMPLE DESCRIPTION – 1F3
1	Stack Temperature	K	430
2	Velocity	m/sec	11.46
3	Volume of Gas Discharge	Nm^3/hr	32148
4	Oxygen as O_2	%	8.2
5	Carbon Monoxide as CO	mg/Nm^3	BDL(DL:1.14)
6	Carbon Dioxide as CO_2	%	9.6
7	Particulate Matter	mg/Nm^3	18.2
8	Sulphur Dioxide as SO_2	mg/Nm^3	229.2
9	Oxides of Nitrogen as NO_2	mg/Nm^3	191

Consolidated Stack Report

S.NO	Stack Description	CO (mg/Nm3)		PM (mg/Nm3)		SO2 (mg/Nm3)		NO2 (mg/Nm3)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
1	14F1	152	200	15.4	99	116	1689	356	449
2	14F101	140	150	8.1	10	42	59	331	350
3	15F1A	149	192	17.9	85	76	1425	142	433
4	15F1B	103	192	19.4	85	59	1425	172	433
5	15F2A	119	188	18.5	78	61.4	1288	306	425
6	15F2B	84	188	20.3	78	186.9	1288	192	425
7	16F1	148	188	17.4	78	59.1	1288	408	425
8	16F3	142	188	9.7	78	10.2	1288	43	425
9	9F201	185	199	24.4	97	41	1651	421	447
10	9F301	159	200	25.6	100	71.4	1692	425	450
11	10F101	111	200	19.1	99	40.8	1689	232	449
12	1F1A EAST	60	193	14.5	87	164	1464	125	436
13	1F1A WEST	56	193	12.4	87	149.4	1464	101	436
14	71F1	143	200	29.7	99	157.3	1684	335	449
15	73F101	135	198	27	97	51.4	1647	94	447
16	73F102	15	200	15.8	100	10.3	1695	16	450
17	76F11	152	196	33.1	92	20.6	1557	33	441
18	77F1	31	199	18.4	98	20.7	1664	60	448
19	201F1-F2	180	190	14.4	82	367.1	1370	239	430
20	205F1	136	150	16.2	NA	18	50	55	350

S.NO	Stack Description	CO (mg/Nm3)		PM (mg/Nm3)		SO2 (mg/Nm3)		NO2 (mg/Nm3)	
		Result	Limit	Result	Limit	Result	Limit	Result	Limit
21	205F2	11	169	24.9	45	7.7	685	25	388
22	206F1-F2	23	90	15.8	82	258.8	1370	217	430
23	206 F3-F6	49	90	9.8	82	84.4	1370	230	430
24	207 F1	13	169	9.3	44	7.7	669	31	388
25	212 F1	54	150	8.9	10	47	50	27	350
26	GAS TURBIN -1	2	200	28.2	100	12.9	1700	12	450
27	GAS TURBIN -2	6	200	22.2	100	10.3	1700	10	450
28	GAS TURBIN -3	8	200	26.9	100	15.4	1700	16	450
29	207F102	17	198	15.6	97	437.3	1638	167	446
30	207 F201	BDL	169	8.9	44	BDL	685	BDL	388
31	BOILER-1	40	200	57.3	100	922.4	1700	368	450
32	BOILER-3	28	200	60.5	100	998	1700	272	450
33	BOILER-4	12	200	53	100	943	1700	400	450
34	GAS TURBINE -4	11	200	17.4	100	5.1	1700	32	450
35	86F1	11	150	8.6	10	BDL	50	71	350
36	211F1	124	169	23.7	44	49	669	29	388
37	1F1B	13	193	22.9	87	48.8	1464	232	436
38	206 F1	BDL	190	9.4	82	212	1370	193	430
39	206 F2	6	190	9.8	82	289	1370	272	430
40	214 F1	7	169	9.1	44	BDL	669	29	388
41	1F3	BDL	197	18.2	94	229.2	1597	191	444

7.1 FINDINGS ON STACK EMISSION MONITORING:

In Stack Emission monitoring at all stack complying all the parameters against the emission limit values of CPCB/SPCB.

8.0 POINT SOURCE DISPERSION MODELLING:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

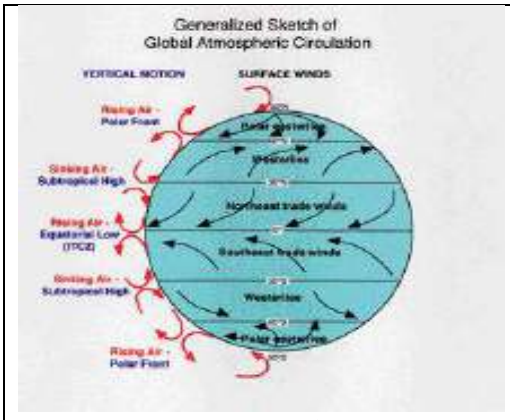
The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from CPCL Monitoring, Manali. For our simulations, the required source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

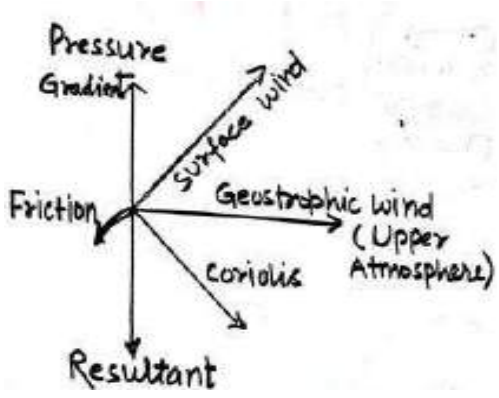
The AERMOD model was applied to study the diffusion of pollutants from CPCL Monitoring, Manali and other sources in Four days from 20.01.2021 to 23.01.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force: Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

14F1

Carbon Monoxide as CO:

Stack Height, m	-	32.38
Exit Velocity, m/Sec	-	12.3
Carbon Monoxide as CO, mg/m3	-	152
Emission load, gm/Sec	-	0.847
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	32.38
Exit Velocity, m/Sec	-	12.3
Particulate matter, mg/m3	-	15.4
Emission load, gm/Sec	-	0.0858
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	32.38
Exit Velocity, m/Sec	-	12.3
Sulphur dioxide as SO2, mg/m3	-	116
Emission load, gm/Sec	-	0.6466
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	32.38

Exit Velocity, m/Sec	-	12.3
Oxides of Nitrogen, mg/m3	-	356
Emission load, gm/Sec	-	1.984
Plume rise, m	-	5

14F101

Carbon Monoxide as CO:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	14.08
Carbon Monoxide as CO, mg/m3	-	140
Emission load, gm/Sec	-	0.843
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	14.08
Particulate matter, mg/m3	-	8.1
Emission load, gm/Sec	-	0.048
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	14.08
Oxides of Nitrogen, mg/m3	-	331
Emission load, gm/Sec	-	1.992
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	14.08
Sulphur dioxide, mg/m3	-	42
Emission load, gm/Sec	-	0.253
Plume rise, m	-	5

15F1A

Carbon Monoxide as CO:

Stack Height, m	-	63.1
Exit Velocity, m/Sec	-	7.3
Carbon Monoxide as CO, mg/m3	-	149
Emission load, gm/Sec	-	3.96
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	63.1
Exit Velocity, m/Sec	-	7.3
Particulate matter, mg/m3	-	17.9
Emission load, gm/Sec	-	0.4757
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	63.1

Exit Velocity, m/Sec	-	7.3
Sulphur dioxide, mg/m3	-	76
Emission load, gm/Sec	-	2.0198
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	63.1
Exit Velocity, m/Sec	-	7.3
Oxides of Nitrogen, mg/m3	-	142
Emission load, gm/Sec	-	3.7739
Plume rise, m	-	3

15F1B

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	8.46
Carbon Monoxide as CO, mg/m3	-	103
Emission load, gm/Sec	-	1.2776
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	8.46
Particulate matter, mg/m3	-	19.4

Emission load, gm/Sec	-	0.2406
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	8.46
Sulphur dioxide, mg/m3	-	59
Emission load, gm/Sec	-	0.7318
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	8.46
Oxides of Nitrogen, mg/m3	-	172
Emission load, gm/Sec	-	2.133
Plume rise, m	-	3

15F2A

Carbon Monoxide as CO:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	9.95
Carbon Monoxide as CO, mg/m3	-	119
Emission load, gm/Sec	-	0.91729
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	9.95
Particulate matter, mg/m3	-	18.5
Emission load, gm/Sec	-	0.1426
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	9.95
Sulphur dioxide, mg/m3	-	61.4
Emission load, gm/Sec	-	0.473
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	9.95
Oxides of Nitrogen, mg/m3	-	306
Emission load, gm/Sec	-	2.3587
Plume rise, m	-	4

15F2B

Carbon Monoxide as CO:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	11.21
Carbon Monoxide as CO, mg/m3	-	84
Emission load, gm/Sec	-	0.857
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	11.21
Particulate matter, mg/m3	-	20.3
Emission load, gm/Sec	-	0.207
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	11.21
Sulphur dioxide, mg/m3	-	186.9
Emission load, gm/Sec	-	1.9077
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	32
Exit Velocity, m/Sec	-	11.21
Oxides of Nitrogen, mg/m3	-	192
Emission load, gm/Sec	-	1.959

Plume rise, m	-	4

16F1

Carbon Monoxide as CO:

Stack Height, m	-	58.2
Exit Velocity, m/Sec	-	10.74
Carbon Monoxide as CO, mg/m3	-	148
Emission load, gm/Sec	-	2.623
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	58.2
Exit Velocity, m/Sec	-	10.74
Particulate matter, mg/m3	-	17.4
Emission load, gm/Sec	-	0.308
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	58.2
Exit Velocity, m/Sec	-	10.74
Sulphur dioxide, mg/m3	-	59.1
Emission load, gm/Sec	-	1.047
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	58.2
Exit Velocity, m/Sec	-	10.74
Oxides of Nitrogen, mg/m3	-	408
Emission load, gm/Sec	-	7.23
Plume rise, m	-	3

16F3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	14.99
Oxides of Nitrogen, mg/m3	-	43
Emission load, gm/Sec	-	0.7068
Plume rise, m	-	5

9F201

Carbon Monoxide as CO:

Stack Height, m	-	47.93
Exit Velocity, m/Sec	-	7.32
Carbon Monoxide as CO, mg/m3	-	185
Emission load, gm/Sec	-	1.6519
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	47.93
Exit Velocity, m/Sec	-	7.32
Particulate matter, mg/m3	-	24.4
Emission load, gm/Sec	-	0.2178
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	47.93
Exit Velocity, m/Sec	-	7.32
Sulphur dioxide, mg/m3	-	41
Emission load, gm/Sec	-	0.3661
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	47.93
Exit Velocity, m/Sec	-	7.32
Oxides of Nitrogen, mg/m3	-	421
Emission load, gm/Sec	-	3.759
Plume rise, m	-	3

9F301

Carbon Monoxide as CO:

Stack Height, m	-	36.4
Exit Velocity, m/Sec	-	9.46
Carbon Monoxide as CO, mg/m3	-	159

Emission load, gm/Sec	-	0.7129
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	36.4
Exit Velocity, m/Sec	-	9.46
Particulate matter, mg/m3	-	25.6
Emission load, gm/Sec	-	0.1147
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	36.4
Exit Velocity, m/Sec	-	9.46
Sulphur dioxide, mg/m3	-	71.4
Emission load, gm/Sec	-	0.320
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	36.4
Exit Velocity, m/Sec	-	9.46
Oxides of Nitrogen, mg/m3	-	425
Emission load, gm/Sec	-	1.905

Plume rise, m	-	4

10F101

Carbon Monoxide as CO:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	9.8
Carbon Monoxide as CO, mg/m3	-	111
Emission load, gm/Sec	-	0.558
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	9.8
Particulate matter , mg/m3	-	19.1
Emission load, gm/Sec	-	0.096
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	9.8
Sulphur dioxide, mg/m3	-	40.8
Emission load, gm/Sec	-	0.205
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	42.7
Exit Velocity, m/Sec	-	9.8
Oxides of Nitrogen, mg/m3	-	232
Emission load, gm/Sec	-	1.16638
Plume rise, m	-	5

1F1A EAST

Carbon Monoxide as CO:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.02
Carbon Monoxide as CO, mg/m3	-	60
Emission load, gm/Sec	-	1.61826
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.02
Particulate matter, mg/m3	-	14.5
Emission load, gm/Sec	-	0.391
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.02
Sulphur dioxide, mg/m3	-	164
Emission load, gm/Sec	-	4.423
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.02
Oxides of Nitrogen, mg/m3	-	125
Emission load, gm/Sec	-	3.3713
Plume rise, m	-	3

1F1A WEST

Carbon Monoxide as CO:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.51
Carbon Monoxide as CO, mg/m3	-	56
Emission load, gm/Sec	-	1.5587
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.51
Particulate matter, mg/m3	-	12.4
Emission load, gm/Sec	-	0.3451
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.51
Sulphur dioxide, mg/m3	-	149.4
Emission load, gm/Sec	-	4.158
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	63.4
Exit Velocity, m/Sec	-	8.51
Oxides of Nitrogen, mg/m3	-	101
Emission load, gm/Sec	-	2.811
Plume rise, m	-	3

71F1

Carbon Monoxide as CO:

Stack Height, m	-	45.82
Exit Velocity, m/Sec	-	7.79

Carbon Monoxide as CO, mg/m3	-	143
Emission load, gm/Sec	-	3.980
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	45.82
Exit Velocity, m/Sec	-	7.79
Particulate matter, mg/m3	-	29.7
Emission load, gm/Sec	-	0.8266
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	45.82
Exit Velocity, m/Sec	-	7.79
Sulphur dioxide, mg/m3	-	157.3
Emission load, gm/Sec	-	4.378
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	45.82
Exit Velocity, m/Sec	-	7.79
Oxides of Nitrogen, mg/m3	-	335
Emission load, gm/Sec	-	9.3245
Plume rise, m	-	4

73F101

Carbon Monoxide as CO:

Stack Height, m	-	53.38
Exit Velocity, m/Sec	-	7.95
Carbon Monoxide as CO, mg/m3	-	135
Emission load, gm/Sec	-	1.435
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	53.38
Exit Velocity, m/Sec	-	7.95
Particulate matter, mg/m3	-	27
Emission load, gm/Sec	-	0.287
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	53.38
Exit Velocity, m/Sec	-	7.95
Sulphur dioxide, mg/m3	-	51.4
Emission load, gm/Sec	-	0.546
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	53.38
Exit Velocity, m/Sec	-	7.95
Oxides of Nitrogen, mg/m3	-	94
Emission load, gm/Sec	-	0.9992
Plume rise, m	-	4

73F102

Carbon Monoxide as CO:

Stack Height, m	-	48.85
Exit Velocity, m/Sec	-	6.8
Carbon Monoxide as CO, mg/m3	-	15
Emission load, gm/Sec	-	0.159
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	48.85
Exit Velocity, m/Sec	-	6.8
Particulate matter, mg/m3	-	15.8
Emission load, gm/Sec	-	0.1679
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	48.85
Exit Velocity, m/Sec	-	6.8

Sulphur dioxide, mg/m3	-	10.3
Emission load, gm/Sec	-	0.109
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	48.85
Exit Velocity, m/Sec	-	6.8
Sulphur dioxide, mg/m3	-	16
Emission load, gm/Sec	-	0.17
Plume rise, m	-	3

76F11

Carbon Monoxide as CO:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	30.7
Carbon Monoxide as CO, mg/m3	-	152
Emission load, gm/Sec	-	4.640
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	30.7
Particulate matter, mg/m3	-	33.1
Emission load, gm/Sec	-	1.01

Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	30.7
Sulphur dioxide, mg/m3	-	20.6
Emission load, gm/Sec	-	0.6288
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	30.7
Oxides of Nitrogen, mg/m3	-	33
Emission load, gm/Sec	-	1.007
Plume rise, m	-	4

77F1

Carbon Monoxide as CO:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	10.21
Carbon Monoxide as CO, mg/m3	-	31
Emission load, gm/Sec	-	0.128
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	10.21
Particulate matter, mg/m3	-	18.4
Emission load, gm/Sec	-	0.0763
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	10.21
Sulphur dioxide, mg/m3	-	20.7
Emission load, gm/Sec	-	0.0858
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	49.25
Exit Velocity, m/Sec	-	10.21
Oxides of Nitrogen, mg/m3	-	60
Emission load, gm/Sec	-	0.2488
Plume rise, m	-	5

201F1-F2

Carbon Monoxide as CO:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	18.5

Carbon Monoxide as CO, mg/m3	-	180
Emission load, gm/Sec	-	14.699
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	18.5
Particulate matter, mg/m3	-	14.4
Emission load, gm/Sec	-	1.1759
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	18.5
Sulphur dioxide, mg/m3	-	367.1
Emission load, gm/Sec	-	29.977
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	18.5
Oxides of Nitrogen, mg/m3	-	239
Emission load, gm/Sec	-	19.517
Plume rise, m	-	5

205F1

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.93
Carbon Monoxide as CO, mg/m3	-	136
Emission load, gm/Sec	-	11.105
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.93
Particulate matter, mg/m3	-	16.2
Emission load, gm/Sec	-	1.32
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.93
Oxides of Nitrogen, mg/m3	-	55
Emission load, gm/Sec	-	4.491
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	60

Exit Velocity, m/Sec	-	5.93
Sulphur dioxide, mg/m3	-	18
Emission load, gm/Sec	-	1.47
Plume rise, m	-	4

205F2

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	14.4
Carbon Monoxide as CO, mg/m3	-	11
Emission load, gm/Sec	-	0.2705
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	14.4
Particulate matter, mg/m3	-	24.9
Emission load, gm/Sec	-	0.6125
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	14.4
Sulphur dioxide, mg/m3	-	7.7

Emission load, gm/Sec	-	0.189
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	14.4
Oxides of Nitrogen, mg/m3	-	25
Emission load, gm/Sec	-	0.6149
Plume rise, m	-	3

206F1-F2

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	6.28
Carbon Monoxide as CO, mg/m3	-	23
Emission load, gm/Sec	-	0.191
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	6.28
Particulate matter, mg/m3	-	15.8
Emission load, gm/Sec	-	0.131
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	6.28
Sulphur dioxide, mg/m3	-	258.8
Emission load, gm/Sec	-	2.15
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	6.28
Oxides of Nitrogen, mg/m3	-	217
Emission load, gm/Sec	-	1.80
Plume rise, m	-	4

206 F3-F6

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	13.76
Carbon Monoxide as CO, mg/m3	-	49
Emission load, gm/Sec	-	0.407
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	13.76
Particulate matter, mg/m3	-	9.8
Emission load, gm/Sec	-	0.081
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	13.76
Sulphur dioxide, mg/m3	-	84.4
Emission load, gm/Sec	-	0.70
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	13.76
Oxides of Nitrogen, mg/m3	-	230
Emission load, gm/Sec	-	1.91
Plume rise, m	-	4

207 F1

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4

Carbon Monoxide as CO, mg/m3	-	13
Emission load, gm/Sec	-	0.126
Plume rise, m	-	5

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Particulate matter, mg/m3	-	9.3
Emission load, gm/Sec	-	0.0904
Plume rise, m	-	5

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Oxides of Nitrogen, mg/m3	-	31
Emission load, gm/Sec	-	0.30
Plume rise, m	-	5

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Sulphur dioxide, mg/m3	-	7.7
Emission load, gm/Sec	-	0.0748
Plume rise, m	-	5

212 F1

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	6.3
Oxides of Nitrogen, mg/m3	-	27
Emission load, gm/Sec	-	0.294
Plume rise, m	-	5

GAS TURBIN -1

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Carbon Monoxide as CO, mg/m3	-	2
Emission load, gm/Sec	-	0.038
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Particulate matter, mg/m3	-	28.2
Emission load, gm/Sec	-	0.54
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100

Exit Velocity, m/Sec	-	10.84
Sulphur dioxide, mg/m3	-	12.9
Emission load, gm/Sec	-	0.247
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Oxides of Nitrogen, mg/m3	-	12
Emission load, gm/Sec	-	0.23
Plume rise, m	-	3

GAS TURBIN -2

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Carbon Monoxide as CO, mg/m3	-	6
Emission load, gm/Sec	-	0.115
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Particulate matter, mg/m3	-	22.2

Emission load, gm/Sec	-	0.4255
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Sulphur dioxide, mg/m3	-	10.3
Emission load, gm/Sec	-	0.197
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.84
Oxides of Nitrogen, mg/m3	-	10
Emission load, gm/Sec	-	0.191
Plume rise, m	-	3

GAS TURBIN -3

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.05
Carbon Monoxide as CO, mg/m3	-	8
Emission load, gm/Sec	-	0.1395
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.05
Particulate matter, mg/m3	-	26.9
Emission load, gm/Sec	-	0.469
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.05
Sulphur dioxide, mg/m3	-	15.4
Emission load, gm/Sec	-	0.2686
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	10.05
Oxides of Nitrogen, mg/m3	-	16
Emission load, gm/Sec	-	0.279
Plume rise, m	-	3

207F102

Carbon Monoxide as CO:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	5.2
Carbon Monoxide as CO, mg/m3	-	17
Emission load, gm/Sec	-	0.2965
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	5.2
Particulate matter, mg/m3	-	15.6
Emission load, gm/Sec	-	0.272
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	5.2
Sulphur dioxide, mg/m3	-	437.3
Emission load, gm/Sec	-	7.629
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	5.2
Oxides of Nitrogen, mg/m3	-	167
Emission load, gm/Sec	-	2.9135

Plume rise, m	-	3

207 F201

Oxides of Nitrogen as NO2:

Stack Height, m	-	35
Exit Velocity, m/Sec	-	6.14
Oxides of Nitrogen, mg/m3	-	8.9
Emission load, gm/Sec	-	0.084
Plume rise, m	-	3

BOILER-1

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.1
Carbon Monoxide as CO, mg/m3	-	40
Emission load, gm/Sec	-	1.004
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.1
Particulate matter, mg/m3	-	57.3
Emission load, gm/Sec	-	1.438

Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.1
Sulphur dioxide, mg/m3	-	922.4
Emission load, gm/Sec	-	23.15
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.1
Oxides of Nitrogen, mg/m3	-	368
Emission load, gm/Sec	-	9.2378
Plume rise, m	-	3

BOILER-3

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.7
Carbon Monoxide as CO, mg/m3	-	28
Emission load, gm/Sec	-	0.7028
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.7
Particulate matter, mg/m3	-	60.5
Emission load, gm/Sec	-	1.5187
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.7
Sulphur dioxide, mg/m3	-	998
Emission load, gm/Sec	-	25.05
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.7
Oxides of Nitrogen, mg/m3	-	272
Emission load, gm/Sec	-	6.8279
Plume rise, m	-	3

BOILER-4

Carbon Monoxide as CO:

Stack Height, m	-	100

Exit Velocity, m/Sec	-	15.6
Carbon Monoxide as CO, mg/m3	-	12
Emission load, gm/Sec	-	3.1118
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.6
Particulate matter, mg/m3	-	53
Emission load, gm/Sec	-	13.74
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.6
Sulphur dioxide, mg/m3	-	943
Emission load, gm/Sec	-	244.5398
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	15.6
Oxides of Nitrogen, mg/m3	-	400
Emission load, gm/Sec	-	103.728

Plume rise, m	-	3

GAS TURBINE -4

Carbon Monoxide as CO:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	14.9
Carbon Monoxide as CO, mg/m3	-	11
Emission load, gm/Sec	-	0.2937
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	14.9
Particulate matter, mg/m3	-	17.4
Emission load, gm/Sec	-	0.4647
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	14.9
Sulphur dioxide, mg/m3	-	5.1
Emission load, gm/Sec	-	0.1362
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	100
Exit Velocity, m/Sec	-	14.9
Oxides of Nitrogen, mg/m3	-	32
Emission load, gm/Sec	-	0.854
Plume rise, m	-	3

86F1

Oxides of Nitrogen as NO2:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	4.8
Oxides of Nitrogen, mg/m3	-	71
Emission load, gm/Sec	-	1.6058
Plume rise, m	-	3

211F1

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.5
Carbon Monoxide as CO, mg/m3	-	124
Emission load, gm/Sec	-	1.171
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	60

Exit Velocity, m/Sec	-	5.5
Particulate matter, mg/m3	-	23.7
Emission load, gm/Sec	-	0.2238
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.5
Sulphur dioxide, mg/m3	-	49
Emission load, gm/Sec	-	0.4627
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5.5
Oxides of Nitrogen, mg/m3	-	29
Emission load, gm/Sec	-	0.2738
Plume rise, m	-	3

1F1B

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Carbon Monoxide as CO, mg/m3	-	13

Emission load, gm/Sec	-	0.125
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Particulate matter, mg/m3	-	22.9
Emission load, gm/Sec	-	0.2215
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Sulphur dioxide, mg/m3	-	48.8
Emission load, gm/Sec	-	0.472
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	9.4
Oxides of Nitrogen, mg/m3	-	232
Emission load, gm/Sec	-	2.2445
Plume rise, m	-	3

206 F1

Particulate matter:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	5.66
Particulate matter, mg/m3	-	9.4
Emission load, gm/Sec	-	0.033
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	5.66
Sulphur dioxide, mg/m3	-	212
Emission load, gm/Sec	-	0.7487
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	5.66
Oxides of Nitrogen, mg/m3	-	193
Emission load, gm/Sec	-	0.681
Plume rise, m	-	3

206 F2

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5
Carbon Monoxide as CO, mg/m3	-	6
Emission load, gm/Sec	-	0.021
Plume rise, m	-	4

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5
Particulate matter, mg/m3	-	9.8
Emission load, gm/Sec	-	0.0346
Plume rise, m	-	4

Sulphur dioxide as SO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5
Sulphur dioxide, mg/m3	-	289
Emission load, gm/Sec	-	1.020
Plume rise, m	-	4

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	5
Oxides of Nitrogen, mg/m3	-	272

Emission load, gm/Sec	-	0.9606
Plume rise, m	-	4

214 F1

Carbon Monoxide as CO:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	21.58
Carbon Monoxide as CO, mg/m3	-	7
Emission load, gm/Sec	-	0.262
Plume rise, m	-	3

Particulate matter:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	21.58
Particulate matter, mg/m3	-	9.1
Emission load, gm/Sec	-	0.3407
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	60
Exit Velocity, m/Sec	-	21.58
Oxides of Nitrogen, mg/m3	-	29
Emission load, gm/Sec	-	1.086
Plume rise, m	-	3

1F3

Particulate matter:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	11.46
Particulate matter, mg/m3	-	18.2
Emission load, gm/Sec	-	0.1625
Plume rise, m	-	3

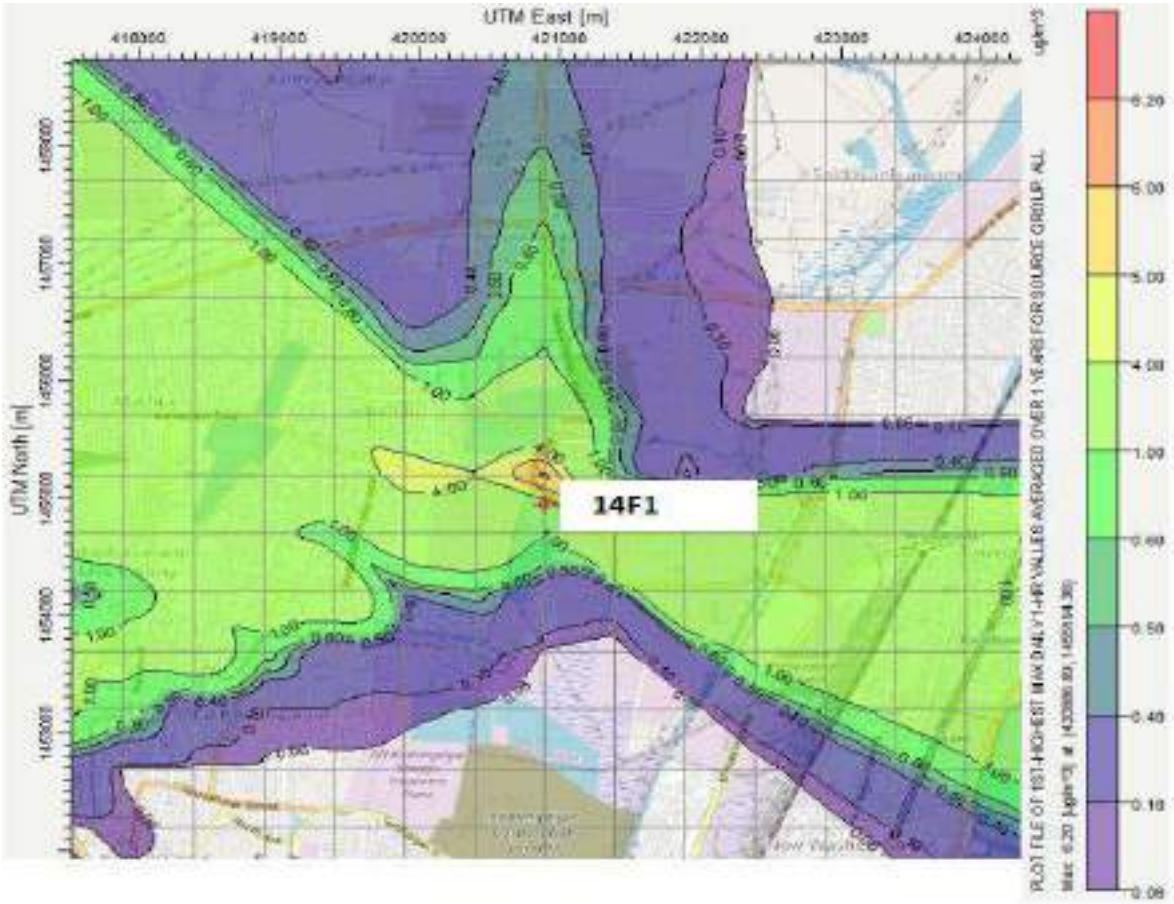
Sulphur dioxide as SO2:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	11.46
Sulphur dioxide, mg/m3	-	229.2
Emission load, gm/Sec	-	2.0467
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	40
Exit Velocity, m/Sec	-	11.46
Oxides of Nitrogen, mg/m3	-	191
Emission load, gm/Sec	-	1.7056
Plume rise, m	-	3

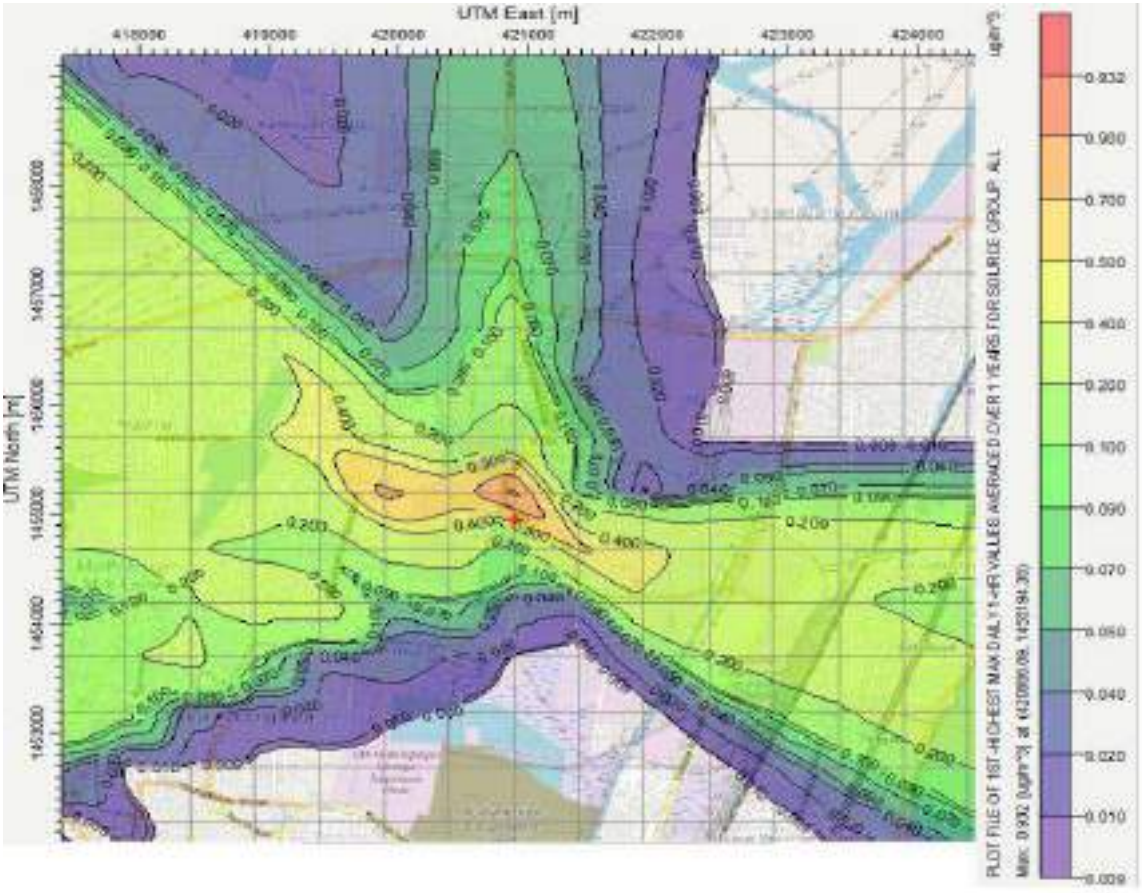
STACK EMISSION DISPERSION MODELLING – Stack - 14F1 @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
152	0.78	8.78	0.87	0.0177

Stack - 14F1 emission of Carbon Monoxide concentration is 152mg/m^3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 8.78µg/m^3 at 2km dispersion Carbon Monoxide is 0.87µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0177µg/m^3 and the predominant wind direction is ESE.

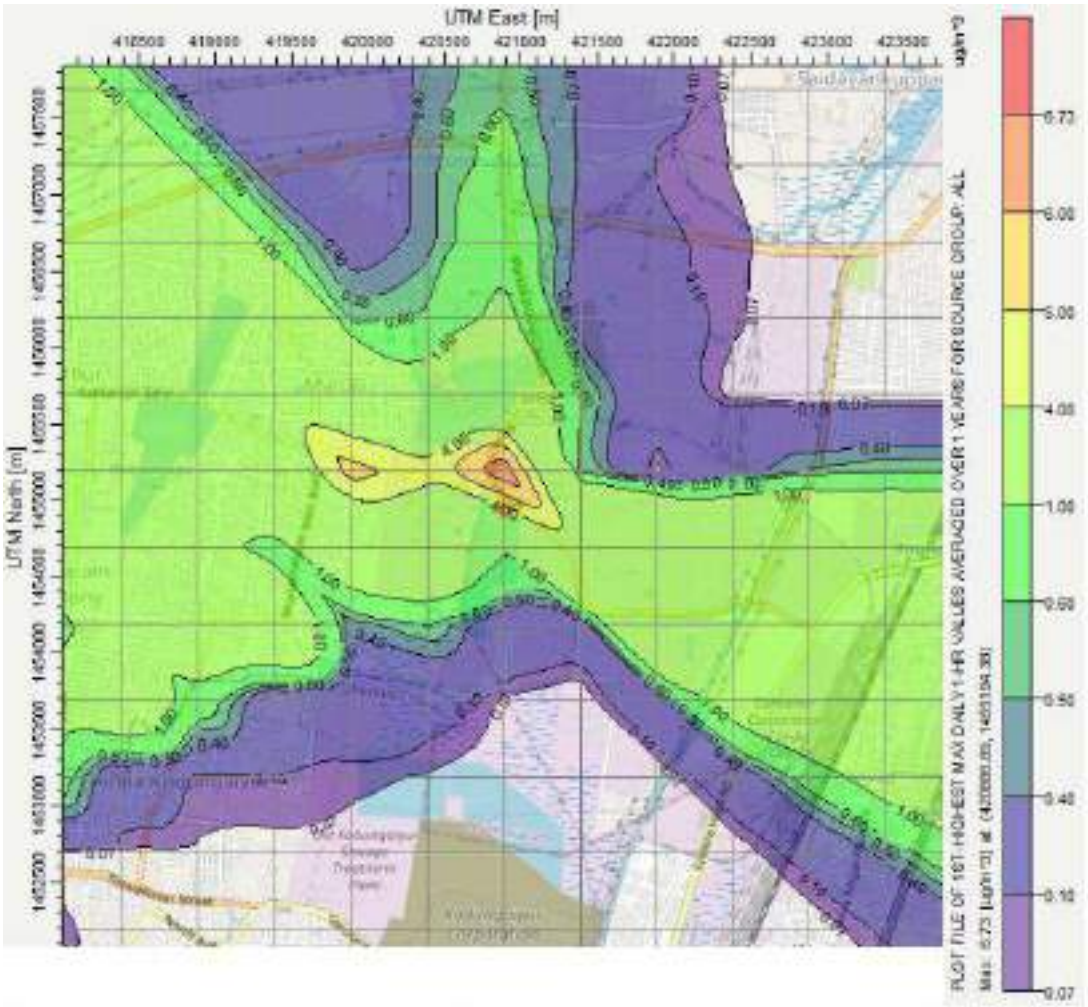
STACK EMISSION DISPERSION MODELLING – Stack - 14F1 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
15.4	0.82	0.932	0.155	0.0567

Stack - 14F1 emission of Particulate matter concentration is 15.4mg/m^3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 0.932µg/m^3 at 2km dispersion Particulate matter Particulate matter is 0.155µg/m^3 and at 5km dispersion Particulate matter is 0.0567µg/m^3 and the predominant wind direction is ESE.

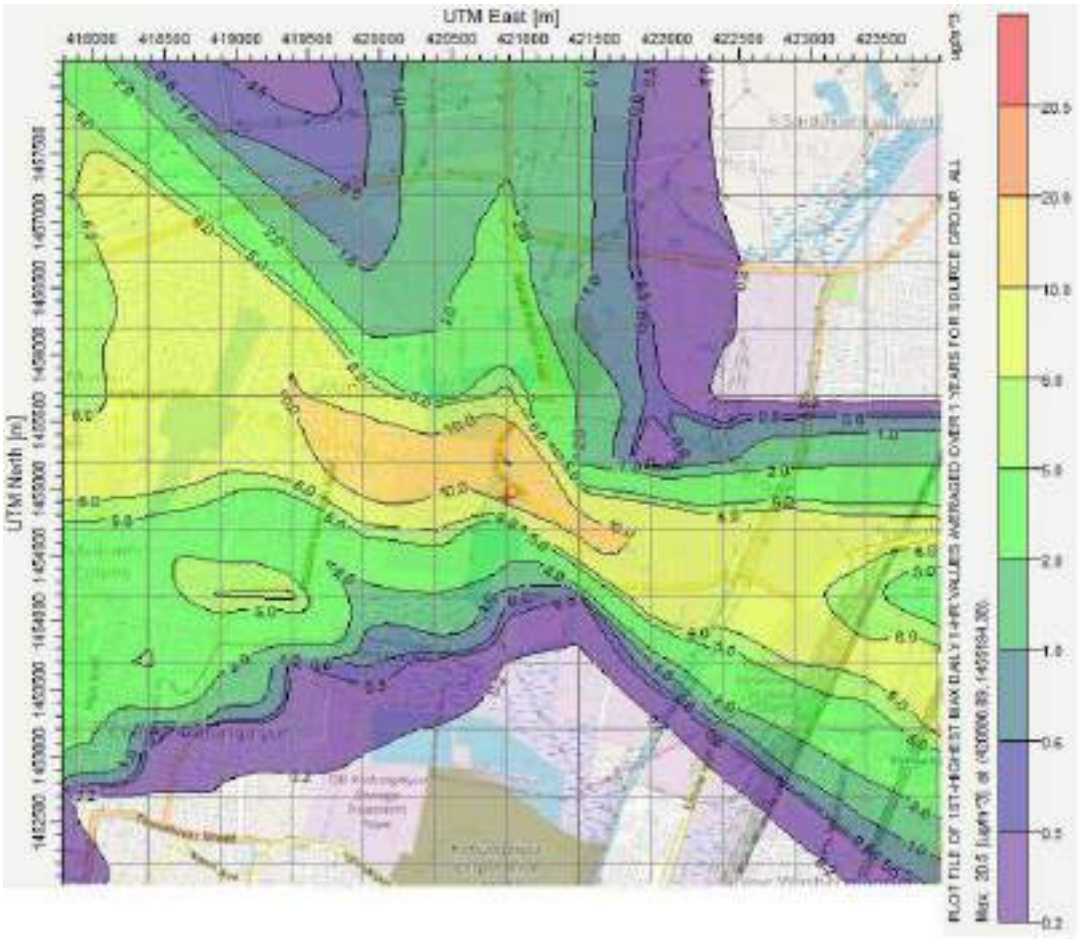
STACK EMISSION DISPERSION MODELLING – Stack - 14F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
116	0.78	6.73	1.23	0.76

Stack - 14F1 emission of Sulphur dioxide concentration is 116mg/m^3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 6.73µg/m^3 at 2km dispersion Sulphur dioxide is 1.23µg/m^3 and at 5km dispersion Sulphur dioxide is 0.76µg/m^3 and the predominant wind direction is ESE.

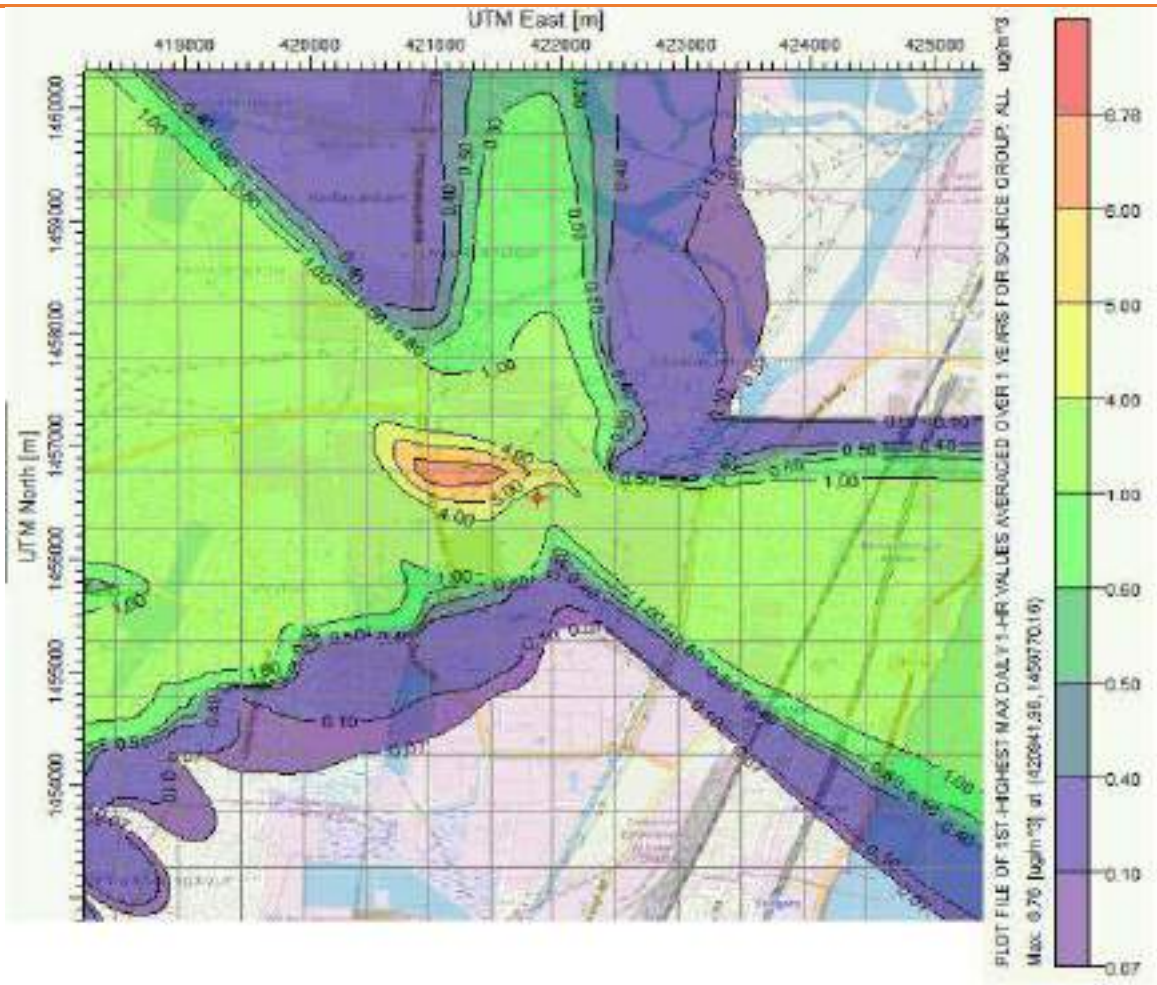
STACK EMISSION DISPERSION MODELLING – Stack - 14F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
356	0.85	20.5	2.28	0.776

Stack - 14F1 emission of Oxides of Nitrogen concentration is 356mg/m^3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 20.5µg/m^3 at 2km dispersion Oxides of Nitrogen is 2.28µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.776µg/m^3 and the predominant wind direction is ESE.

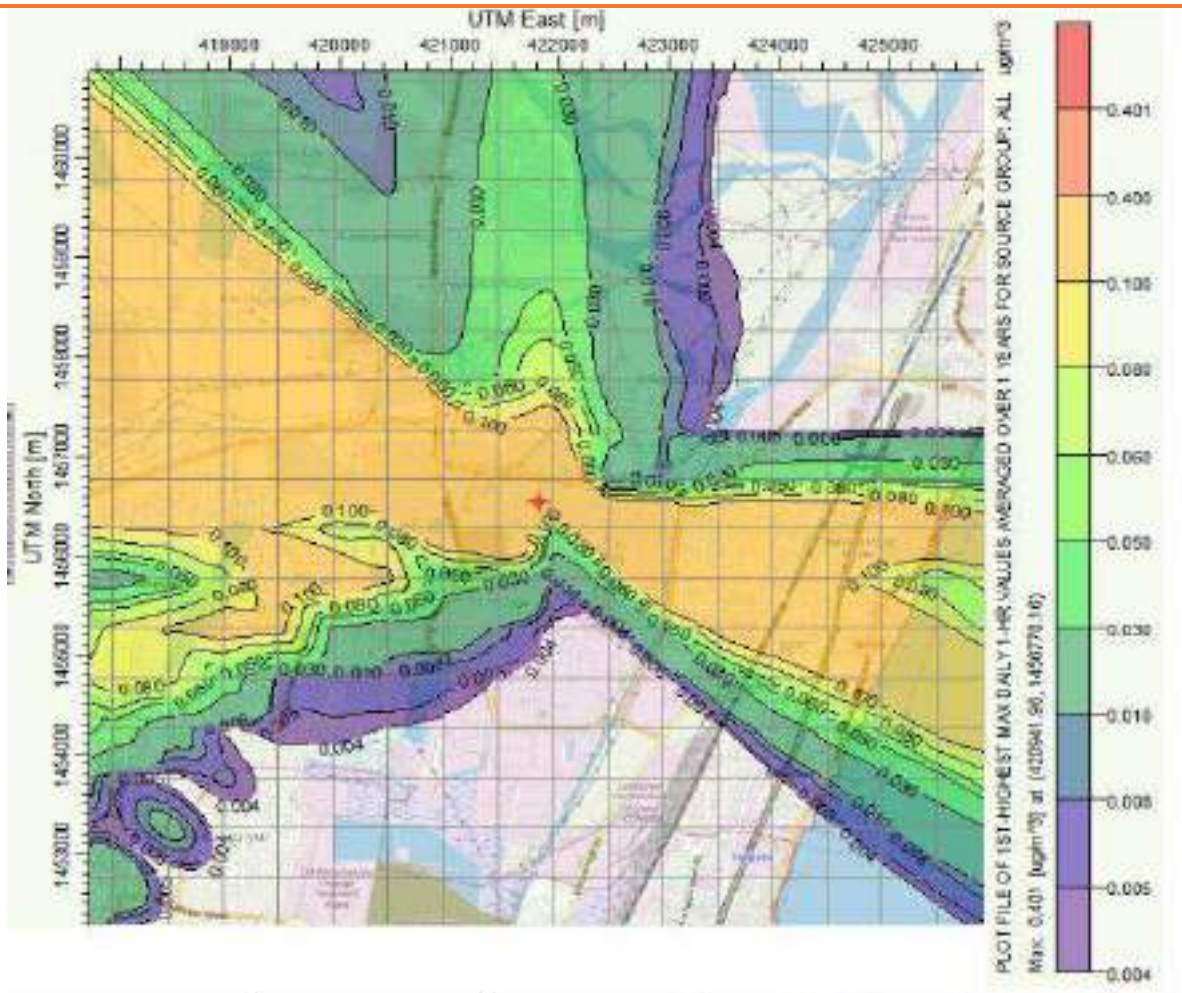
STACK EMISSION DISPERSION MODELLING – Stack - 14F101 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
140	0.799	6.76	1.786	0.57

Stack - 14F101 emission of Carbon Monoxide concentration is 140mg/m^3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.799km at the concentration of 6.76µg/m^3 at 2km dispersion Carbon Monoxide is 1.786µg/m^3 and at 5km dispersion Carbon Monoxide is 0.57µg/m^3 and the predominant wind direction is ESE.

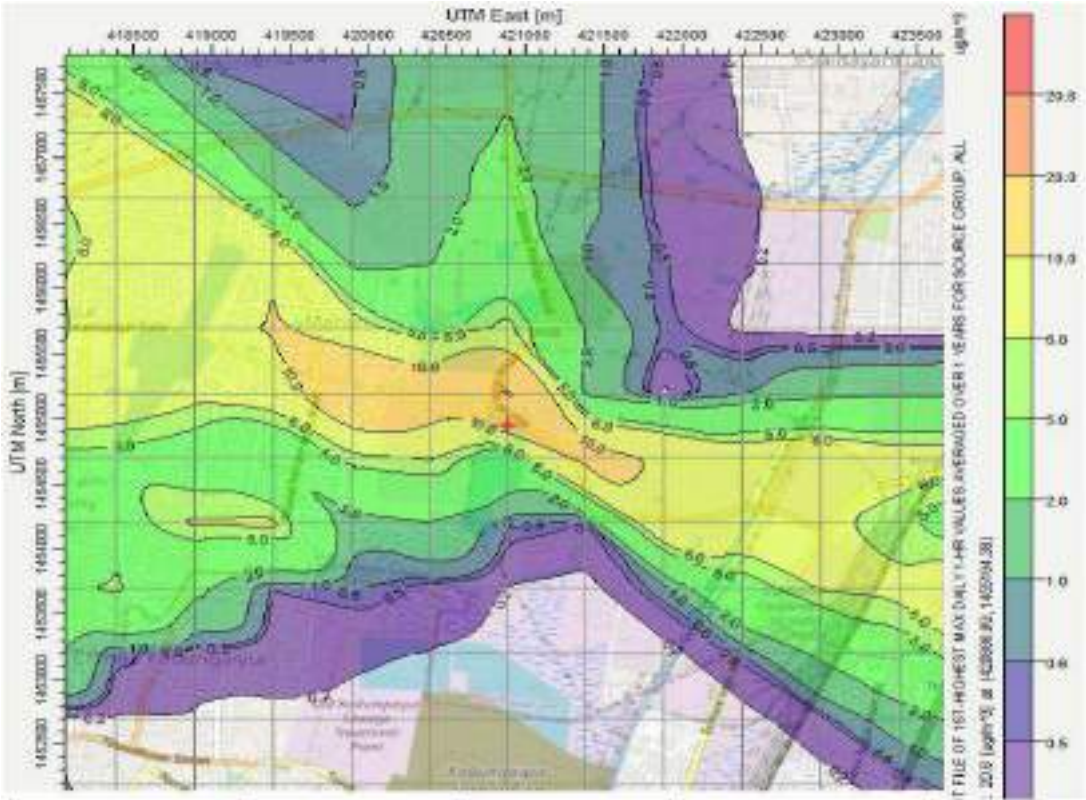
STACK EMISSION DISPERSION MODELLING – Stack - 14F101 @ 2 & 5KM – Particulate Matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
8.1	0.995	0.401	0.0334	0.00631

Stack - 14F101 emission of Particulate matter concentration is 8.1mg/m^3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.995km at the concentration of 0.401µg/m^3 at 2km dispersion Particulate matter is 0.0334µg/m^3 and at 5km dispersion Particulate matter is 0.00631µg/m^3 and the predominant wind direction is ESE.

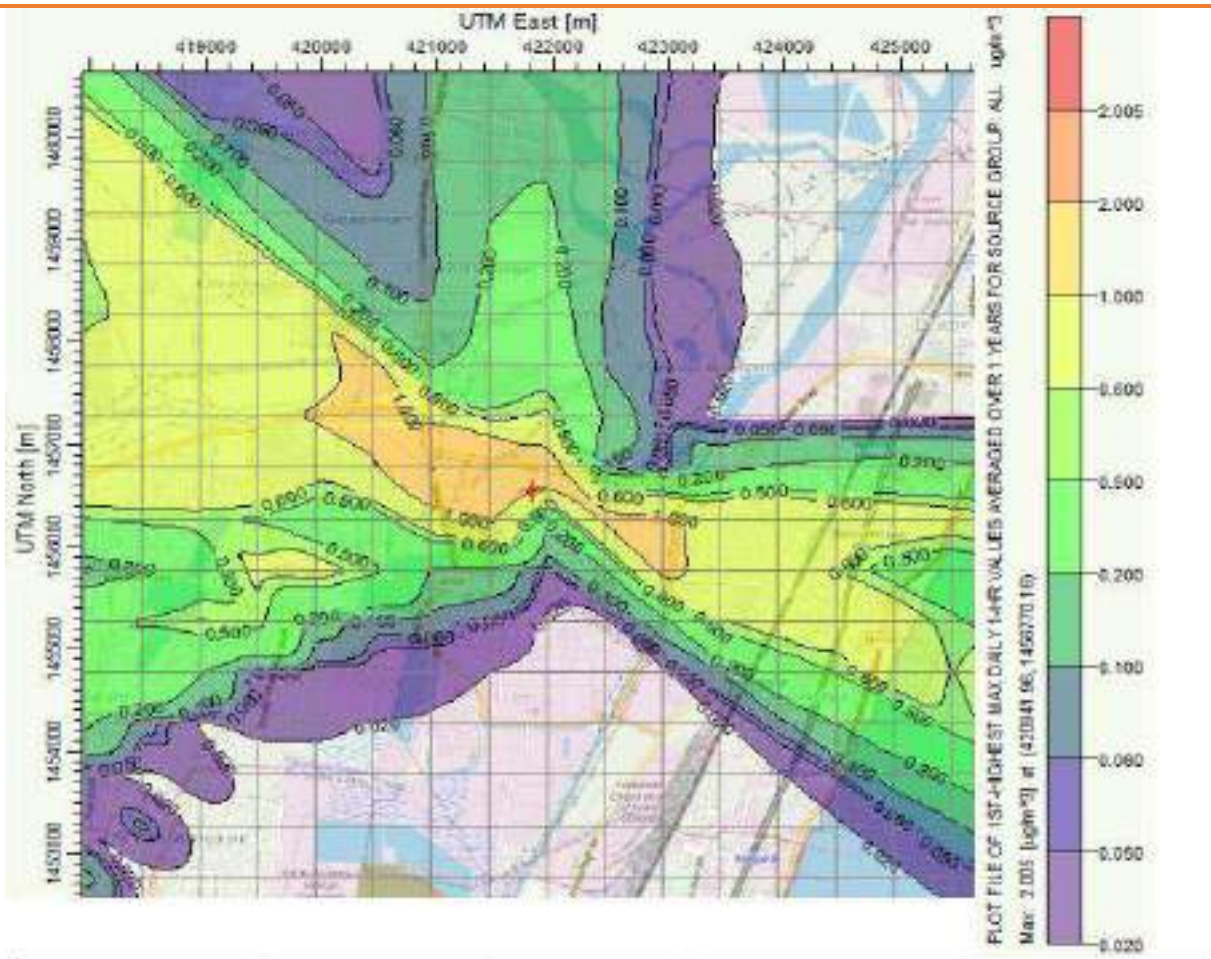
STACK EMISSION DISPERSION MODELLING – Stack - 14F101 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
331	0.75	20.8	2.78	0.892

Stack - 14F101 emission of Oxides of Nitrogen concentration is 331mg/m^3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 20.8µg/m^3 at 2km dispersion Oxides of Nitrogen is 2.78µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.892µg/m^3 and the predominant wind direction is ESE.

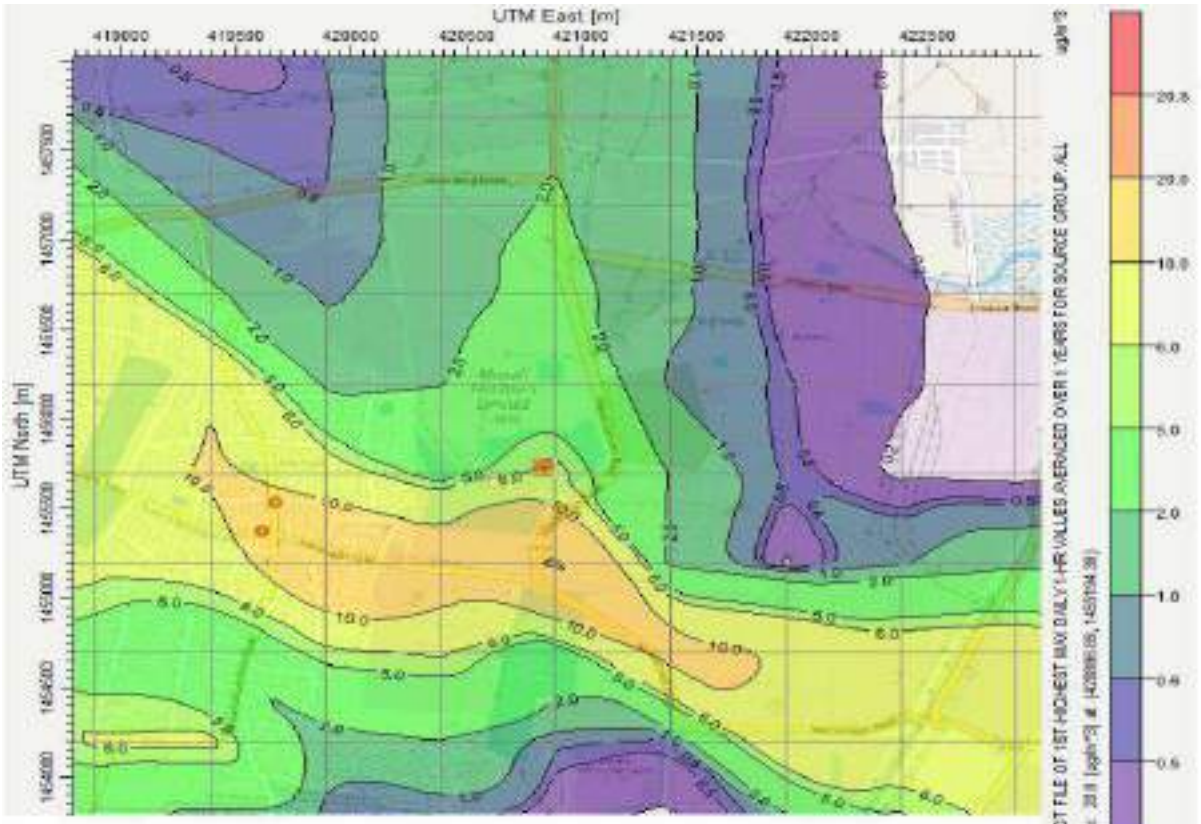
STACK EMISSION DISPERSION MODELLING – Stack - 14F101 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
42	0.831	2.005	0.211	0.0856

Stack - 14F101 emission of Sulphur dioxide concentration is 42mg/m^3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.831km at the concentration of 2.005µg/m^3 at 2km dispersion Sulphur dioxide is 0.211µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0856µg/m^3 and the predominant wind direction is ESE.

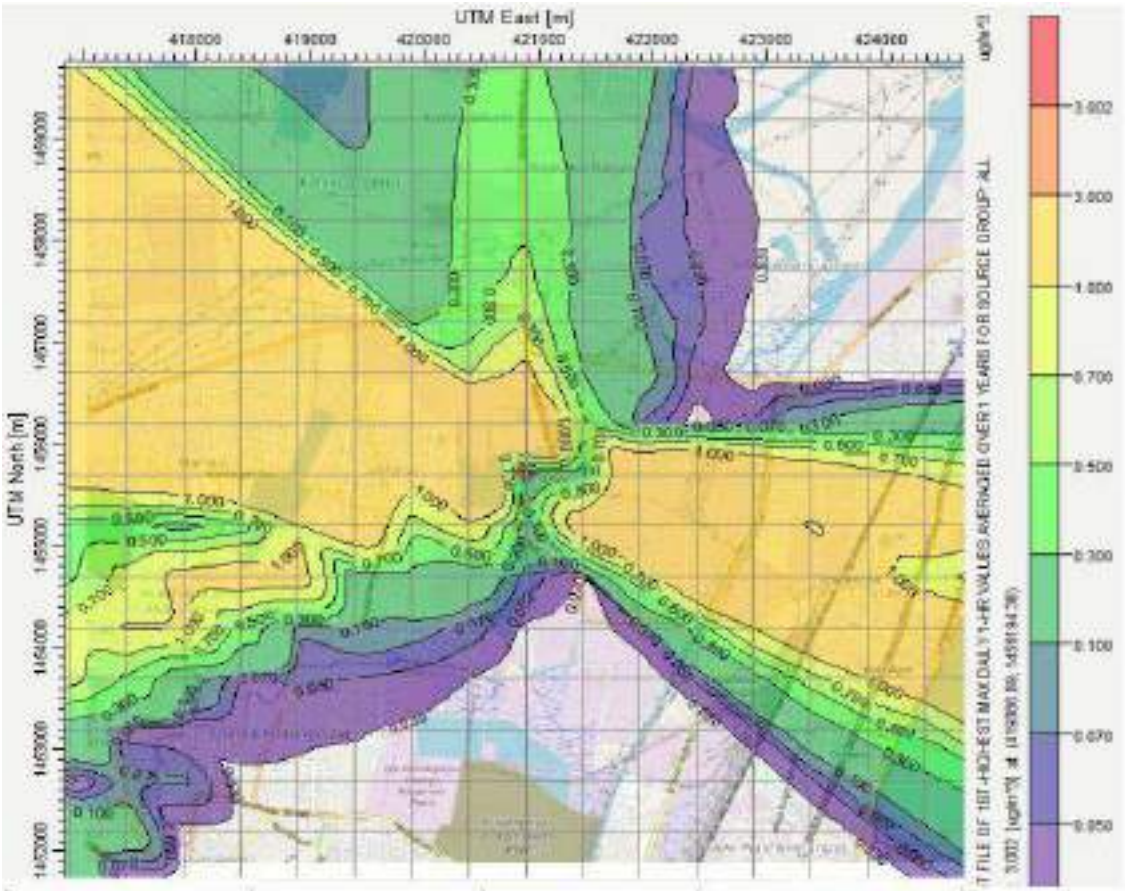
STACK EMISSION DISPERSION MODELLING – Stack - 15F1A @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
149	0.89	20.8	2.22	1.788

Stack - 15F1A emission of Carbon Monoxide is 149mg/m^3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 20.8µg/m^3 at 2km dispersion Carbon Monoxide is 2.22µg/m^3 and at 5km dispersion Carbon Monoxide is 1.788µg/m^3 and the predominant wind direction is ESE.

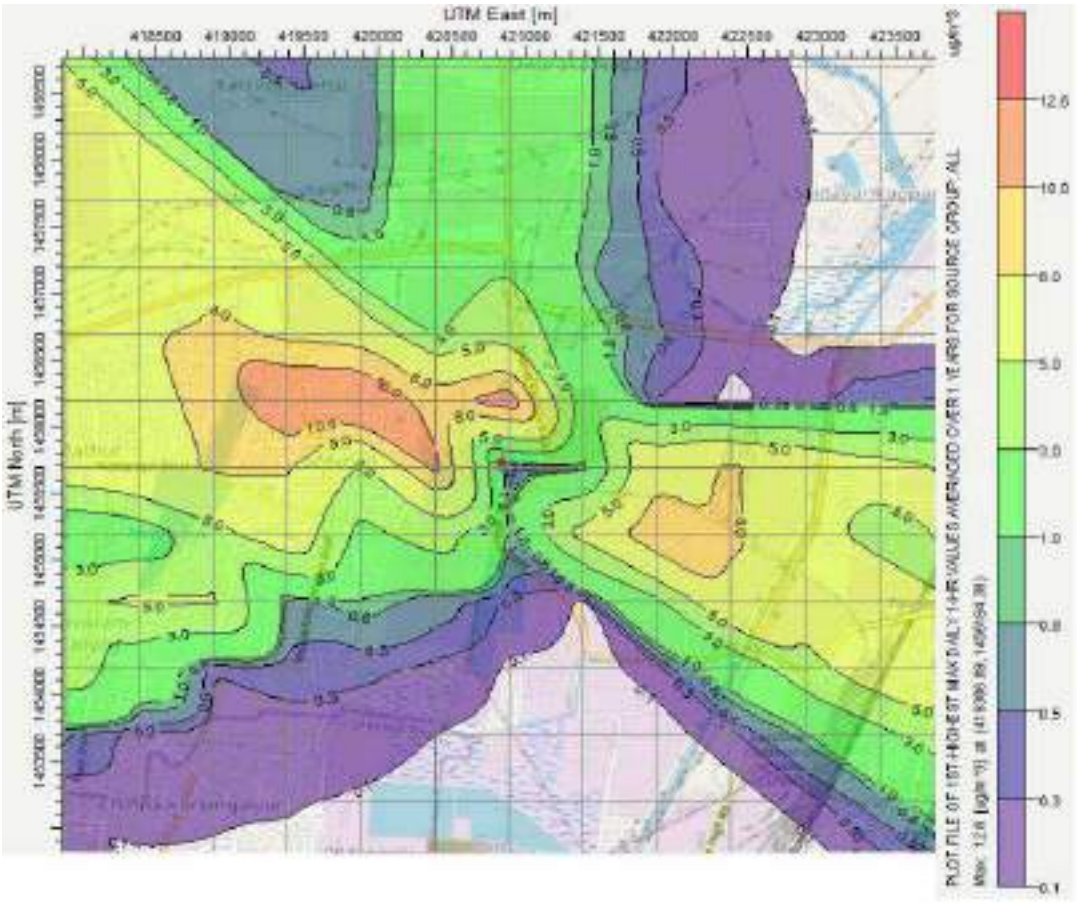
STACK EMISSION DISPERSION MODELLING – Stack - 15F1A @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
17.9	0.71	3.002	1.11	0.534

Stack - 15F1A emission of Particulate matter is 17.9 mg/m^3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 3.002µg/m^3 at 2km dispersion Particulate matter is 1.11µg/m^3 and at 5km dispersion Particulate matter is 0.534µg/m^3 and the predominant wind direction is ESE.

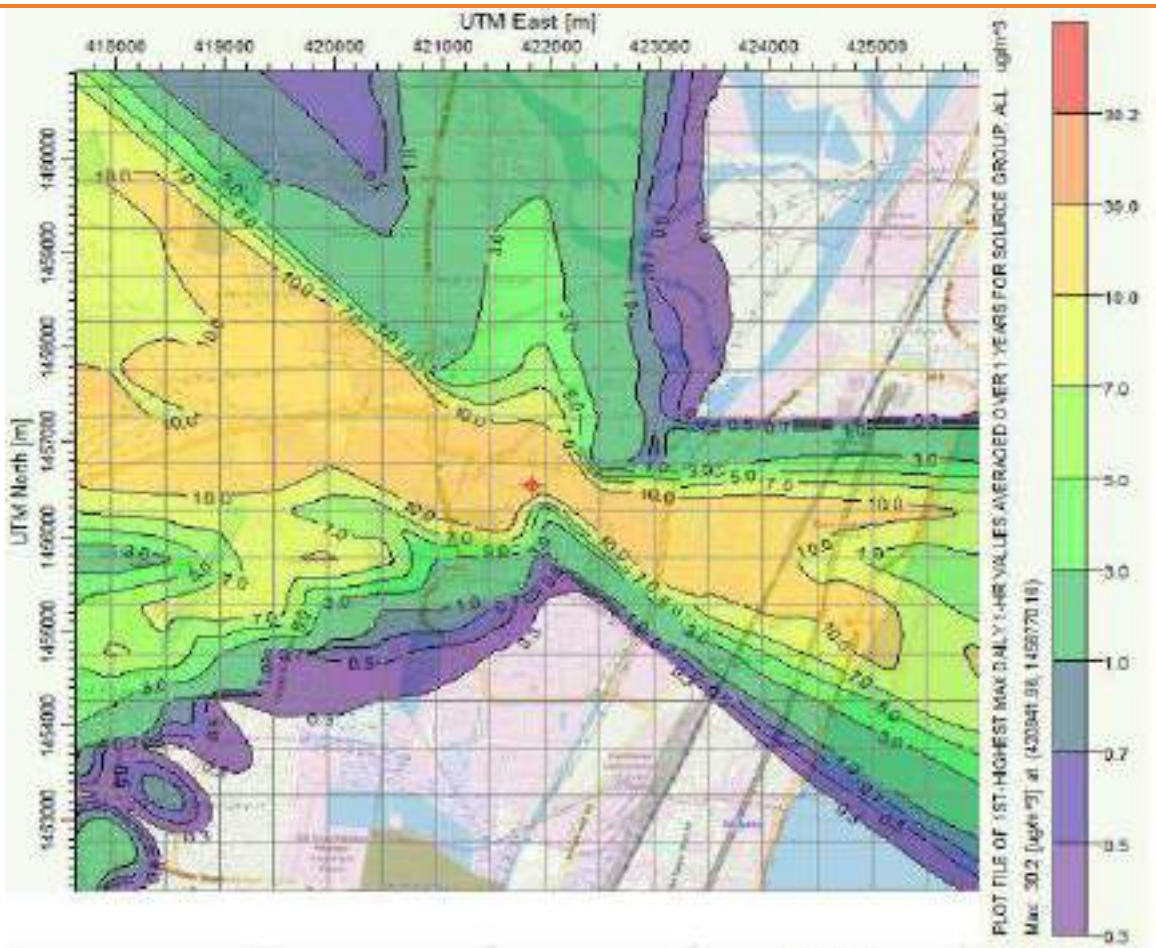
STACK EMISSION DISPERSION MODELLING – Stack - 15F1A @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
76	0.81	12.6	2.22	0.45

Stack - 15F1A emission of Sulphur dioxide is 76mg/m^3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 12.6µg/m^3 at 2km dispersion Sulphur dioxide is 2.22µg/m^3 and at 5km dispersion Sulphur dioxide is 0.45µg/m^3 and the predominant wind direction is ESE.

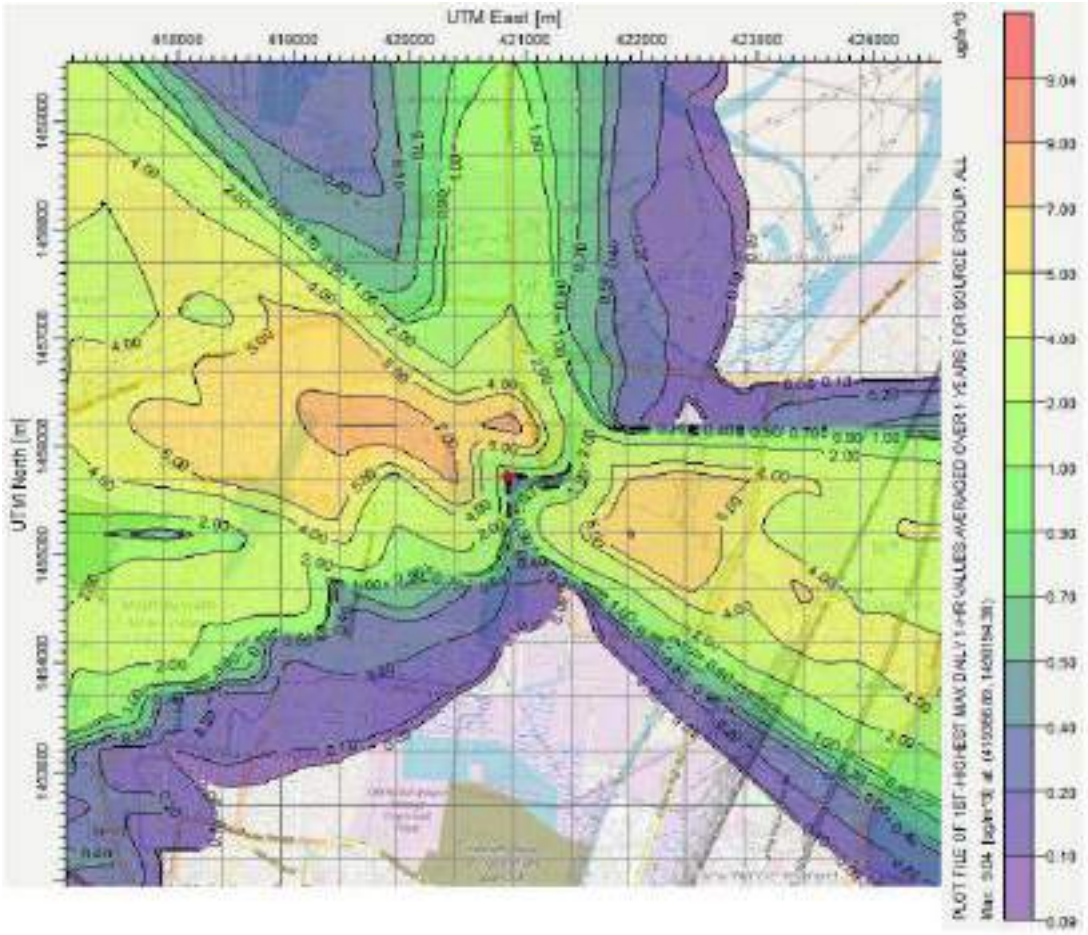
STACK EMISSION DISPERSION MODELLING – Stack - 15F1A @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
12.4	0.8	30.2	2.38	0.782

Stack - 15F1A emission of Oxides of Nitrogen is 12.4 mg/m^3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8 km at the concentration of 30.2µg/m^3 at 2km dispersion Oxides of Nitrogen is 2.38µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.782µg/m^3 and the predominant wind direction is ESE.

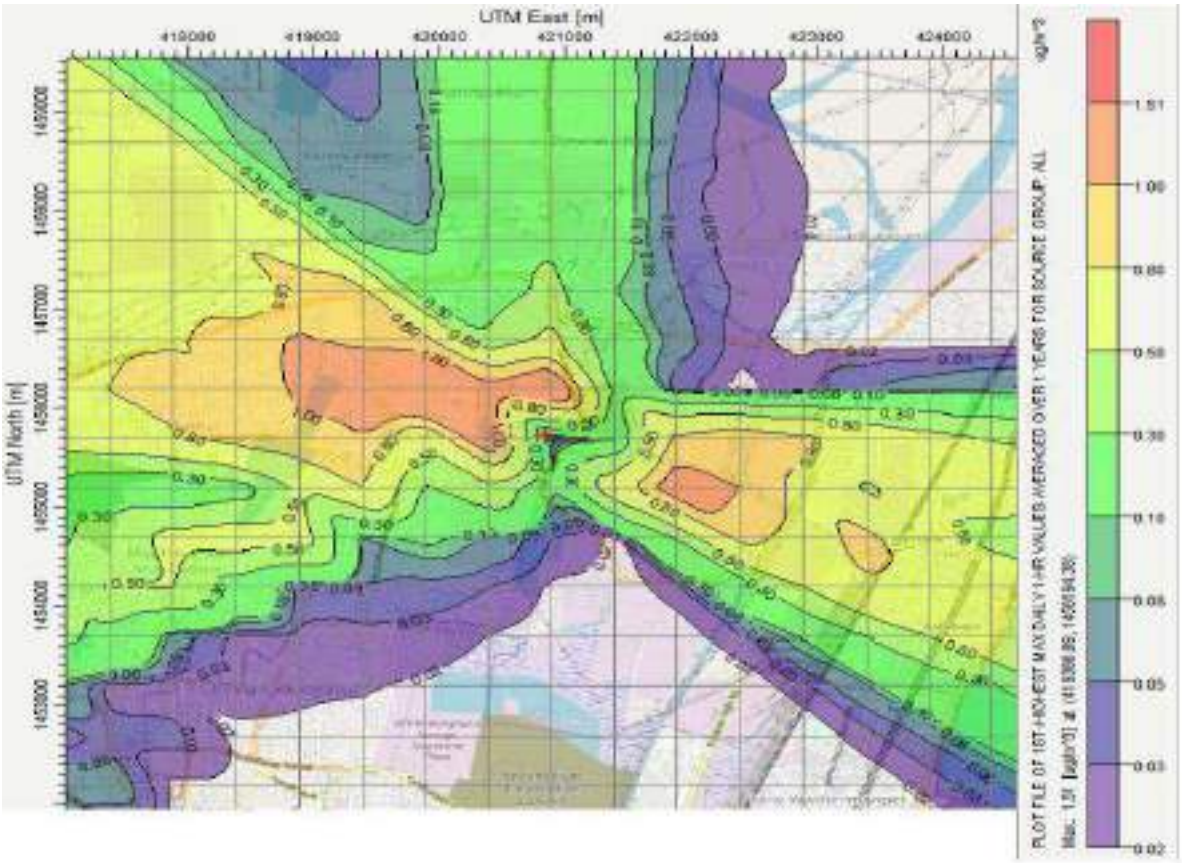
STACK EMISSION DISPERSION MODELLING – Stack - 15F1B @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
103	0.77	9.04	2.8	0.52

Stack - **15F1B** emission of Carbon Monoxide is 103mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 9.04µg/m3 at 2km dispersion Carbon Monoxide is 2.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.52µg/m3 and the predominant wind direction is ESE.

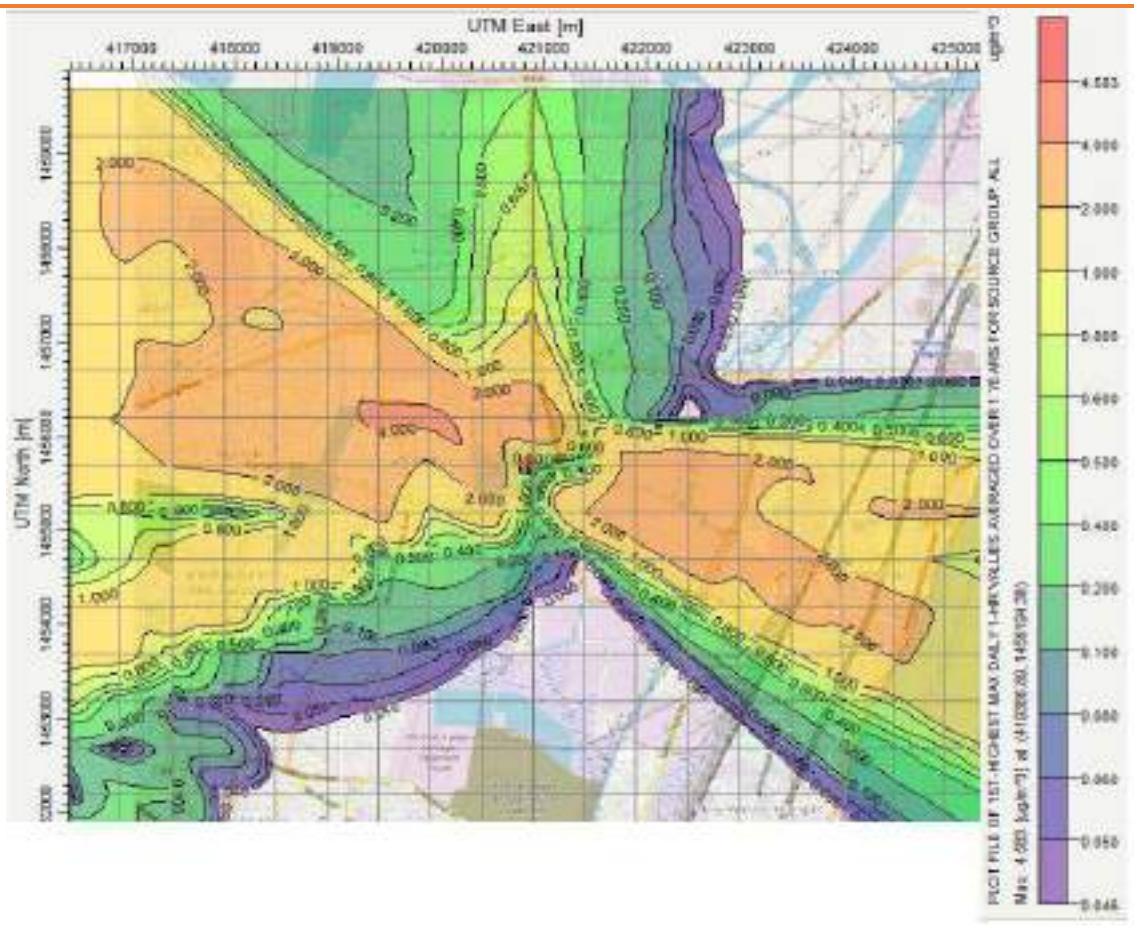
STACK EMISSION DISPERSION MODELLING – Stack - 15F1B @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
19.4	0.72	1.51	0.76	0.099

Stack - **15F1B** emission of Particulate matter is 19.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.72km at the concentration of 1.51µg/m3 at 2km dispersion Particulate matter is 0.76µg/m3 and at 5km dispersion Particulate matter is 0.099µg/m3 and the predominant wind direction is ESE.

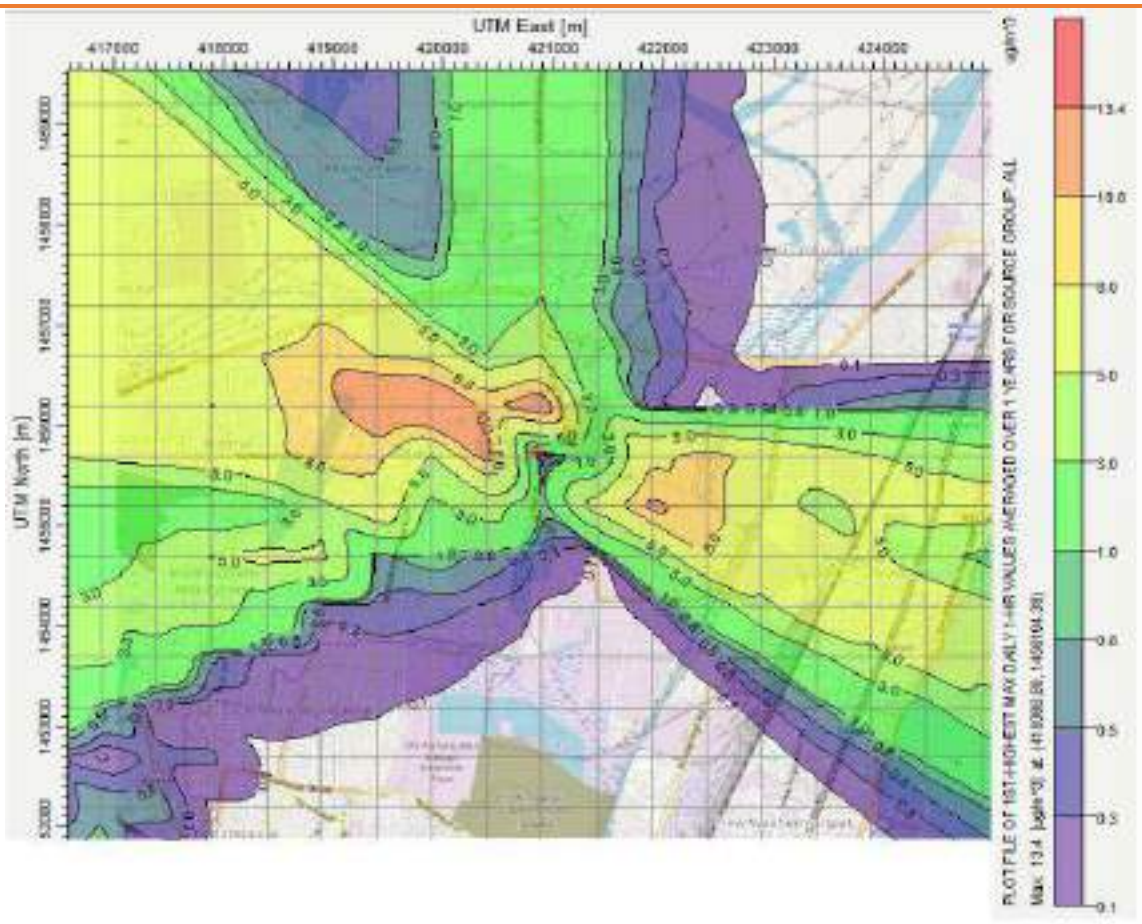
STACK EMISSION DISPERSION MODELLING – Stack - 15F1B @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
59	0.7	4.583	0.78	0.0753

Stack - **15F1B** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 4.583µg/m3 at 2km dispersion Sulphur dioxide is 0.78µg/m3 and at 5km dispersion Sulphur dioxide is 0.0753µg/m3 and the predominant wind direction is ESE.

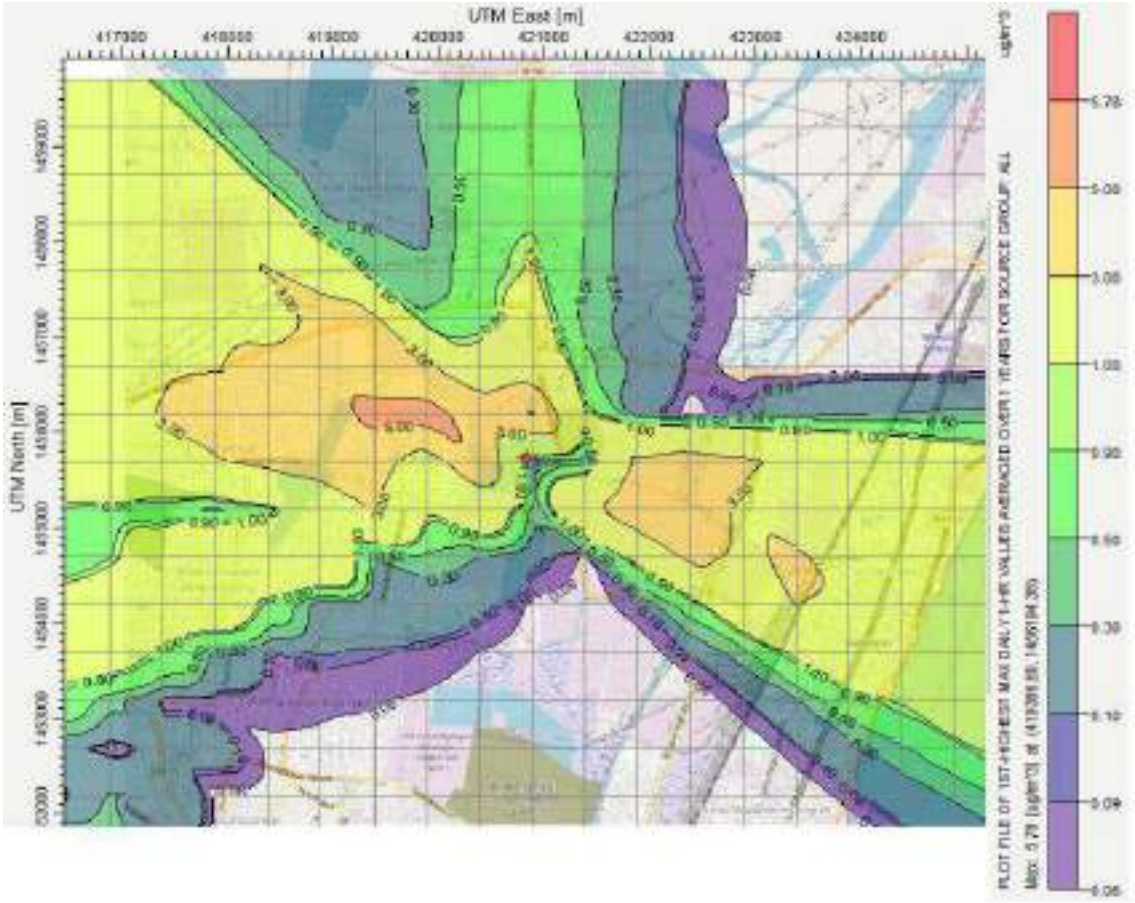
STACK EMISSION DISPERSION MODELLING – Stack - 15F1B @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
172	0.89	13.4	4.56	1.11

Stack - **15F1B** emission of Oxides of Nitrogen is 172mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 13.4µg/m3 at 2km dispersion Oxides of Nitrogen is 4.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.11µg/m3 and the predominant wind direction is ESE.

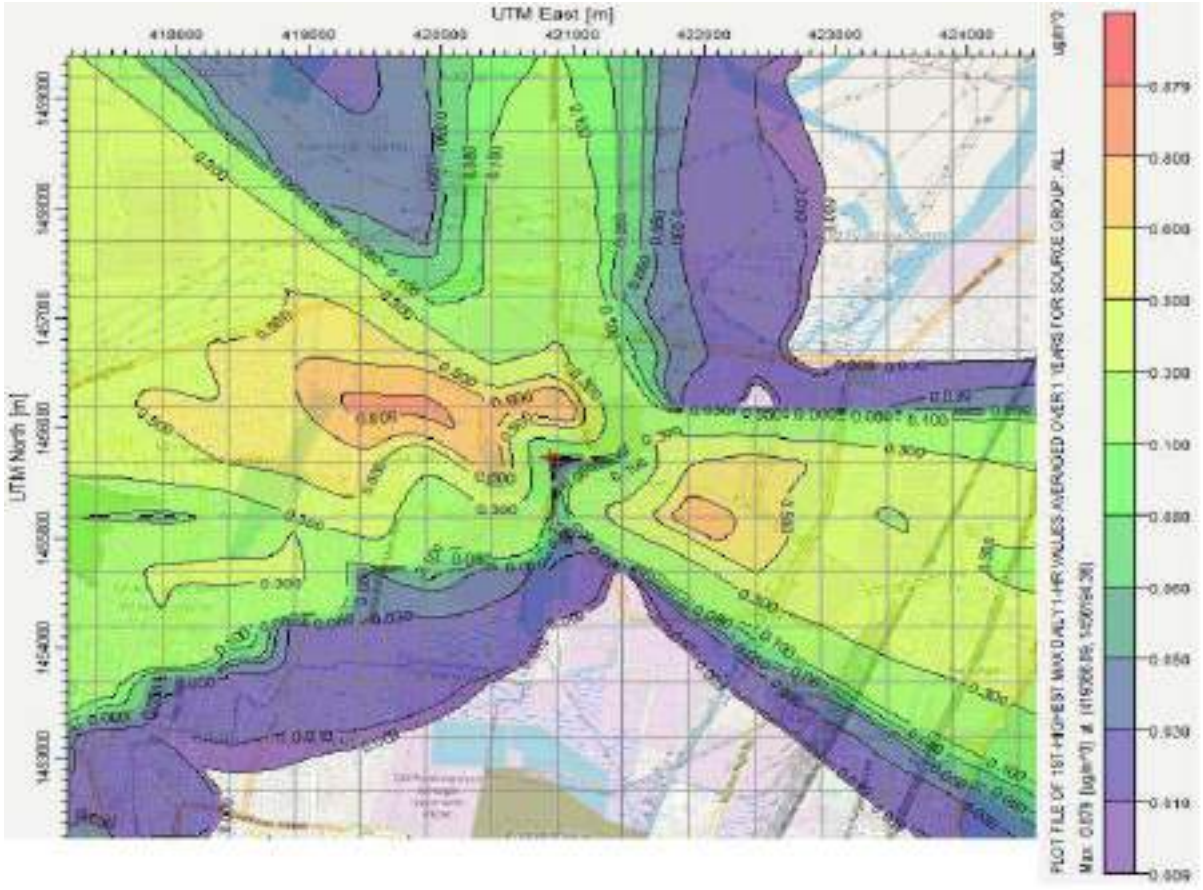
STACK EMISSION DISPERSION MODELLING – Stack - 15F2A @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
119	0.78	5.78	1.8	0.54

Stack - **15F2A** emission of Carbon Monoxide is 119mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.78µg/m3 at 2km dispersion Carbon Monoxide is 1.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.54µg/m3 and the predominant wind direction is ESE.

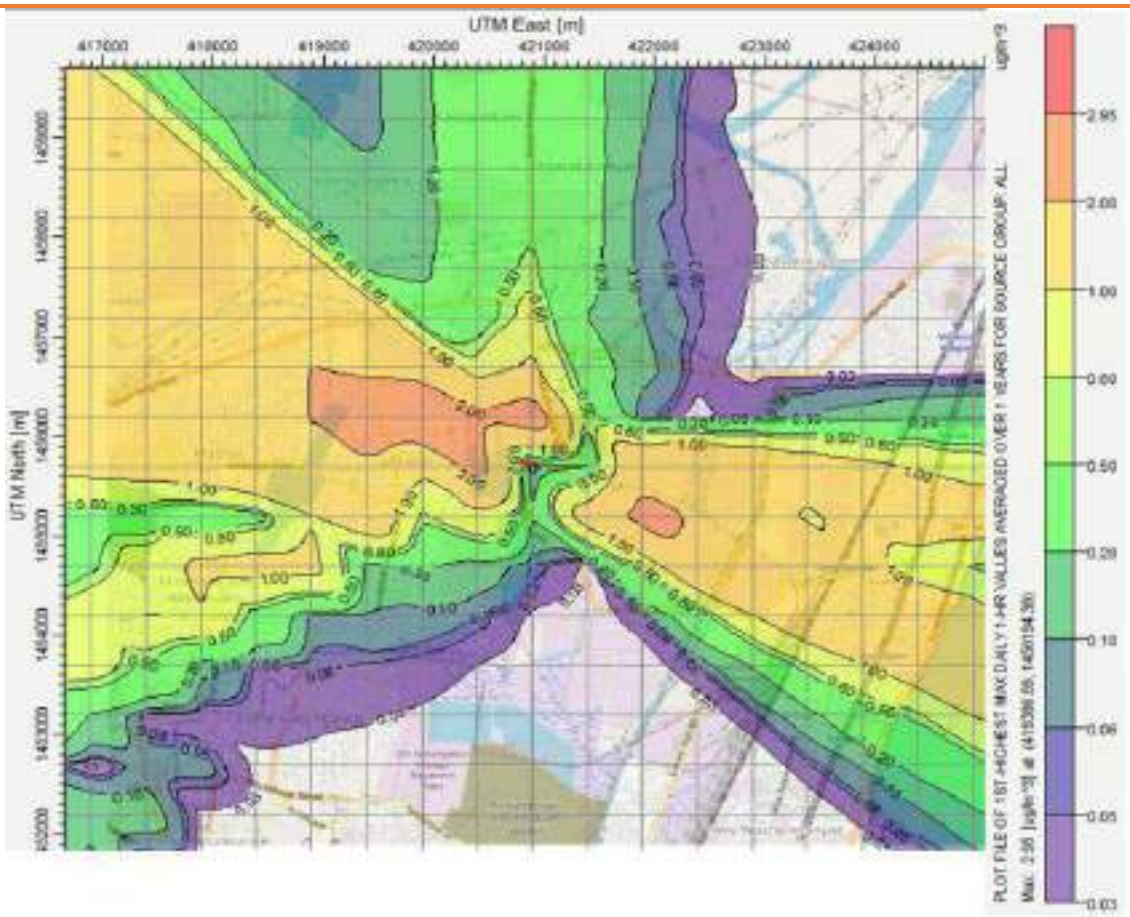
STACK EMISSION DISPERSION MODELLING – Stack - 15F2A @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
18.5	0.73	0.879	0.08	0.005

Stack - **15F2A** emission of Particulate matter is 18.5mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 0.879µg/m3 at 2km dispersion Particulate matter is 0.08µg/m3 and at 5km dispersion Particulate matter is 0.005µg/m3 and the predominant wind direction is ESE.

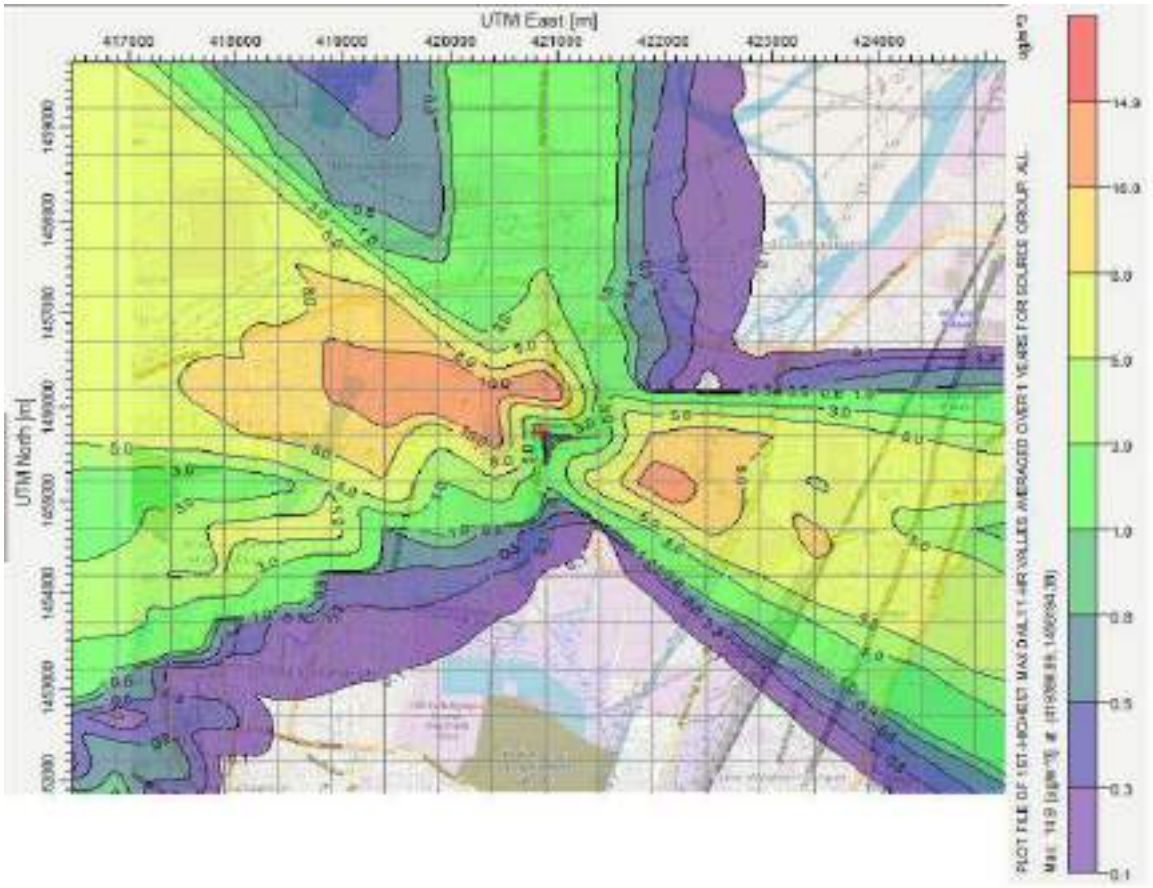
STACK EMISSION DISPERSION MODELLING – Stack - 15F2A @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
61	0.82	2.95	0.82	0.0736

Stack - **15F2A** emission of Sulphur dioxide is 61mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 2.95µg/m3 at 2km dispersion Sulphur dioxide is 0.62µg/m3 and at 5km dispersion Sulphur dioxide is 0.0736µg/m3 and the predominant wind direction is ESE.

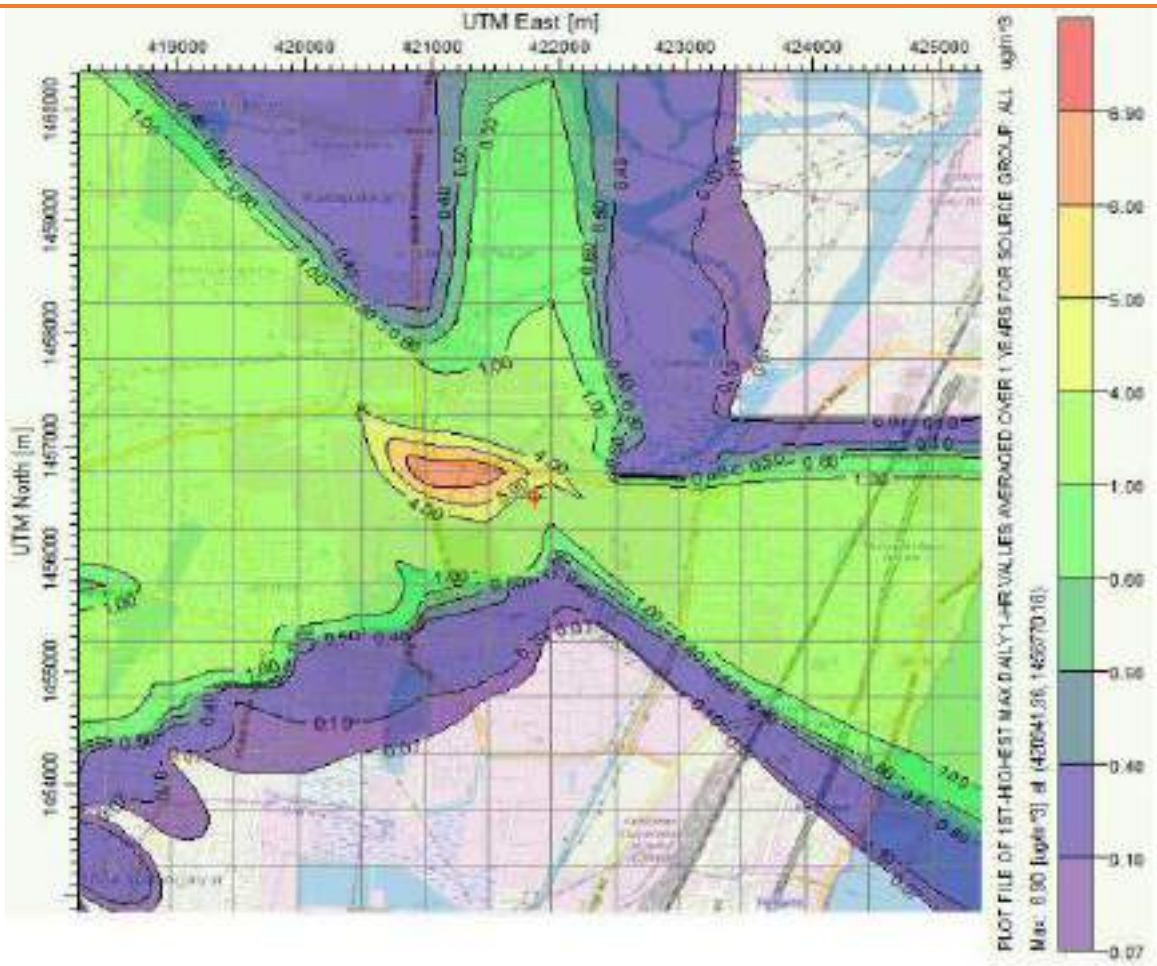
STACK EMISSION DISPERSION MODELLING – Stack - 15F2A @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
306	0.87	14.9	5.55	2.22

Stack - **15F2A** emission of Oxides of Nitrogen is 306mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 14.9µg/m3 at 2km dispersion Oxides of Nitrogen is 5.55µg/m3 and at 5km dispersion Oxides of Nitrogen is 2.22µg/m3 and the predominant wind direction is ESE.

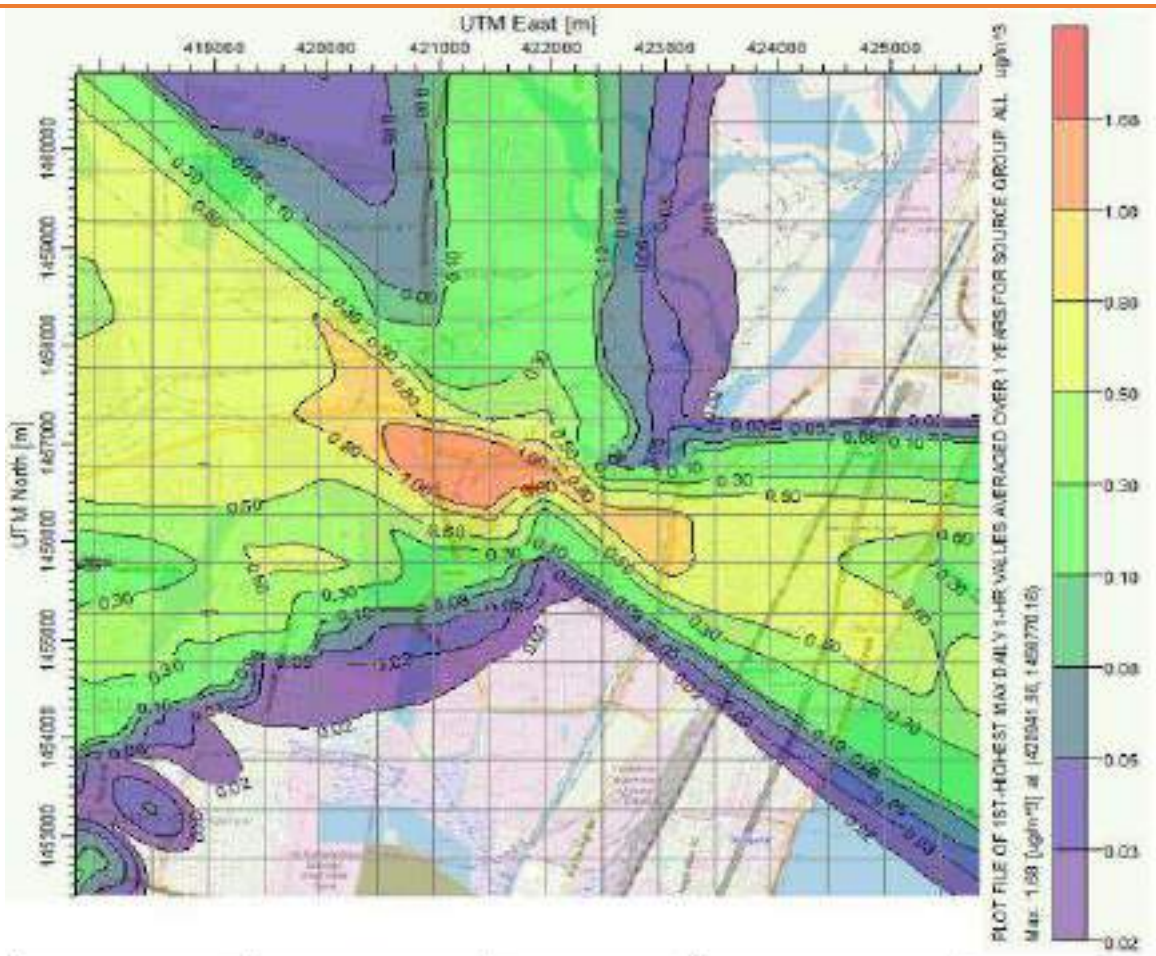
STACK EMISSION DISPERSION MODELLING – Stack - 15F2B @ 2 & 5KM – Carbon Monoxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
84	0.89	6.9	0.876	0.07212

Stack - **15F2B** emission of Carbon Monoxide is 84mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 6.9µg/m3 at 2km dispersion Carbon Monoxide is 0.876µg/m3 and at 5km dispersion Carbon Monoxide is 0.07212µg/m3 and the predominant wind direction is ESE.

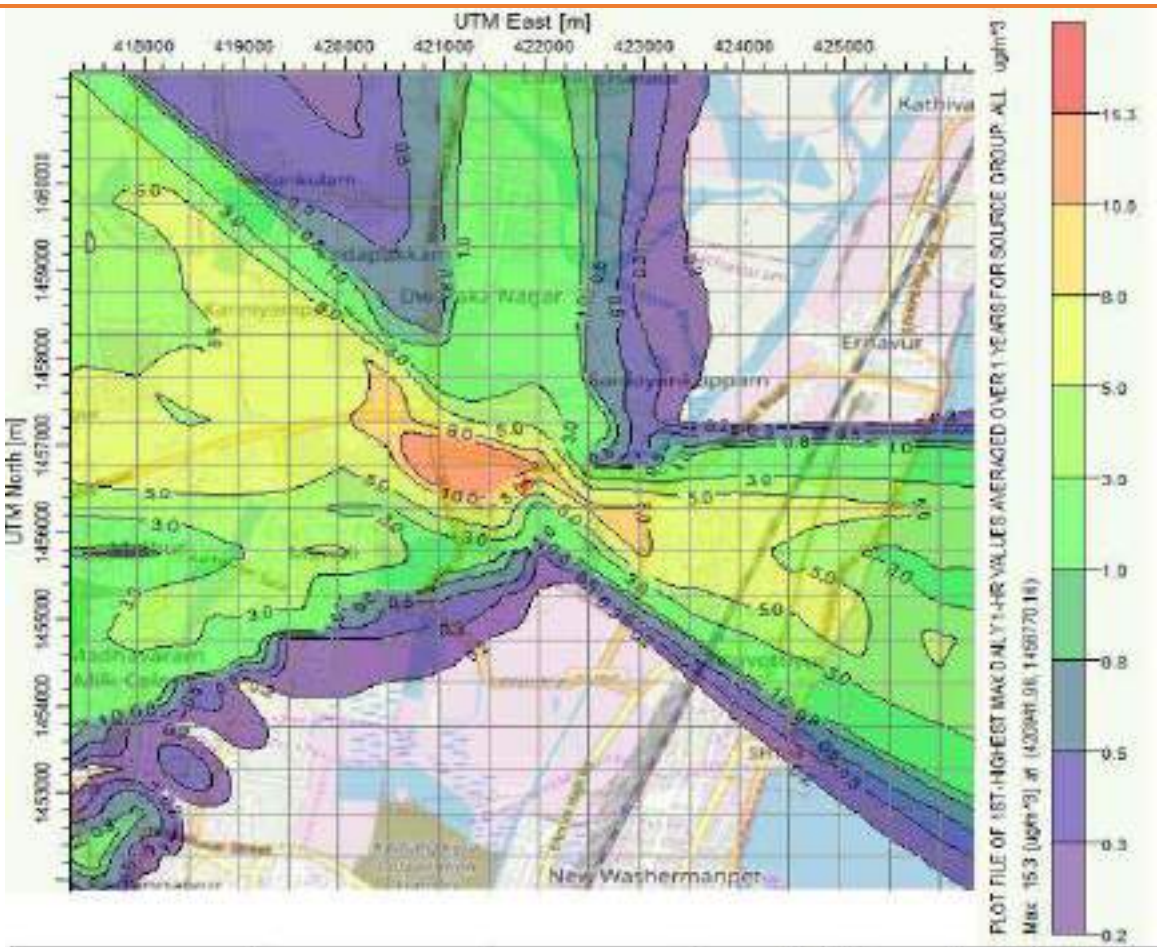
STACK EMISSION DISPERSION MODELLING – Stack - 15F2B @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
20.3	0.912	1.68	0.522	0.086

Stack - **15F2B** emission of Particulate matter is 20.3mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.912km at the concentration of 1.68µg/m3 at 2km dispersion Particulate matter is 0.522µg/m3 and at 5km dispersion Particulate matter is 0.086µg/m3 and the predominant wind direction is ESE.

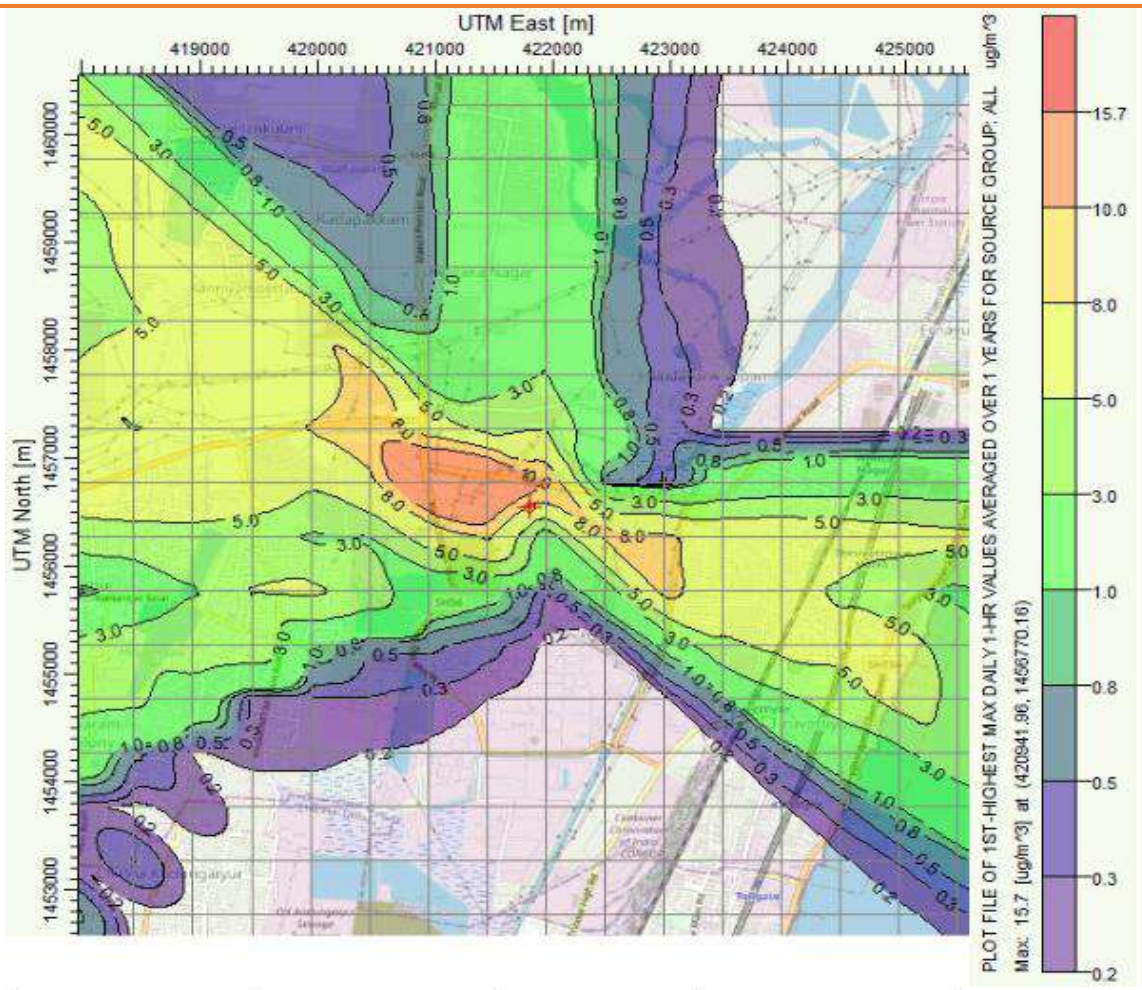
STACK EMISSION DISPERSION MODELLING – Stack - 15F2B @ 2 & 5KM – Sulphur dioxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
187	0.8657	15.3	0.987	0.0467

Stack - **15F2B** emission of Sulphur dioxide is 187mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8657km at the concentration of 15.3µg/m3 at 2km dispersion Sulphur dioxide is 0.987µg/m3 and at 5km dispersion Sulphur dioxide is 0.0467µg/m3 and the predominant wind direction is ESE.

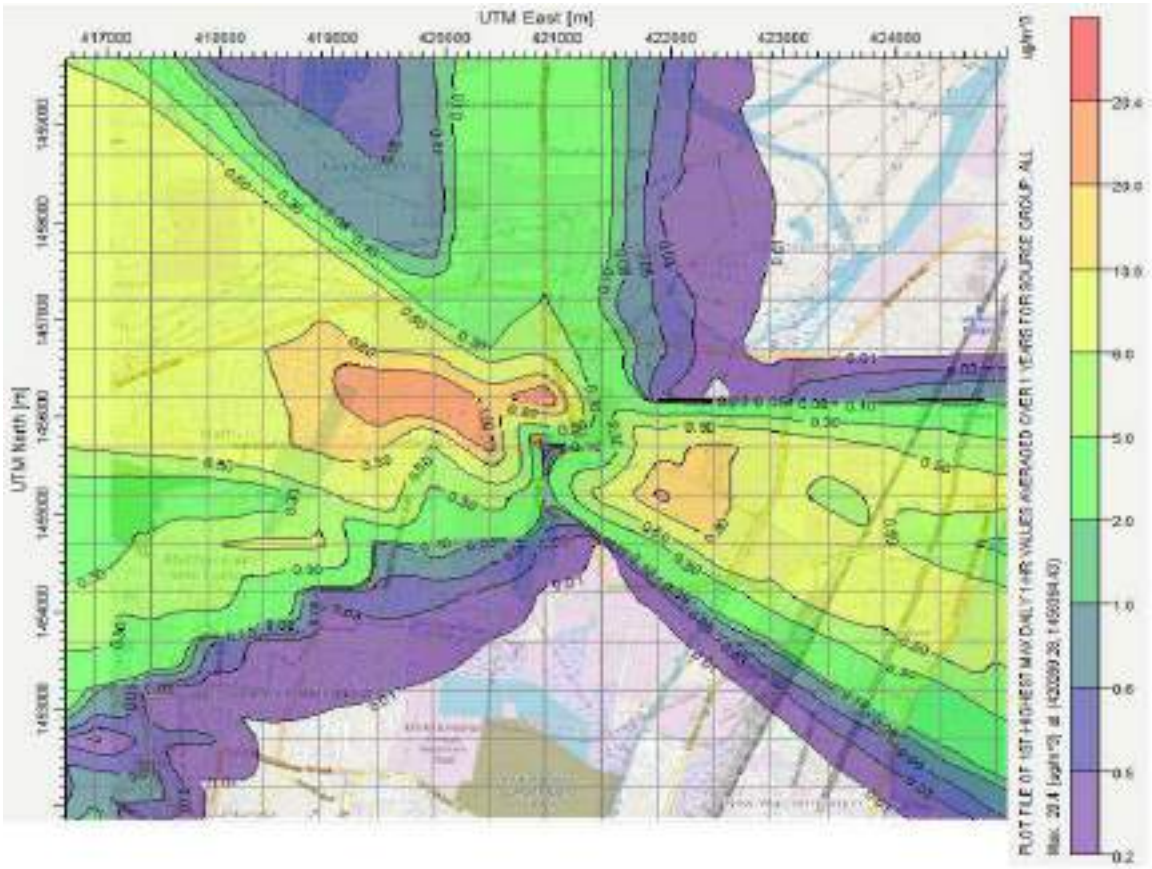
STACK EMISSION DISPERSION MODELLING – Stack - 15F2B @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
192	0.888	15.7	2.2354	0.987

Stack - **15F2B** emission of Oxides of Nitrogen is 192mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.888km at the concentration of 15.7µg/m3 at 2km dispersion Oxides of Nitrogen is 2.2354µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.987µg/m3 and the predominant wind direction is ESE.

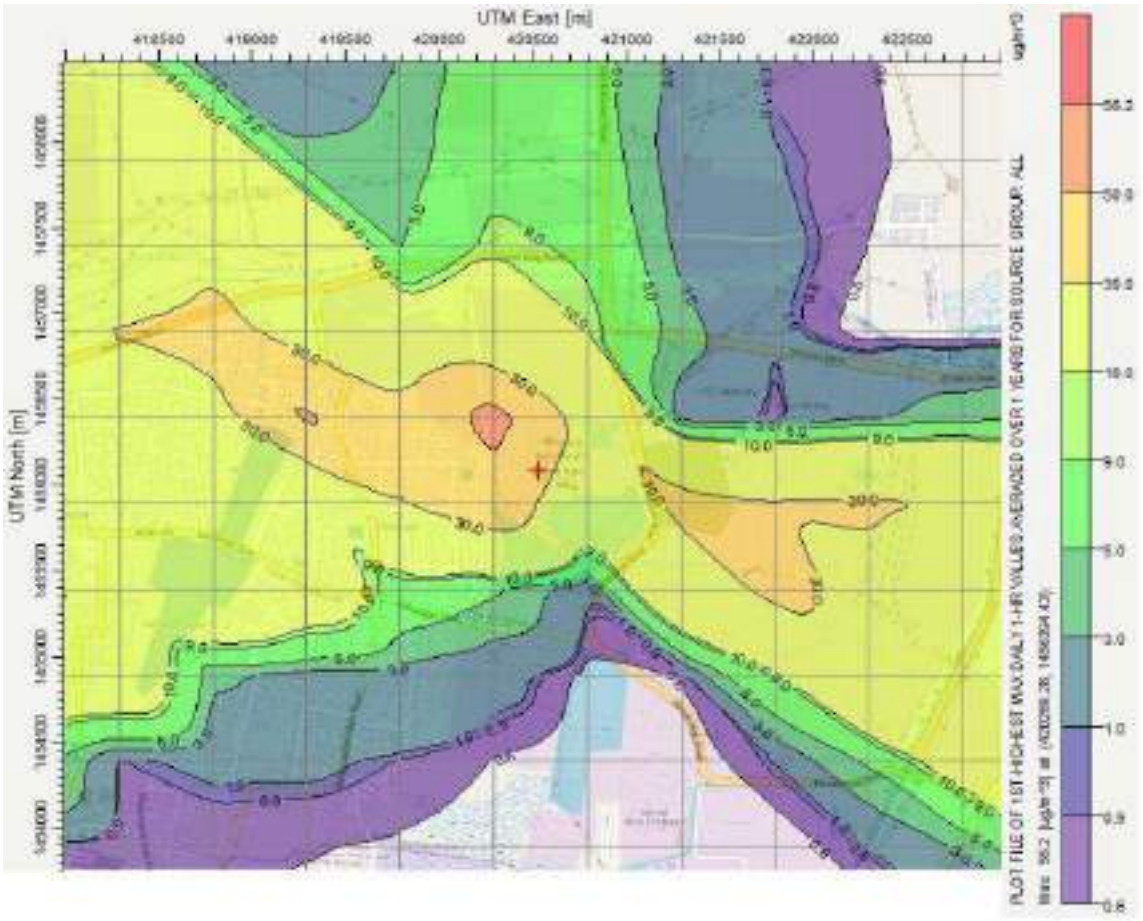
STACK EMISSION DISPERSION MODELLING – Stack - 16F1 @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
148	0.97	20.4	8.32	0.952

Stack - **16F1** emission of Carbon Monoxide is 148mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 20.4µg/m3 at 2km dispersion Carbon Monoxide is 8.32µg/m3 and at 5km dispersion Carbon Monoxide is 0.952µg/m3 and the predominant wind direction is ESE.

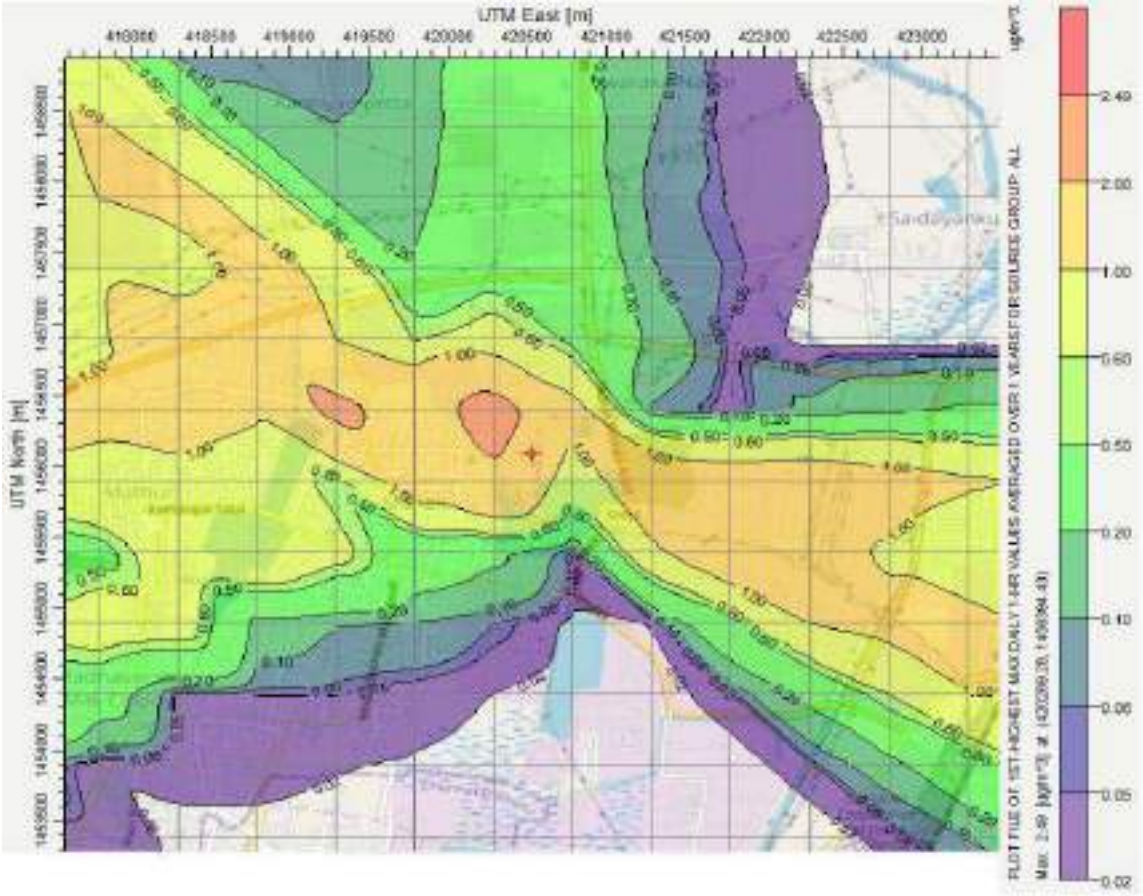
STACK EMISSION DISPERSION MODELLING – Stack - 16F1 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
17.4	0.78	56.2	9.91	2.19

Stack - **16F1** emission of Particulate matter is 17.4mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 56.2µg/m3 at 2km dispersion Particulate matter is 9.91µg/m3 and at 5km dispersion Particulate matter is 2.19µg/m3 and the predominant wind direction is ESE.

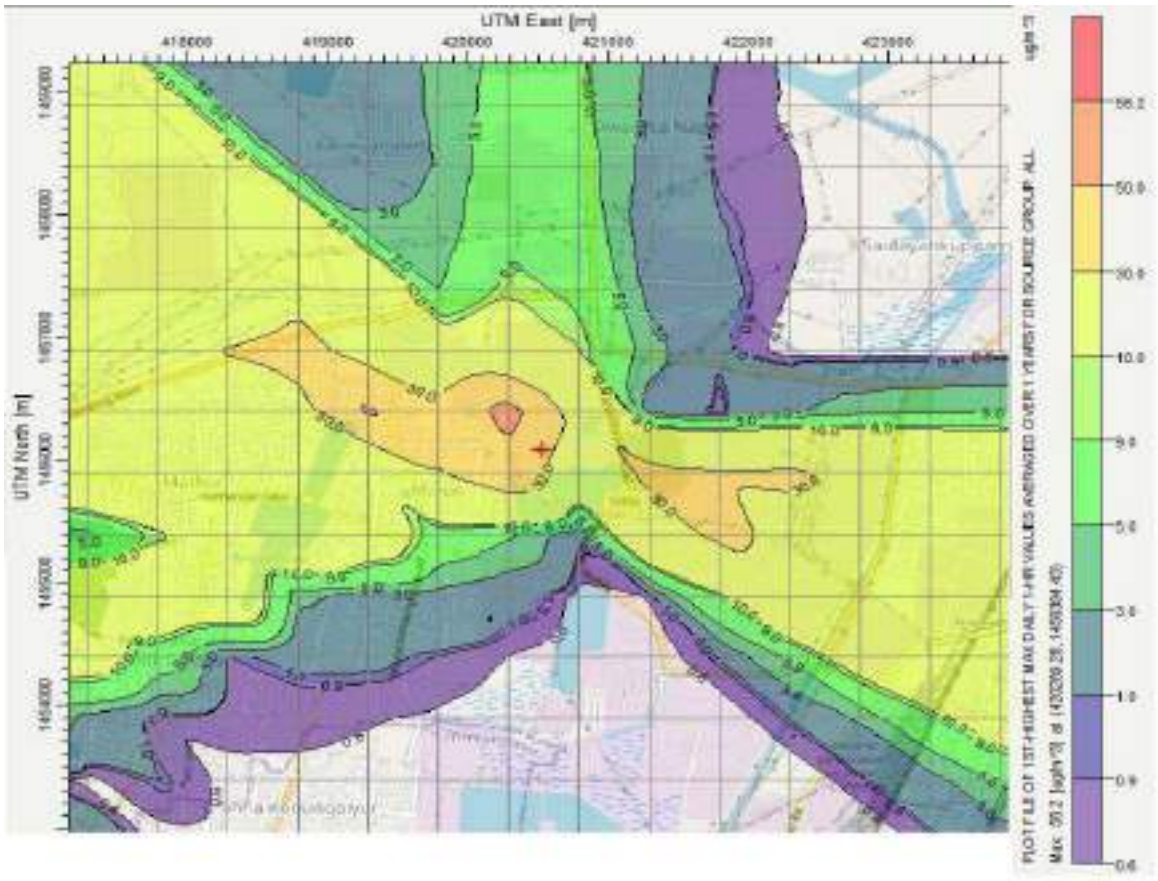
STACK EMISSION DISPERSION MODELLING – Stack - 16F1 @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
59	0.83	2.49	0.855	0.072

Stack - **16F1** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.855µg/m3 and at 5km dispersion Sulphur dioxide is 0.072µg/m3 and the predominant wind direction is ESE.

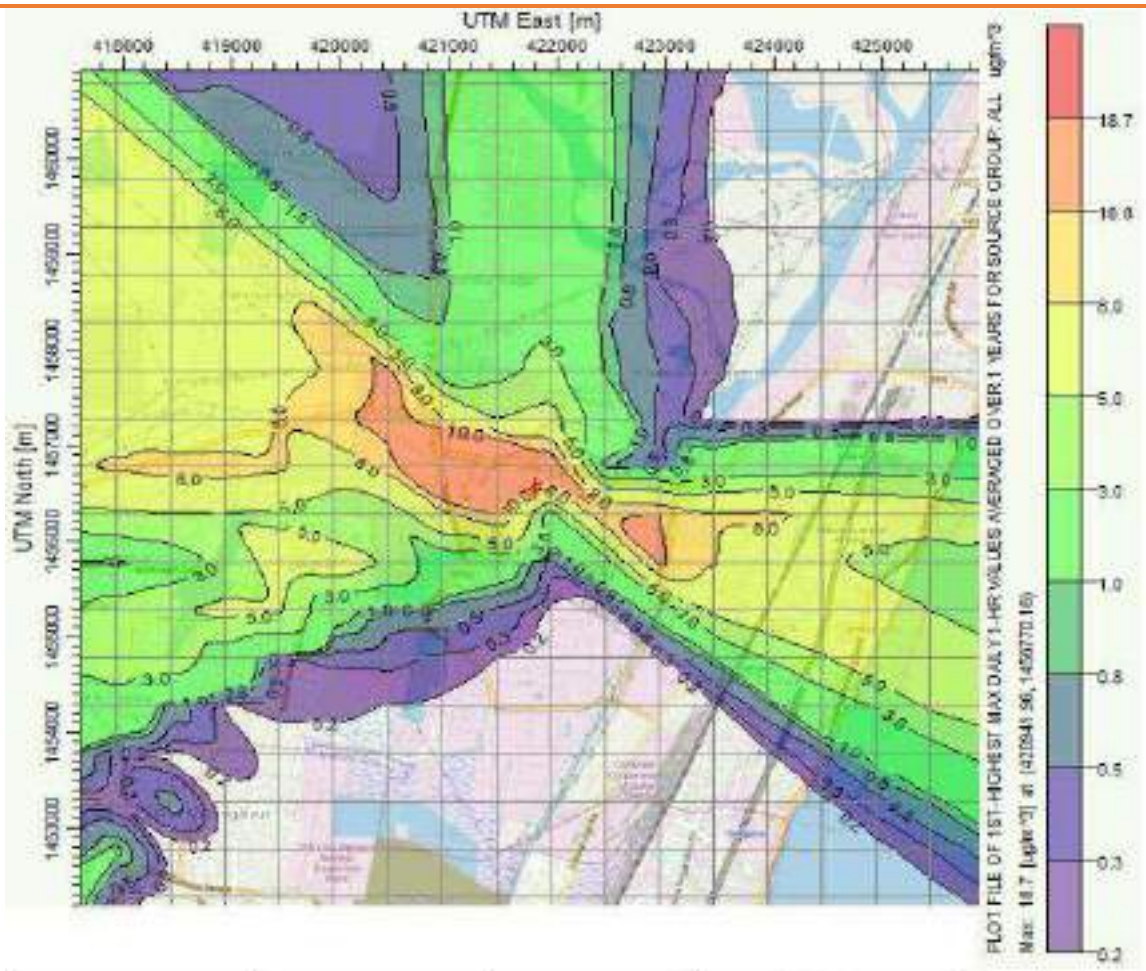
STACK EMISSION DISPERSION MODELLING – Stack - 16F1 @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
408	0.83	56.2	10.11	1.47

Stack - **16F1** emission of Oxides of Nitrogen is 408mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 56.2µg/m3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m3 and the predominant wind direction is ESE.

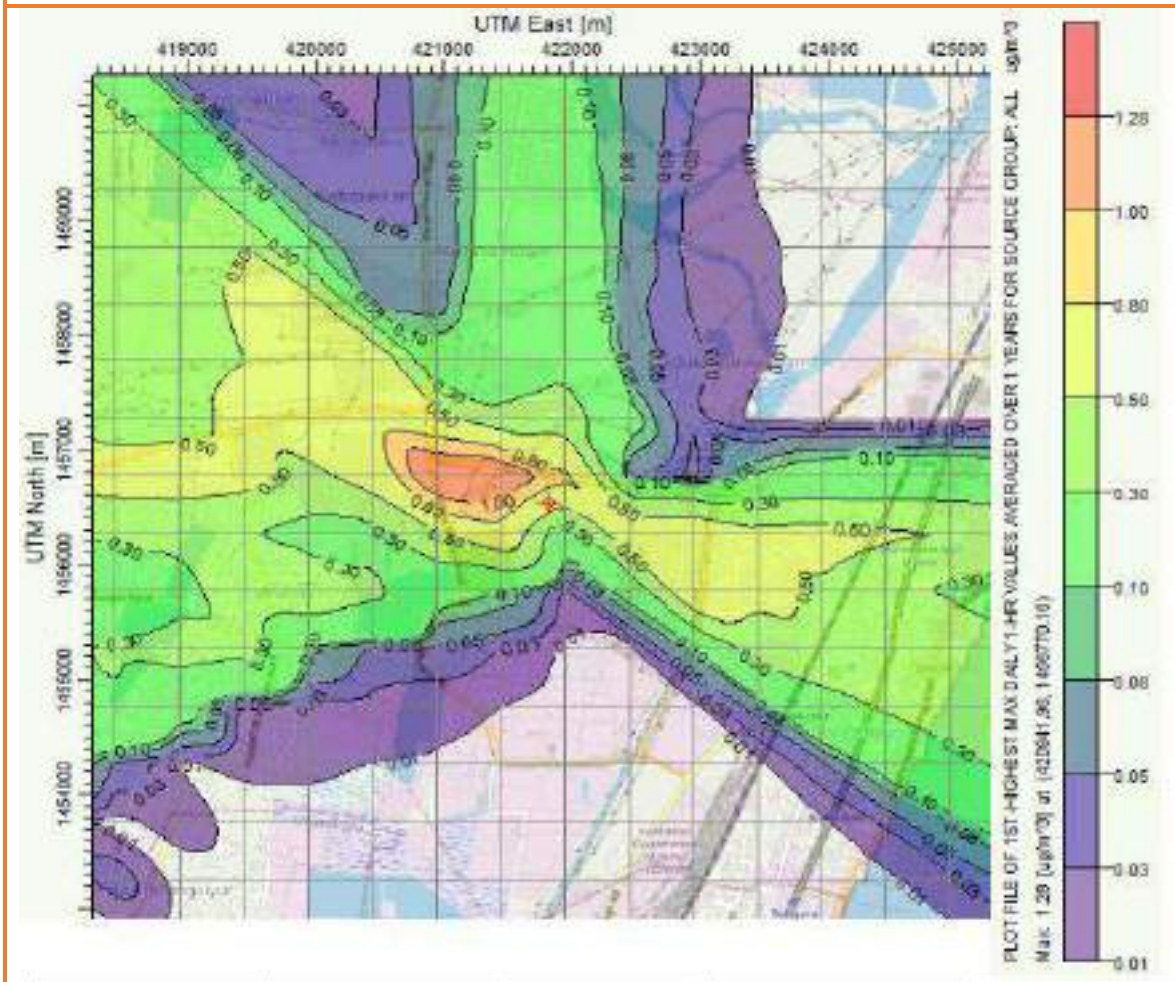
STACK EMISSION DISPERSION MODELLING – Stack - 16F3 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
142	0.889	18.7	1.56	0.321

Stack - **16F3** emission of Carbon Monoxide is 142mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.889km at the concentration of 18.7µg/m3 at 2km dispersion Carbon Monoxide is 1.56µg/m3 and at 5km dispersion Carbon Monoxide is 0.321µg/m3 and the predominant wind direction is ESE.

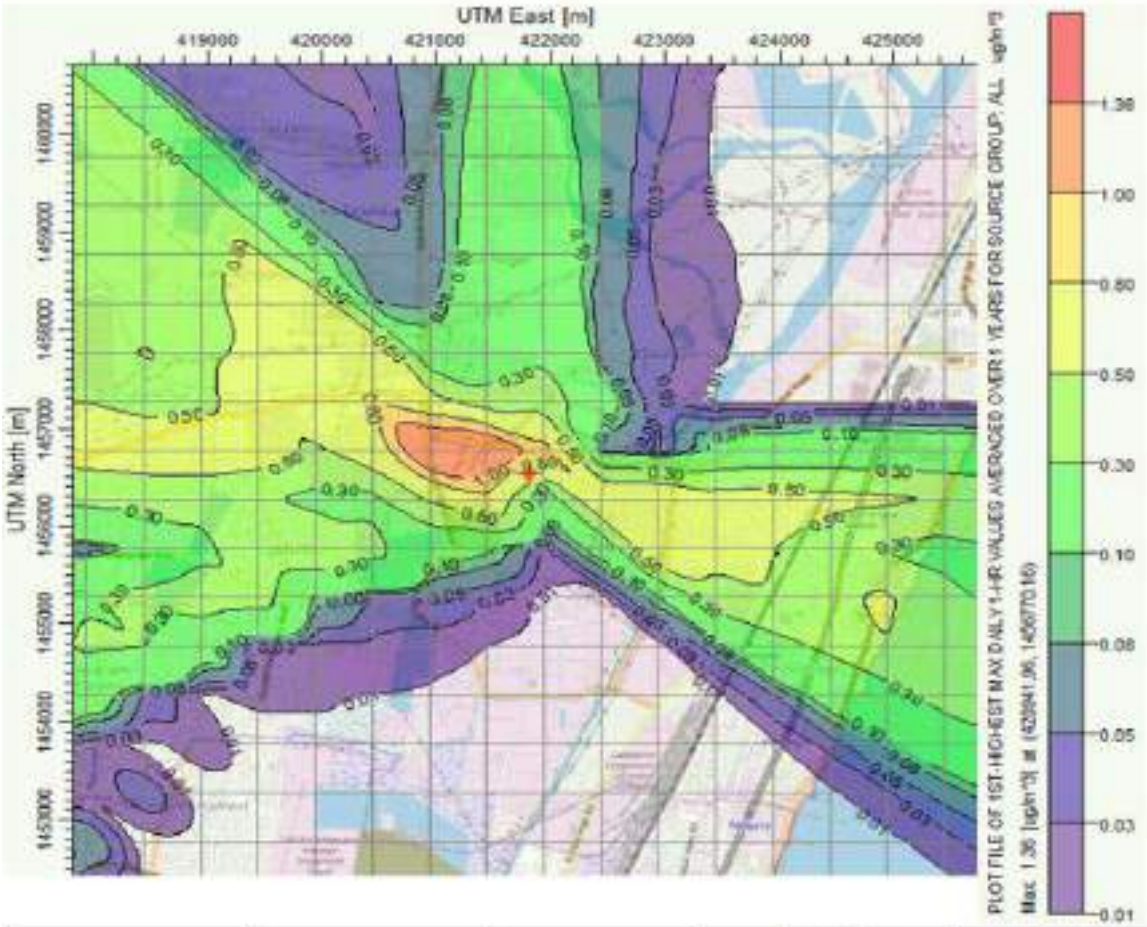
STACK EMISSION DISPERSION MODELLING – Stack - 16F3 @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.7	0.785	1.28	0.11	0.0693

Stack - 16F3 emission of Particulate matter is 9.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.785km at the concentration of 1.28µg/m3 at 2km dispersion Particulate matter is 0.11µg/m3 and at 5km dispersion Particulate matter is 0.0693µg/m3 and the predominant wind direction is ESE.

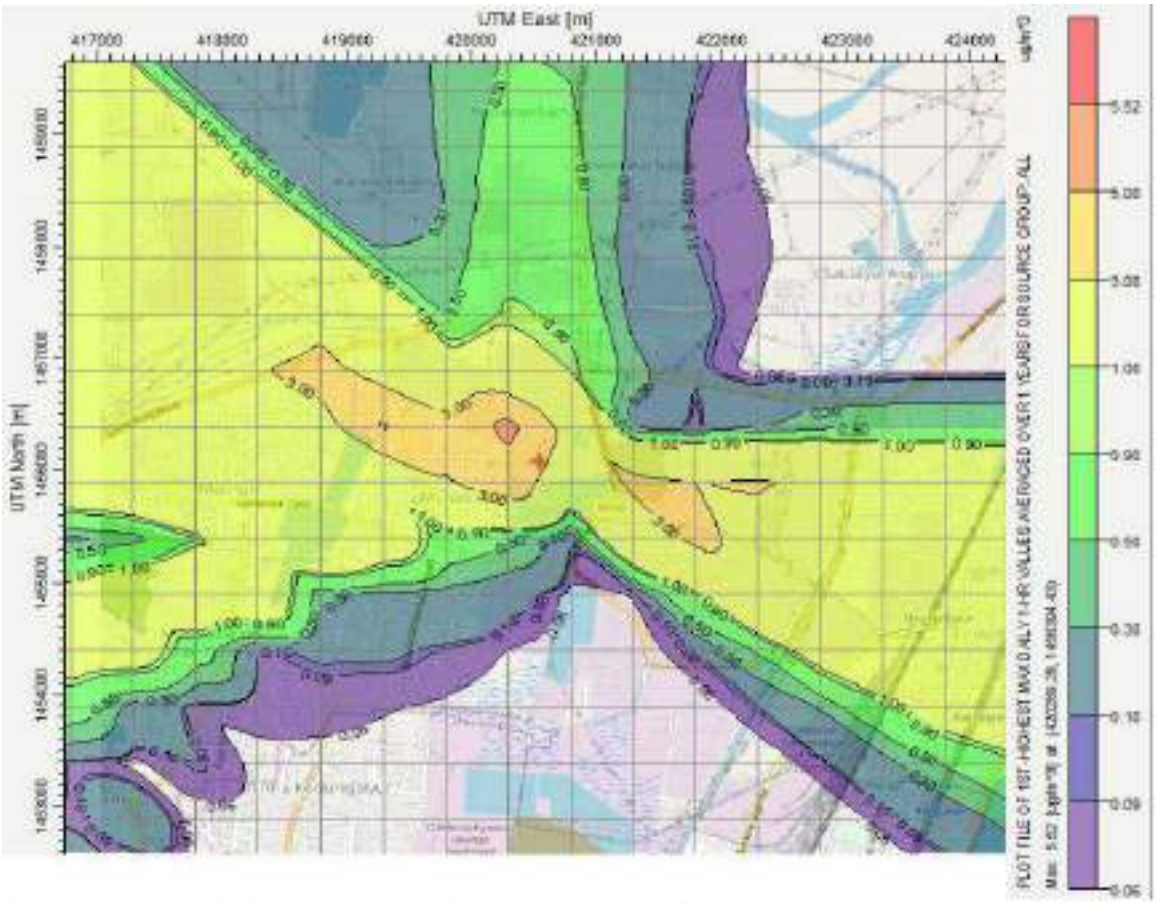
STACK EMISSION DISPERSION MODELLING – Stack - 16F3 @ 2 & 5KM – Sulphur Dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
10	0.869	1.36	0.19	0.0461

Stack - **16F3** emission of Sulphur dioxide is 10mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.869km at the concentration of 1.36µg/m3 at 2km dispersion Sulphur dioxide is 0.19µg/m3 and at 5km dispersion Sulphur dioxide is 0.0461µg/m3 and the predominant wind direction is ESE.

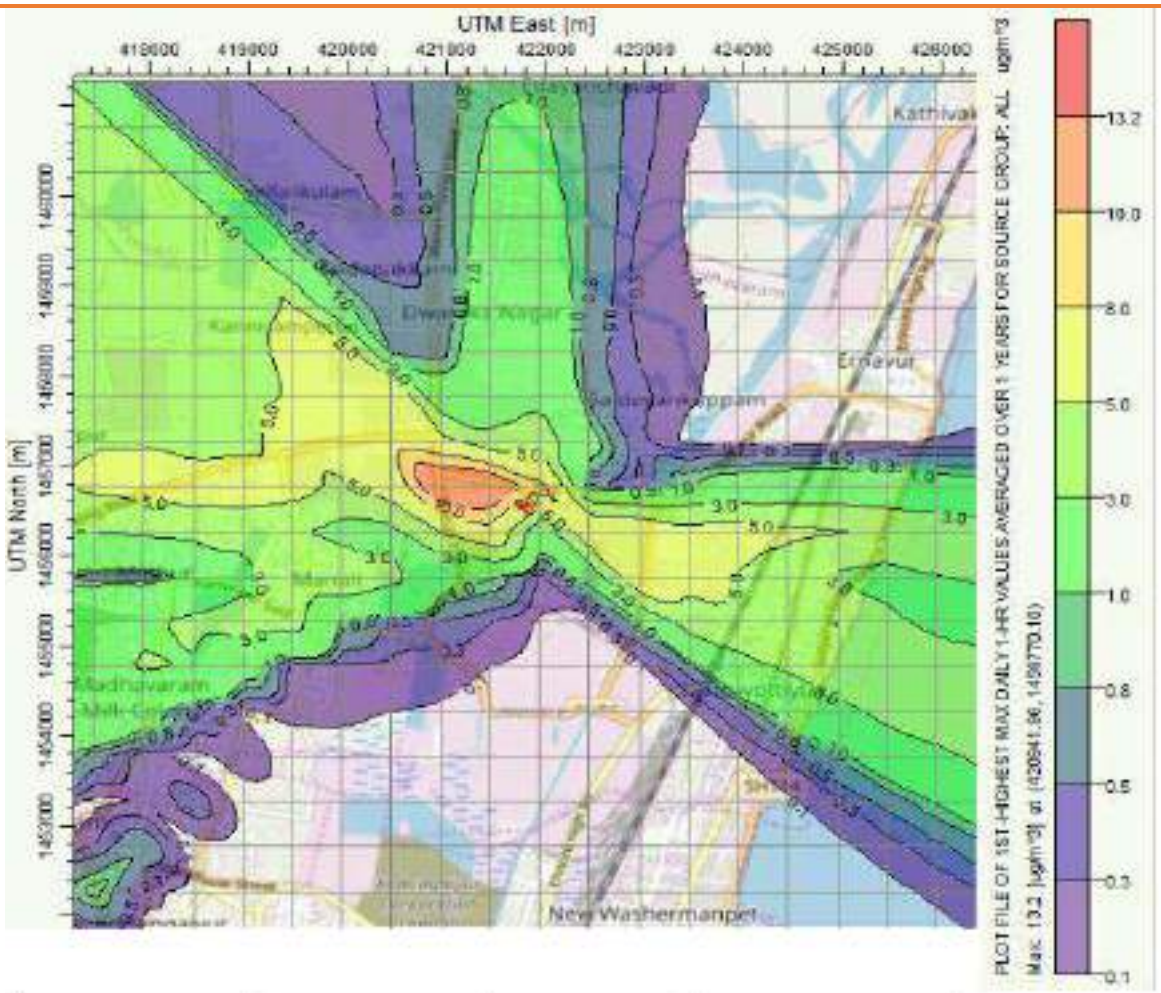
STACK EMISSION DISPERSION MODELLING – Stack - 16F3 @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
43	0.81	5.52	1.789	0.809

Stack - **16F3** emission of Oxides of Nitrogen is 43mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 5.52µg/m3 at 2km dispersion Oxides of Nitrogen is 1.789µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.809µg/m3 and the predominant wind direction is ESE.

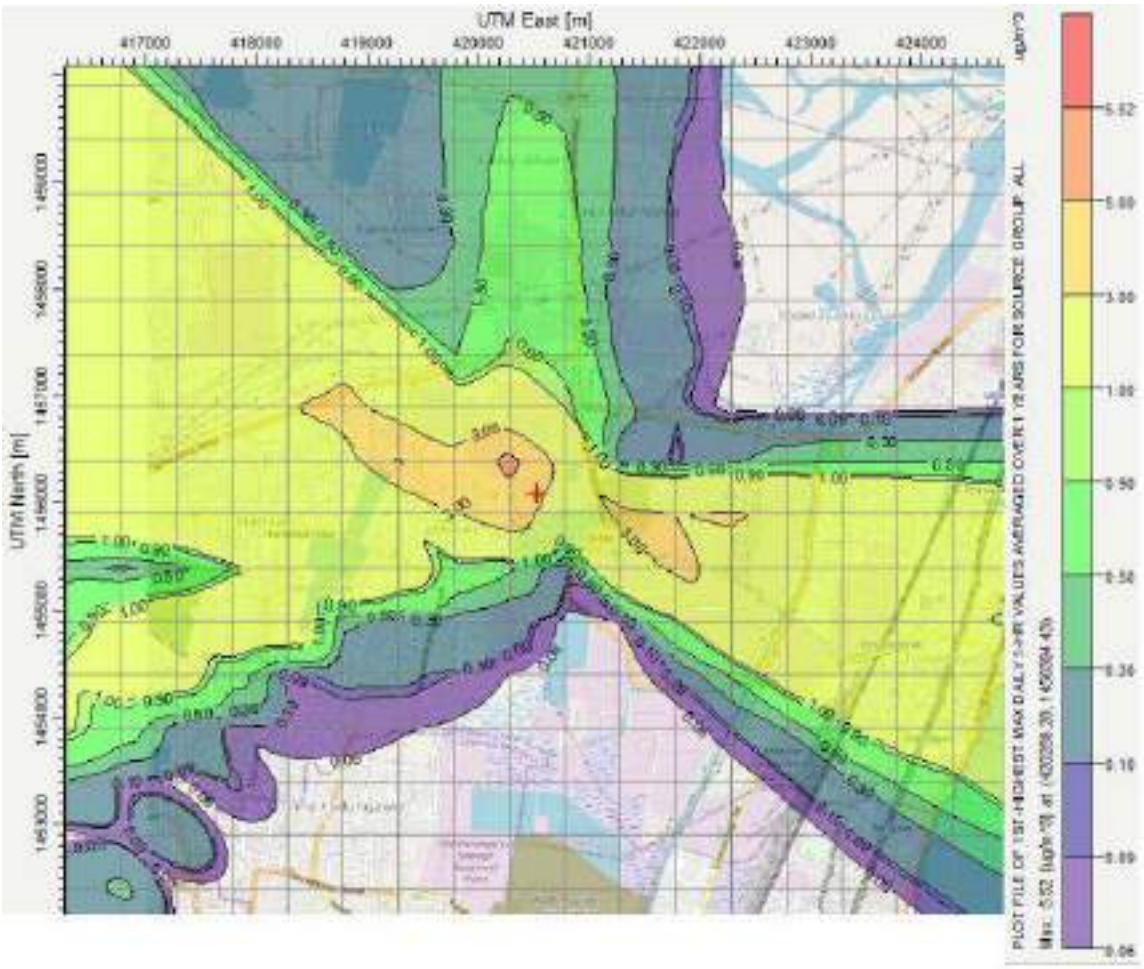
STACK EMISSION DISPERSION MODELLING – Stack - 9F201 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
185	0.789	13.2	1.31	0.0866

Stack - **9F201** emission of Carbon Monoxide is 185 mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.789km at the concentration of 13.2µg/m3 at 2km dispersion Carbon Monoxide is 1.31µg/m3 and at 5km dispersion Carbon Monoxide is 0.0866µg/m3 and the predominant wind direction is ESE.

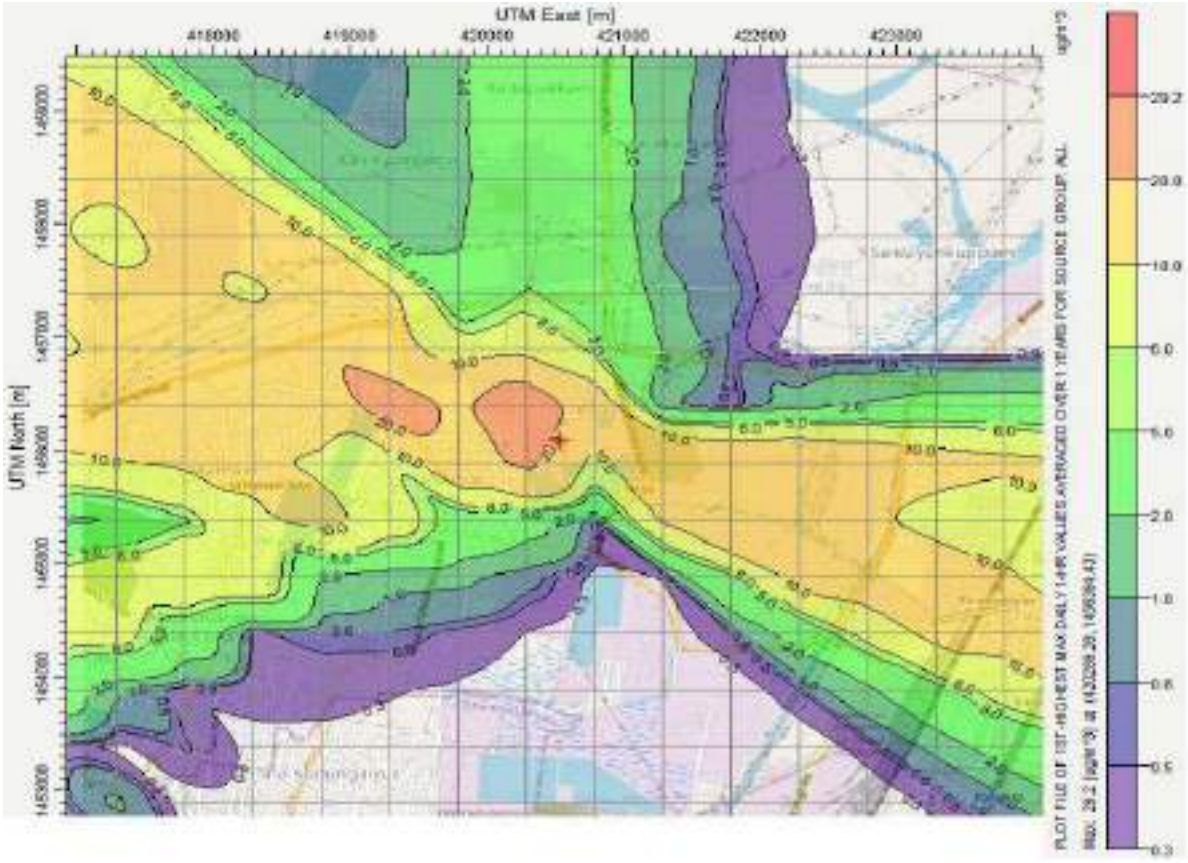
STACK EMISSION DISPERSION MODELLING – Stack - 9F201 @ 2 & 5KM – Particulate matte



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
24.4	0.77	5.52	2.16	0.42

Stack - **9F201** emission of Particulate matter is 24.4mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 5.52µg/m3 at 2km dispersion Particulate matter is 2.16µg/m3 and at 5km dispersion Particulate matter is 0.42µg/m3 and the predominant wind direction is ESE.

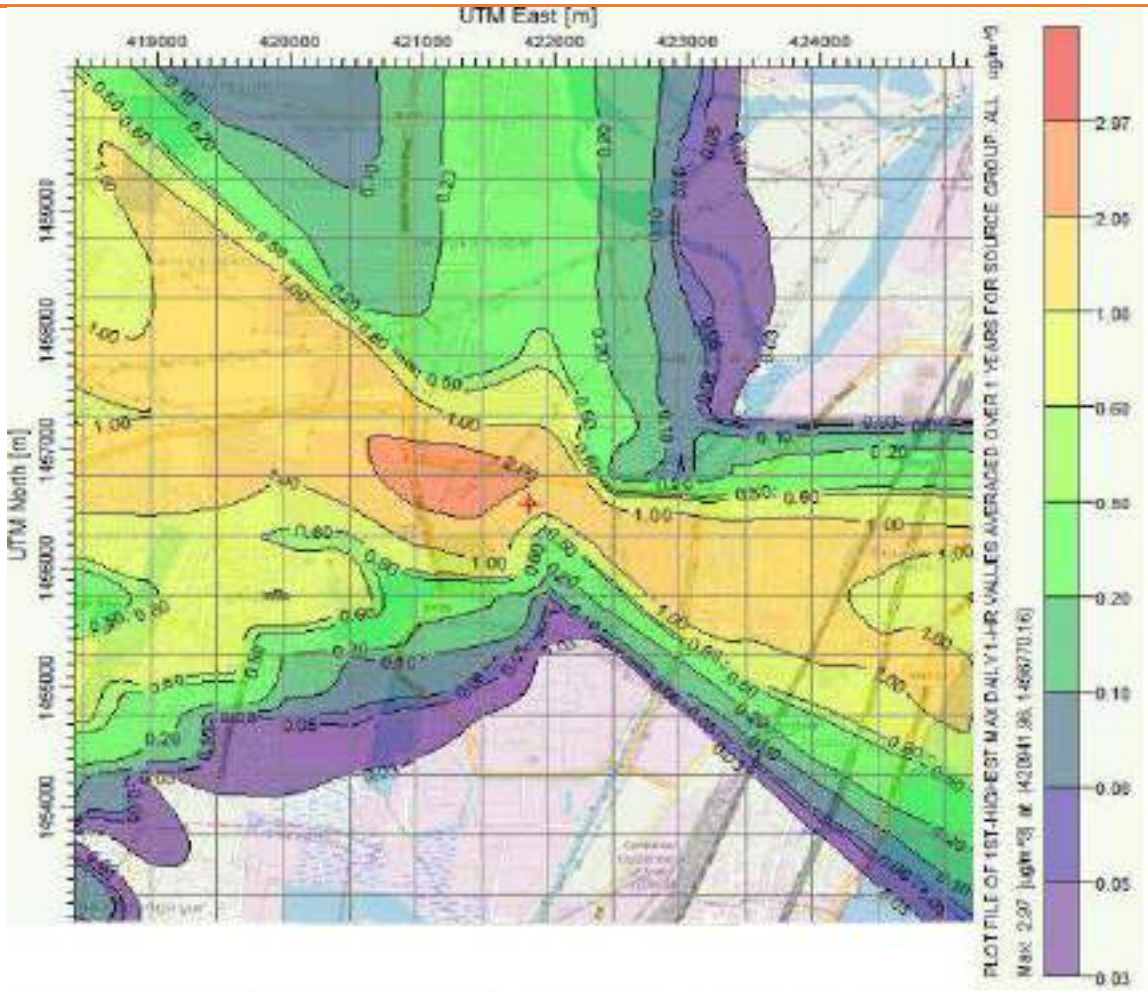
STACK EMISSION DISPERSION MODELLING – Stack - 9F201 @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
421	0.88	29.2	2.89	0.75

Stack - **9F201** emission of Oxides of Nitrogen is 421mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 29.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.89µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

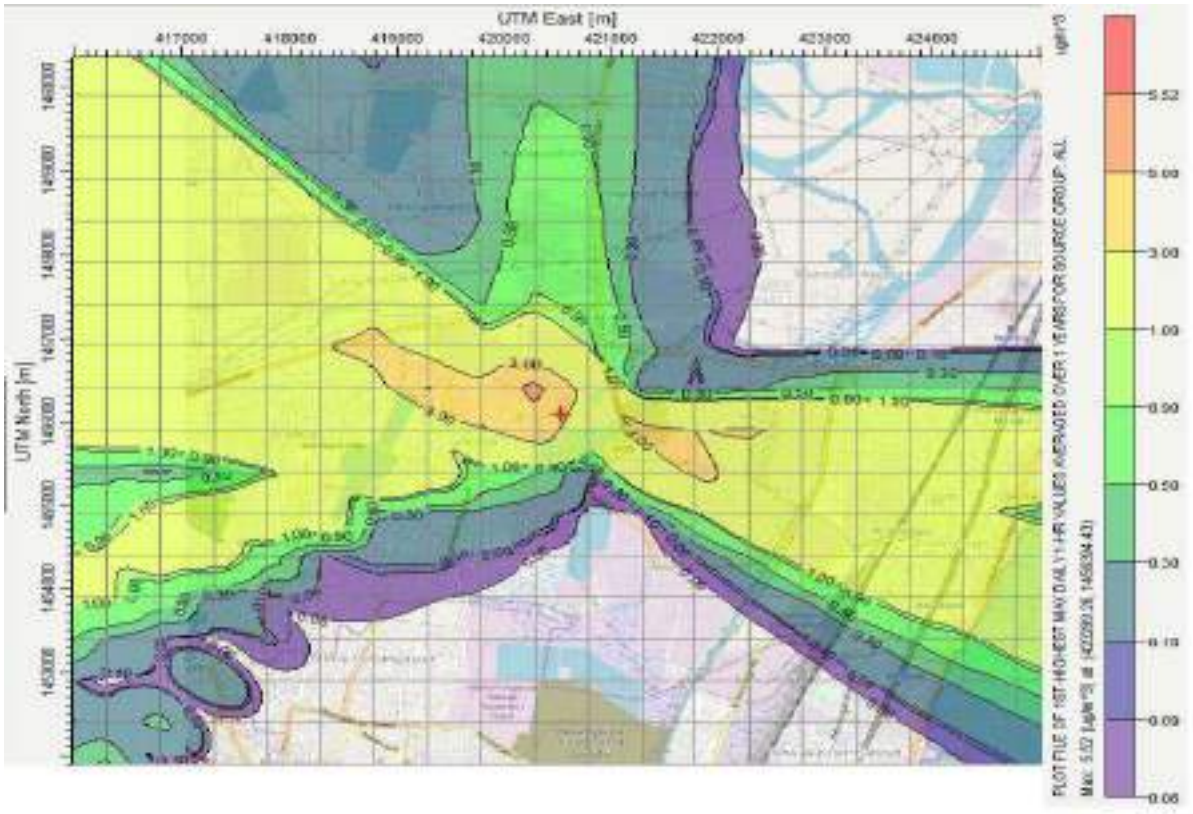
STACK EMISSION DISPERSION MODELLING – Stack - 9F201 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
41	0.982	2.97	0.666	0.0231

Stack - **9F201** emission of Sulphur dioxide is 41mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.982km at the concentration of 2.97µg/m3 at 2km dispersion Sulphur dioxide is 0.666µg/m3 and at 5km dispersion Sulphur dioxide is 0.0231µg/m3 and the predominant wind direction is ESE.

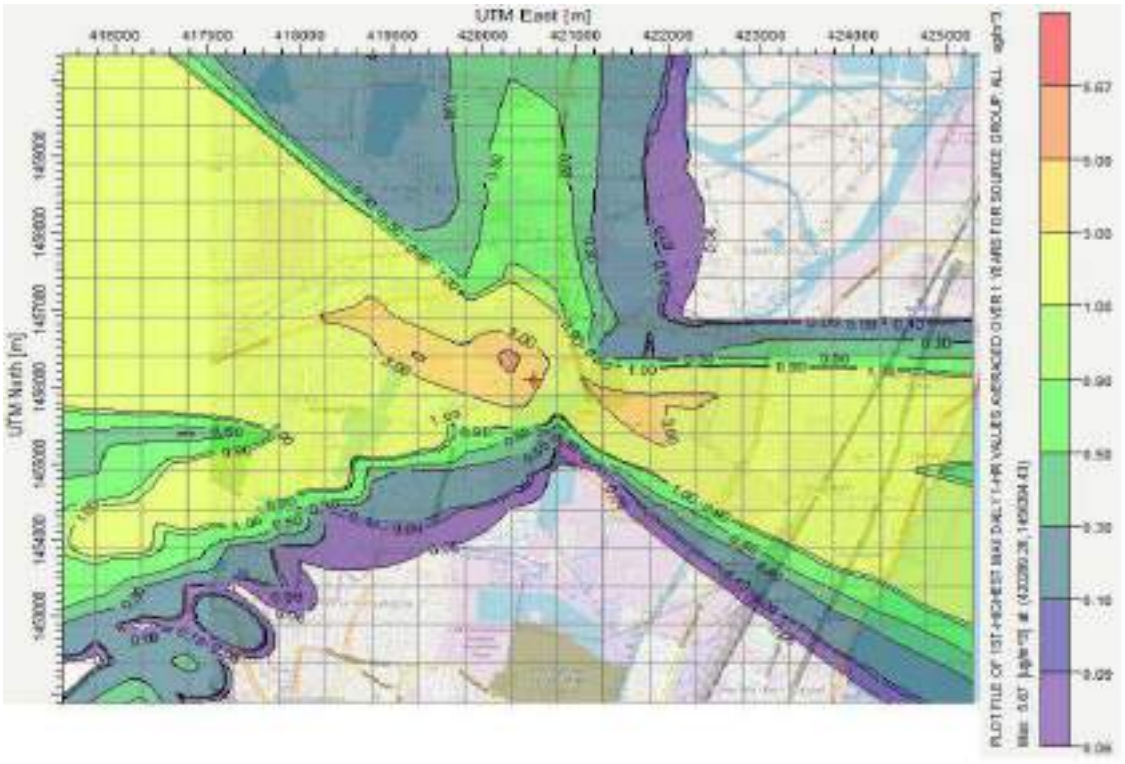
STACK EMISSION DISPERSION MODELLING – Stack - 9F301 @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
159	0.7	5.52	2.42	0.56

Stack - **9F301** emission of Carbon Monoxide is 159mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 5.52µg/m3 at 2km dispersion Carbon Monoxide is 2.42µg/m3 and at 5km dispersion Carbon Monoxide is 0.56µg/m3 and the predominant wind direction is ESE.

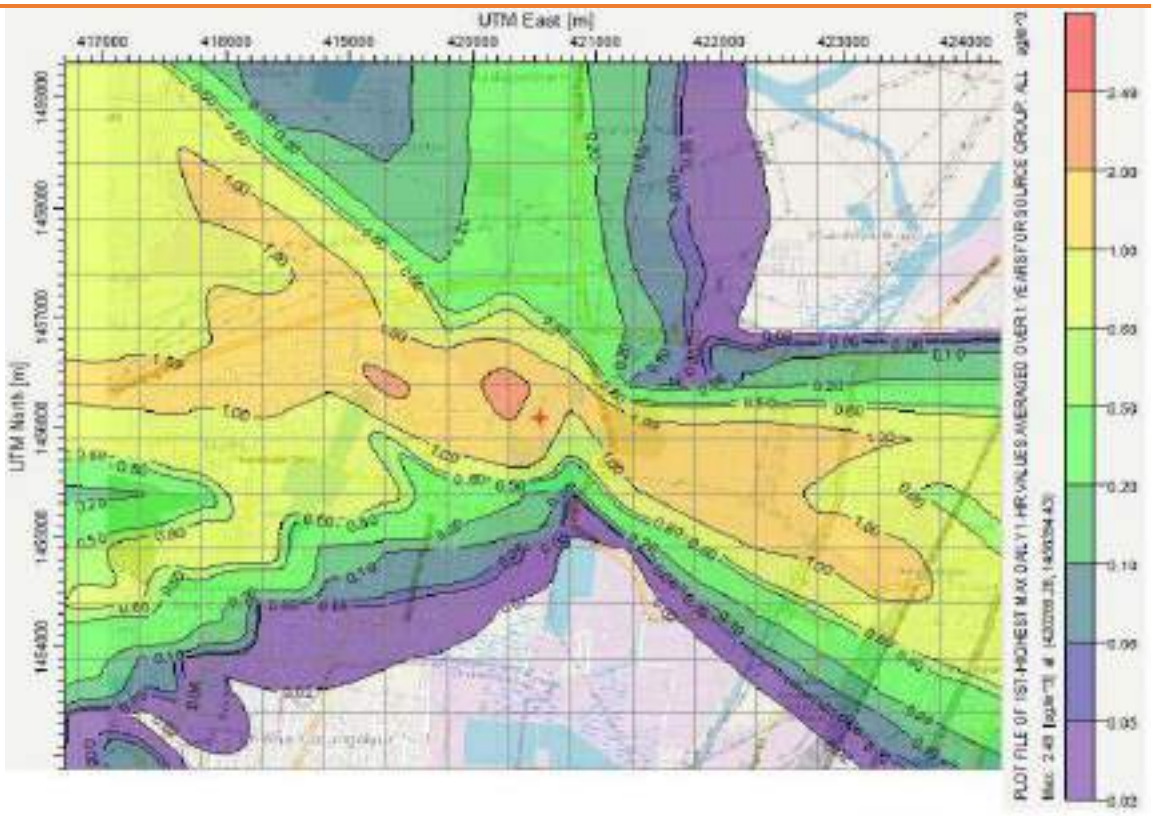
STACK EMISSION DISPERSION MODELLING – Stack - 9F301 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
25.6	0.78	5.67	2.11	0.36

Stack - **9F301** emission of Particulate matter is 25.6mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.67µg/m3 at 2km dispersion Particulate matter is 2.11µg/m3 and at 5km dispersion Particulate matter is 0.36µg/m3 and the predominant wind direction is ESE.

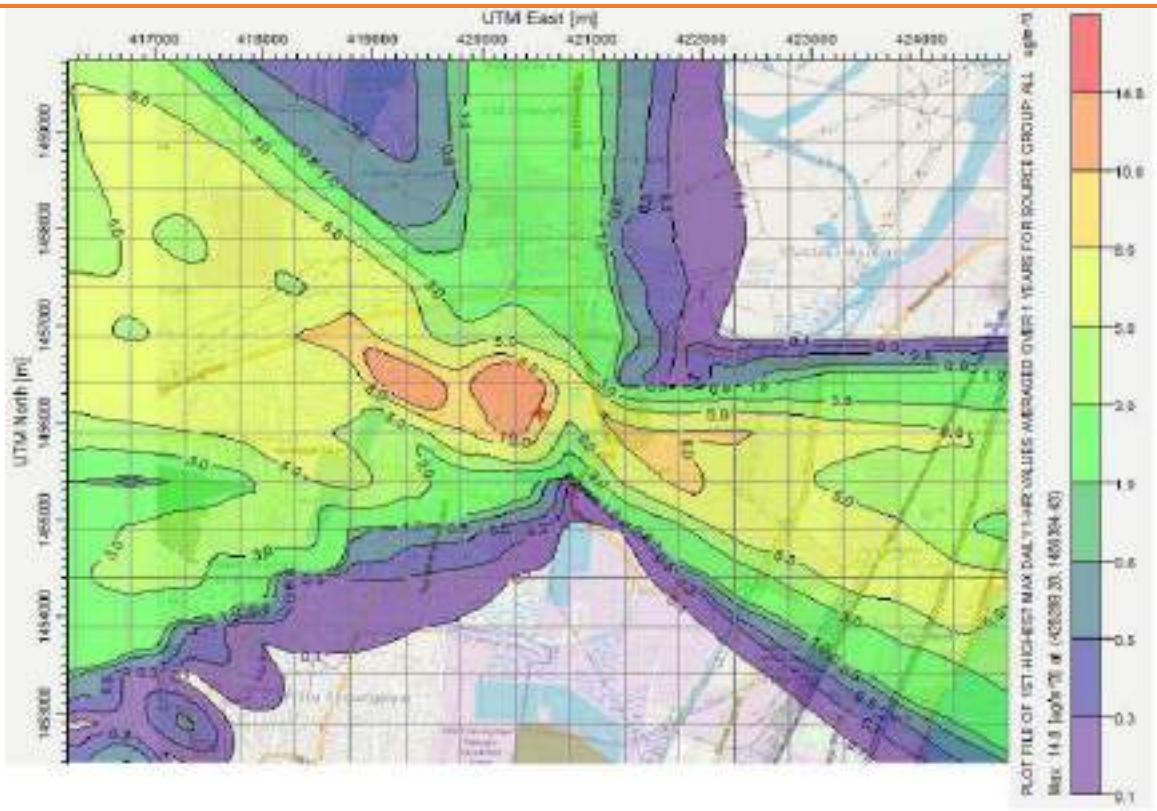
STACK EMISSION DISPERSION MODELLING – Stack - 9F301 @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
71	0.73	2.49	0.44	0.0925

Stack - **9F301** emission of Sulphur dioxide is 71mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.0925µg/m3 and the predominant wind direction is ESE.

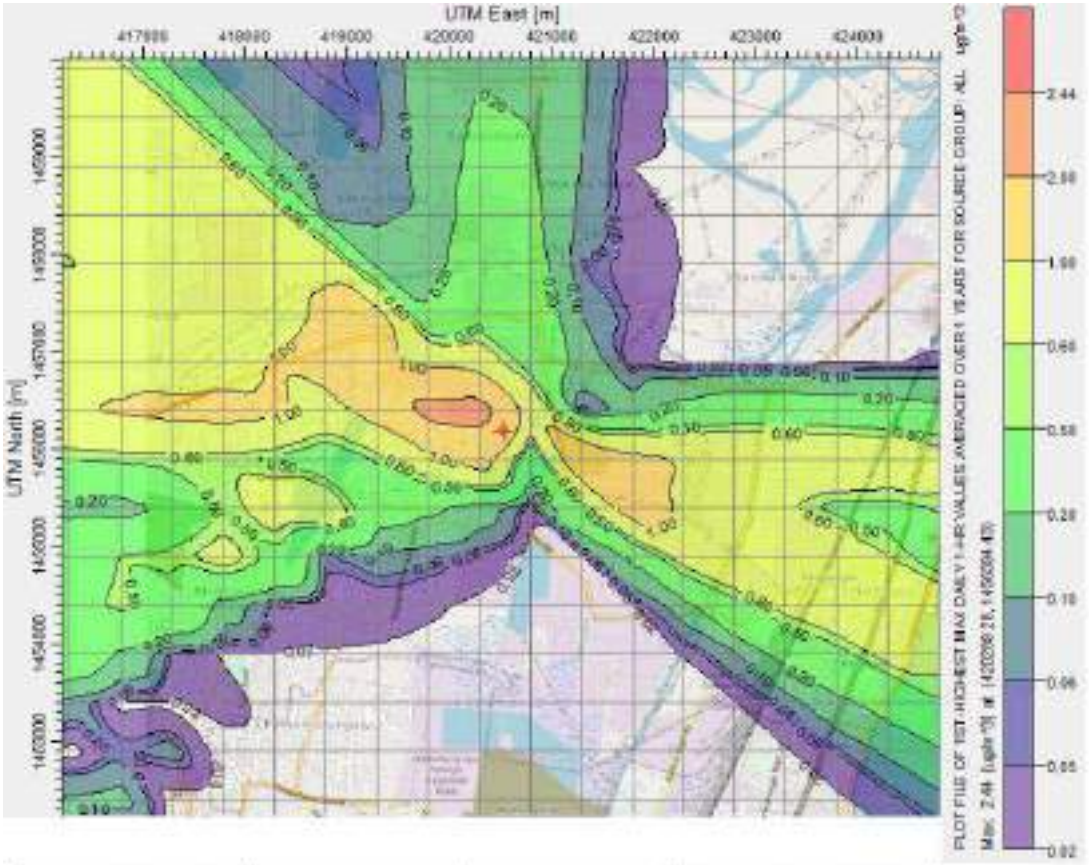
STACK EMISSION DISPERSION MODELLING – Stack - 9F301 @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
425	0.68	14.8	3.75	0.541

Stack - **9F301** emission of Oxides of Nitrogen is 425mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.8µg/m3 at 2km dispersion Oxides of Nitrogen is 3.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.541µg/m3 and the predominant wind direction is ESE.

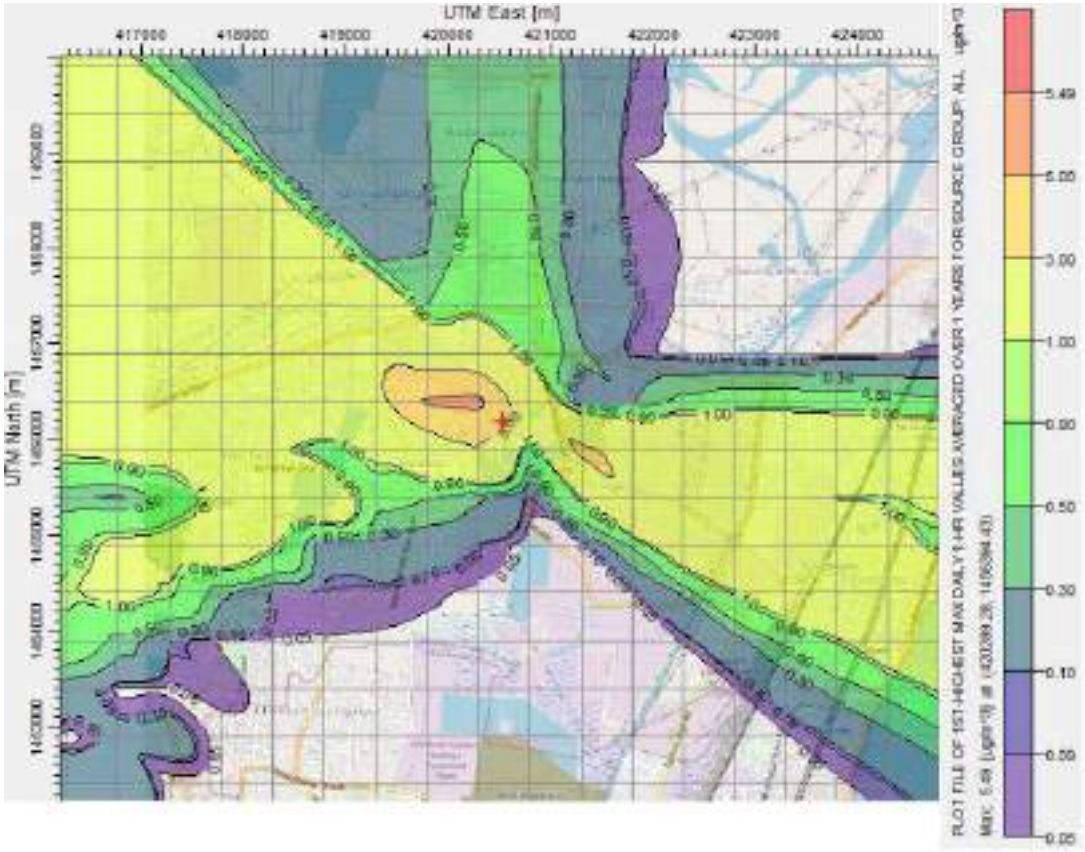
STACK EMISSION DISPERSION MODELLING – Stack - 205F2 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
11	0.91	2.44	0.92	0.0667

Stack – 205F2 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.44µg/m3 at 2km dispersion Carbon Monoxide is 0.92µg/m3 and at 5km dispersion Carbon Monoxide is 0.0667µg/m3 and the predominant wind direction is ESE.

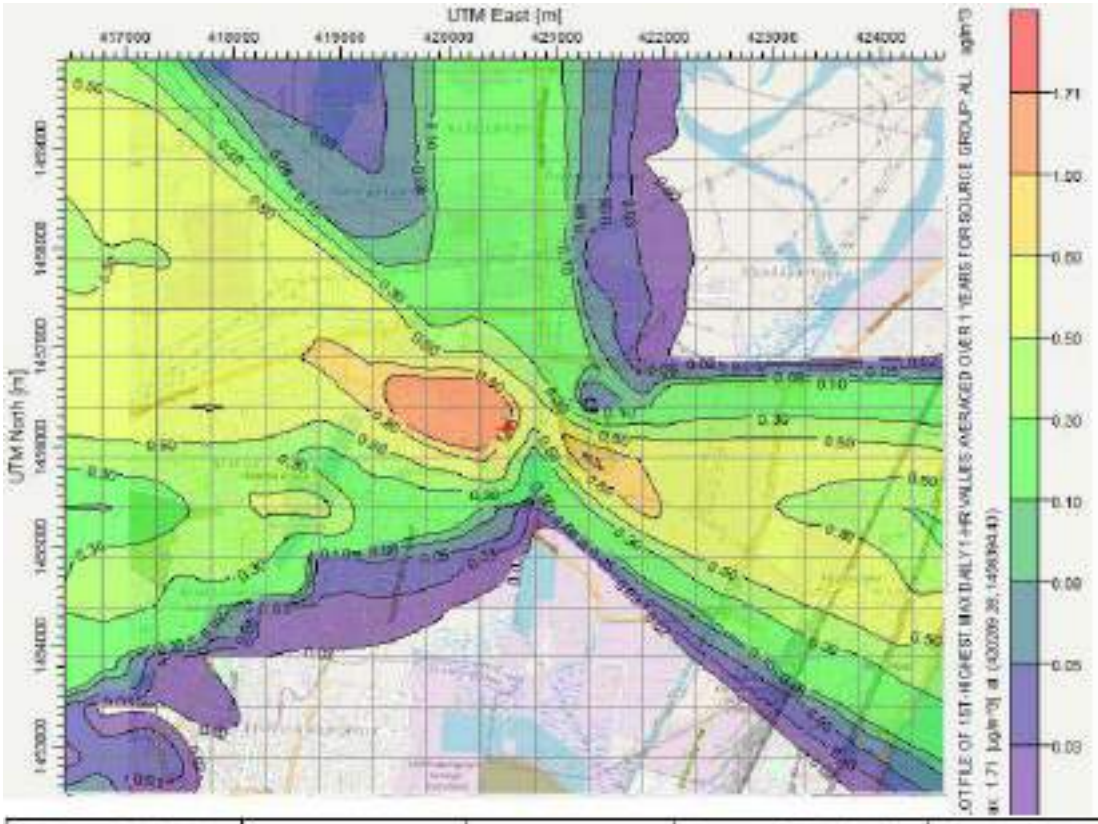
STACK EMISSION DISPERSION MODELLING – Stack - 205F2 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
24.9	0.89	5.49	1.05	0.0132

Stack – 205F2 emission of Particulate matter concentration is 24.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 5.49µg/m3 at 2km dispersion Particulate matter is 1.05µg/m3 and at 5km dispersion Particulate matter is 0.0132µg/m3 and the predominant wind direction is ESE.

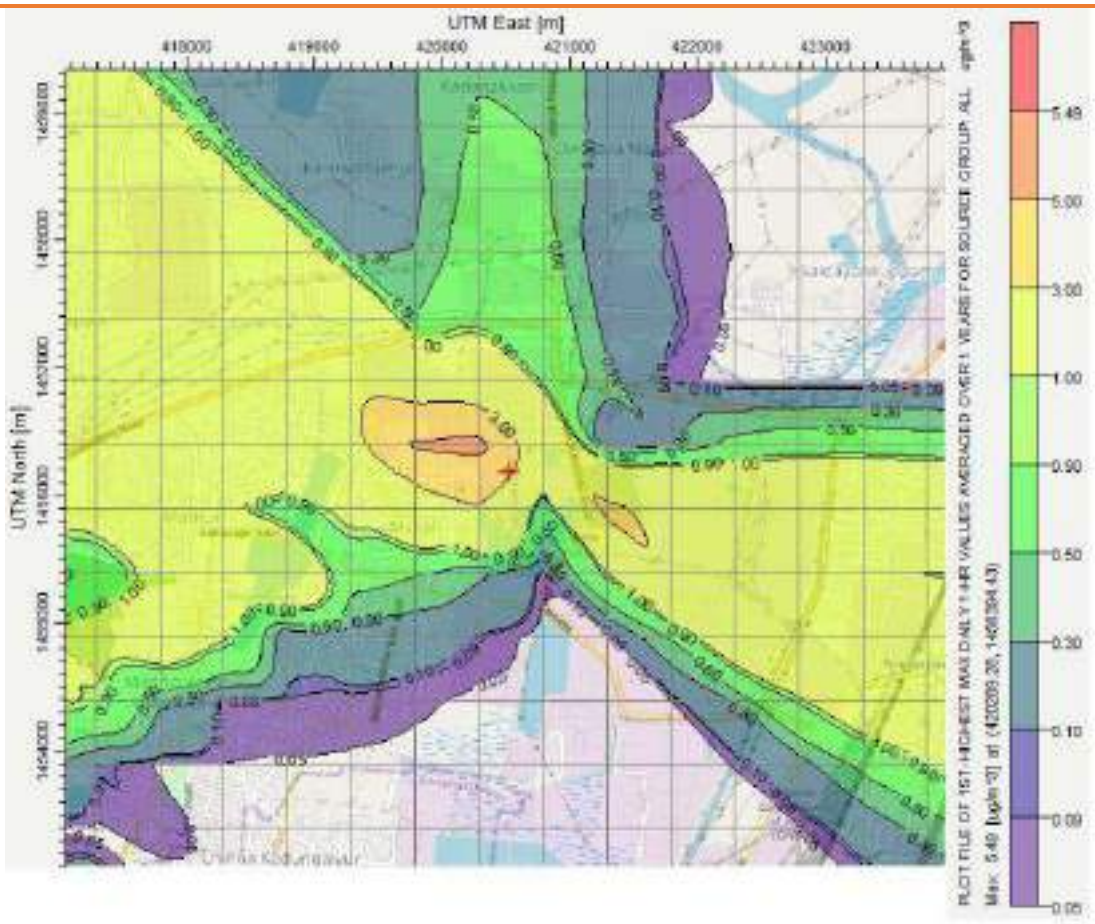
STACK EMISSION DISPERSION MODELLING – Stack - 205F2 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7.7	0.65	1.71	0.89	0.064

Stack – 205F2 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.65km at the concentration of 1.71µg/m3 at 2km dispersion Sulphur dioxide is 0.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.064µg/m3 and the predominant wind direction is ESE.

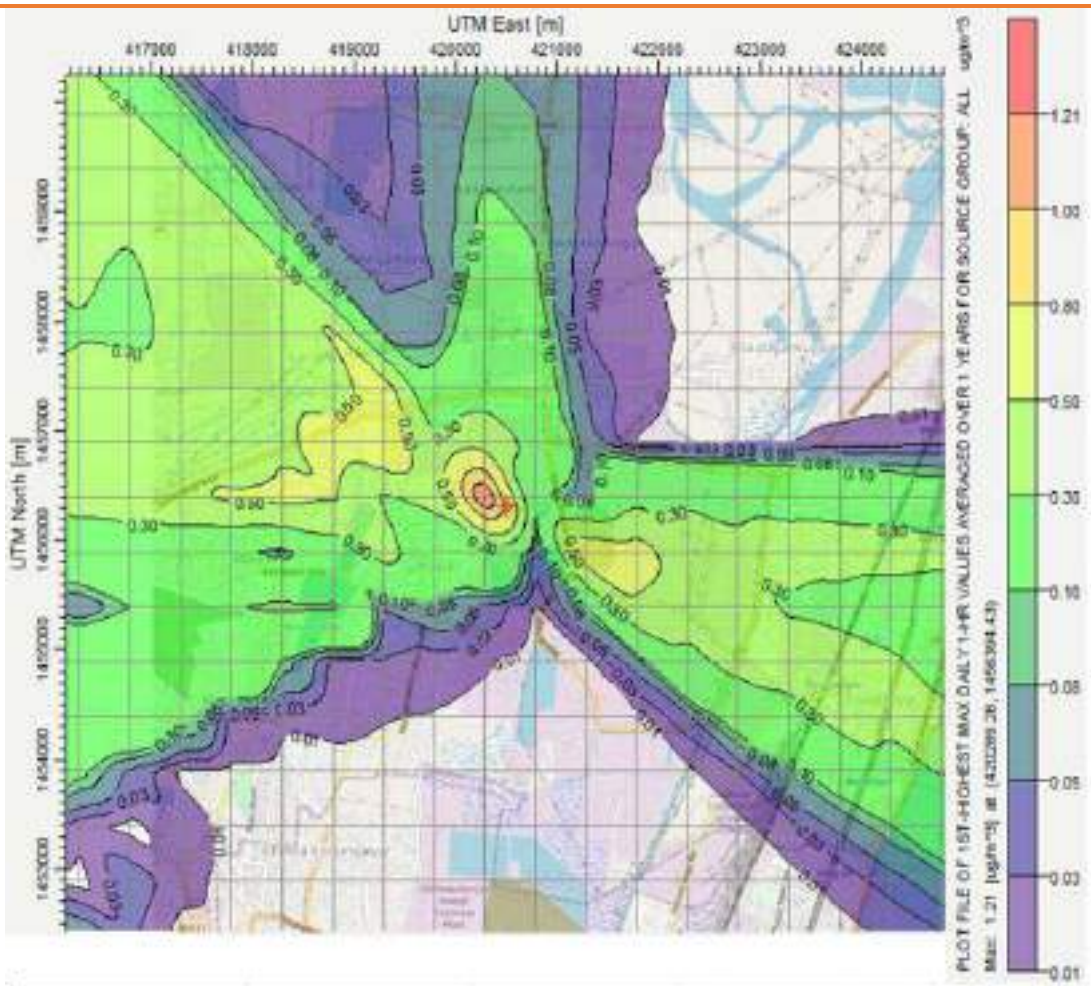
STACK EMISSION DISPERSION MODELLING – Stack - 205F2 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
25	0.88	5.49	0.43	0.0792

Stack – 205F2 emission of Oxides of Nitrogen concentration is 25.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 5.49µg/m3 at 2km dispersion Oxides of Nitrogen is 0.43µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0792µg/m3 and the predominant wind direction is ESE.

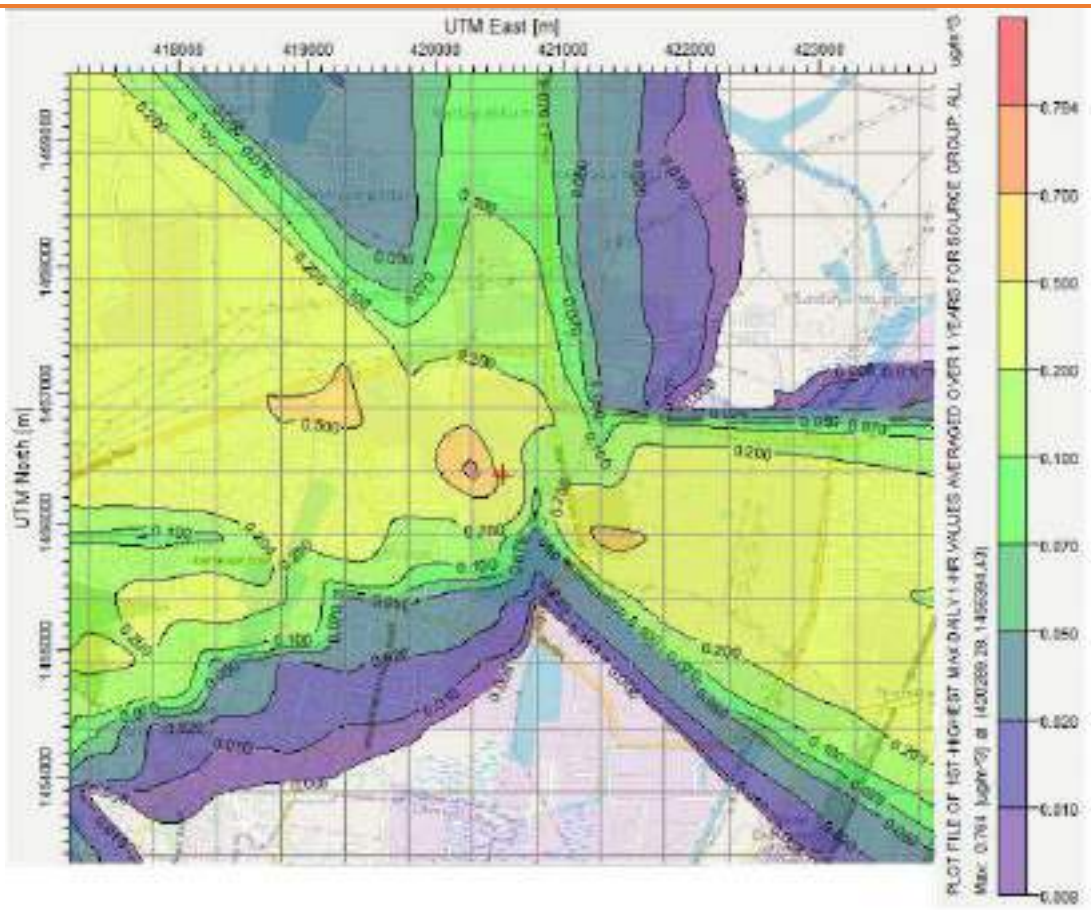
STACK EMISSION DISPERSION MODELLING – Stack - 206F1-F2 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
23	0.78	1.21	0.45	0.0697

Stack – 206F1-F2 emission of Carbon Monoxide concentration is 23.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.0697µg/m3 and the predominant wind direction is ESE.

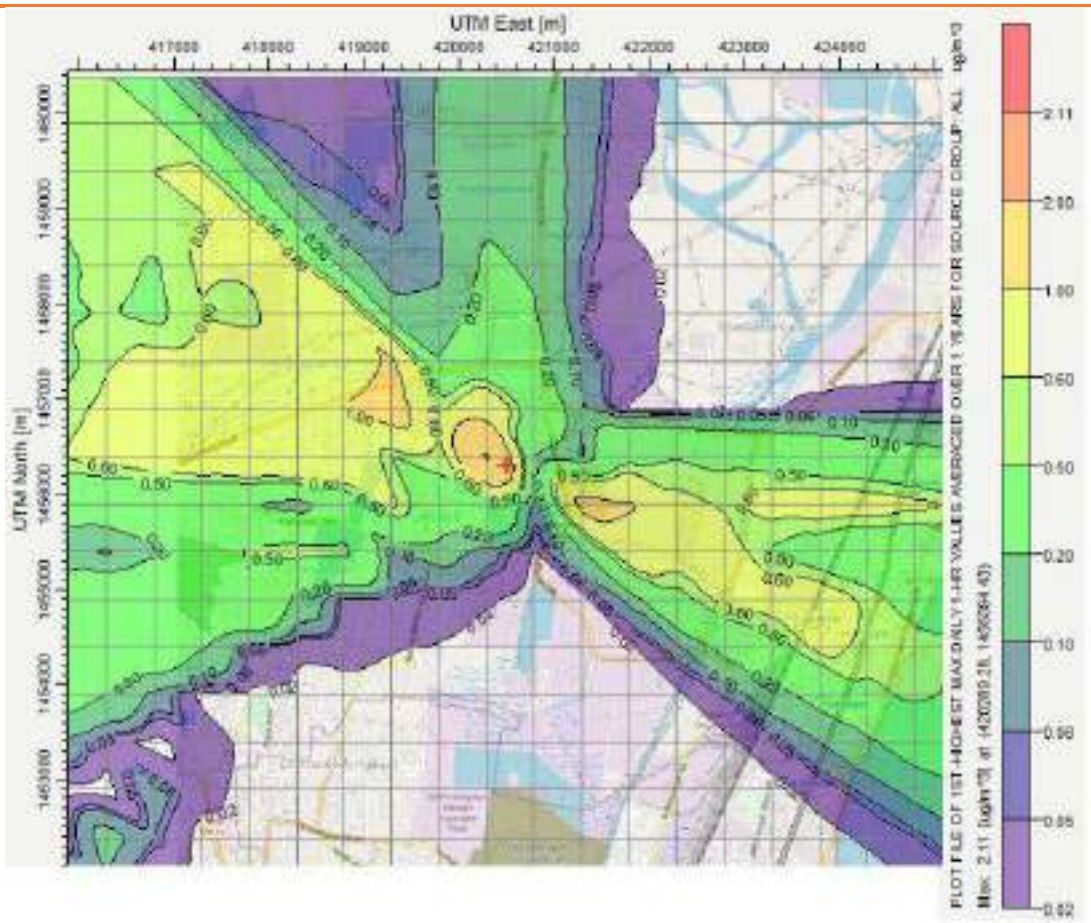
STACK EMISSION DISPERSION MODELLING – Stack - 206F1-F2 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
15.8	0.9	0.764	0.12	0.097

Stack – 206F1-F2 emission of Particulate matter concentration is 15.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 0.764µg/m3 at 1km dispersion Particulate matter is 0.12µg/m3 and at 2km dispersion Particulate matter is 0.097µg/m3 and the predominant wind direction is ESE

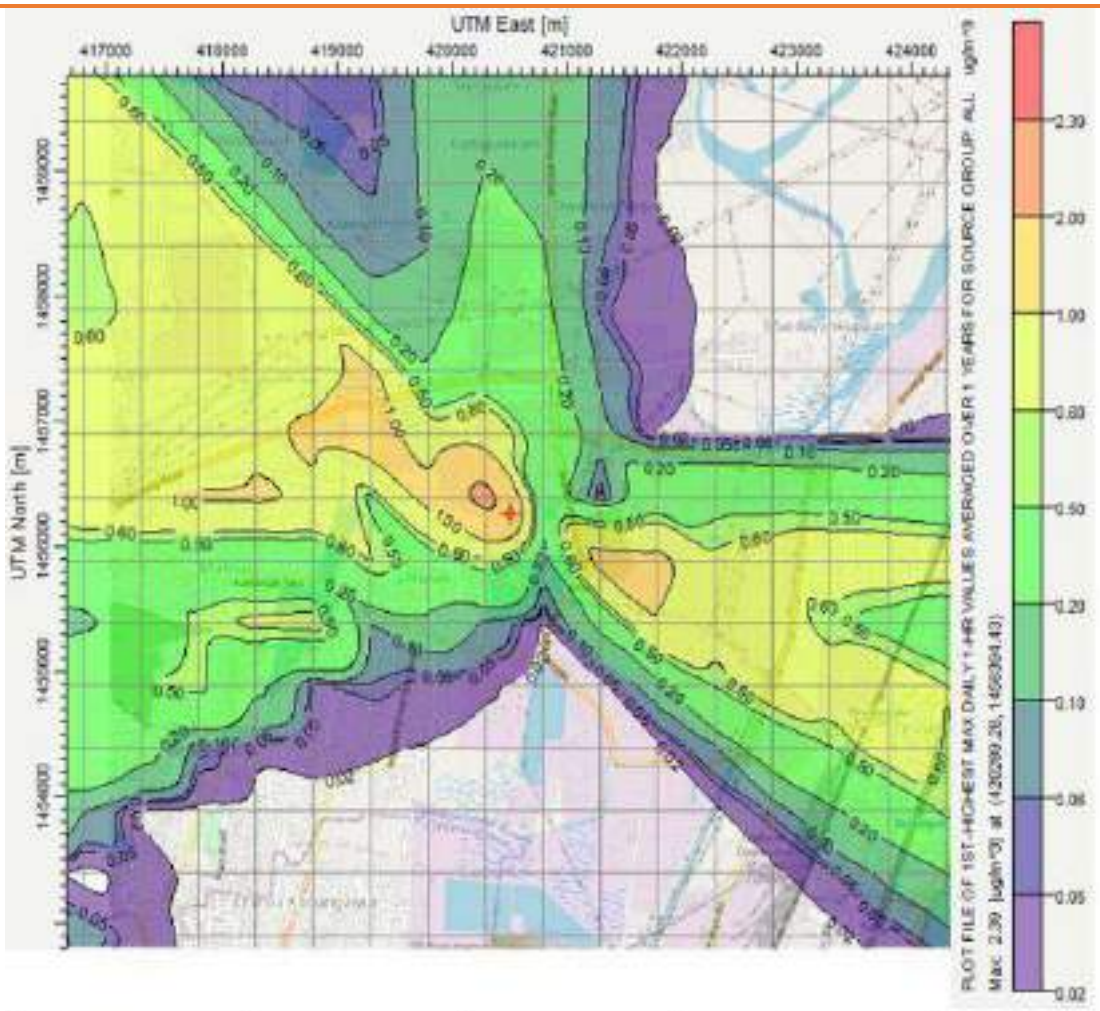
STACK EMISSION DISPERSION MODELLING – Stack - 206F1-F2 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
259	0.81	2.11	0.765	0.0911

Stack – 206F1-F2 emission of Sulphur dioxide concentration is 259mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.765µg/m3 and at 5km dispersion Sulphur dioxide is 0.0911µg/m3 and the predominant wind direction is ESE.

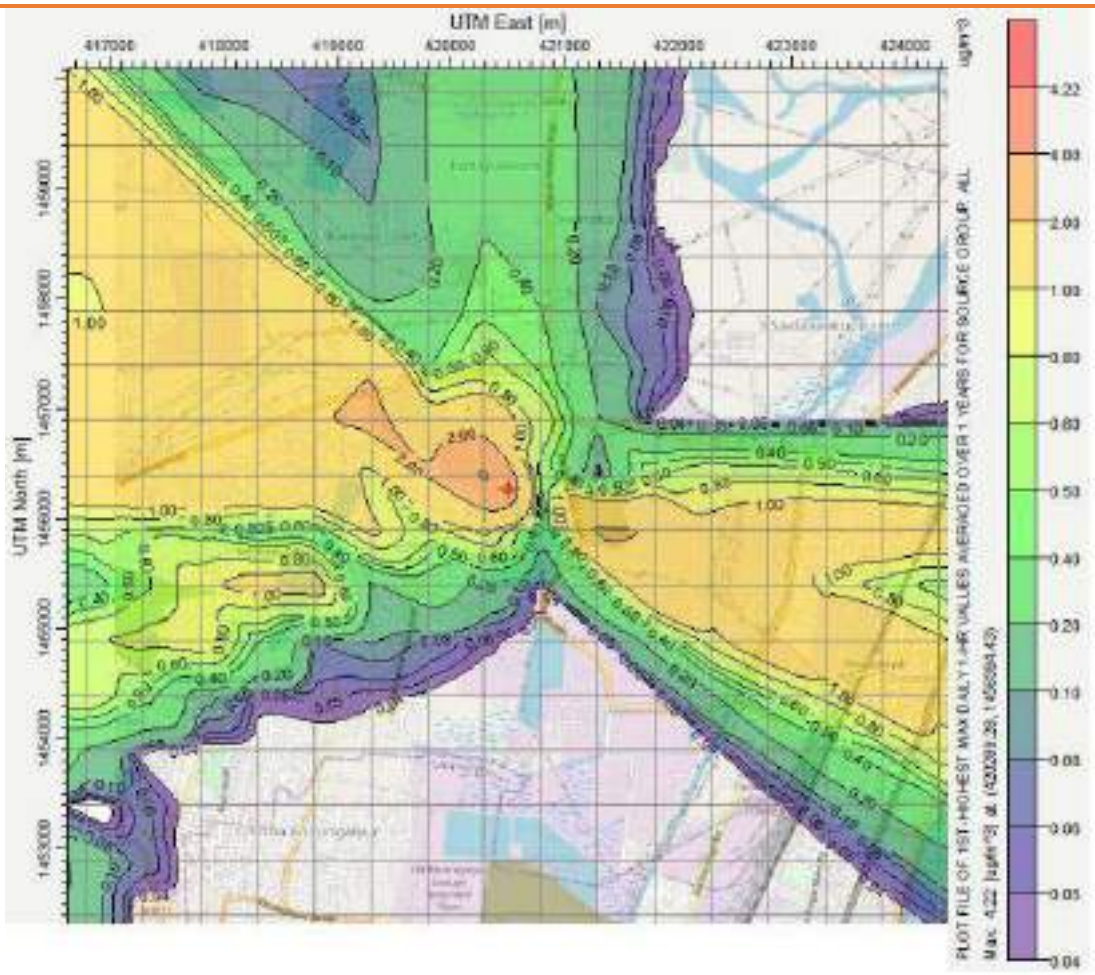
STACK EMISSION DISPERSION MODELLING – Stack - 206F1-F2 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
217	0.9	2.39	0.875	0.0522

Stack – 206F1-F2 emission of Oxides of Nitrogen concentration is 217mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.875µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0522µg/m3 and the predominant wind direction is ESE.

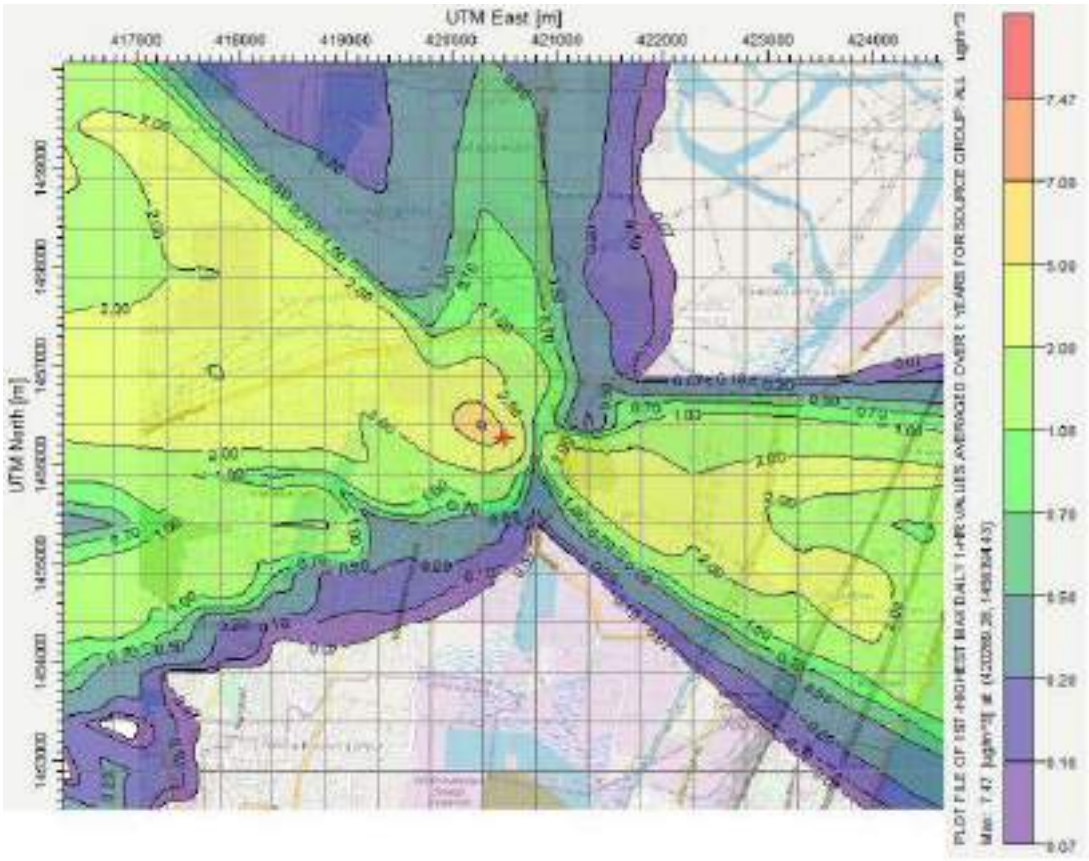
STACK EMISSION DISPERSION MODELLING – Stack - 206F3-F6 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
49	0.98	4.22	0.621	0.022

Stack – 206F3-F6 emission of Carbon Monoxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 4.22µg/m3 at 2km dispersion Carbon Monoxide is 0.621µg/m3 and at 5km dispersion Carbon Monoxide is 0.022µg/m3 and the predominant wind direction is ESE.

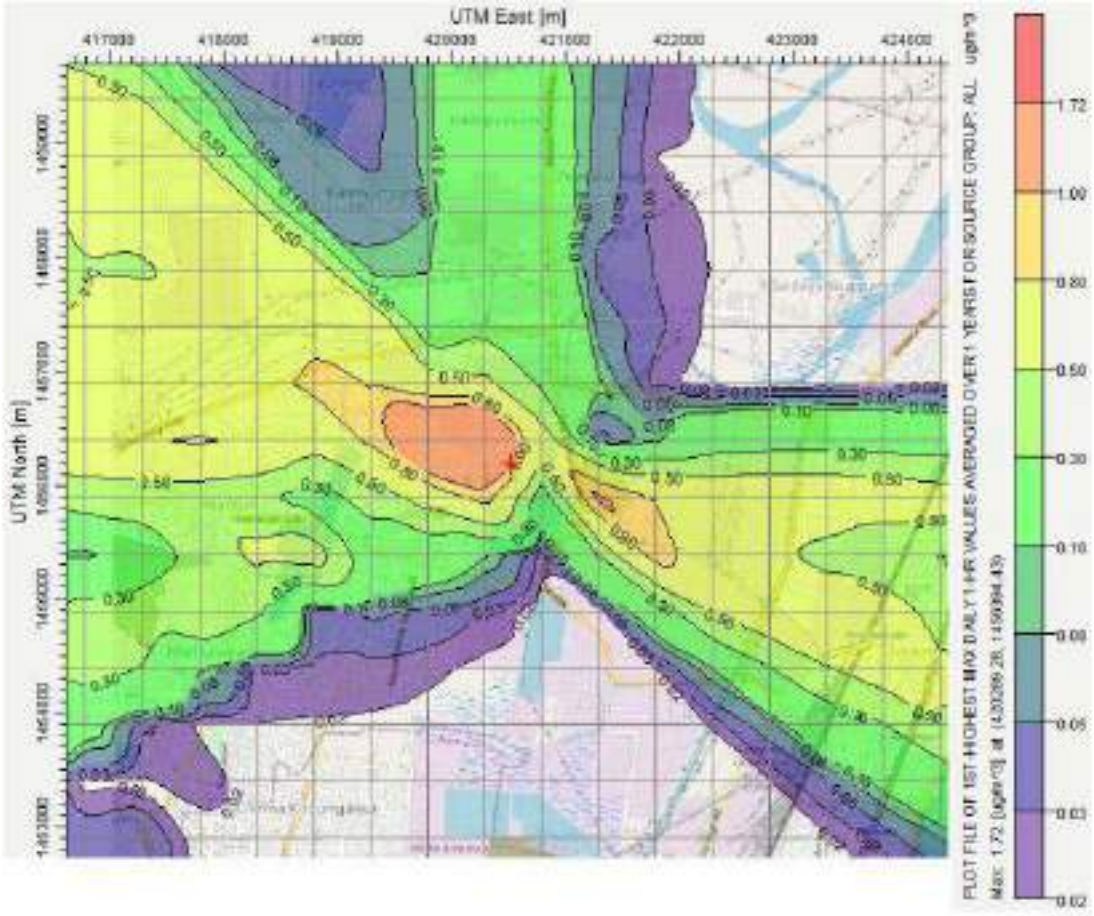
STACK EMISSION DISPERSION MODELLING – Stack - 206F3-F6 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
84.4	0.87	7.47	0.841	0.0941

Stack – 206F3-F6 emission of Sulphur dioxide concentration is 84.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 7.47µg/m3 at 2km dispersion Sulphur dioxide is 0.841µg/m3 and at 5km dispersion Sulphur dioxide is 0.0941µg/m3 and the predominant wind direction is ESE.

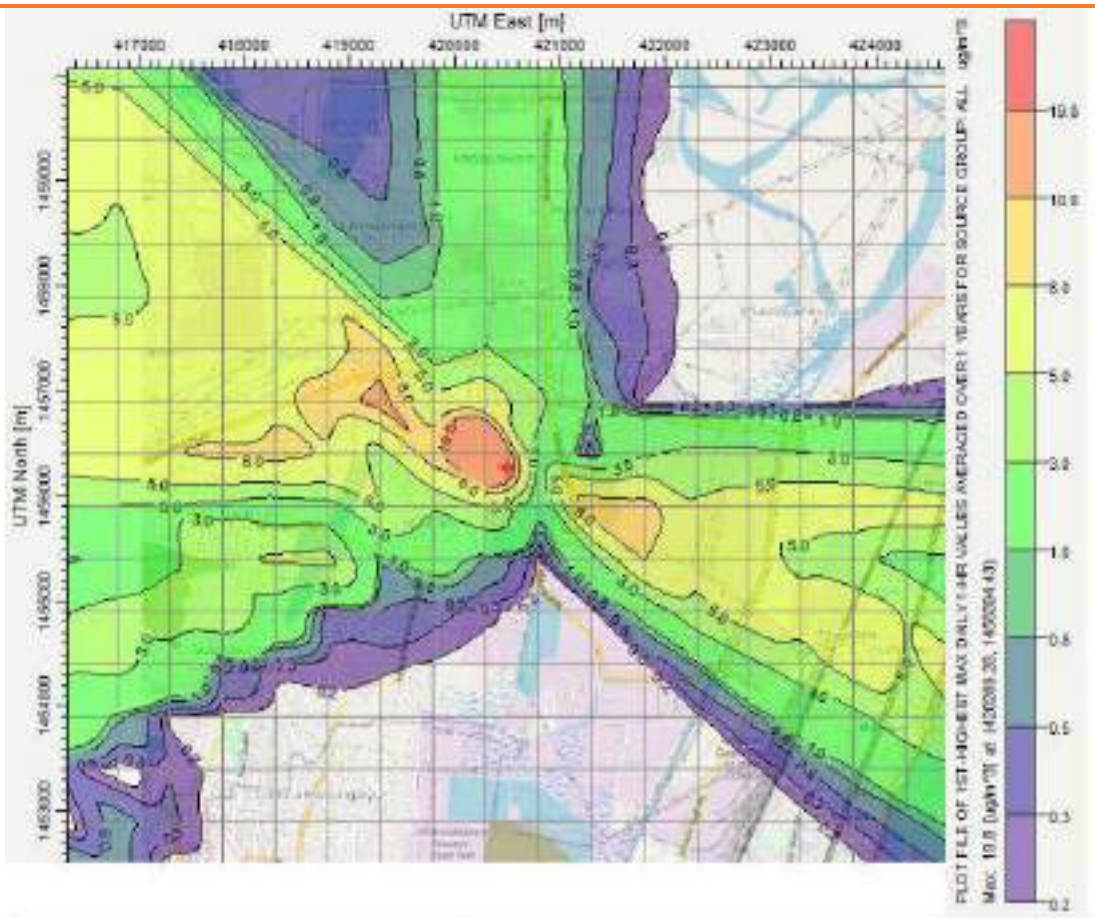
STACK EMISSION DISPERSION MODELLING – Stack - 206F3-F6 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.8	0.79	1.72	0.89	0.0567

Stack – 206F3-F6 emission of Particulate matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 1.72µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.0567µg/m3 and the predominant wind direction is ESE.

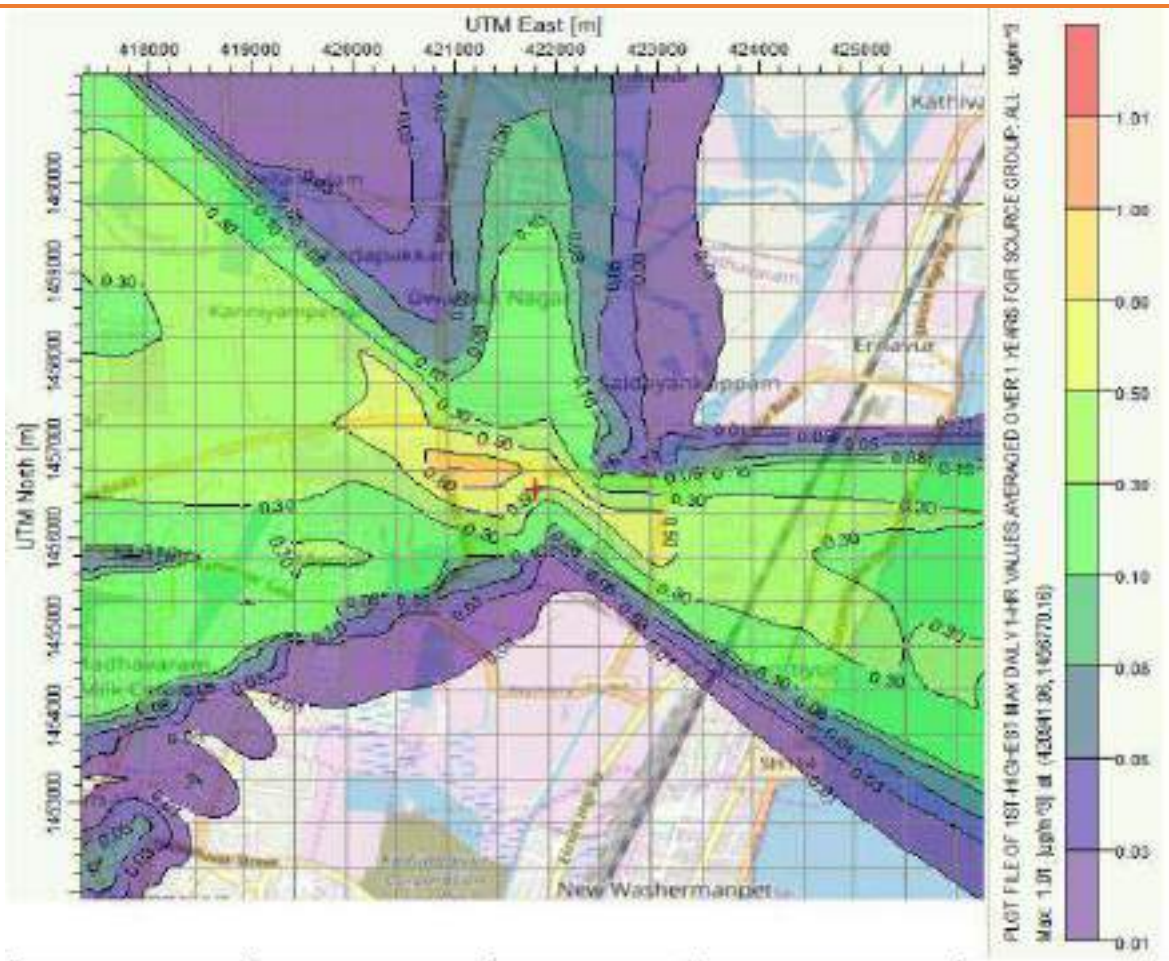
STACK EMISSION DISPERSION MODELLING – Stack - 206F3-F6 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
230	0.8	19.8	1.87	0.126

Stack – 206F3-F6 emission of Oxides of Nitrogen concentration is 230mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 19.8µg/m3 at 2km dispersion Oxides of Nitrogen is 1.87µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.126µg/m3 and the predominant wind direction is ESE.

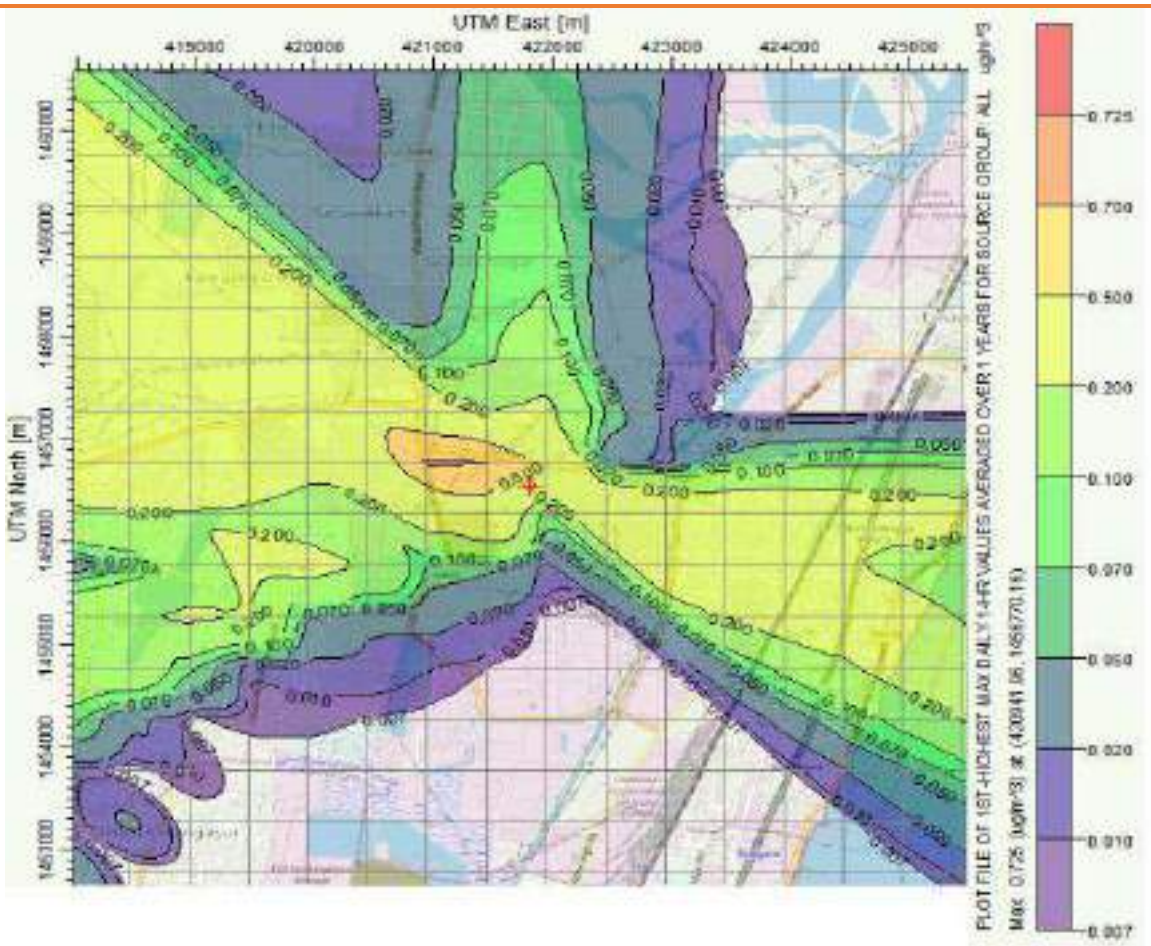
STACK EMISSION DISPERSION MODELLING – Stack – 207 F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
13	0.793	1.01	0.14	0.0641

Stack – 207F1 emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.793km at the concentration of 1.01µg/m3 at 2km dispersion Carbon Monoxide is 0.14µg/m3 and at 5km dispersion Carbon Monoxide is 0.0641µg/m3 and the predominant wind direction is ESE.

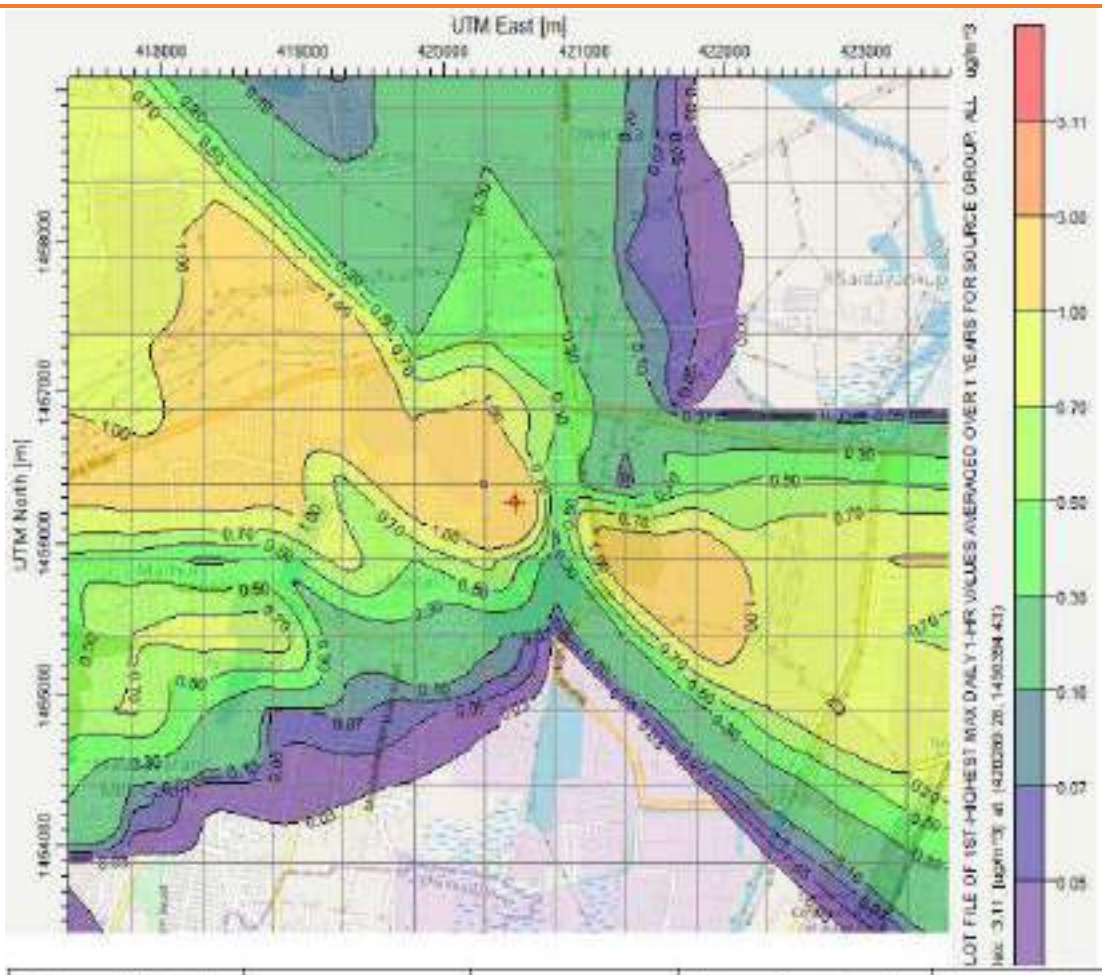
STACK EMISSION DISPERSION MODELLING – Stack – 207 F1 @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.3	0.879	0.725	0.086	0.0043

Stack – 207F1 emission of Particulate matter concentration is 9.3mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.879km at the concentration of 0.725µg/m3 at 2km dispersion Particulate matter is 0.086µg/m3 and at 5km dispersion Particulate matter is 0.0043µg/m3 and the predominant wind direction is ESE.

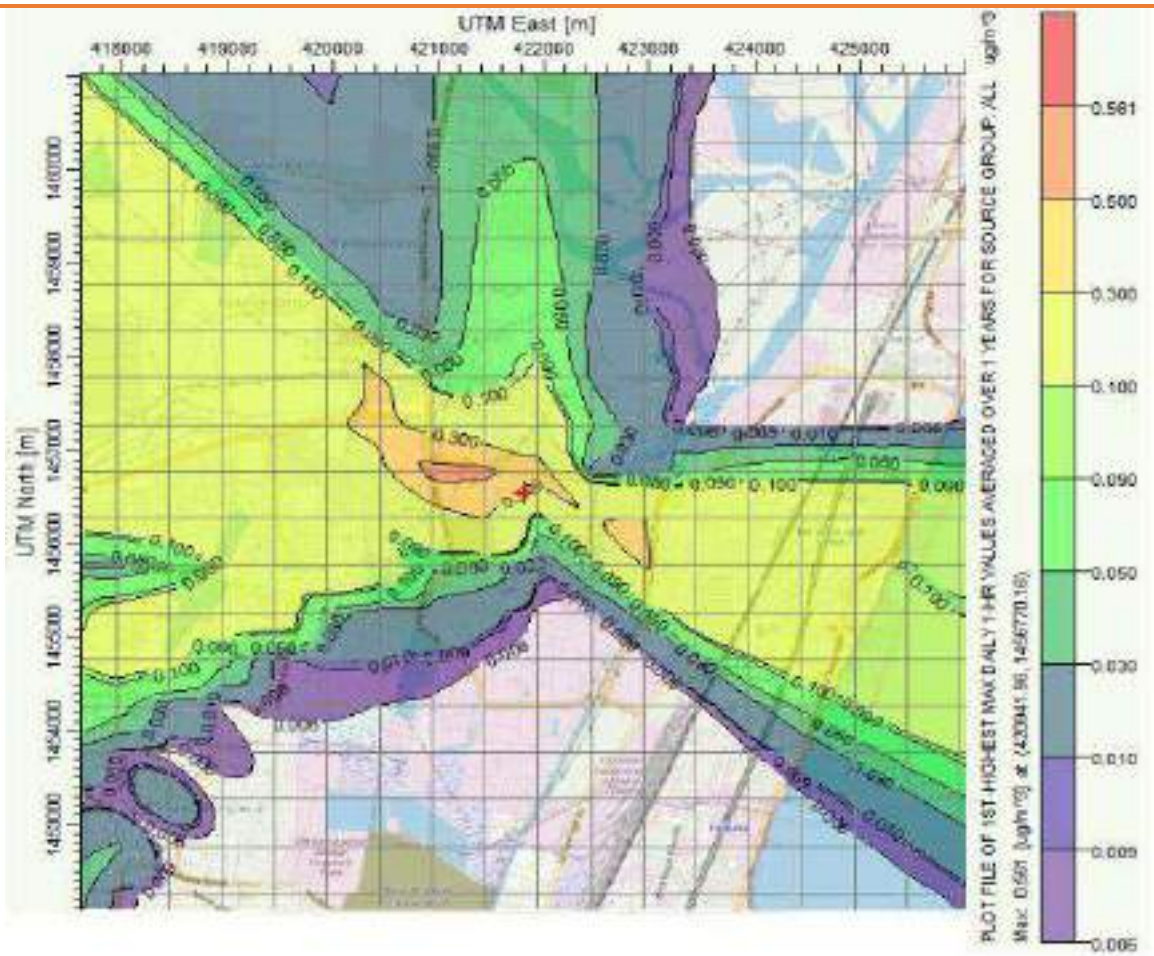
STACK EMISSION DISPERSION MODELLING – Stack – 207 F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
31	0.77	3.11	0.42	0.0314

Stack – 207F1 emission of Oxides of Nitrogen concentration is 31mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 3.11µg/m3 at 2km dispersion Oxides of Nitrogen is 0.42µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0314µg/m3 and the predominant wind direction is ESE.

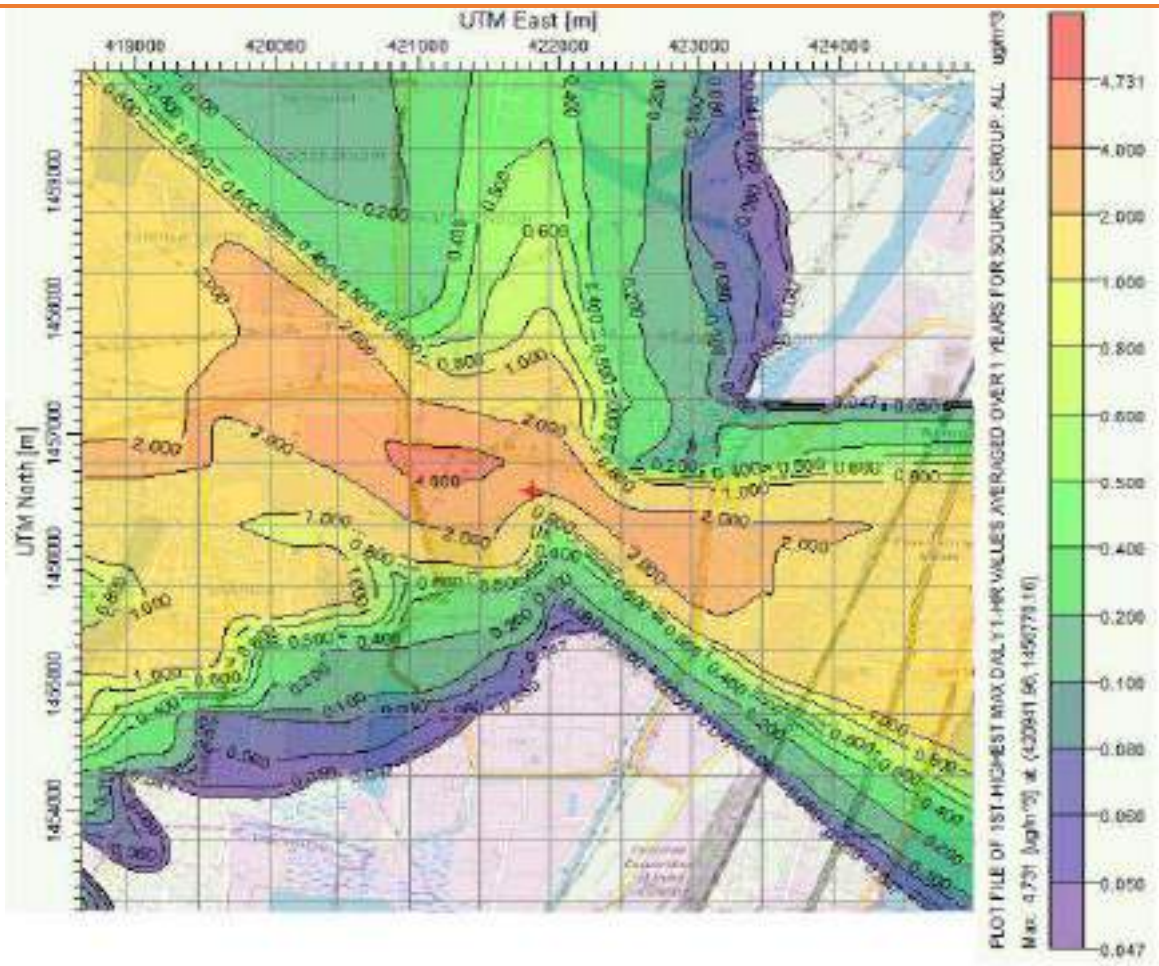
STACK EMISSION DISPERSION MODELLING – Stack – 207 F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7.7	0.824	0.561	0.0431	0.00856

Stack – 207F1 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.824km at the concentration of 0.561µg/m3 at 2km dispersion Sulphur dioxide is 0.0431µg/m3 and at 5km dispersion Sulphur dioxide is 0.00856µg/m3 and the predominant wind direction is ESE.

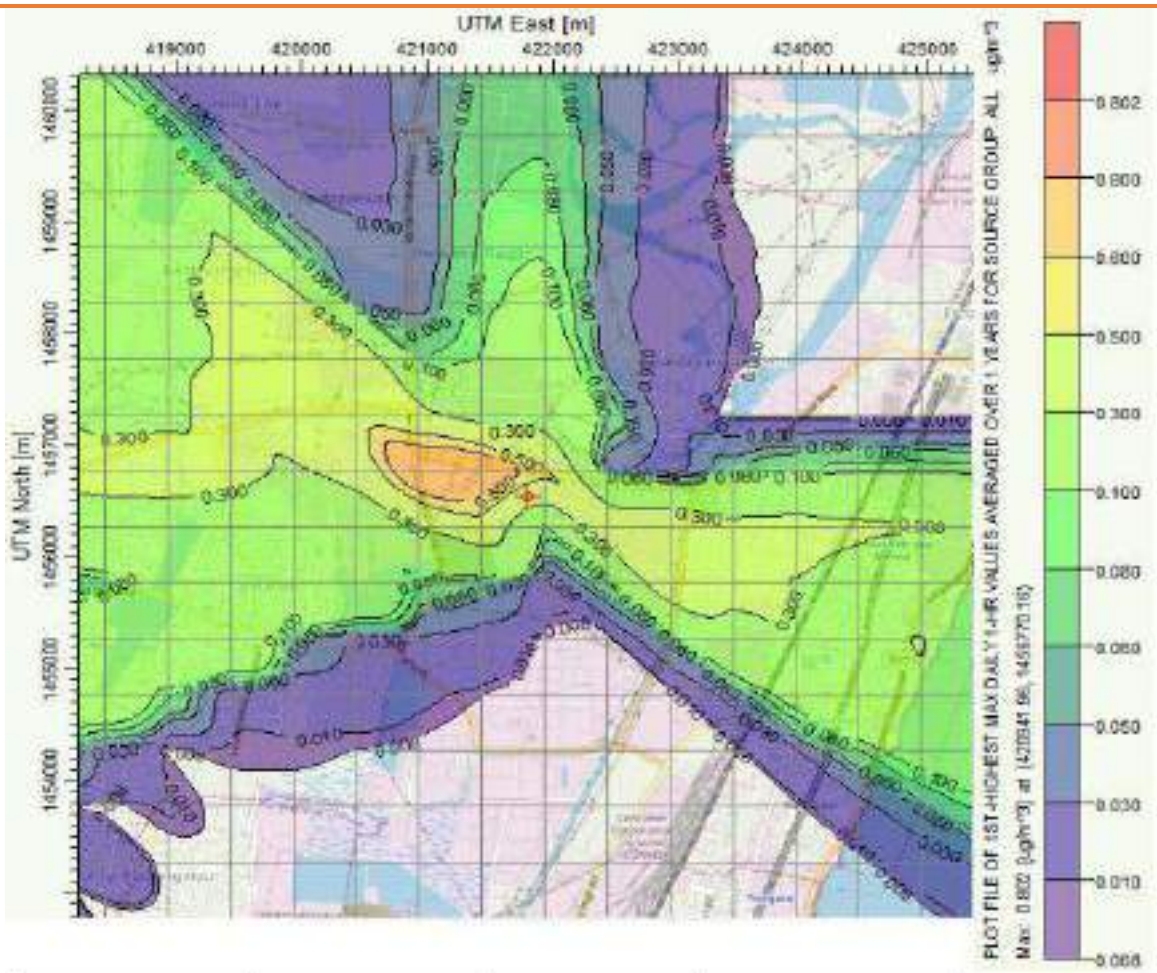
STACK EMISSION DISPERSION MODELLING – Stack – 212 F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
54	1.57	4.731	0.681	0.8654

Stack – 212F1 emission of Carbon Monoxide concentration is 54mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.57km at the concentration of 4.731µg/m3 at 2km dispersion Carbon Monoxide is 0.681µg/m3 and at 5km dispersion Carbon Monoxide is 0.8654µg/m3 and the predominant wind direction is ESE.

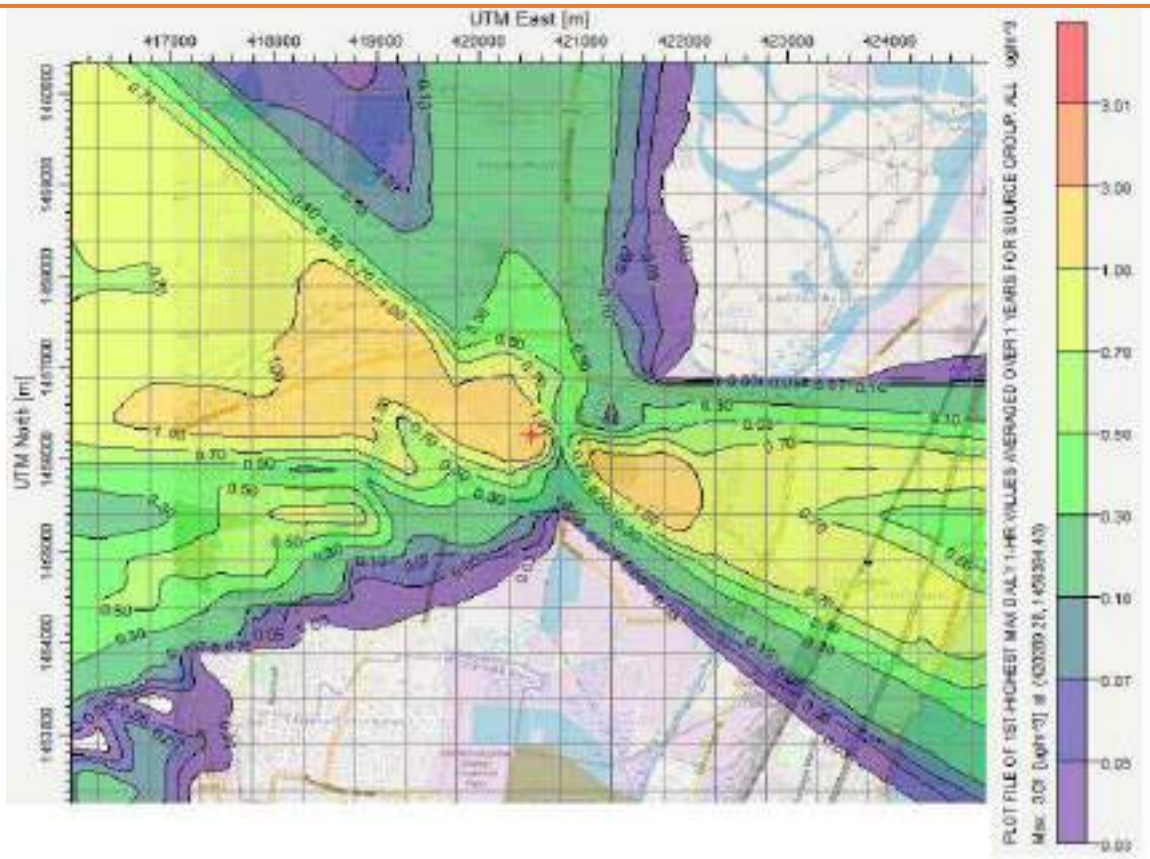
STACK EMISSION DISPERSION MODELLING – Stack – 212 F1 @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
8.9	0.86	0.802	0.0766	0.00599

Stack – 212F1 emission of Particulate matter concentration is 8.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 0.802µg/m3 at 2km dispersion Particulate matter is 0.0766µg/m3 and at 5km dispersion Particulate matter is 0.00599µg/m3 and the predominant wind direction is ESE.

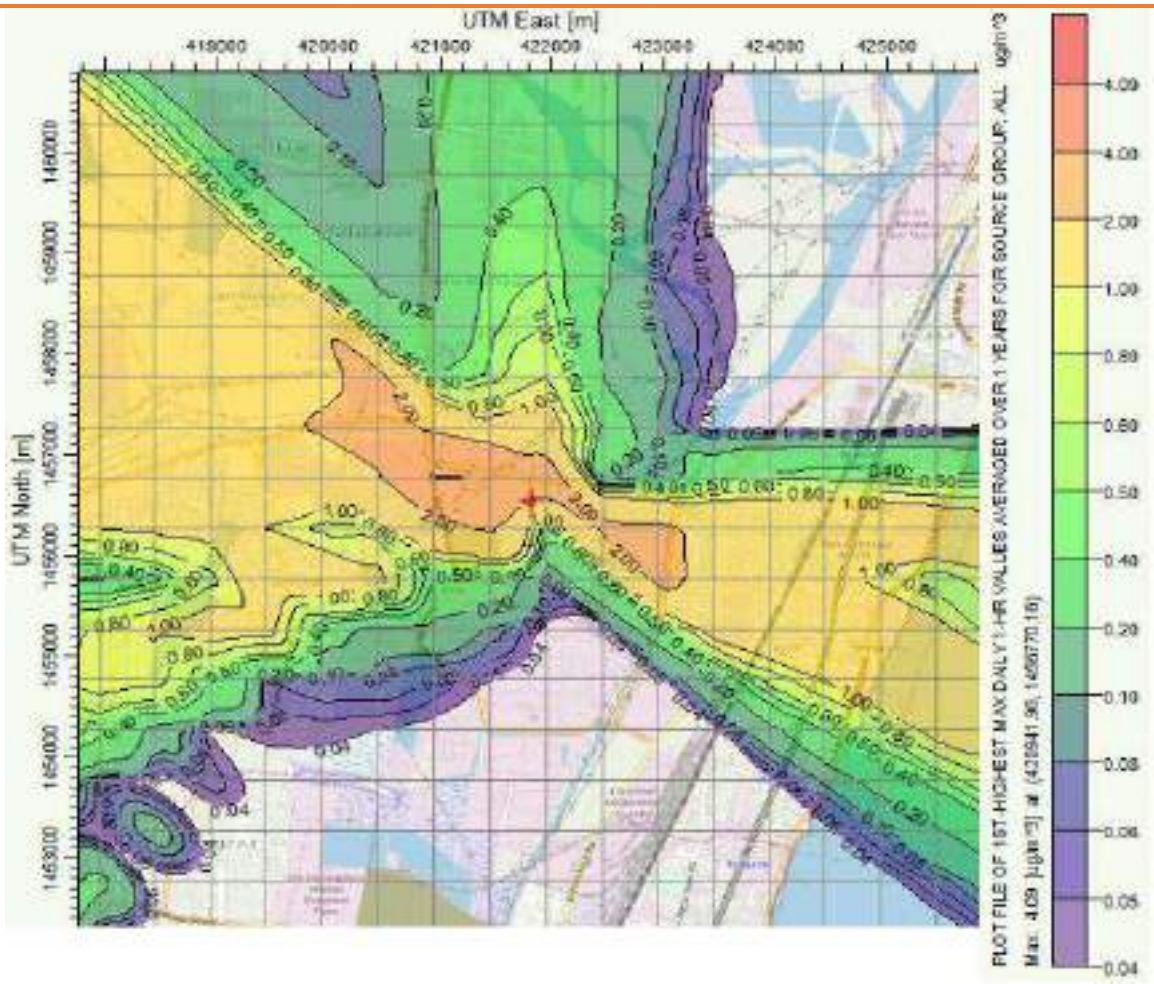
STACK EMISSION DISPERSION MODELLING – Stack – 212 F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
27	0.86	3.01	1.03	0.0929

Stack – 212F1 emission of Oxides of Nitrogen concentration is 27mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 3.01µg/m3 at 2km dispersion Oxides of Nitrogen is 1.03µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0929µg/m3 and the predominant wind direction is ESE.

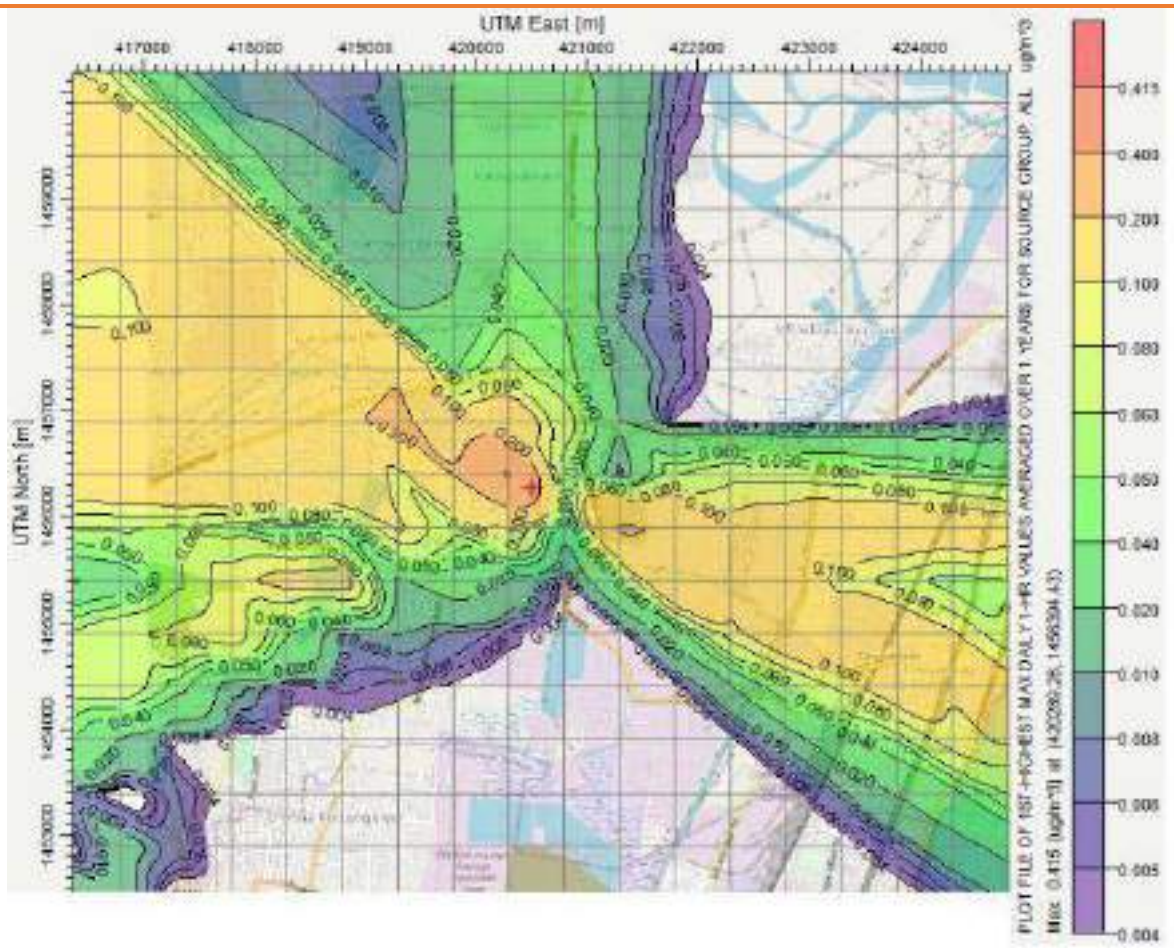
STACK EMISSION DISPERSION MODELLING – Stack – 212 F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
47	0.91	4.09	0.261	0.07867

Stack – 212F1 emission of Sulphur dioxide concentration is 47mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.09µg/m3 at 2km dispersion Sulphur dioxide is 0.261µg/m3 and at 5km dispersion Sulphur dioxide is 0.07867µg/m3 and the predominant wind direction is ESE.

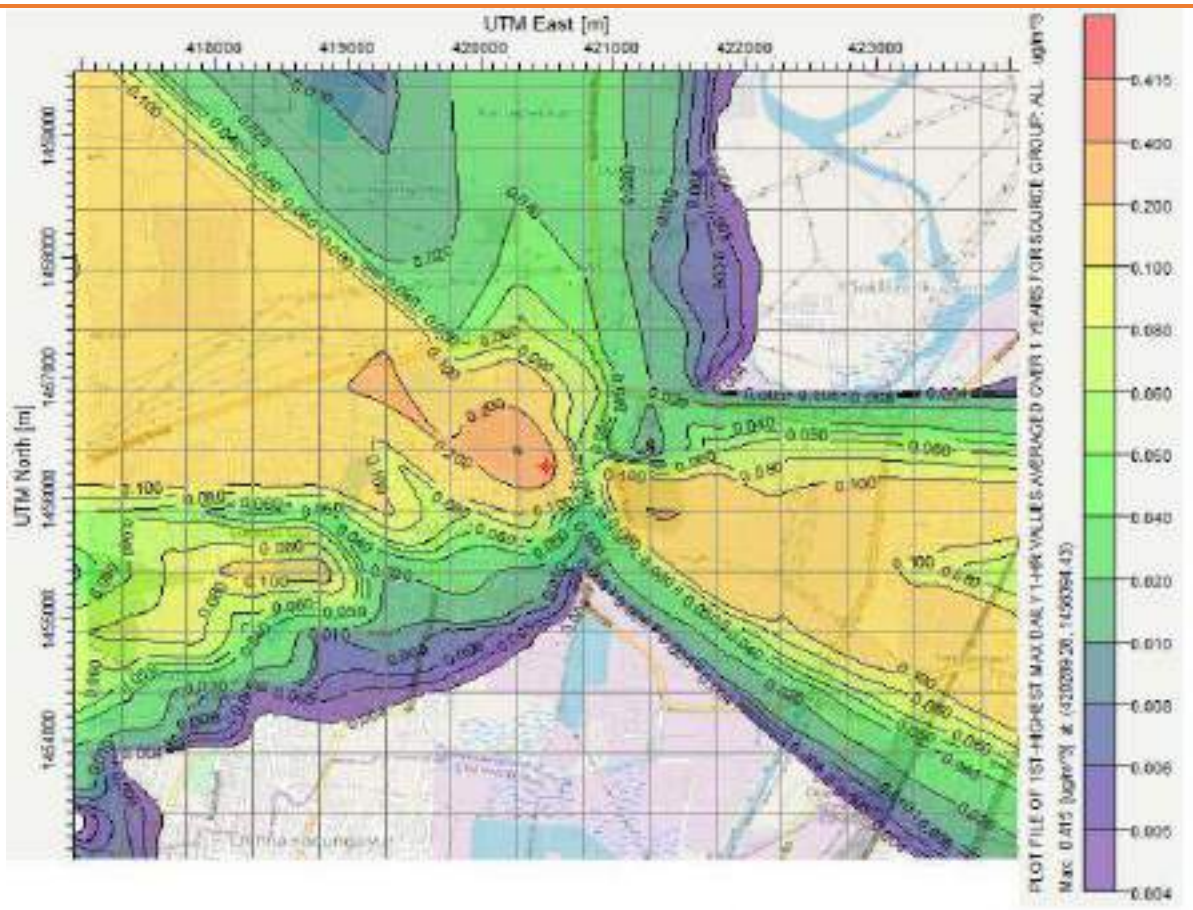
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
2	0.61	0.415	0.055	0.0097

Stack – Gas Turbin-1 emission of Carbon Monoxide concentration is 2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.61km at the concentration of 0.415µg/m3 at 2km dispersion Carbon Monoxide is 0.055µg/m3 and at 5km dispersion Carbon Monoxide is 0.0097µg/m3 and the predominant wind direction is ESE.

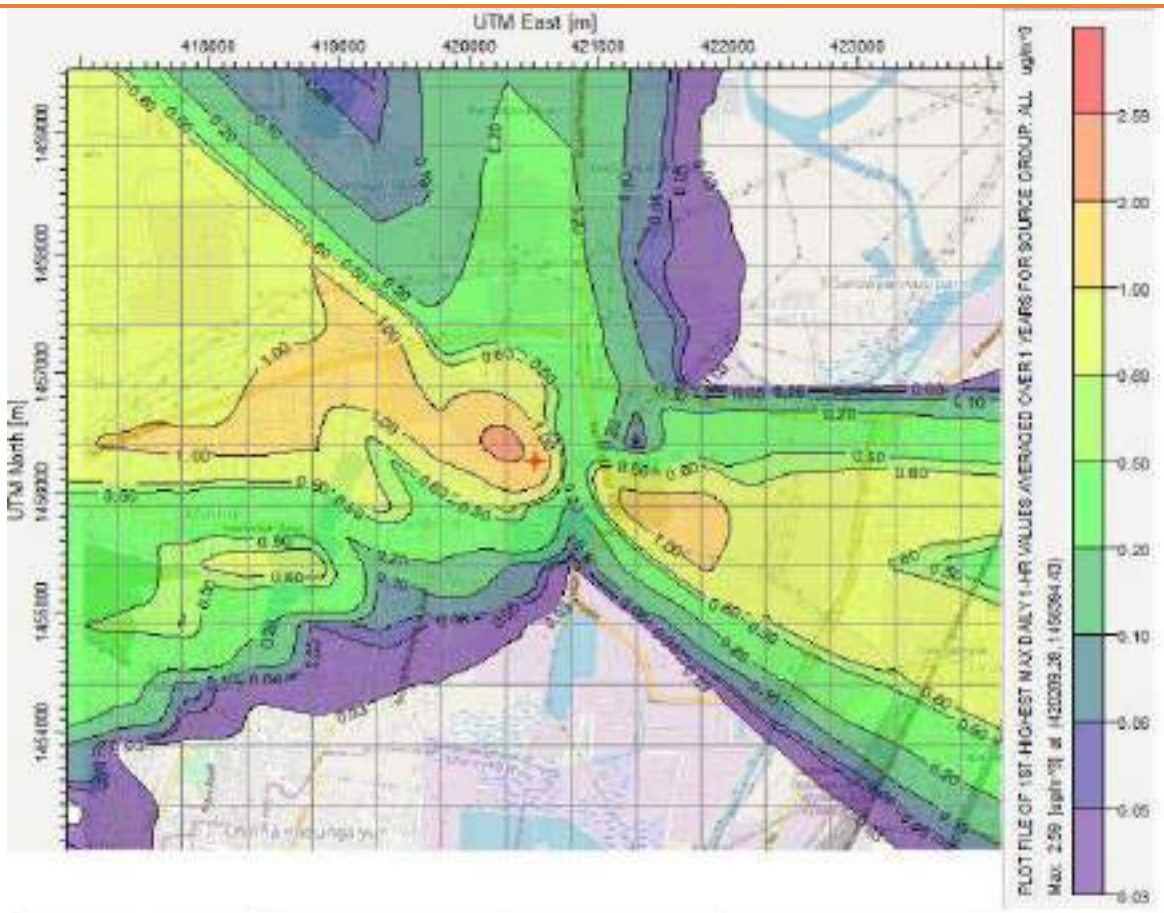
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-1 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
28.2	0.7	0.415	0.0735	0.0872

Stack – Gas Turbin-1 emission of Particulate Matter concentration is 28.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 0.415µg/m3 at 2km dispersion Particulate Matter is 0.0735µg/m3 and at 5km dispersion Particulate Matter is 0.0872µg/m3 and the predominant wind direction is ESE.

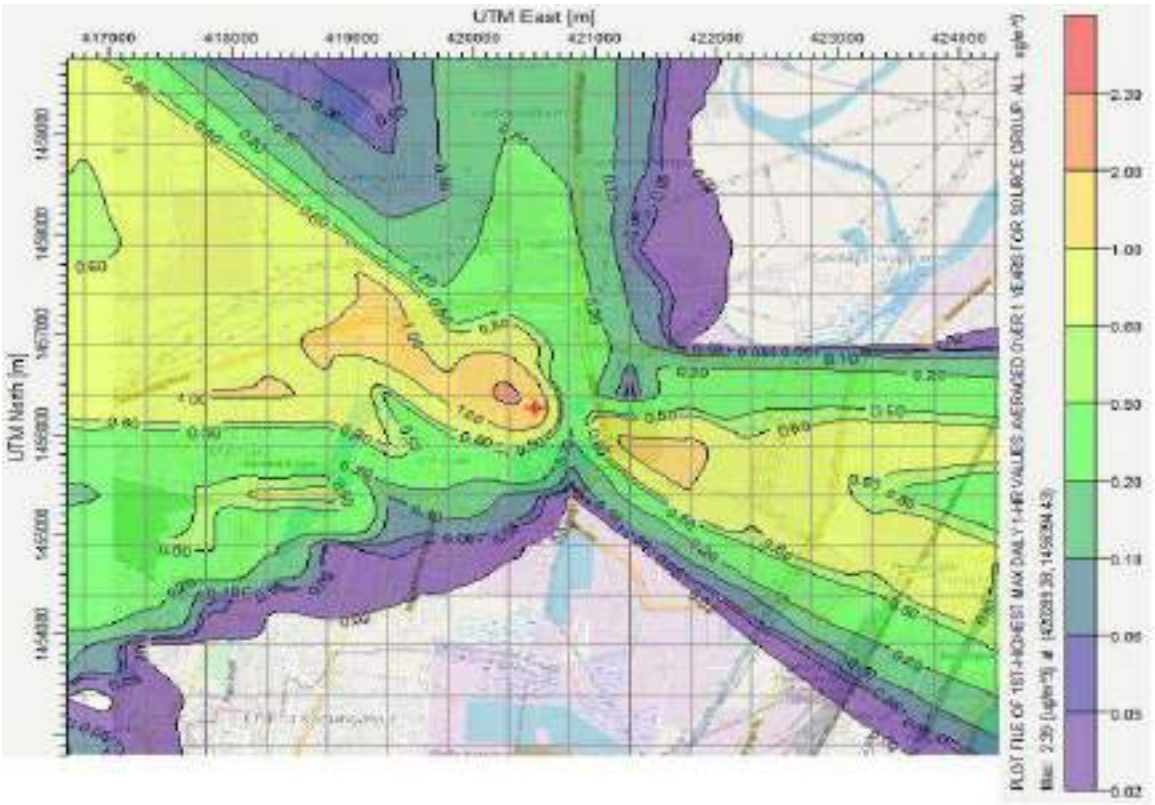
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
12.9	0.69	2.59	0.71	0.088

Stack – Gas Turbin-1 emission of Sulphur dioxide concentration is 12.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 2.59µg/m3 at 2km dispersion Sulphur dioxide is 0.71µg/m3 and at 5km dispersion Sulphur dioxide is 0.088µg/m3 and the predominant wind direction is ESE.

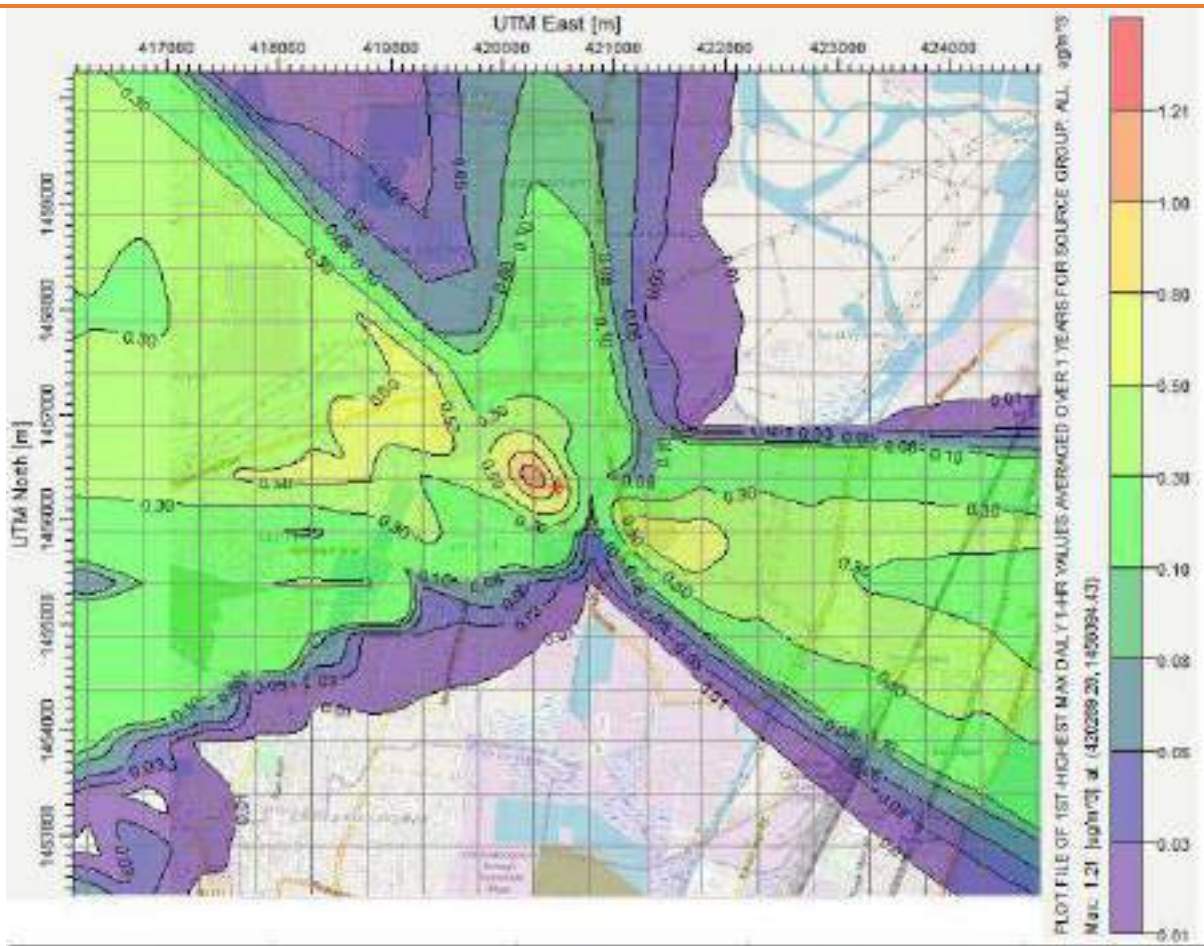
STACK EMISSION DISPERSION MODELLING – Stack Gas Turbin-1 @ 2 & 5KM – Oxides of Nitrogen (NO2)



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
12	0.83	2.39	0.13	0.0955

Stack – Gas Turbin-1 emission of Oxides of Nitrogen concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.13µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0955µg/m3 and the predominant wind direction is ESE.

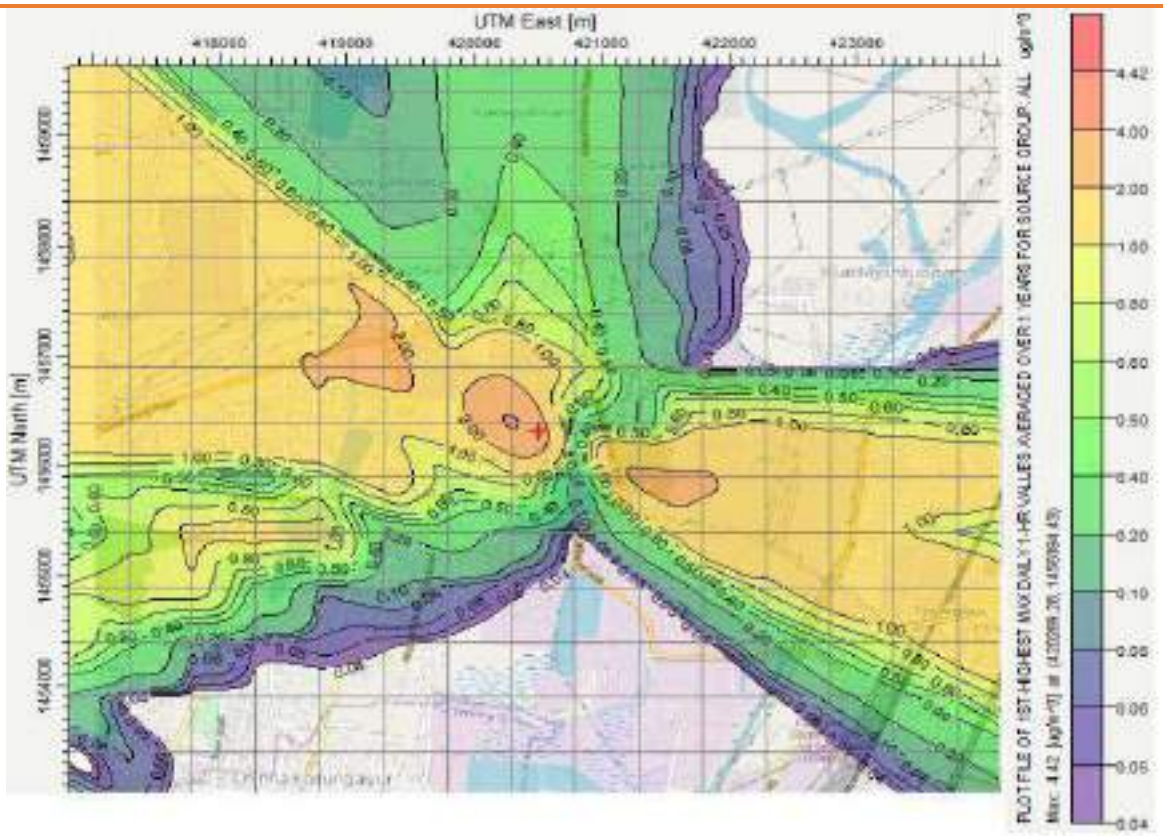
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-2 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
6	0.98	1.21	0.2	0.0785

Stack – Gas Turbin-2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.2µg/m3 and at 5km dispersion Carbon Monoxide is 0.0785µg/m3 and the predominant wind direction is ESE.

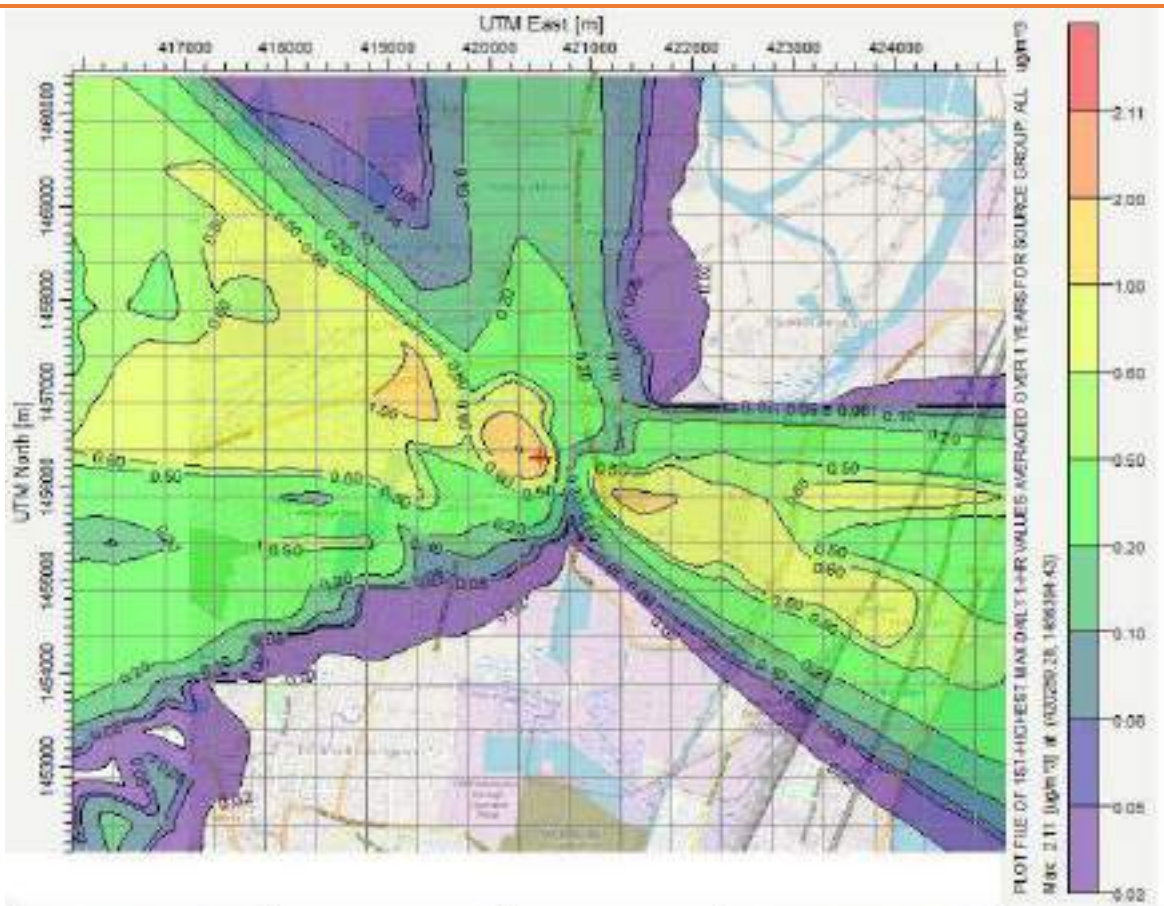
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-2 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
22.2	0.89	4.42	0.24	0.098

Stack – Gas Turbin-2 emission of Particulate Matter concentration is 22.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 4.42µg/m3 at 2km dispersion Particulate Matter is 0.24µg/m3 and at 5km dispersion Particulate Matter is 0.098µg/m3 and the predominant wind direction is ESE.

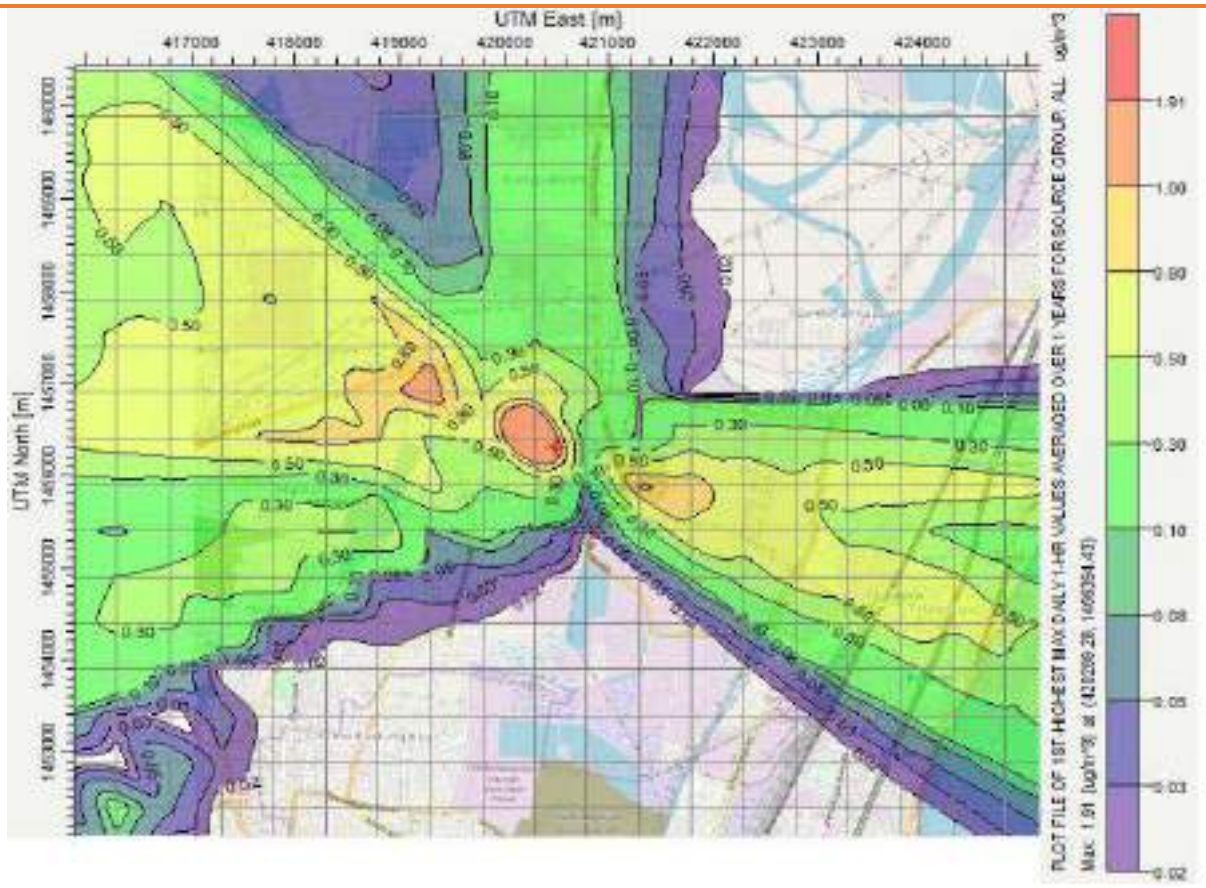
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-2 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
10.3	0.91	2.11	0.865	0.0351

Stack – Gas Turbin-2 emission of Sulphur dioxide concentration is 10.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.865µg/m3 and at 5km dispersion Sulphur dioxide is 0.0351µg/m3 and the predominant wind direction is ESE.

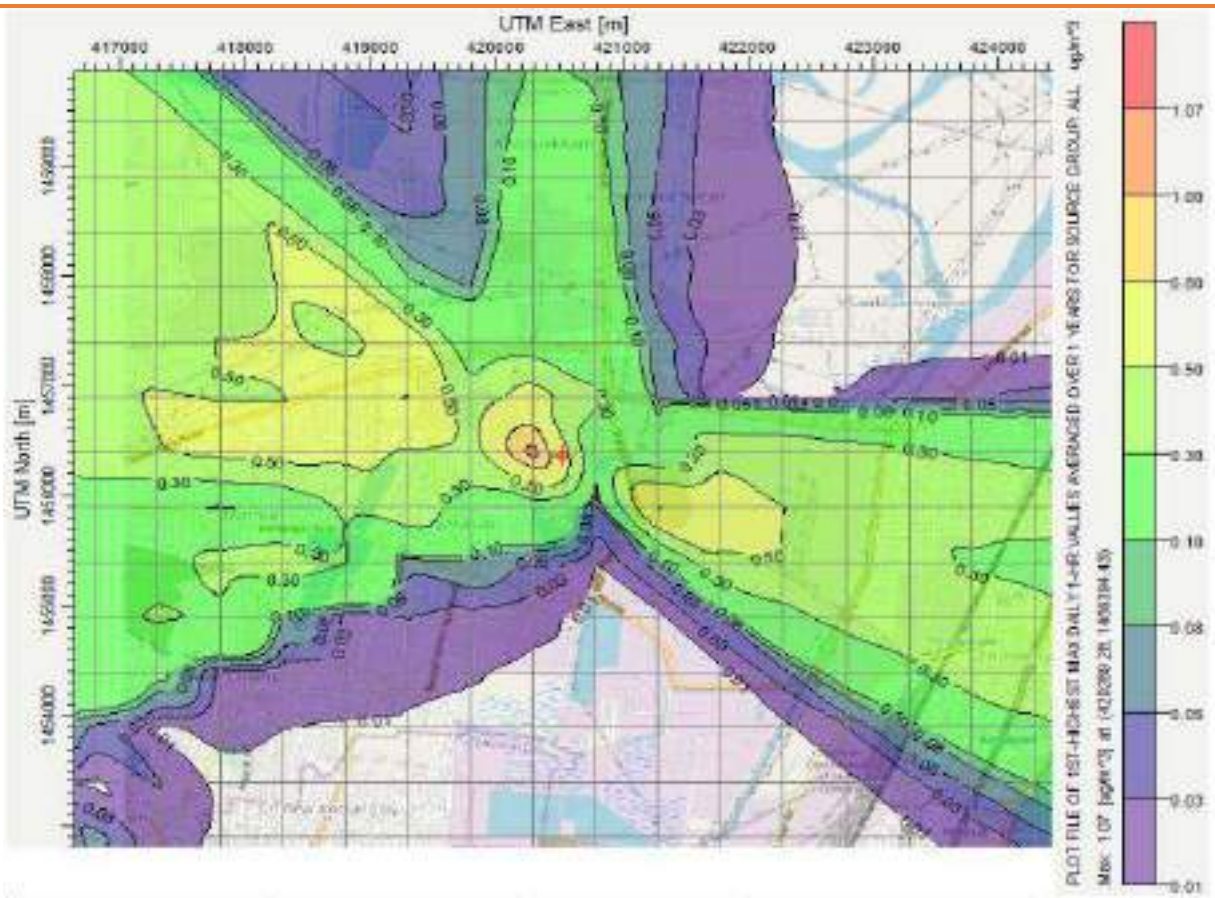
STACK EMISSION DISPERSION MODELLING – Stack Gas Turbin-2 @ 2 & 5KM – Oxides of Nitrogen (NO2)



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
10	0.78	1.91	0.75	0.0767

Stack – Gas Turbin-2 emission of Oxides of Nitrogen concentration is 10mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.91µg/m3 at 2km dispersion Oxides of Nitrogen is 0.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0767µg/m3 and the predominant wind direction is ESE.

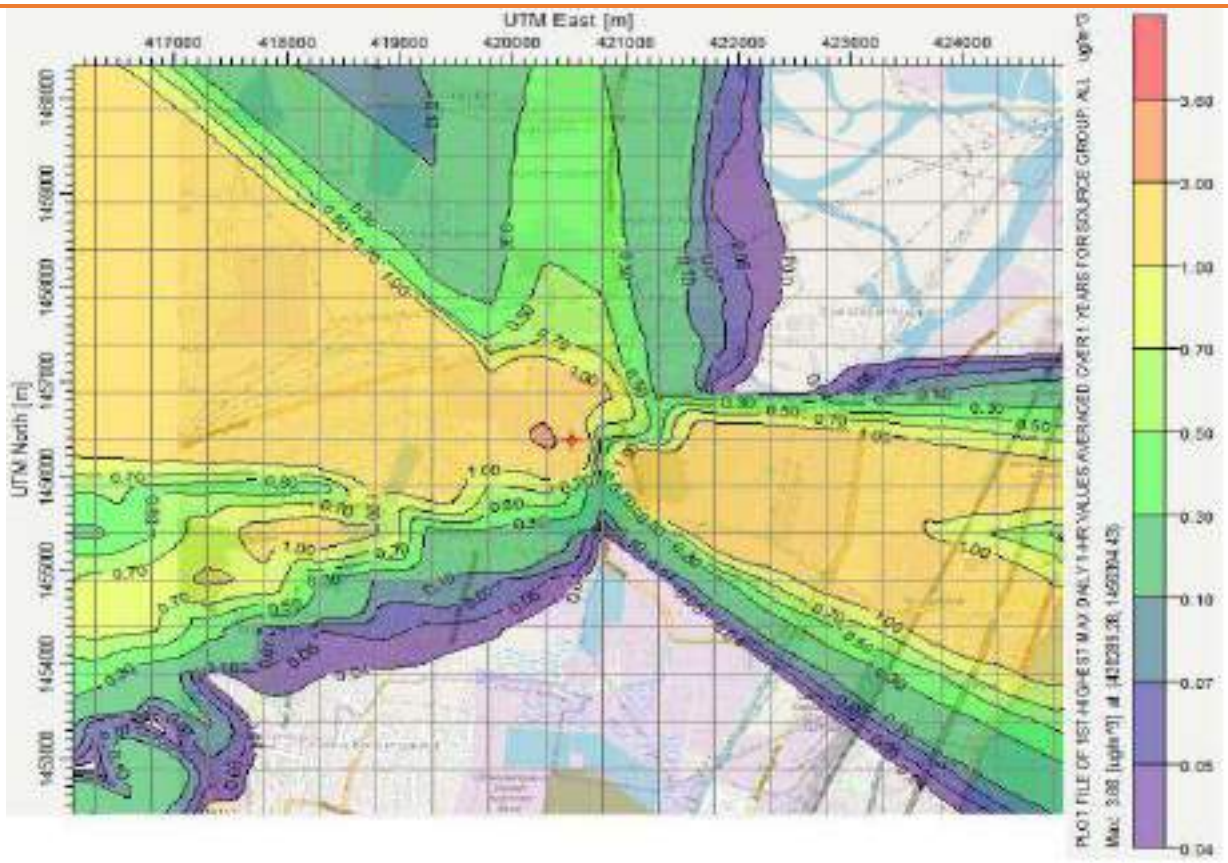
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-3 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
8	0.8	1.07	0.124	0.065

Stack – Gas Turbin-3 emission of Carbon Monoxide concentration is 8mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.07µg/m3 at 2km dispersion Carbon Monoxide is 0.124µg/m3 and at 5km dispersion Carbon Monoxide is 0.065µg/m3 and the predominant wind direction is ESE.

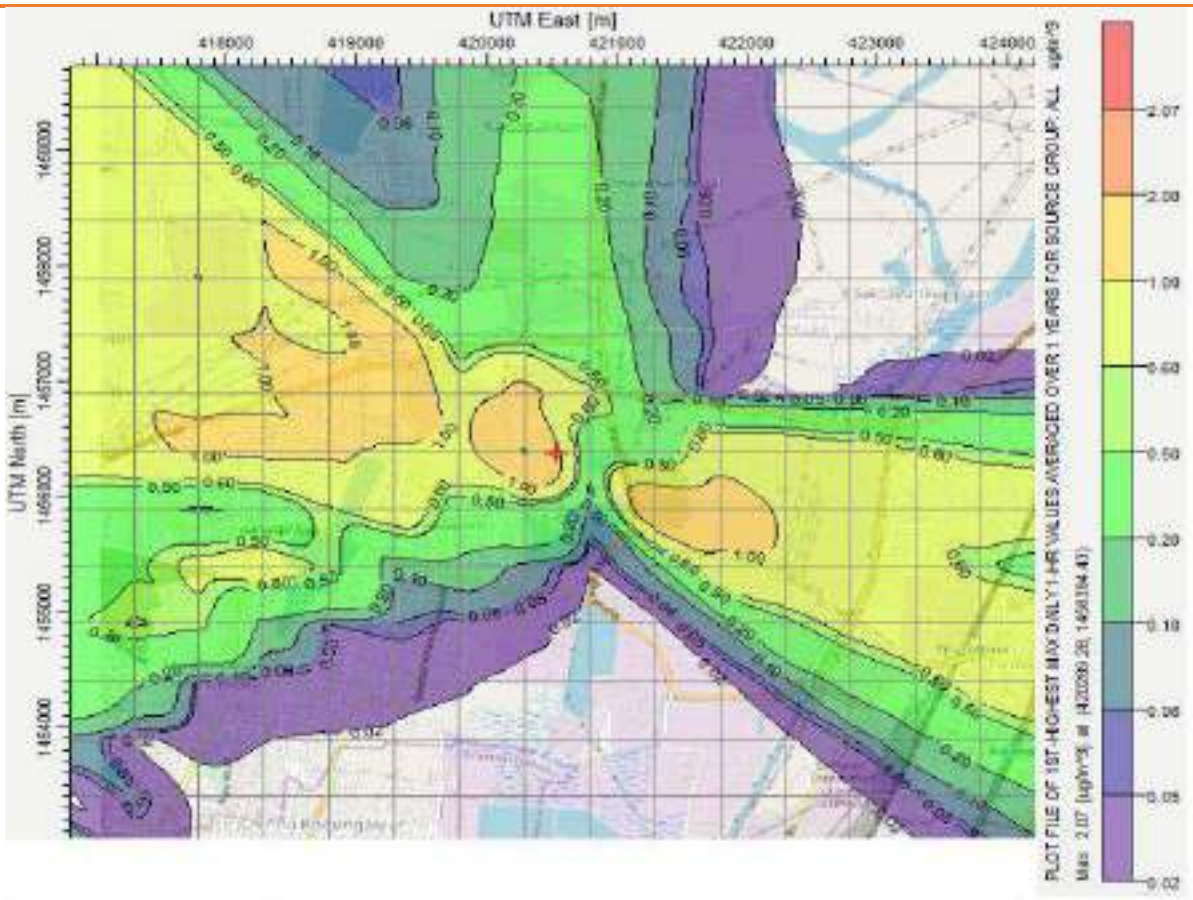
STACK EMISSION DISPERSION MODELLING – Stack – Gas Turbin-3 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
26.9	0.98	3.6	0.97	0.083

Stack – Gas Turbin-3 emission of Particulate Matter concentration is 26.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 3.6µg/m3 at 2km dispersion Particulate Matter is 0.97µg/m3 and at 5km dispersion Particulate Matter is 0.083µg/m3 and the predominant wind direction is ESE.

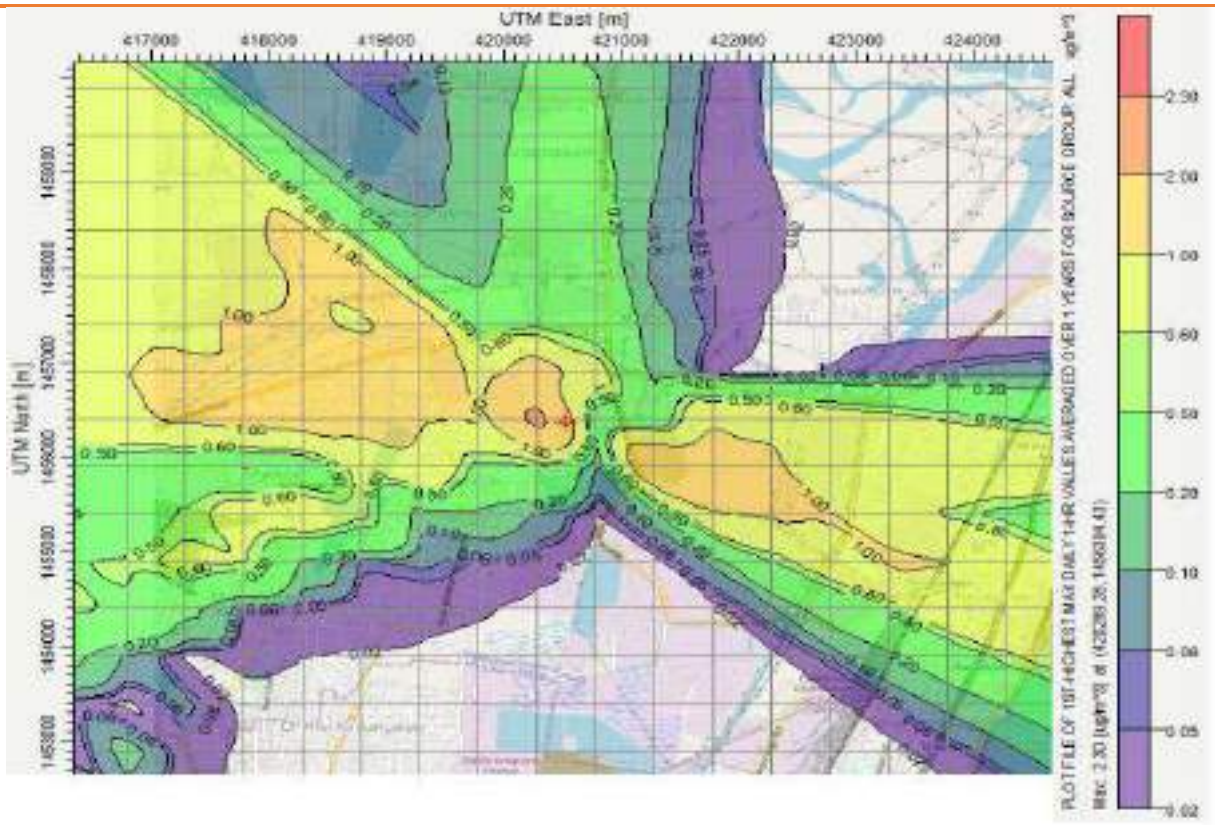
STACK EMISSION DISPERSION MODELLING - Gas Turbin-3 @ 2 & 5KM Sulphur Dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
15.4	0.8	2.07	0.85	0.0963

Stack – Gas Turbin-3 emission of Sulphur dioxide concentration is 15.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 2.07µg/m3 at 2km dispersion Sulphur dioxide is 0.85µg/m3 and at 5km dispersion Sulphur dioxide is 0.0963µg/m3 and the predominant wind direction is ESE.

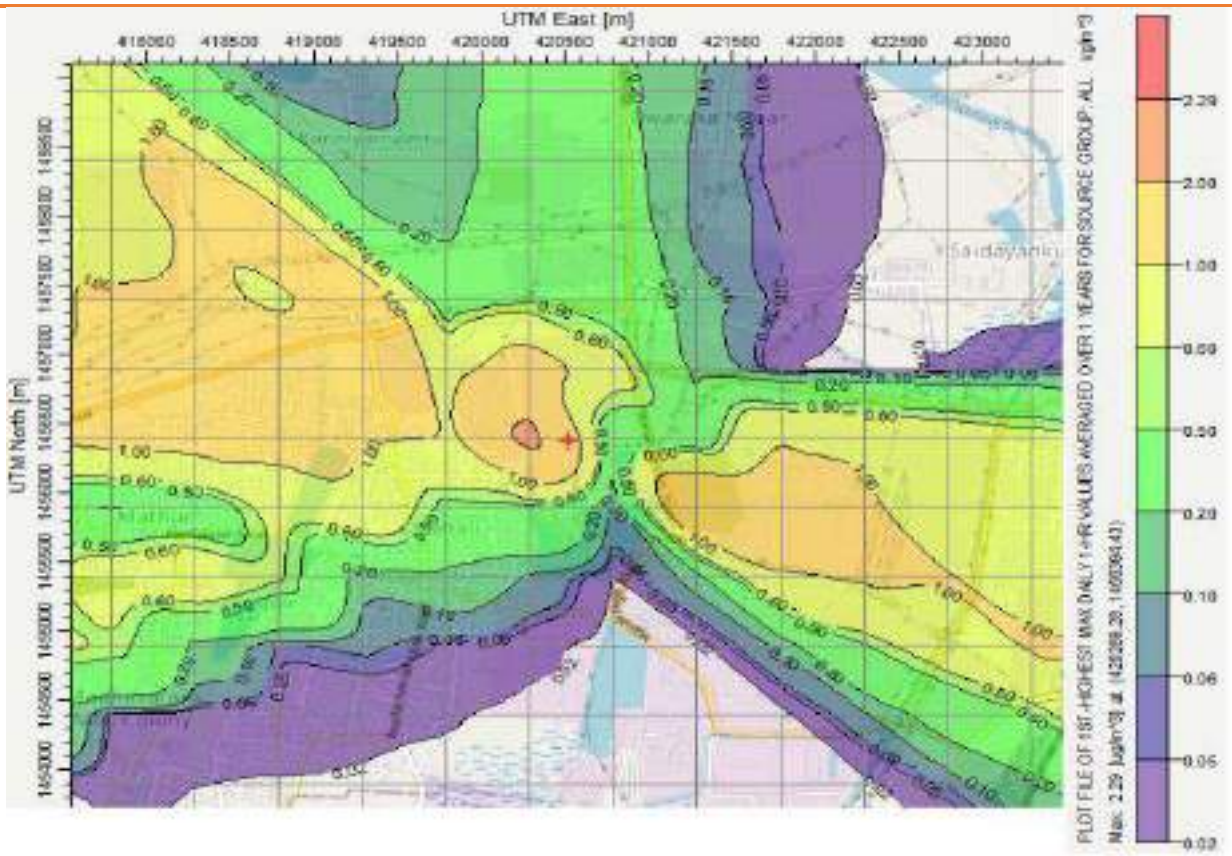
STACK EMISSION DISPERSION MODELLING – Stack Gas Turbin-3 @ 2 & 5KM – Oxides of Nitrogen (NO2)



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
16	0.777	2.3	0.83	0.0981

Stack – Gas Turbin-3 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.777km at the concentration of 2.3µg/m3 at 2km dispersion Oxides of Nitrogen is 0.83µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0981µg/m3 and the predominant wind direction is ESE.

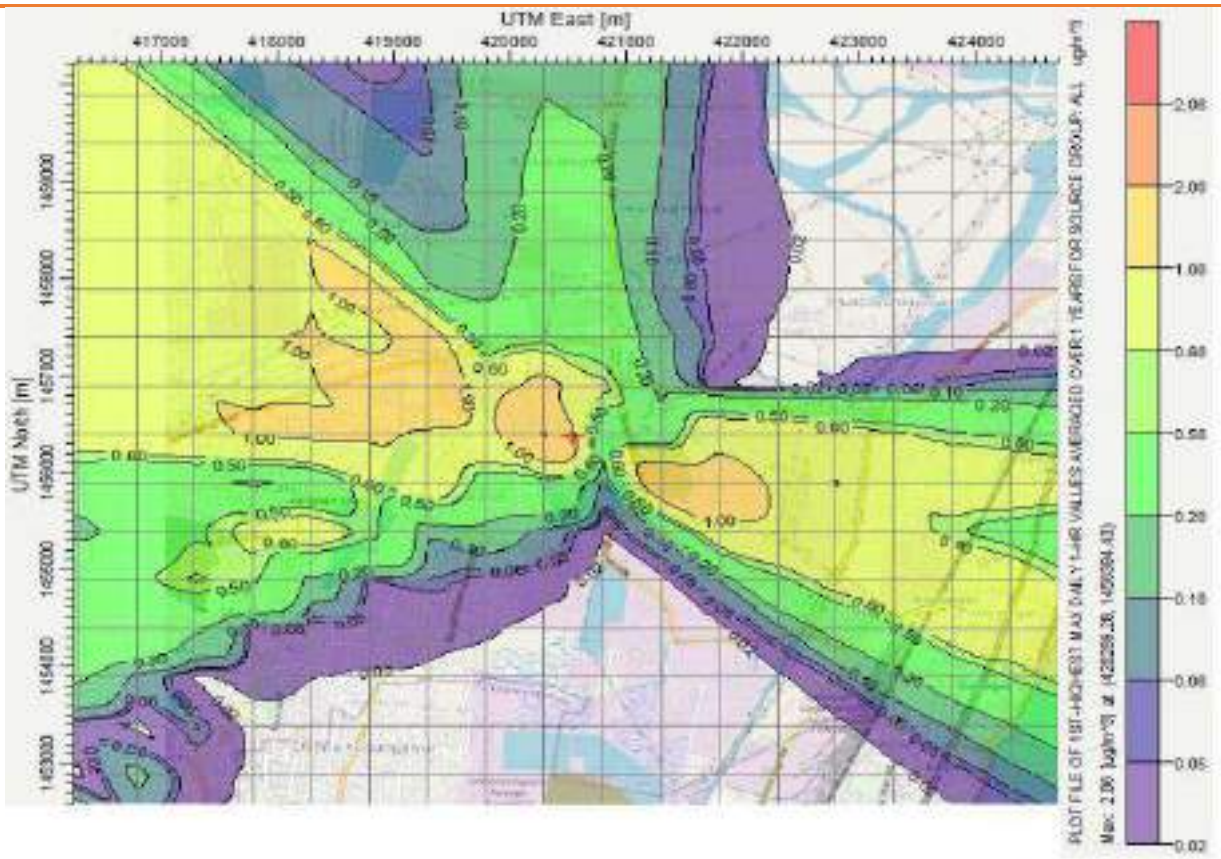
STACK EMISSION DISPERSION MODELLING – Stack – 207F102@ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
17	0.84	2.29	0.461	0.0666

Stack – 207F102 emission of Carbon Monoxide concentration is 17mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 2.29µg/m3 at 2km dispersion Carbon Monoxide is 0.461µg/m3 and at 5km dispersion Carbon Monoxide is 0.0666µg/m3 and the predominant wind direction is ESE.

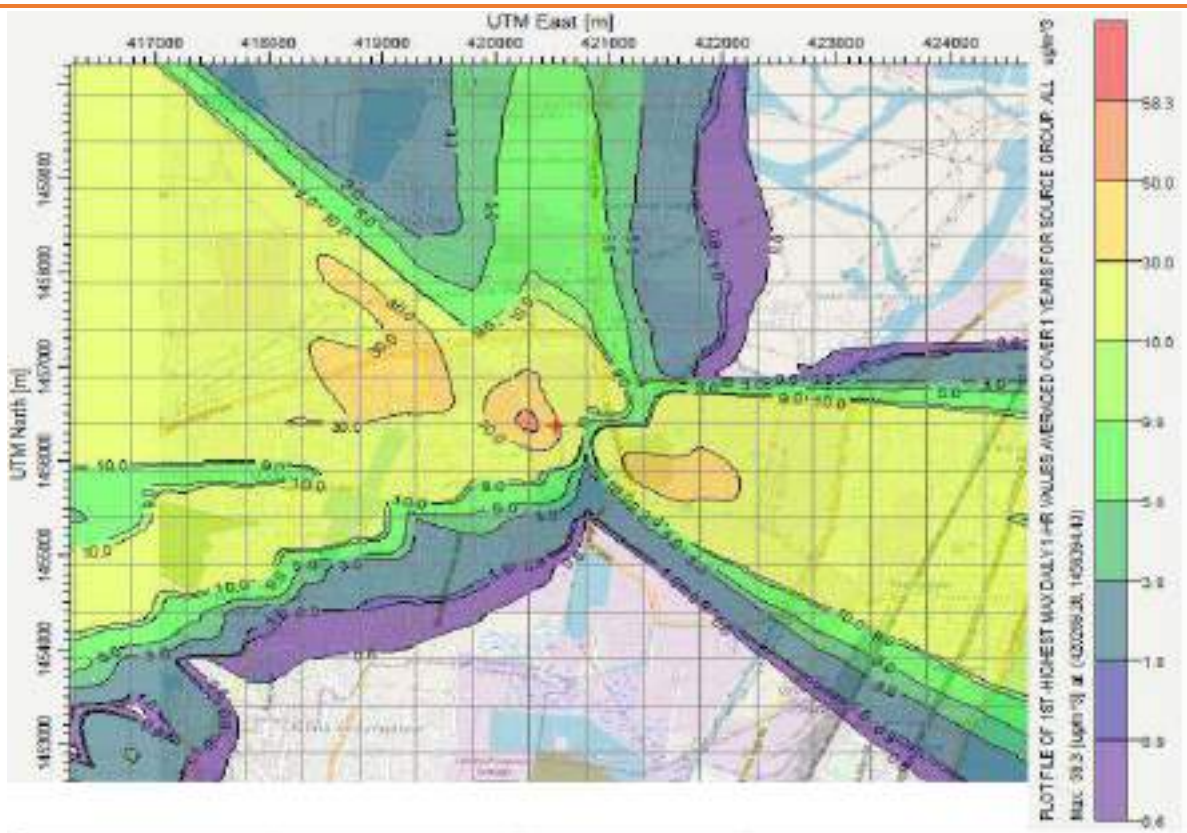
STACK EMISSION DISPERSION MODELLING – Stack – 207F102@ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
15.6	0.99	2.06	0.7654	0.0893

Stack – 207F102 emission of Particulate Matter concentration is 15.6mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 2.06µg/m3 at 2km dispersion Particulate Matter is 0.7654µg/m3 and at 5km dispersion Particulate Matter is 0.0893µg/m3 and the predominant wind direction is ESE.

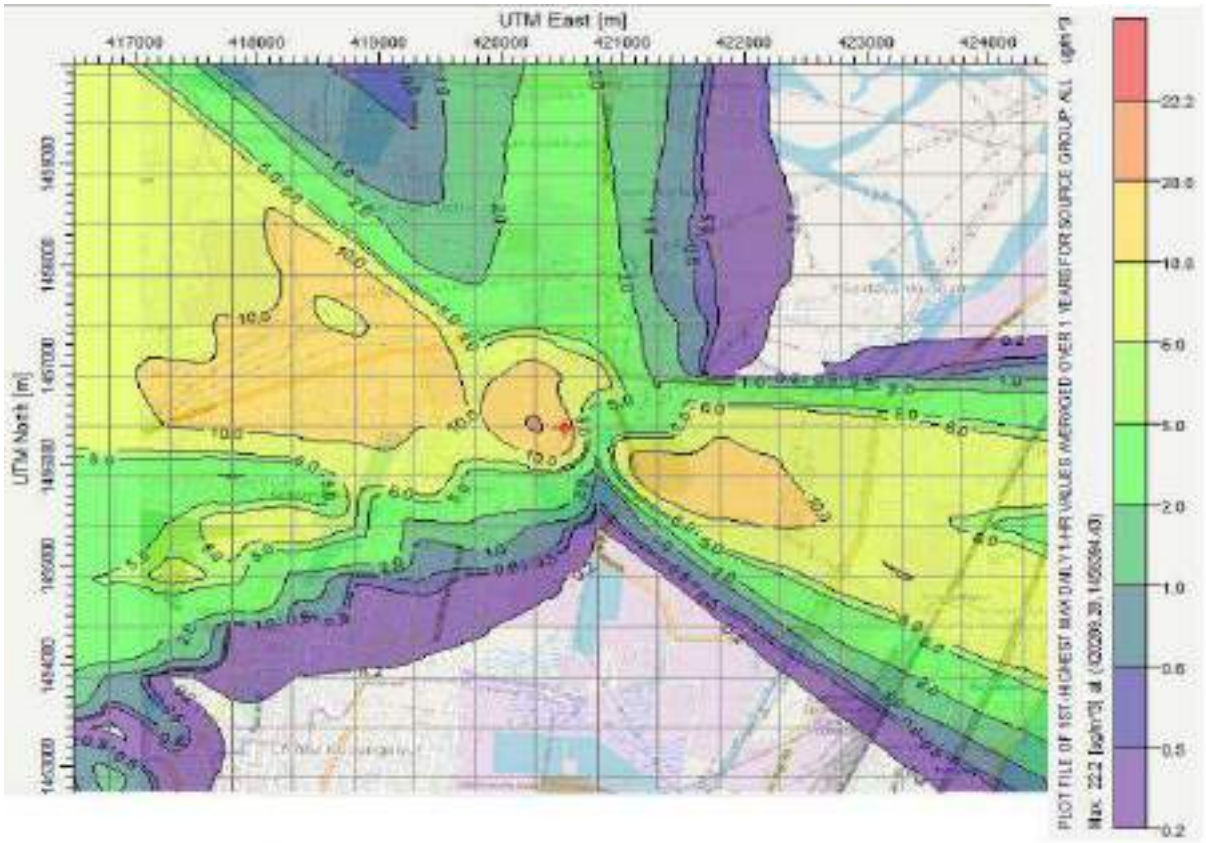
STACK EMISSION DISPERSION MODELLING – Stack – 207F102 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
437.3	1.19	58.3	14.9	0.98

Stack – 207F102 emission of Sulphur dioxide concentration is 437.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.19km at the concentration of 58.3µg/m3 at 2km dispersion Sulphur dioxide is 14.9µg/m3 and at 5km dispersion Sulphur dioxide is 0.98µg/m3 and the predominant wind direction is ESE.

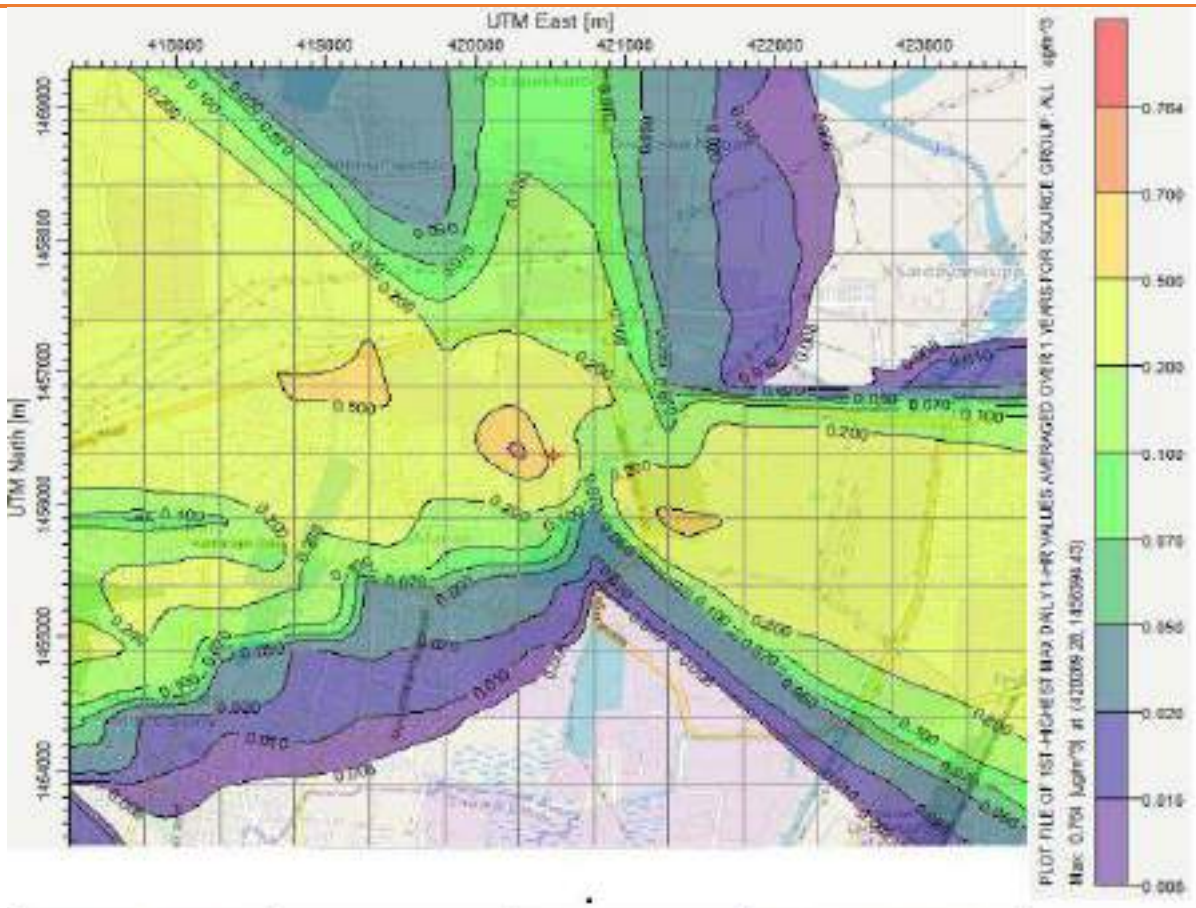
STACK EMISSION DISPERSION MODELLING – Stack 207F102 @ 2 & 5KM – Oxides of Nitrogen (NO2)



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
167	0.98	22.2	2.86	0.421

Stack – 207F102 emission of Oxides of Nitrogen concentration is 167mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 22.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.421µg/m3 and the predominant wind direction is ESE.

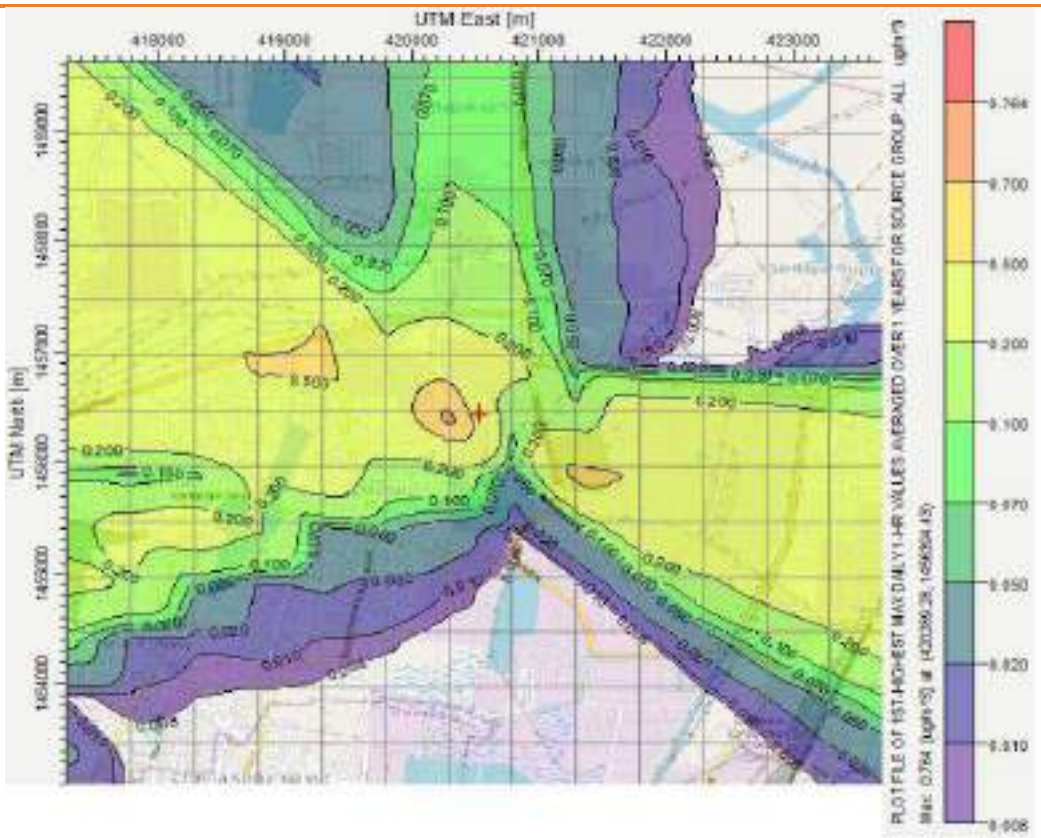
STACK EMISSION DISPERSION MODELLING – (NO2) **Stack 207F201 @ 2 & 5KM – Oxides of Nitrogen**



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
8.9	0.98	0.764	0.0654	0.00331

Stack – 207F201 emission of Oxides of Nitrogen concentration is 8.9mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 6.14m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Oxides of Nitrogen is 0.0654µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.00331µg/m3 and the predominant wind direction is ESE.

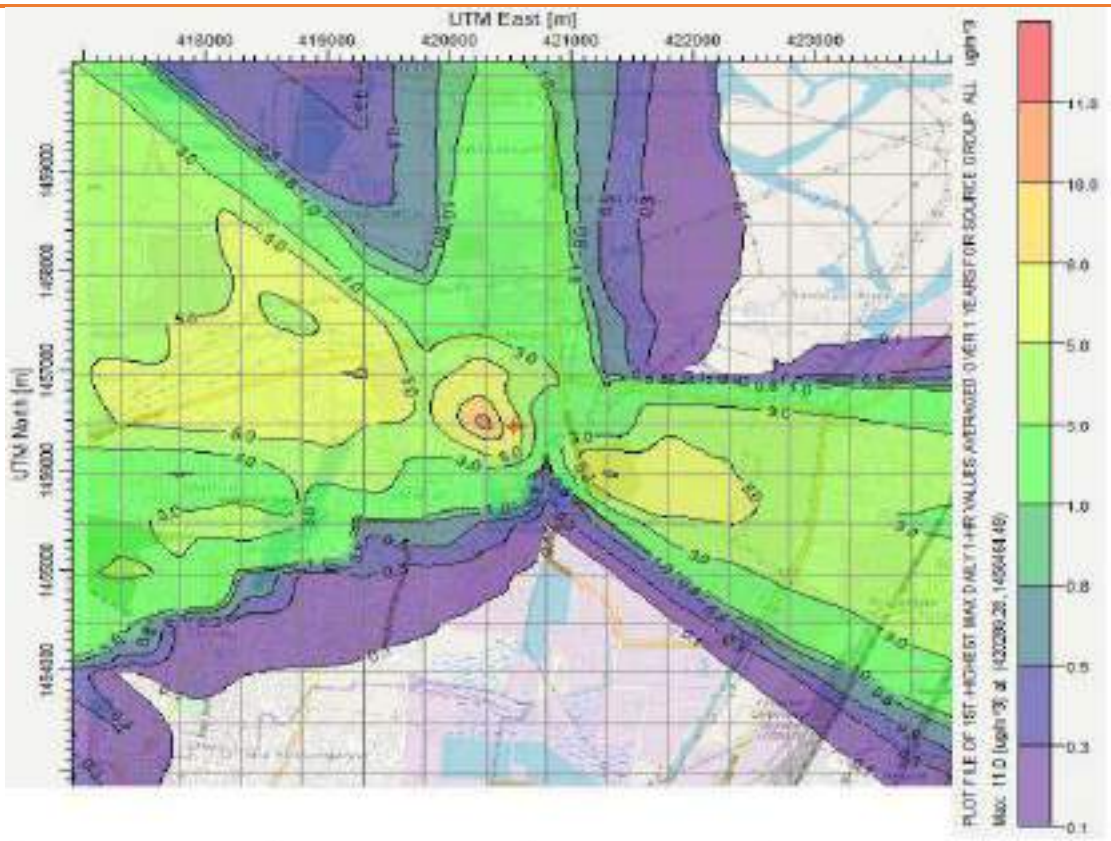
STACK EMISSION DISPERSION MODELLING – Boiler-1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
40	0.98	0.764	0.086	0.00713

Stack – Boiler-1 emission of Carbon Monoxide concentration is 40mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Carbon Monoxide is 0.086µg/m3 and at 5km dispersion Carbon Monoxide is 0.00713µg/m3 and the predominant wind direction is ESE.

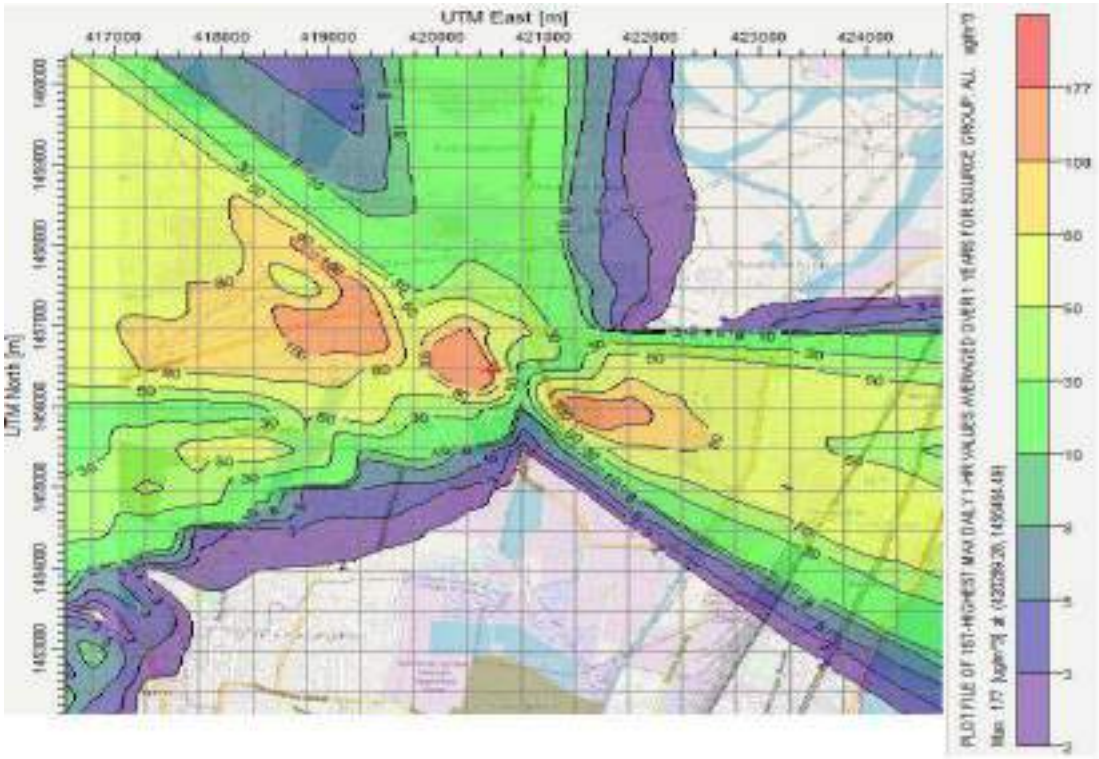
STACK EMISSION DISPERSION MODELLING – Boiler-1 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
57.3	0.78	11	2.768	0.64

Stack – Boiler-1 emission of Particulate Matter concentration is 57.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 11µg/m3 at 2km dispersion Particulate Matter is 2.768µg/m3 and at 5km dispersion Particulate Matter is 0.64µg/m3 and the predominant wind direction is ESE.

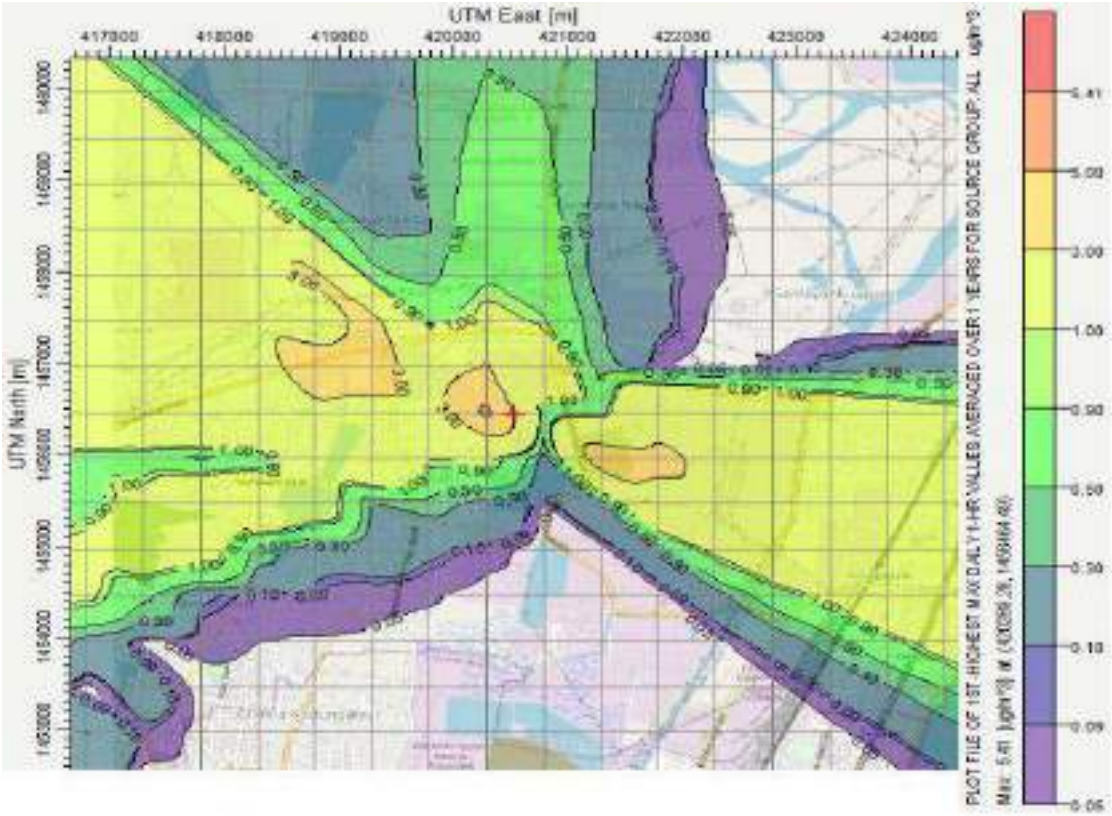
STACK EMISSION DISPERSION MODELLING – Boiler-1 @ 2 & 5KM –
Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
922.4	1.03	177	34.5	4.67

Stack – Boiler-1 emission of Sulphur dioxide concentration is 922.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.03km at the concentration of 177µg/m3 at 2km dispersion Sulphur dioxide is 34.5µg/m3 and at 5km dispersion Sulphur dioxide is 4.67µg/m3 and the predominant wind direction is ESE.

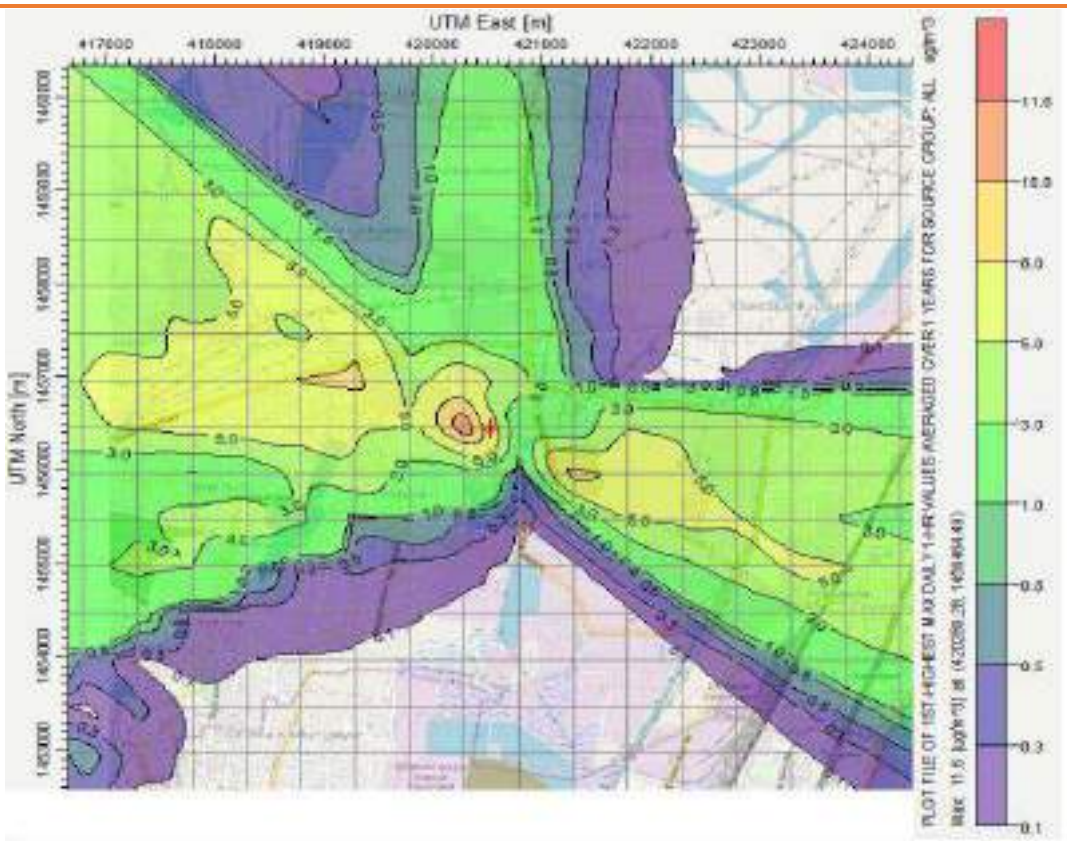
STACK EMISSION DISPERSION MODELLING – Boiler-3 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
28	0.99	5.41	0.77	0.075

Stack – Boiler-3 emission of Carbon Monoxide concentration is 28mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 5.41µg/m3 at 2km dispersion Carbon Monoxide is 0.77µg/m3 and at 5km dispersion Carbon Monoxide is 0.075µg/m3 and the predominant wind direction is ESE.

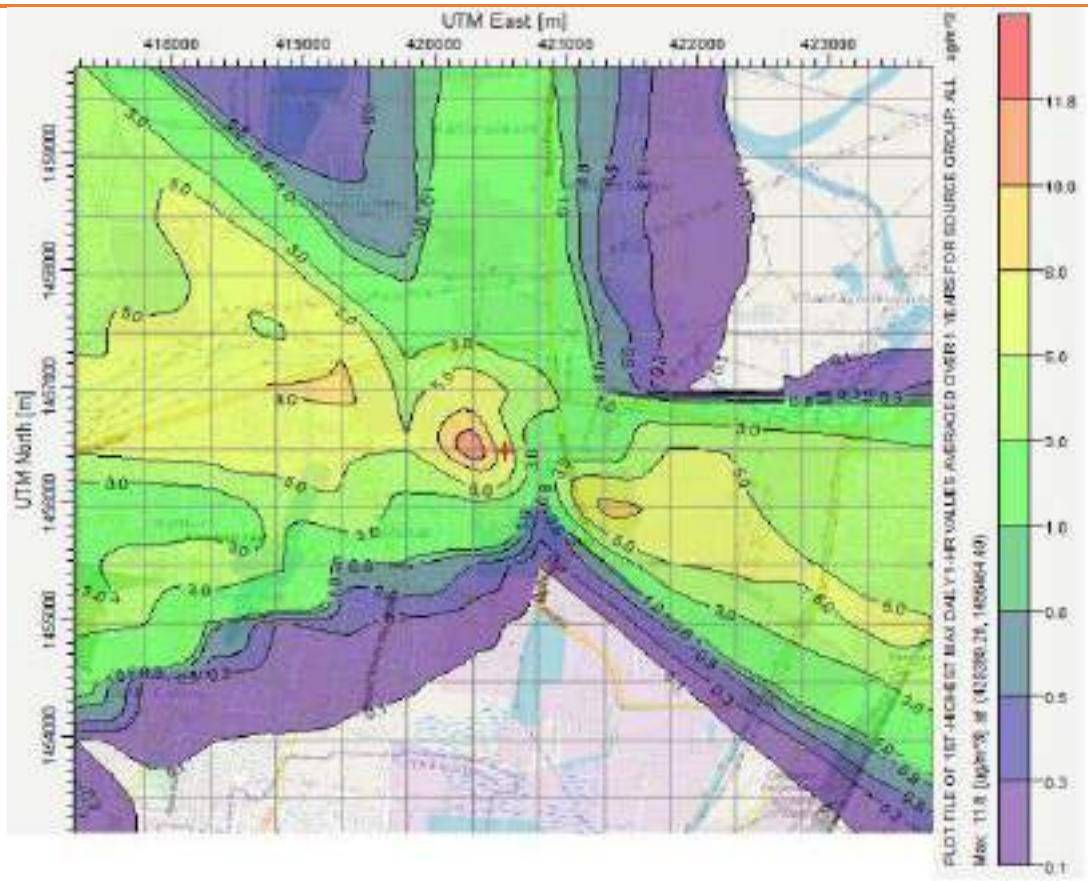
STACK EMISSION DISPERSION MODELLING – Boiler-3 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
60.5	0.89	11.6	2.21	0.865

Stack – Boiler-3 emission of Particulate Matter concentration is 60.5mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 11.6µg/m3 at 2km dispersion Particulate Matter is 2.21µg/m3 and at 5km dispersion Particulate Matter is 0.865µg/m3 and the predominant wind direction is ESE.

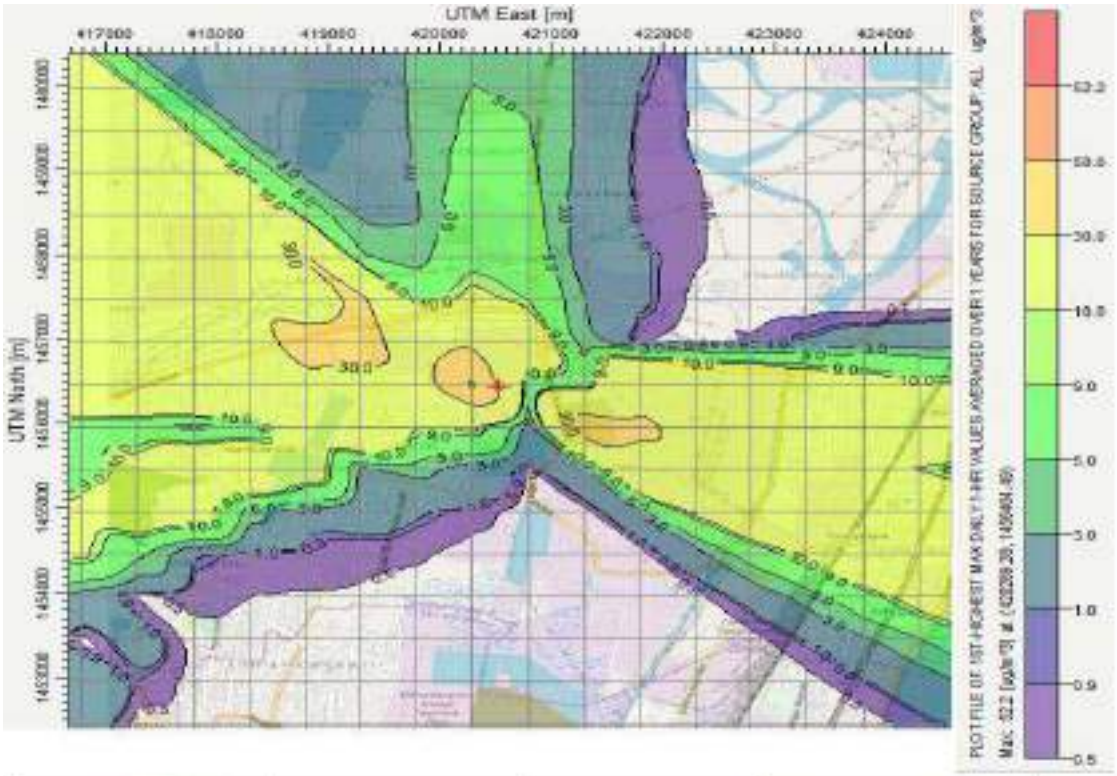
STACK EMISSION DISPERSION MODELLING – Boiler-3 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
998	1.34	11.8	1.89	0.536

Stack – Boiler-3 emission of Sulphur dioxide concentration is 998mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.34km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 1.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.536µg/m3 and the predominant wind direction is ESE.

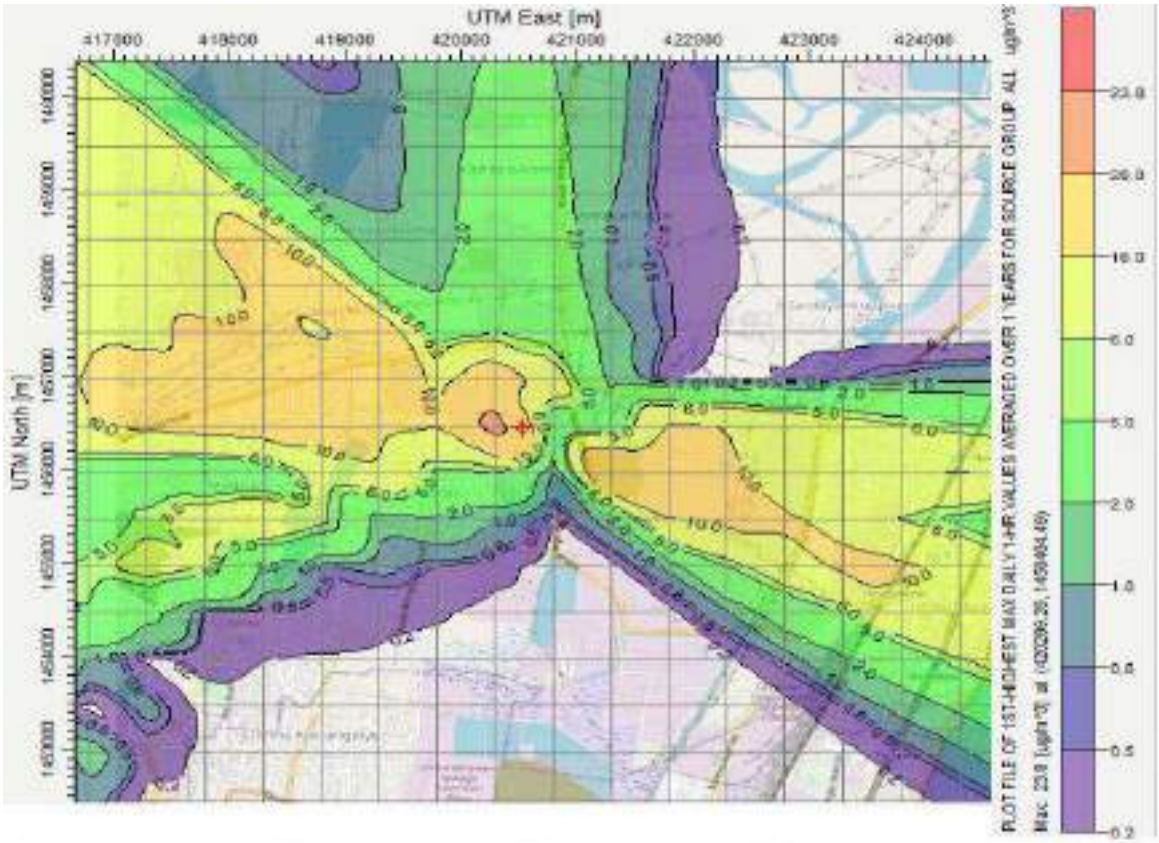
STACK EMISSION DISPERSION MODELLING – Boiler-3 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
272	0.768	52.2	18.16	4.1

Stack – Boiler-3 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.768km at the concentration of 52.2µg/m3 at 2km dispersion Oxides of Nitrogen is 18.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.1µg/m3 and the predominant wind direction is ESE.

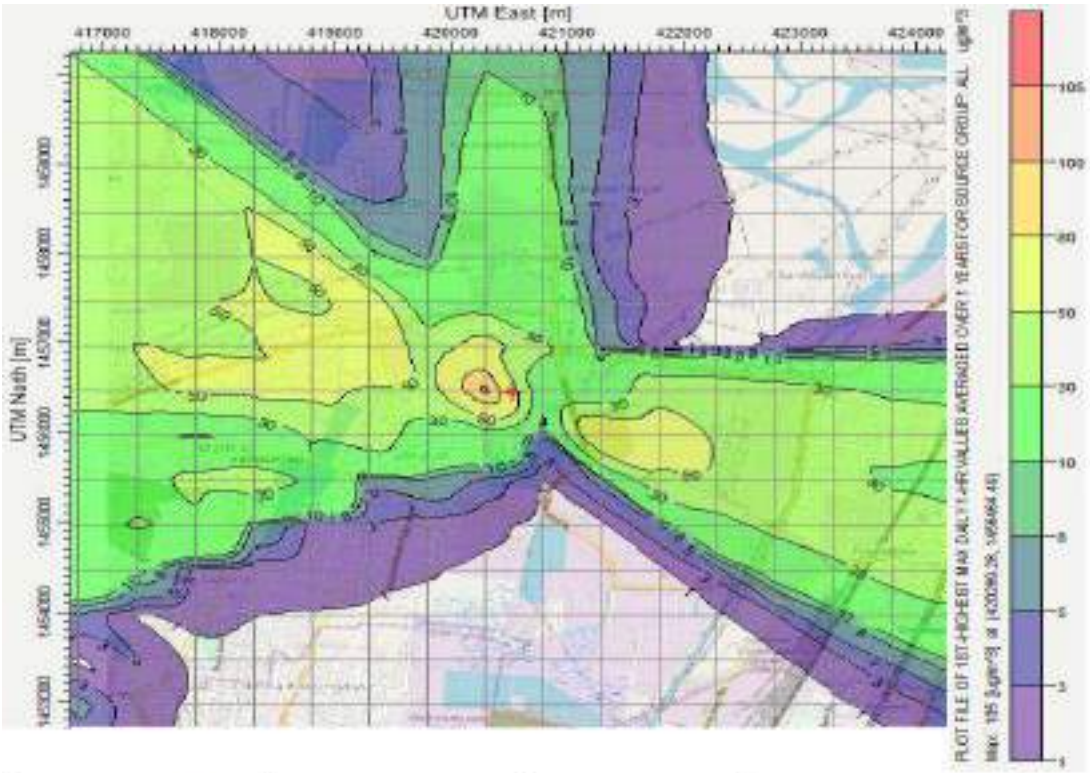
STACK EMISSION DISPERSION MODELLING – Boiler-4 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
12	0.96	23.8	5.34	0.984

Stack – Boiler-4 emission of Carbon Monoxide concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 23.8µg/m3 at 2km dispersion Carbon Monoxide is 5.34µg/m3 and at 5km dispersion Carbon Monoxide is 0.984µg/m3 and the predominant wind direction is ESE.

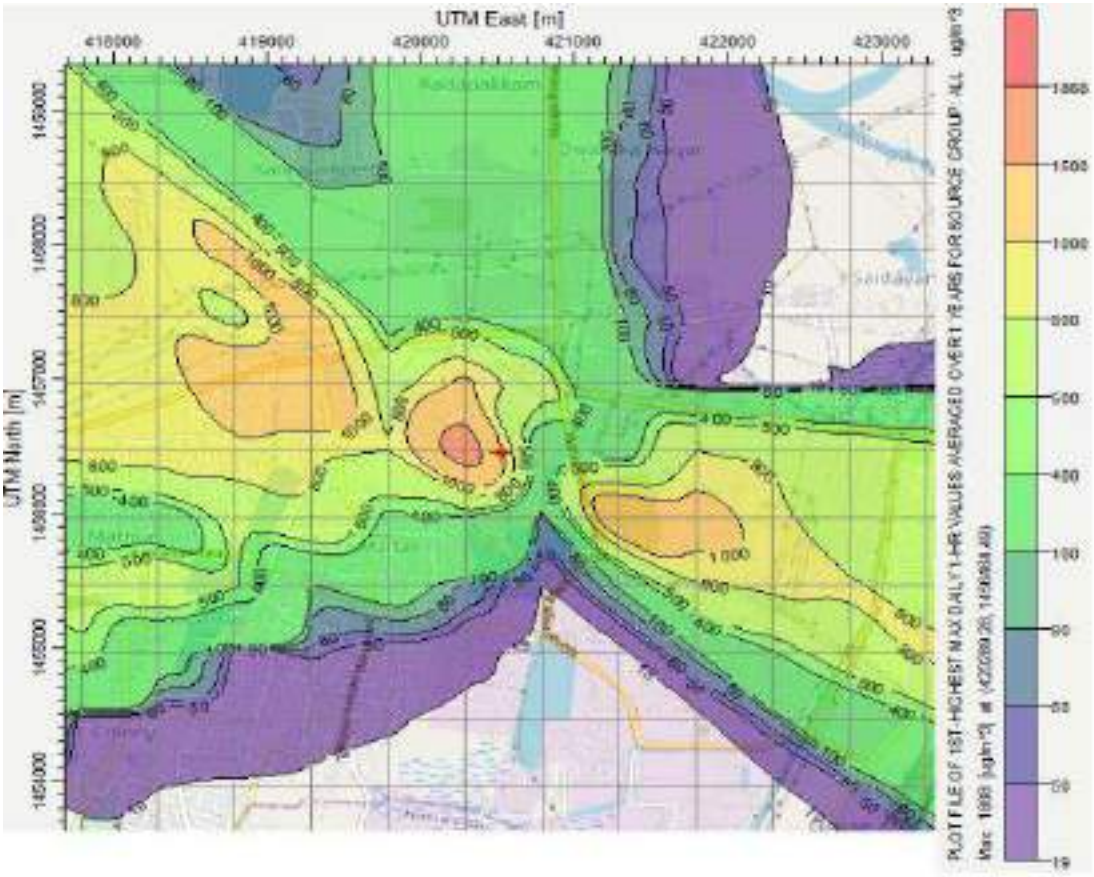
STACK EMISSION DISPERSION MODELLING – Boiler-4 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
53	0.809	105	39.5	9.77

Stack – Boiler-4 emission of Particulate Matter concentration is 53mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.809km at the concentration of 105µg/m3 at 2km dispersion Particulate Matter is 39.5µg/m3 and at 5km dispersion Particulate Matter is 9.77µg/m3 and the predominant wind direction is ESE.

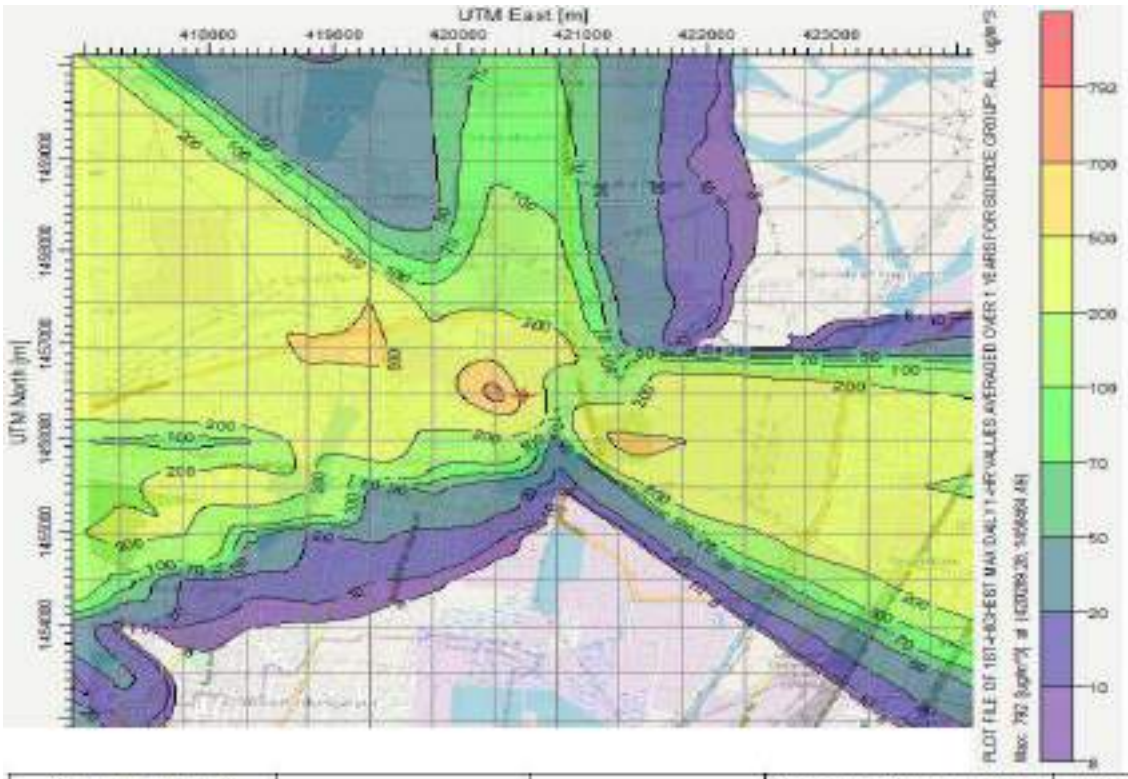
STACK EMISSION DISPERSION MODELLING – Boiler-4 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
943	1.07	1868	454.78	96.456

Stack – Boiler-4 emission of Sulphur dioxide concentration is 943mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.07km at the concentration of 1868µg/m3 at 2km dispersion Sulphur dioxide is 454.78µg/m3 and at 5km dispersion Sulphur dioxide is 96.456µg/m3 and the predominant wind direction is ESE.

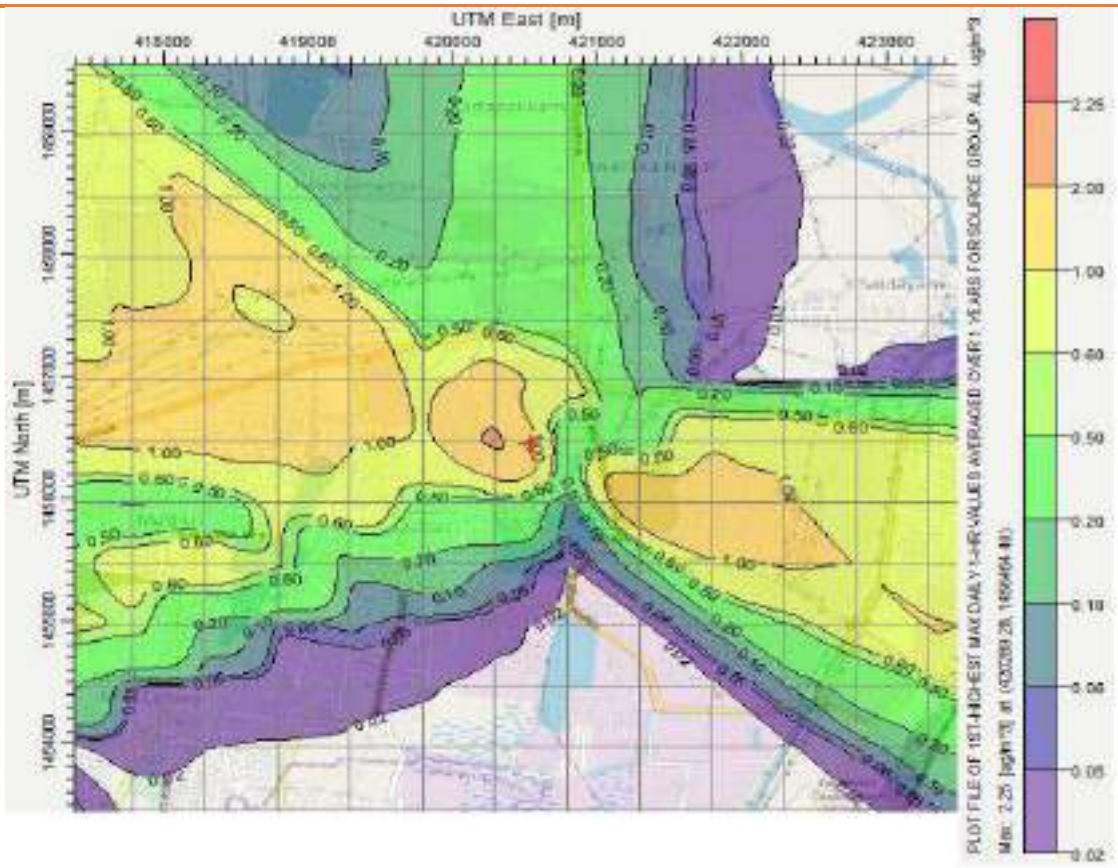
STACK EMISSION DISPERSION MODELLING – Boiler-4 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
400	1.08	792	98.7	12.56

Stack – Boiler-4 emission of Oxides of Nitrogen concentration is 400mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.08km at the concentration of 792µg/m3 at 2km dispersion Oxides of Nitrogen is 98.7µg/m3 and at 5km dispersion Oxides of Nitrogen is 12.56µg/m3 and the predominant wind direction is ESE.

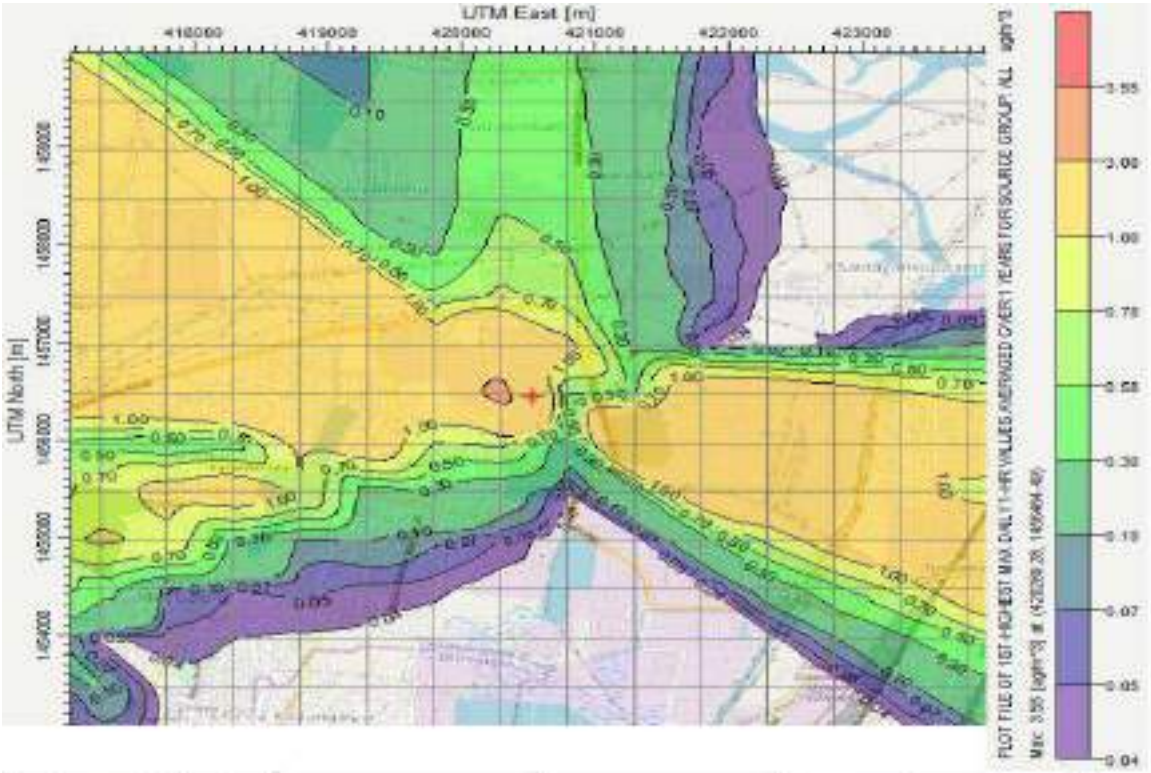
STACK EMISSION DISPERSION MODELLING – Gas Turbine-4 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
11	0.98	2.25	0.45	0.0678

Stack – Gas Turbine-4 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 2.25µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.0678µg/m3 and the predominant wind direction is ESE.

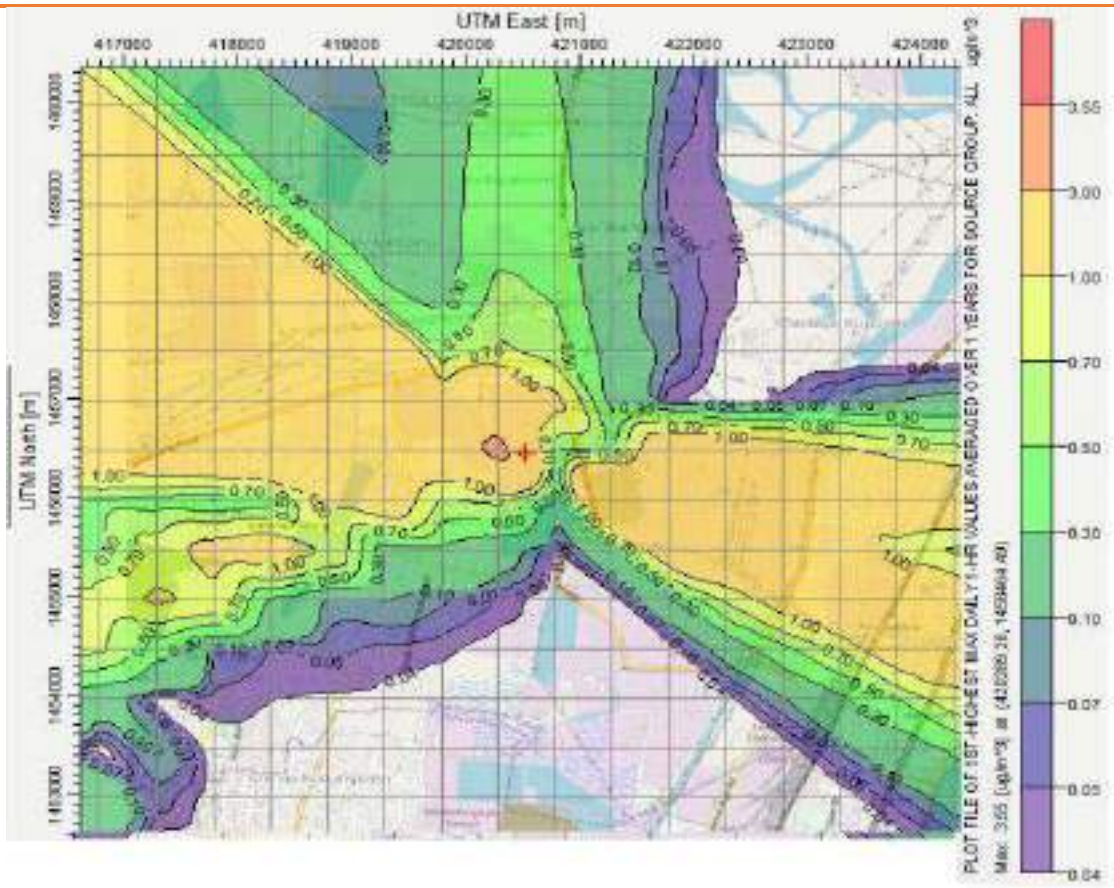
STACK EMISSION DISPERSION MODELLING – Gas Turbine-4 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
17.4	0.88	3.55	0.9	0.065

Stack – Gas Turbine-4 emission of Particulate Matter concentration is 17.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.55µg/m3 at 2km dispersion Particulate Matter is 0.9µg/m3 and at 5km dispersion Particulate Matter is 0.065µg/m3 and the predominant wind direction is ESE.

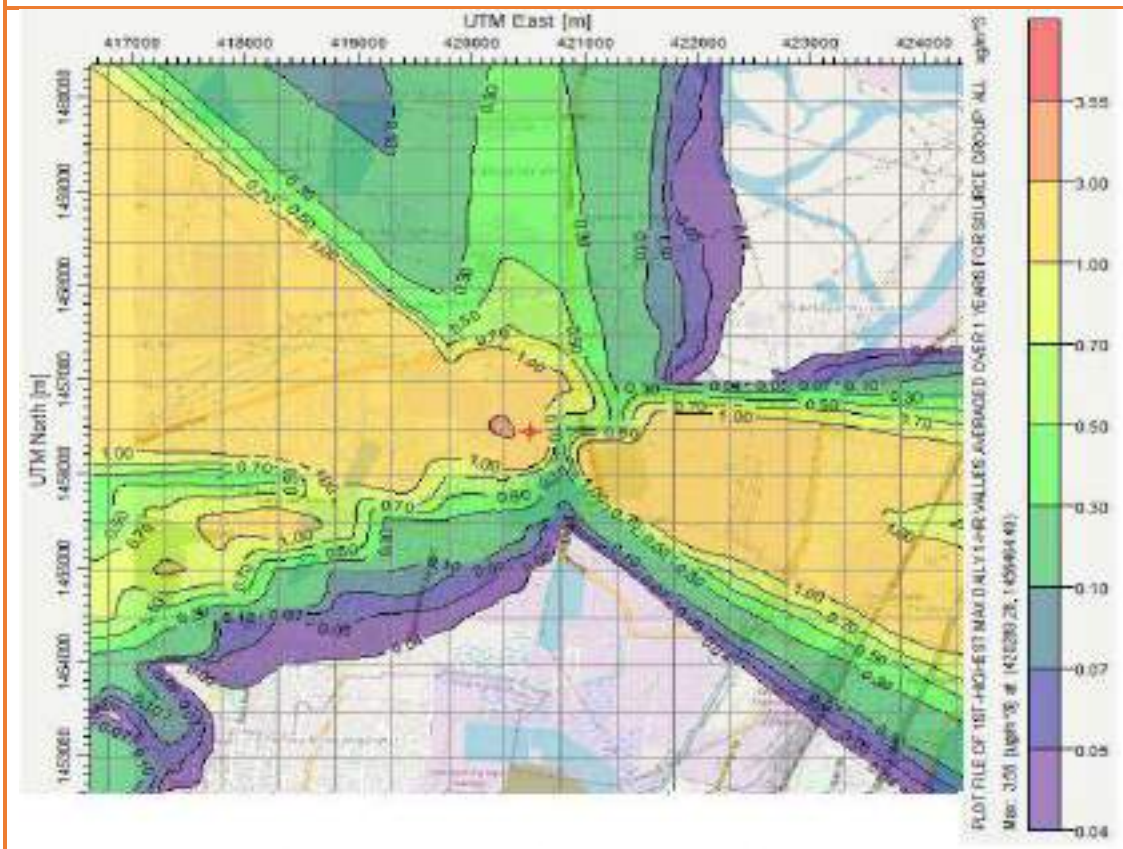
STACK EMISSION DISPERSION MODELLING – Gas Turbine-4 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
5.1	0.95	3.55	0.86	0.094

Stack – Gas Turbine-4 emission of Sulphur dioxide concentration is 5.1mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 3.55µg/m3 at 2km dispersion Sulphur dioxide is 0.86µg/m3 and at 5km dispersion Sulphur dioxide is 0.094µg/m3 and the predominant wind direction is ESE.

STACK EMISSION DISPERSION MODELLING – Gas Turbine-4 @ 2 & 5KM – Oxides of Nitrogen as NO2

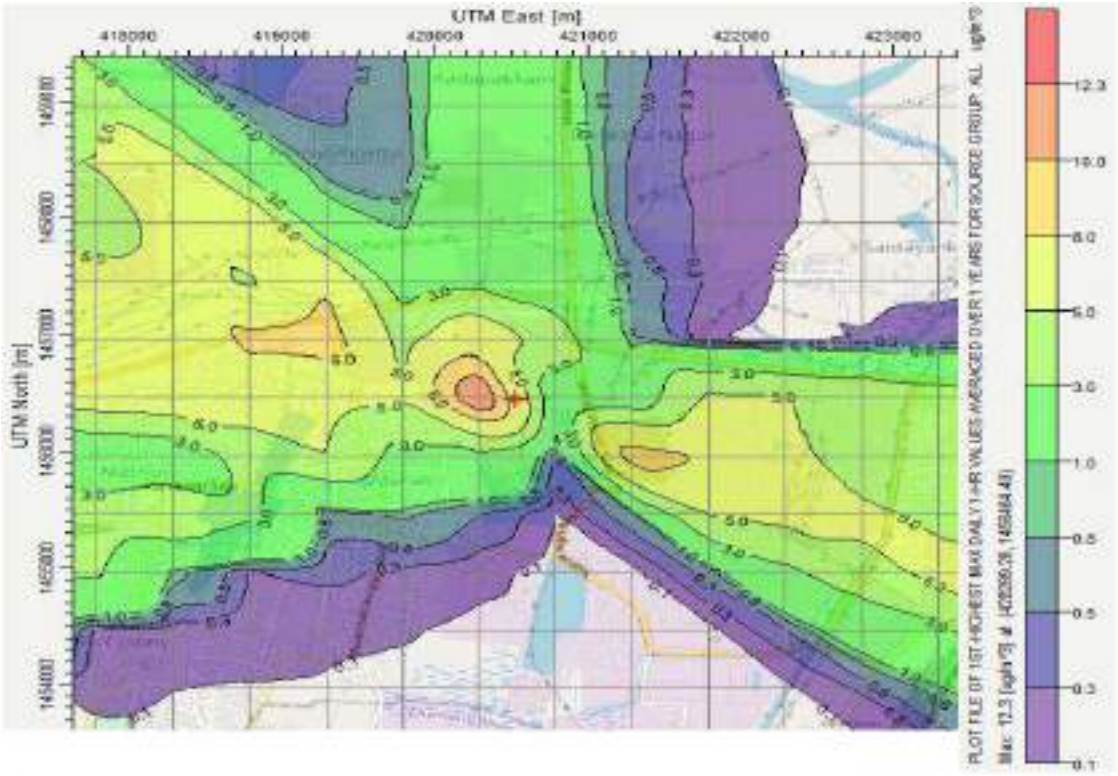


Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
32	0.794	3.55	0.85	0.09

Stack – Gas Turbine-4 emission of Oxides of Nitrogen concentration is 32mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.794km at the concentration of 3.55µg/m3 at 2km dispersion Oxides of Nitrogen is 0.85µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.09µg/m3 and the predominant wind direction is ESE.

STACK EMISSION DISPERSION MODELLING –

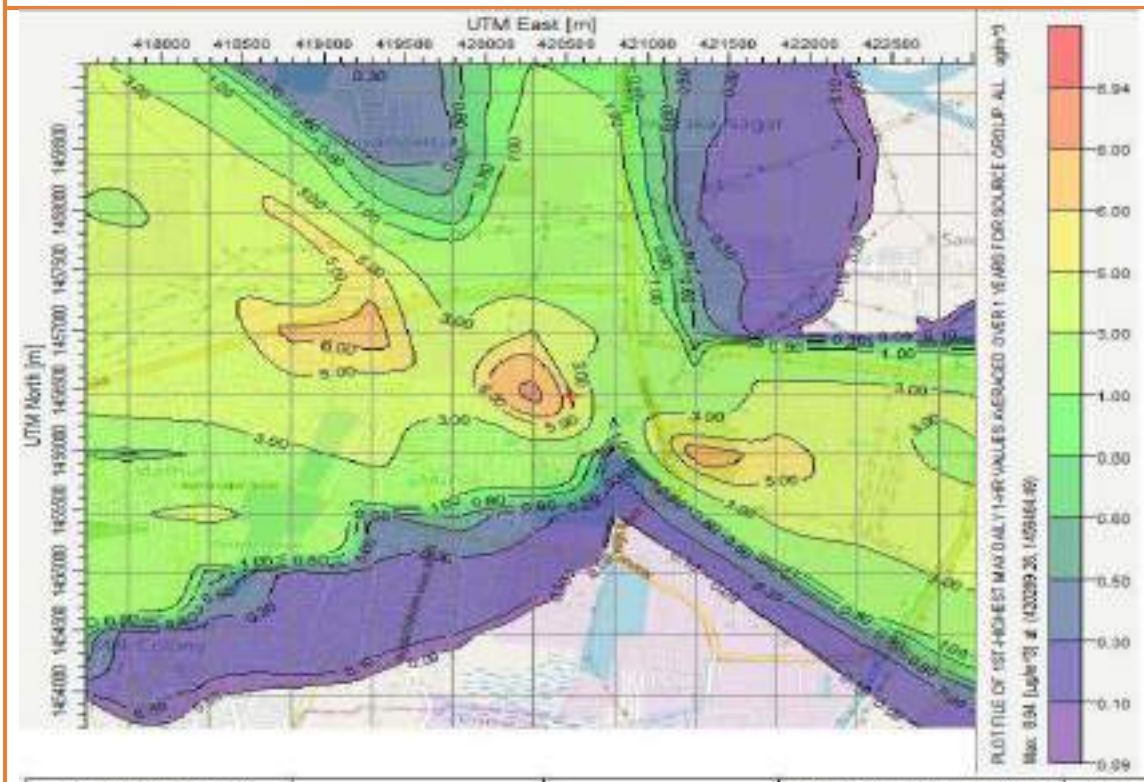
Stack Gas Turbine 4 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
71	0.67	12.3	1.589	0.934

Stack – Gas Turbine-4 emission of Oxides of Nitrogen concentration is 71mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.67km at the concentration of 12.3µg/m3 at 2km dispersion Oxides of Nitrogen is 1.589µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.934µg/m3 and the predominant wind direction is ESE.

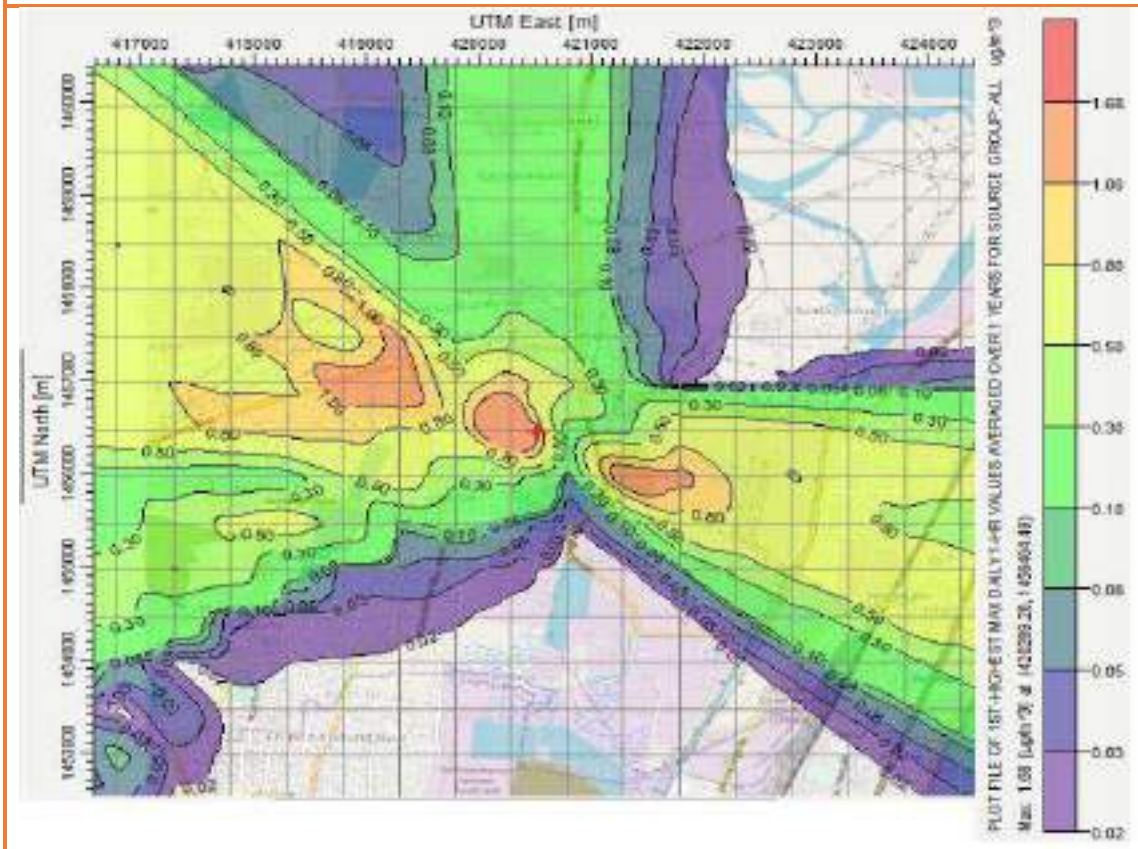
STACK EMISSION DISPERSION MODELLING – Stack 211F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
124	0.623	8.94	1.45	0.456

Stack – 211F1 emission of Carbon Monoxide concentration is 124mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.623km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.456µg/m3 and the predominant wind direction is ESE.

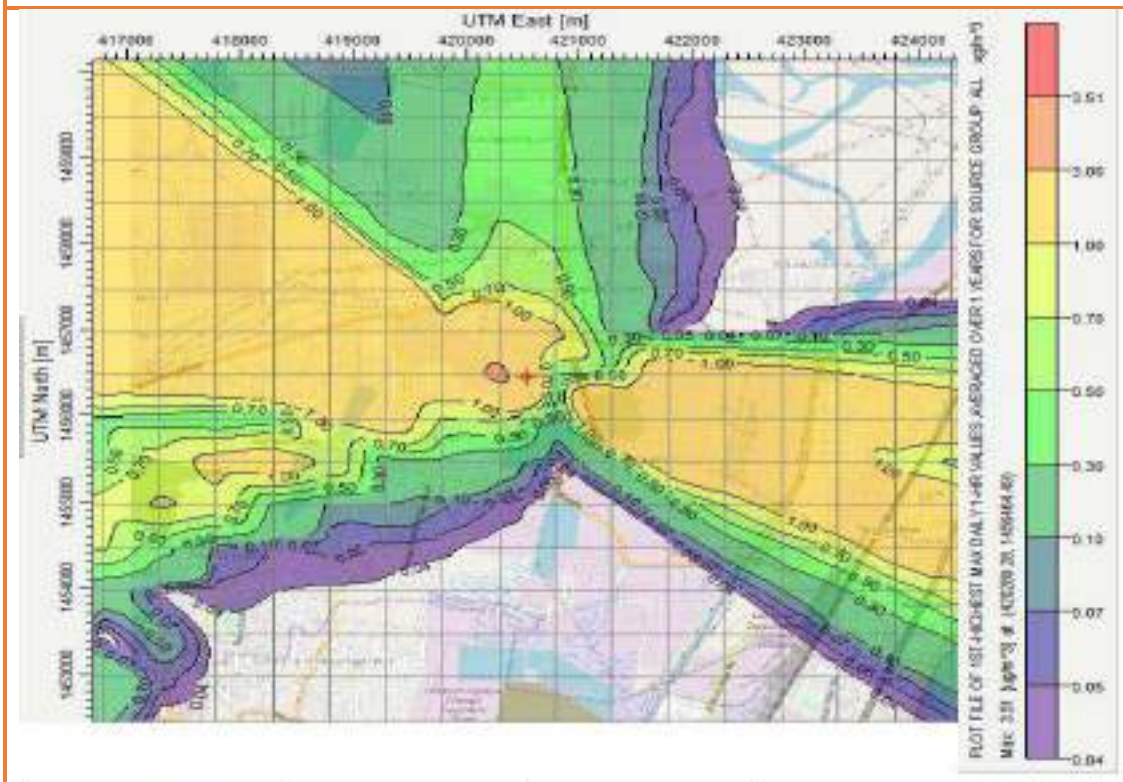
STACK EMISSION DISPERSION MODELLING – Stack 211F1 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
23.7	0.83	1.68	0.2	0.076

Stack – 211F1 emission of Particulate Matter concentration is 23.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.2µg/m3 and at 5km dispersion Particulate Matter is 0.076µg/m3 and the predominant wind direction is ESE.

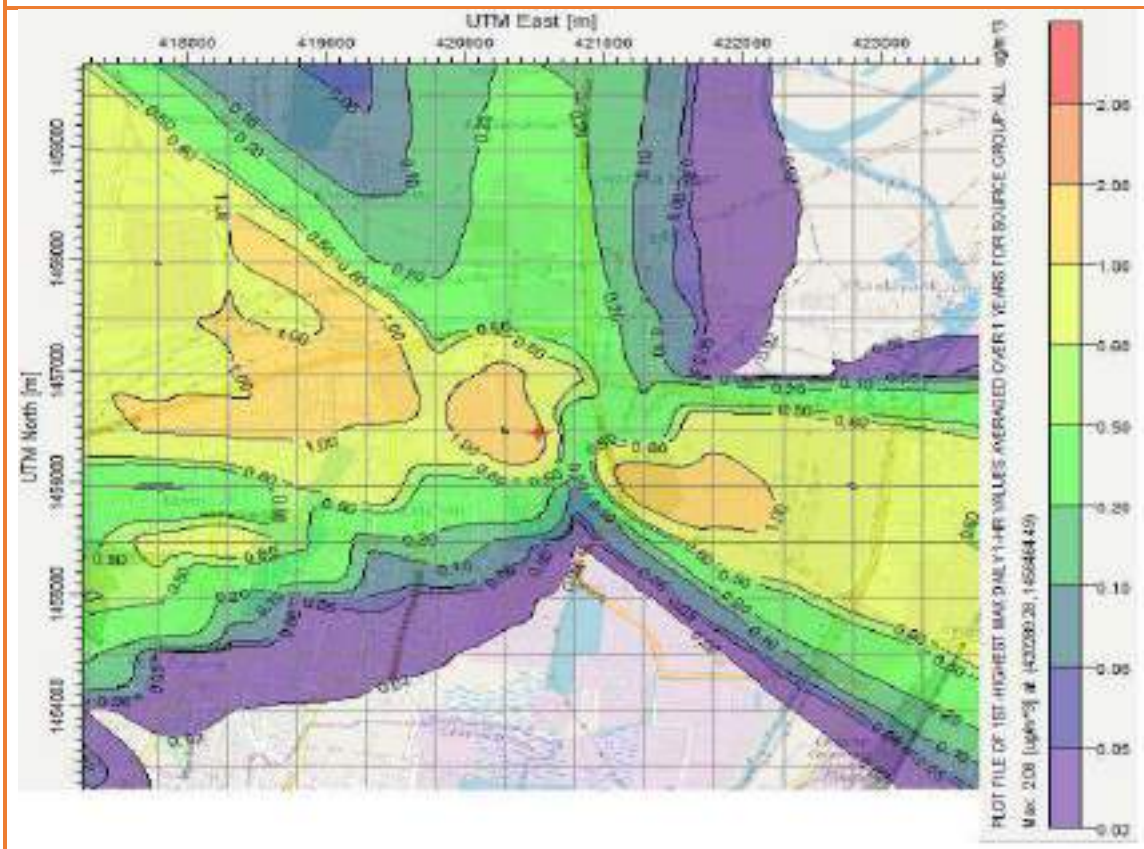
STACK EMISSION DISPERSION MODELLING – Stack 211F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
49	0.931	3.51	0.75	0.0923

Stack – 211F1 emission of Sulphur dioxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.931km at the concentration of 3.51µg/m3 at 2km dispersion Sulphur dioxide is 0.75µg/m3 and at 5km dispersion Sulphur dioxide is 0.0923µg/m3 and the predominant wind direction is ESE.

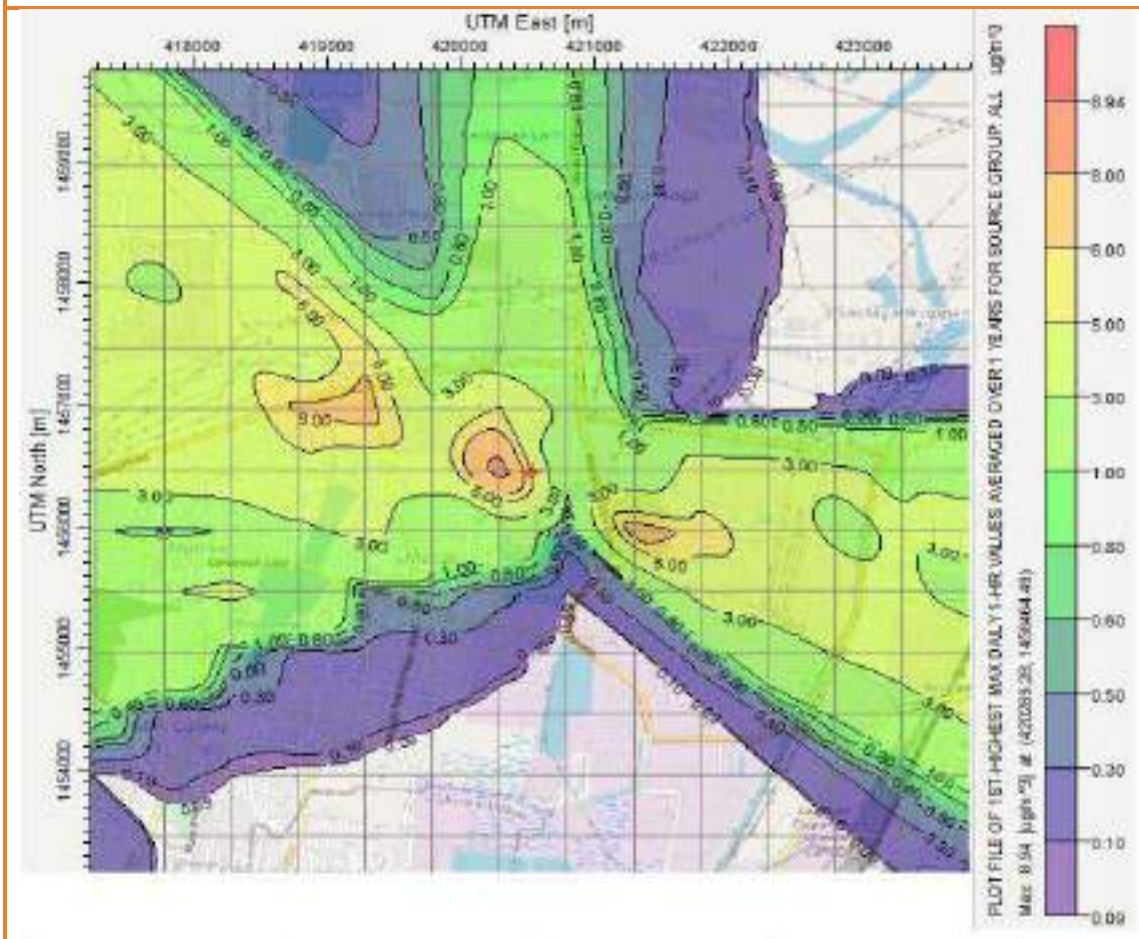
STACK EMISSION DISPERSION MODELLING – Stack 211F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
29	0.97	2.22	0.31	0.0874

Stack – 211F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 2.22µg/m3 at 2km dispersion Oxides of Nitrogen is 0.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0874µg/m3 and the predominant wind direction is ESE.

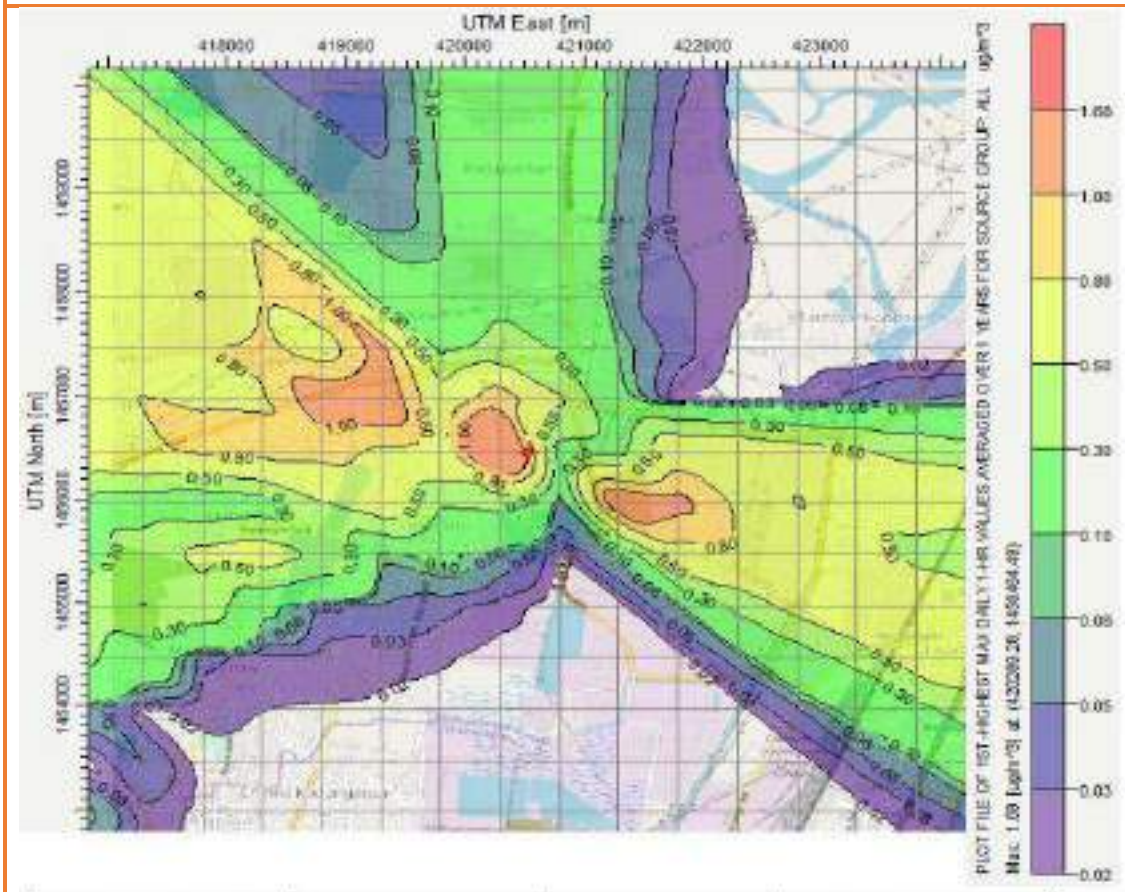
STACK EMISSION DISPERSION MODELLING – Stack 1F1B @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
13	0.91	8.94	1.74	0.976

Stack – 1F1B emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.74µg/m3 and at 5km dispersion Carbon Monoxide is 0.976µg/m3 and the predominant wind direction is ESE.

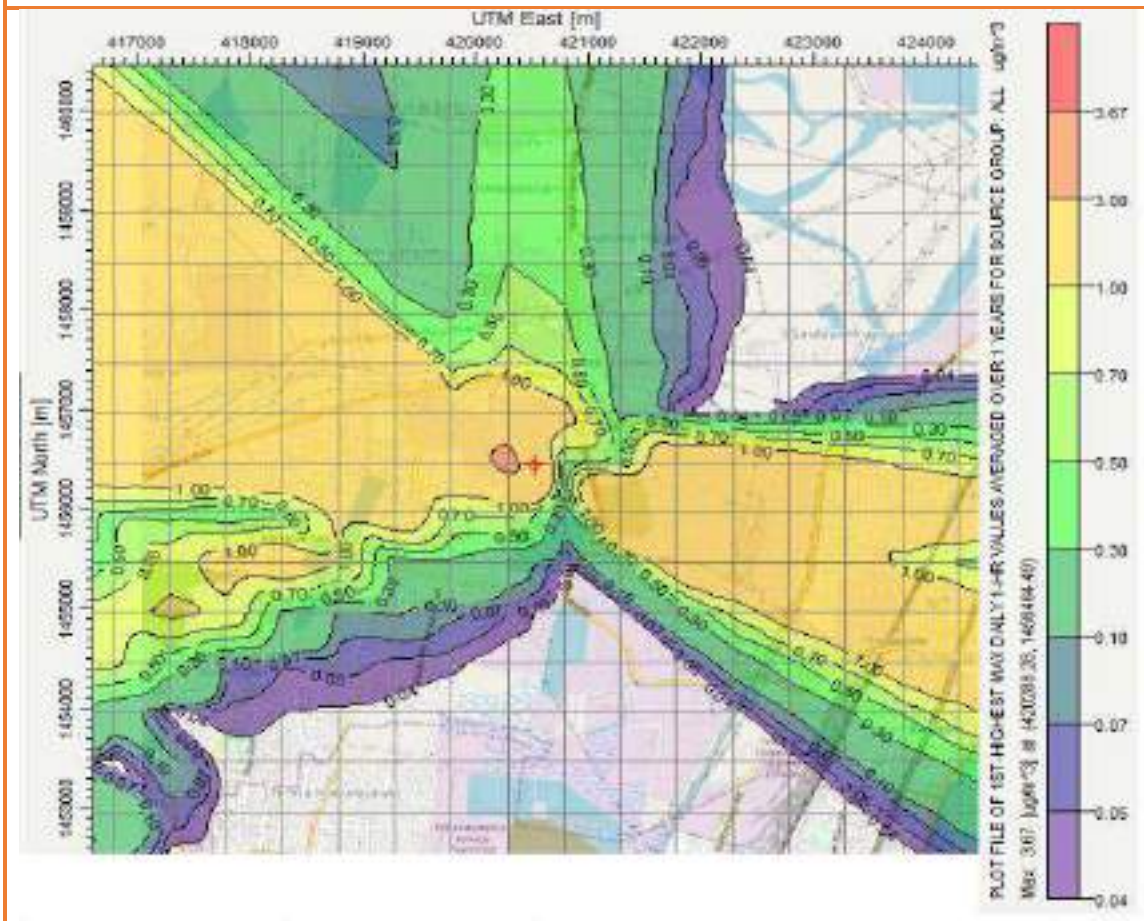
STACK EMISSION DISPERSION MODELLING – Stack 1F1B @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
22.9	0.91	1.68	0.43	0.0618

Stack – 1F1B emission of Particulate Matter concentration is 22.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.43µg/m3 and at 5km dispersion Particulate Matter is 0.0618µg/m3 and the predominant wind direction is ESE.

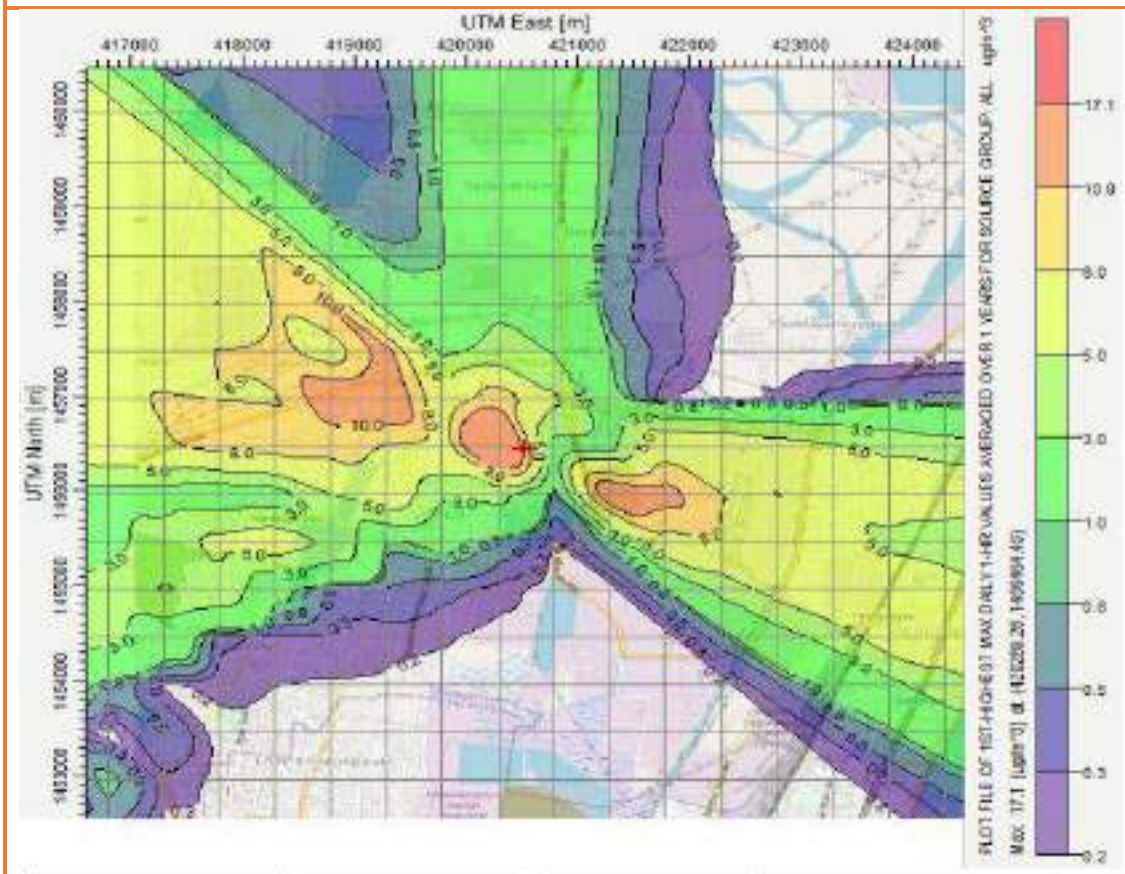
STACK EMISSION DISPERSION MODELLING – Stack 1F1B @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
48.8	0.76	3.67	0.55	0.0751

Stack – 1F1B emission of Sulphur dioxide concentration is 48.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 3.67µg/m3 at 2km dispersion Sulphur dioxide is 0.55µg/m3 and at 5km dispersion Sulphur dioxide is 0.0751µg/m3 and the predominant wind direction is ESE.

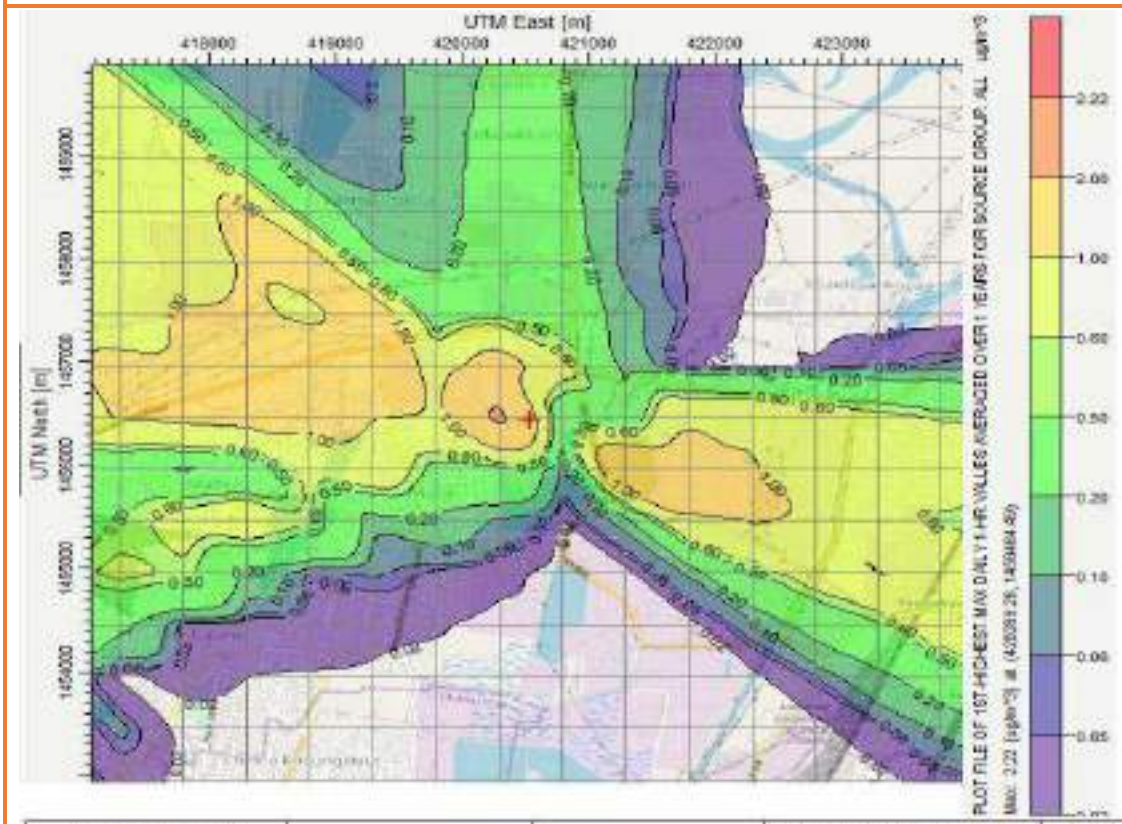
STACK EMISSION DISPERSION MODELLING – Stack 1F1B @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
232	0.8	17.1	2.31	0.551

Stack – 1F1B emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 17.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.551µg/m3 and the predominant wind direction is ESE.

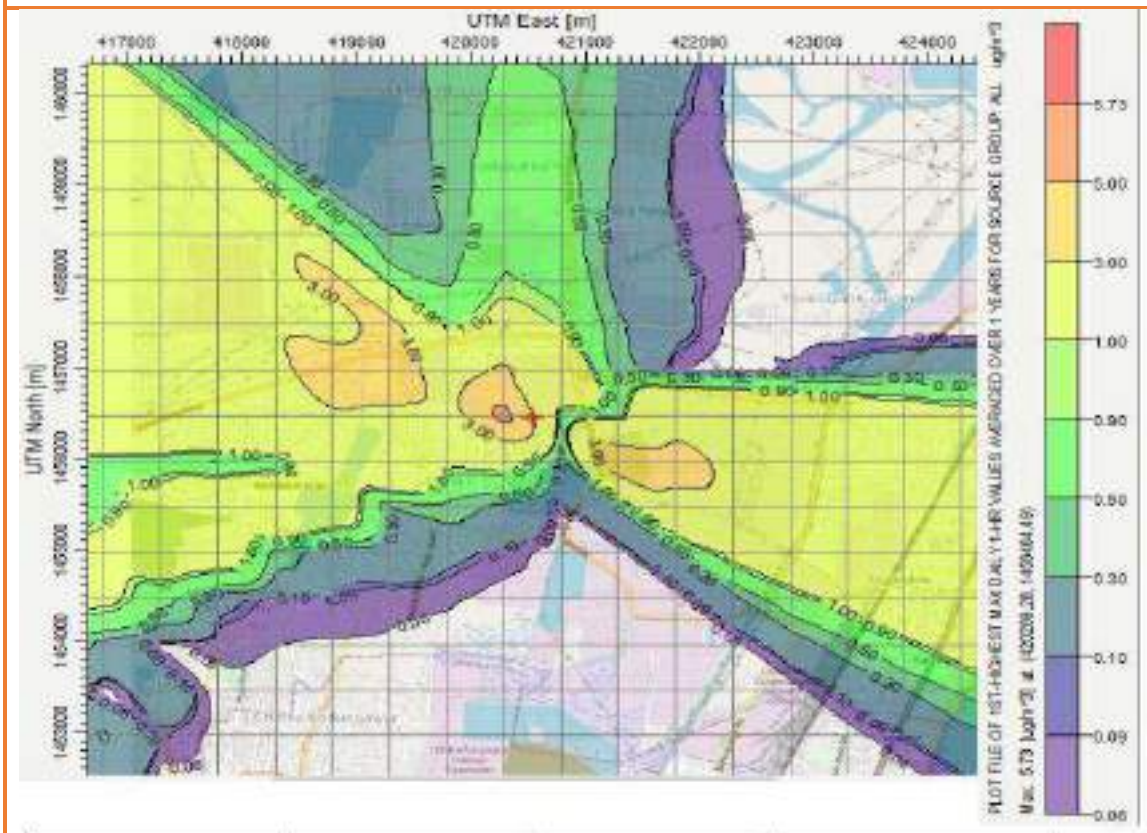
STACK EMISSION DISPERSION MODELLING – Stack 206F1 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.4	0.91	2.22	0.59	0.0823

Stack – 206F1 emission of Particulate Matter concentration is 9.4mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.22µg/m3 at 2km dispersion Particulate Matter is 0.59µg/m3 and at 5km dispersion Particulate Matter is 0.0823µg/m3 and the predominant wind direction is ESE.

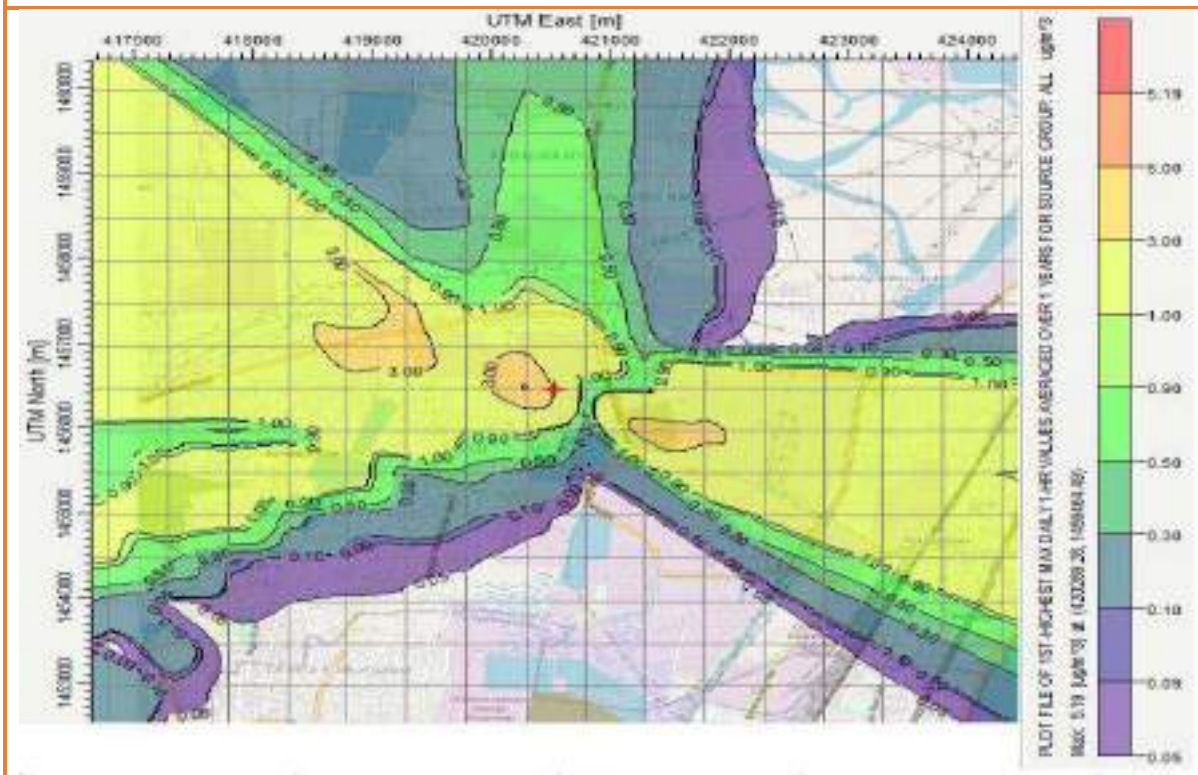
STACK EMISSION DISPERSION MODELLING – Stack 206F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
212	0.87	5.73	0.356	0.065

Stack – 206F1 emission of Sulphur dioxide concentration is 212mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 5.73µg/m3 at 2km dispersion Sulphur dioxide is 0.356µg/m3 and at 5km dispersion Sulphur dioxide is 0.065µg/m3 and the predominant wind direction is ESE.

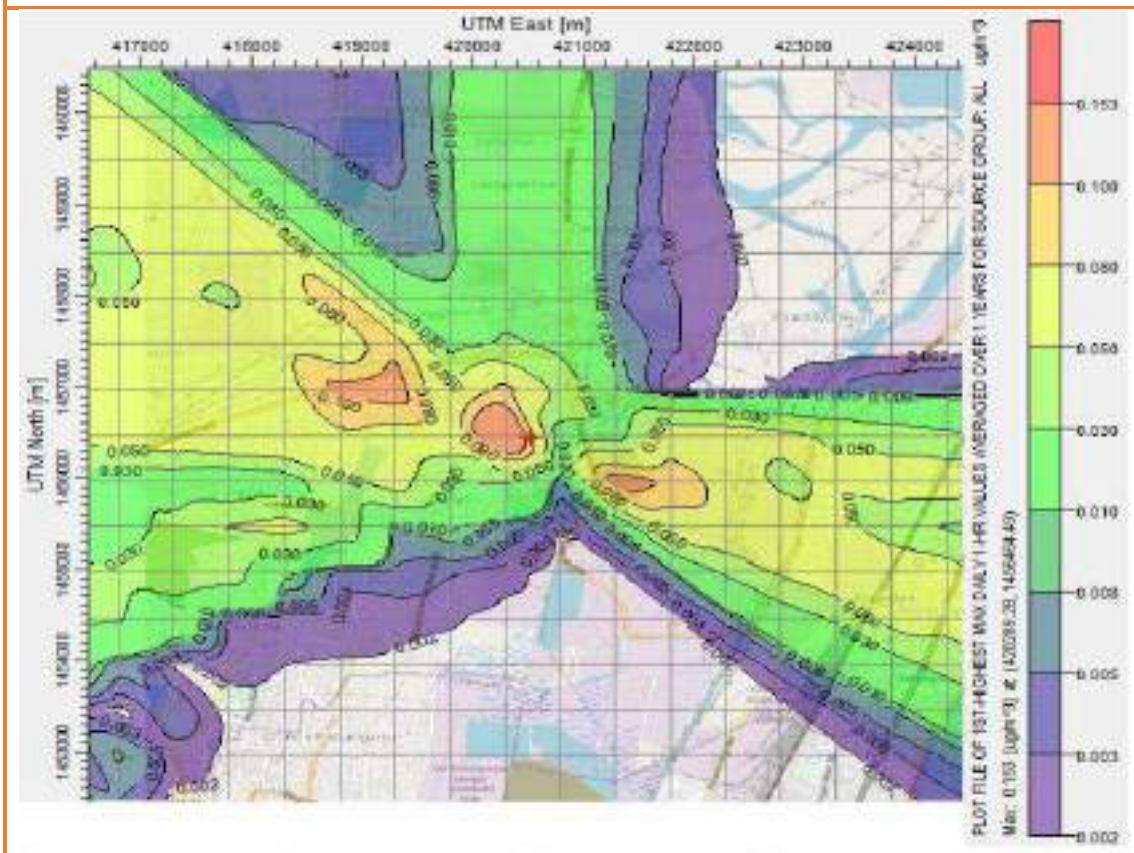
STACK EMISSION DISPERSION MODELLING – Stack 206F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
193	0.98	5.19	0.86	0.0621

Stack – 206F1 emission of Oxides of Nitrogen concentration is 193mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 5.19µg/m3 at 2km dispersion Oxides of Nitrogen is 0.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0621µg/m3 and the predominant wind direction is ESE.

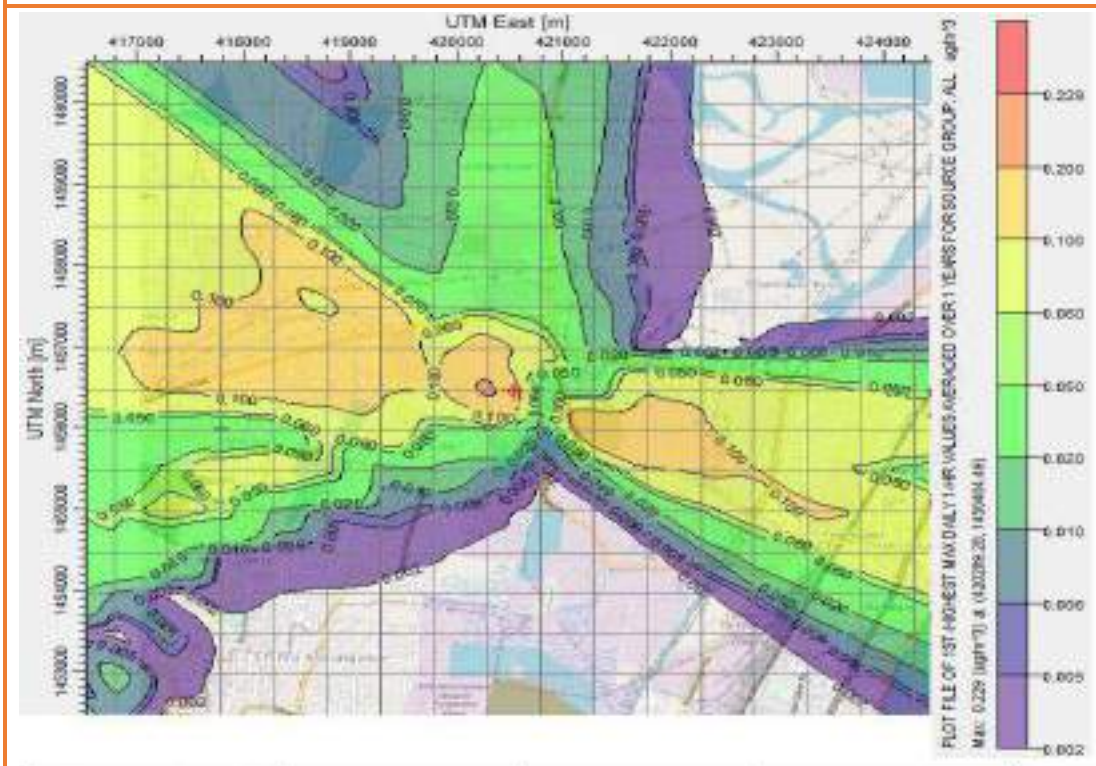
STACK EMISSION DISPERSION MODELLING – Stack 206F2 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
6	0.79	0.153	0.098	0.0113

Stack – 206F2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 0.153µg/m3 at 2km dispersion Carbon Monoxide is 0.098µg/m3 and at 5km dispersion Carbon Monoxide is 0.0113µg/m3 and the predominant wind direction is ESE.

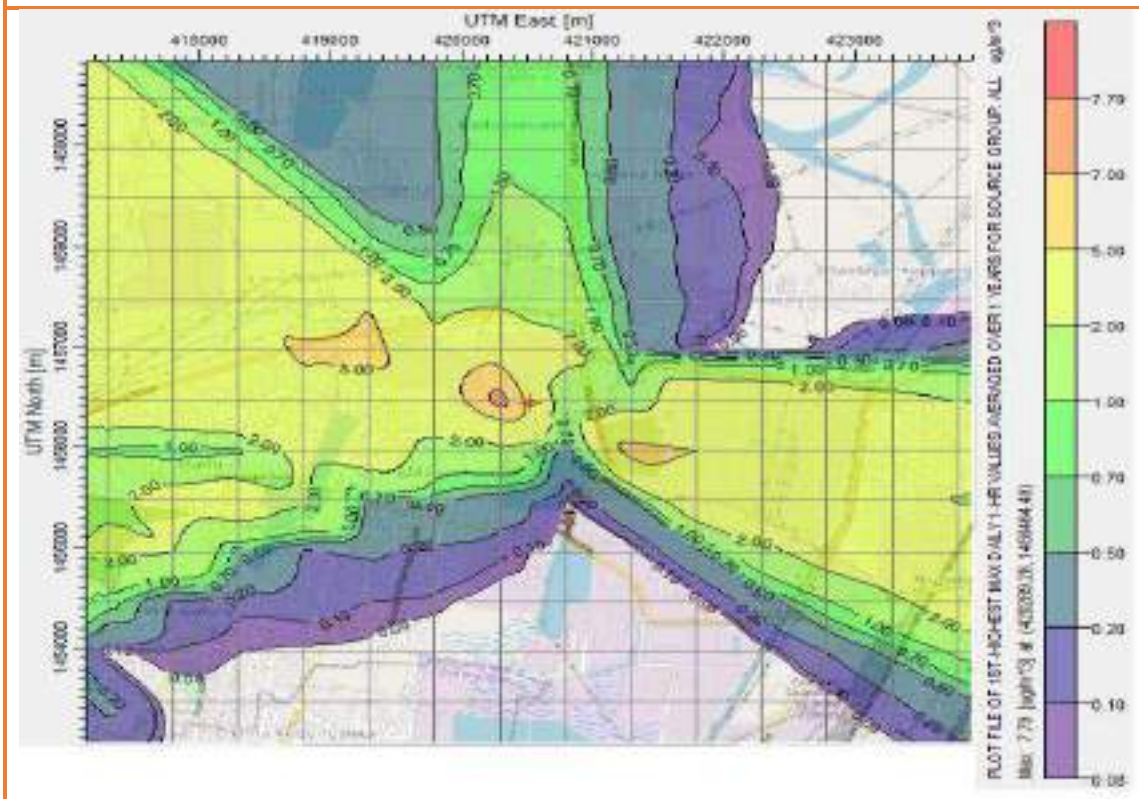
STACK EMISSION DISPERSION MODELLING – Stack 206F2 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.8	0.93	0.229	0.0976	0.0034

Stack – 206F2 emission of Particulate Matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.93km at the concentration of 0.229µg/m3 at 2km dispersion Particulate Matter is 0.0976µg/m3 and at 5km dispersion Particulate Matter is 0.0034µg/m3 and the predominant wind direction is ESE.

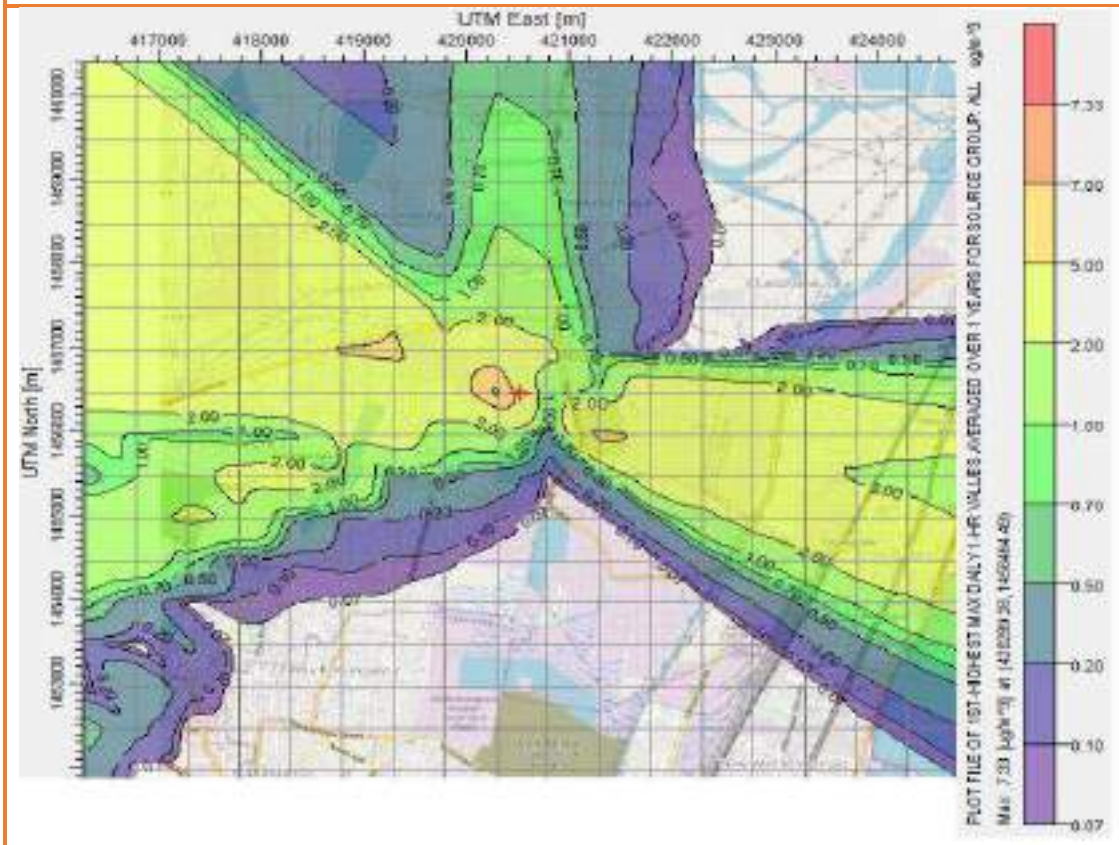
STACK EMISSION DISPERSION MODELLING – Stack 206F2 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
289	0.99	7.79	0.751	0.0134

Stack – 206F2 emission of Sulphur dioxide concentration is 289mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 7.79µg/m3 at 2km dispersion Sulphur dioxide is 0.751µg/m3 and at 5km dispersion Sulphur dioxide is 0.0134µg/m3 and the predominant wind direction is ESE.

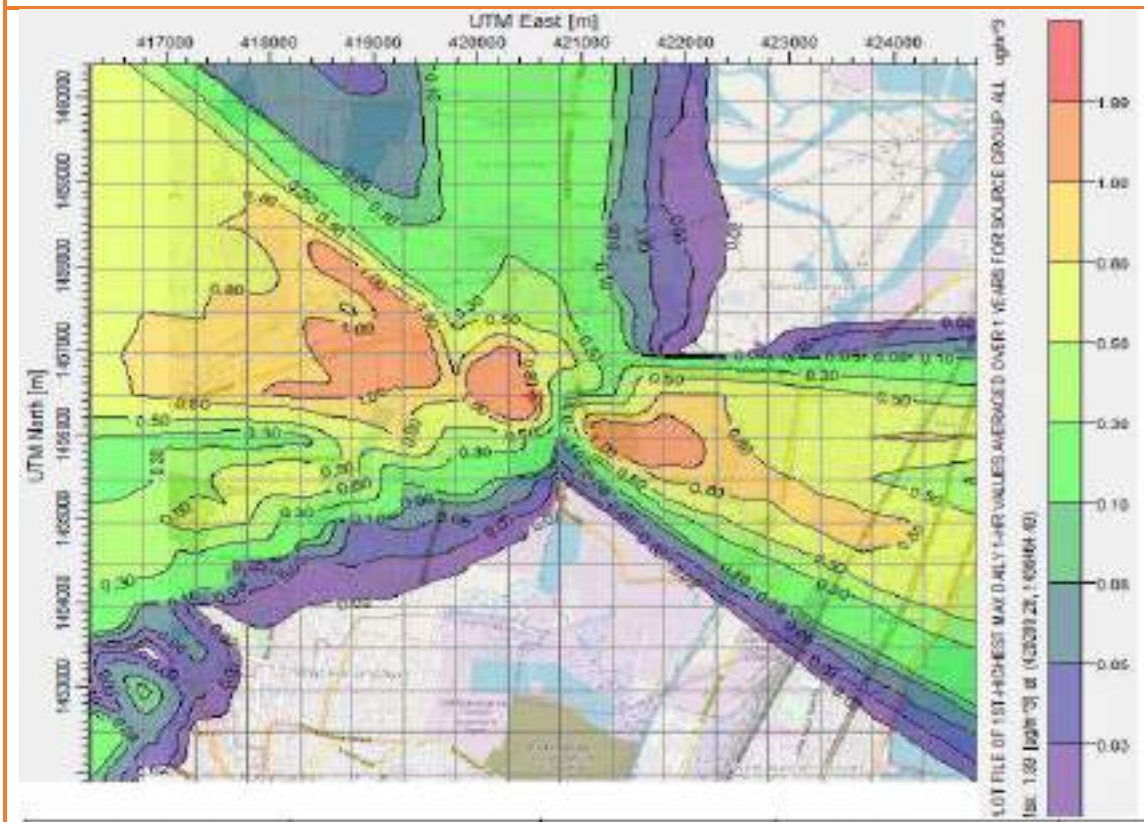
STACK EMISSION DISPERSION MODELLING – Stack 206F2 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
272	0.82	7.33	1.56	0.75

Stack – 206F2 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 7.33µg/m3 at 2km dispersion Oxides of Nitrogen is 1.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

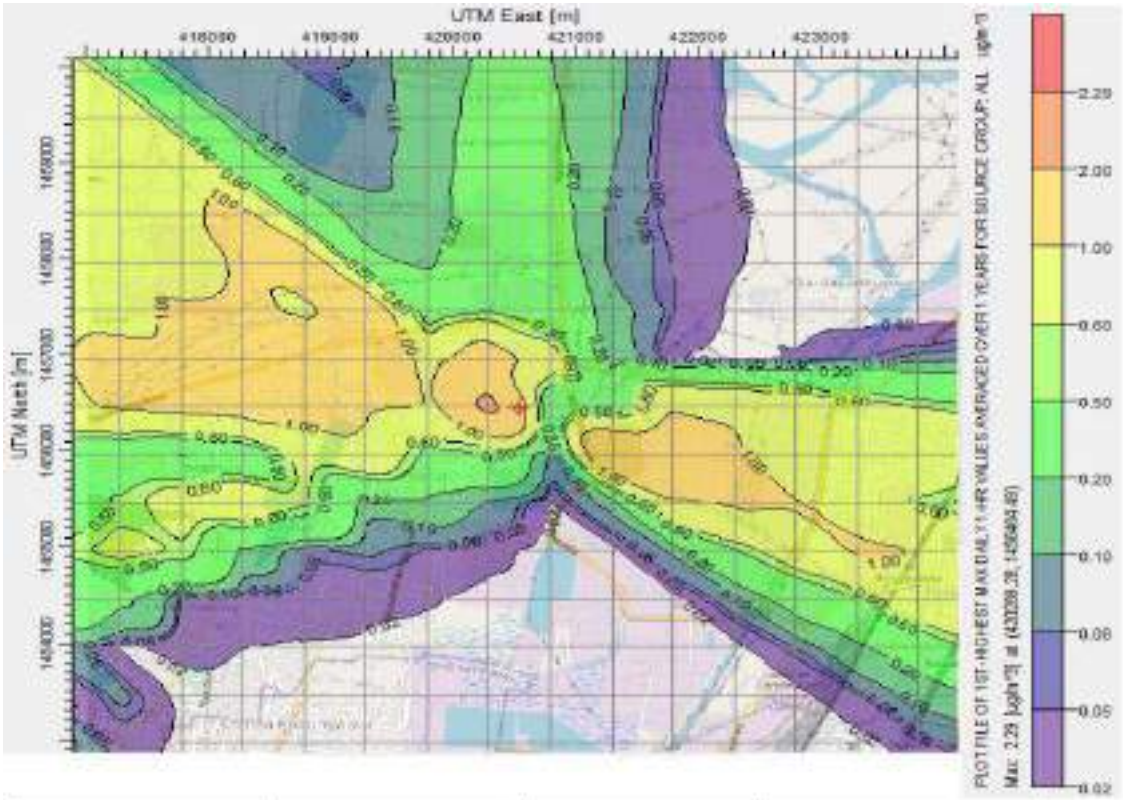
STACK EMISSION DISPERSION MODELLING – Stack 214F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7	0.78	1.99	0.12	0.0431

Stack – 214F1 emission of Carbon Monoxide concentration is 7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.99µg/m3 at 2km dispersion Carbon Monoxide is 0.12µg/m3 and at 5km dispersion Carbon Monoxide is 0.0431µg/m3 and the predominant wind direction is ESE.

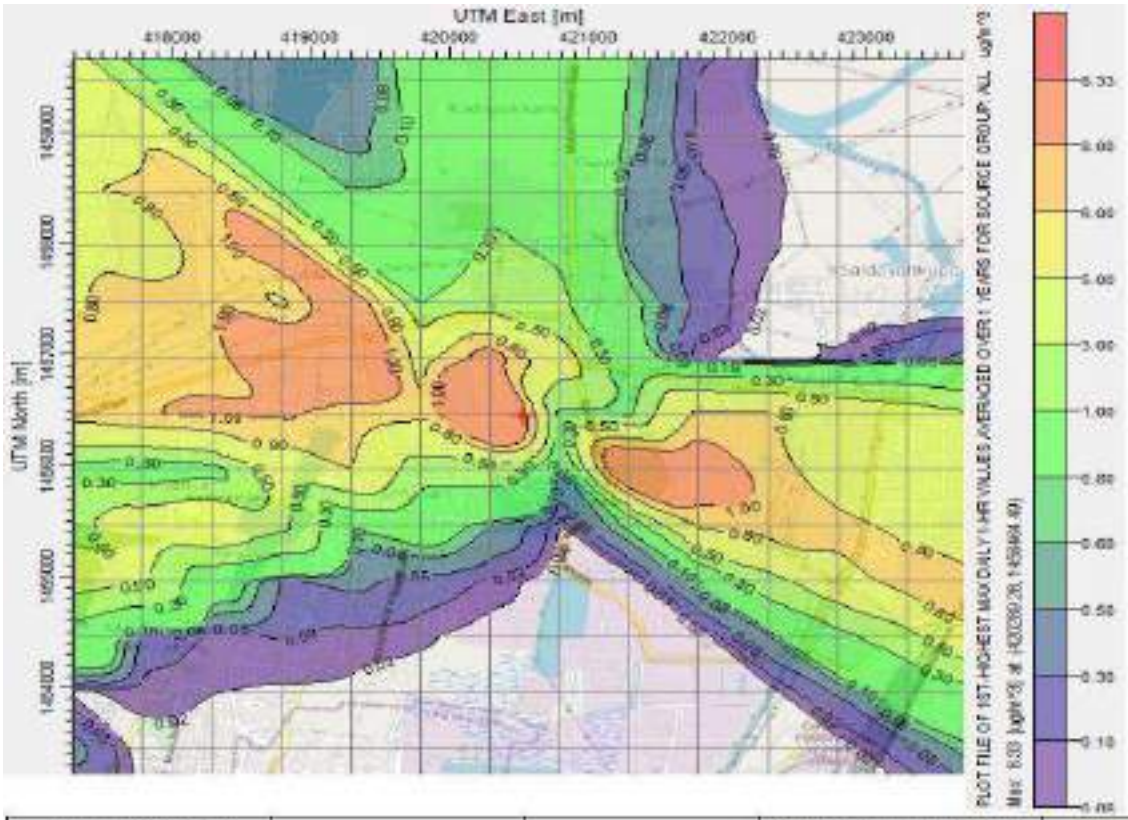
STACK EMISSION DISPERSION MODELLING – Stack 214F1 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.1	0.86	2.29	0.787	0.011

Stack – 214F1 emission of Particulate Matter concentration is 9.1mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 2.29µg/m3 at 2km dispersion Particulate Matter is 0.787µg/m3 and at 5km dispersion Particulate Matter is 0.011µg/m3 and the predominant wind direction is ESE.

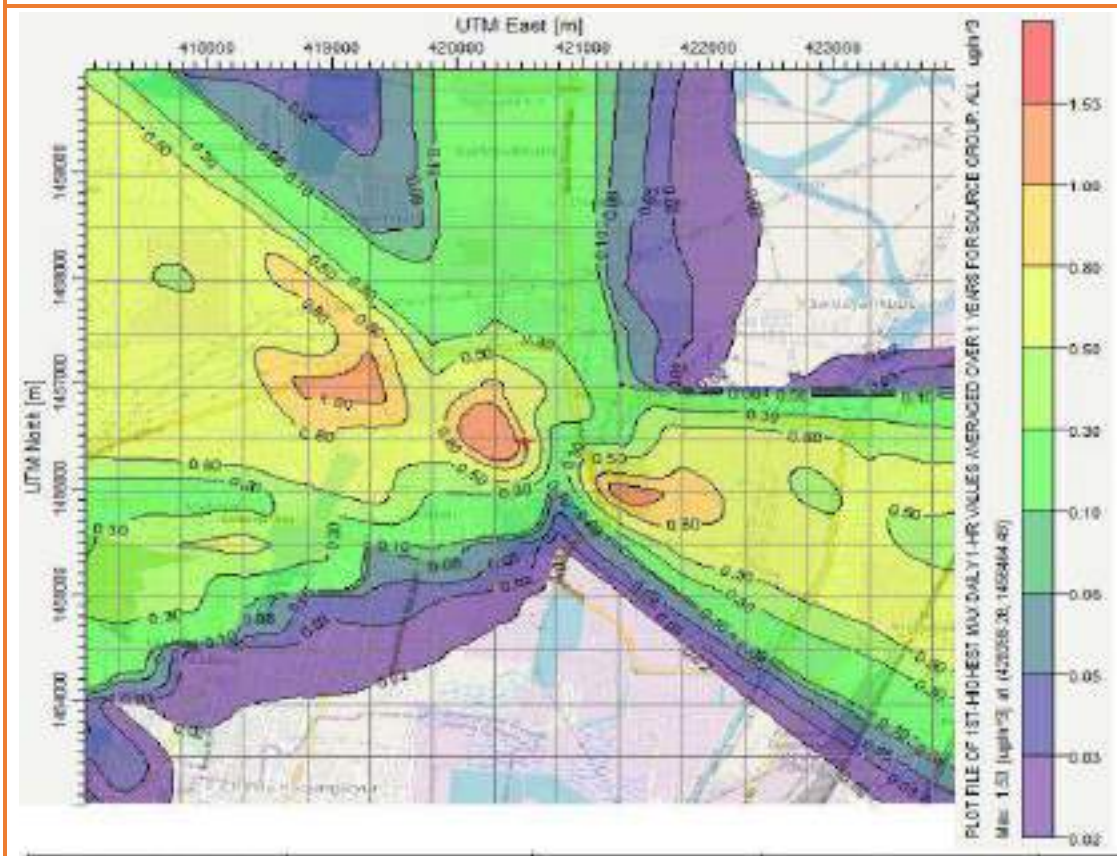
STACK EMISSION DISPERSION MODELLING – Stack 214F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
29	0.85	8.33	2.21	0.97

Stack – 214F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 2.21µg/m3 at 2km dispersion Oxides of Nitrogen is 2.21µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.97µg/m3 and the predominant wind direction is ESE.

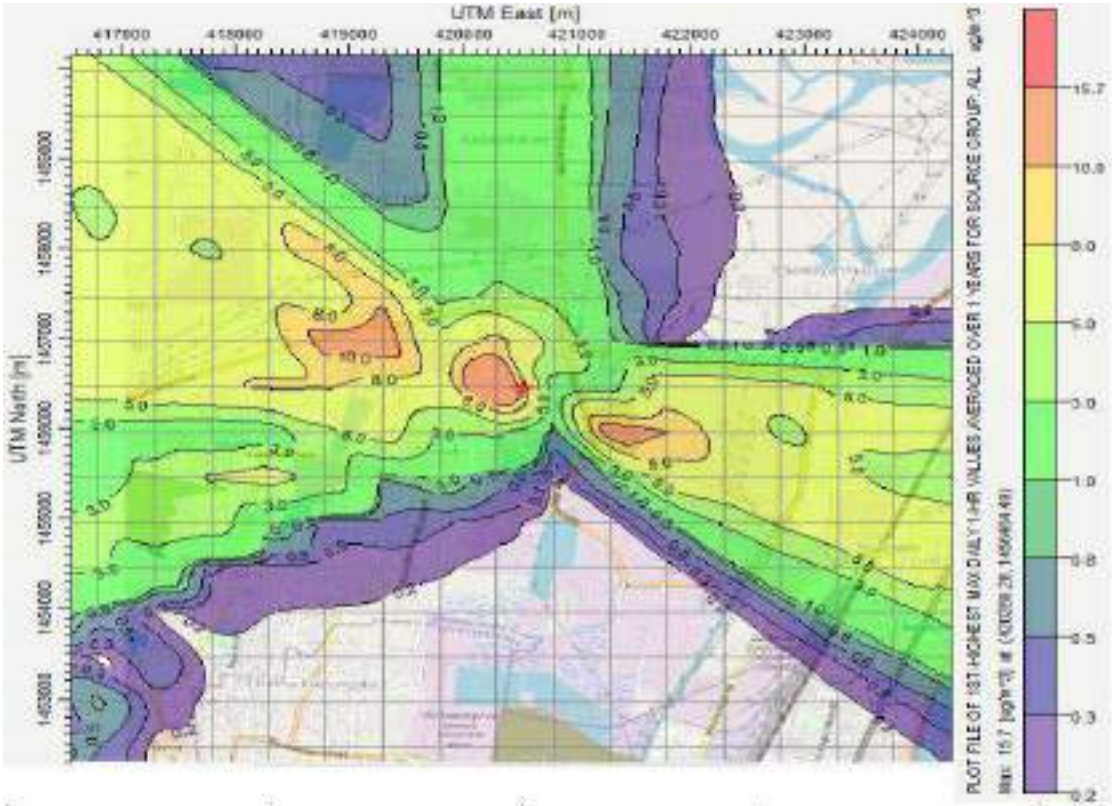
STACK EMISSION DISPERSION MODELLING – Stack 1F3 @ 2 & 5KM – Particulate Matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
18.2	0.87	1.53	0.53	0.017

Stack – 1F3 emission of Particulate Matter concentration is 18.2mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 1.53µg/m3 at 2km dispersion Particulate Matter is 0.53µg/m3 and at 5km dispersion Particulate Matter is 0.017µg/m3 and the predominant wind direction is ESE.

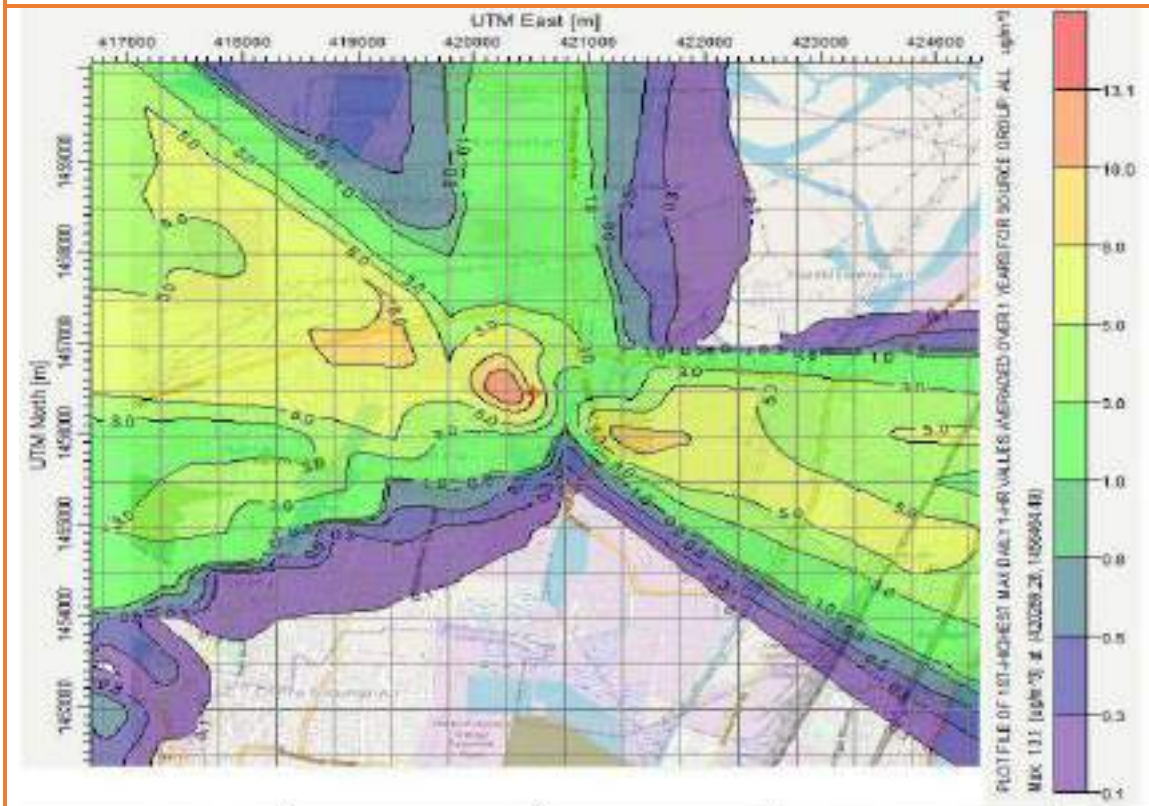
STACK EMISSION DISPERSION MODELLING – Stack 1F3 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
229	0.81	15.7	1.876	0.592

Stack – 1F3 emission of Sulphur dioxide concentration is 222.9mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 15.7µg/m3 at 2km dispersion Sulphur dioxide is 1.876µg/m3 and at 5km dispersion Sulphur dioxide is 0.592µg/m3 and the predominant wind direction is ESE.

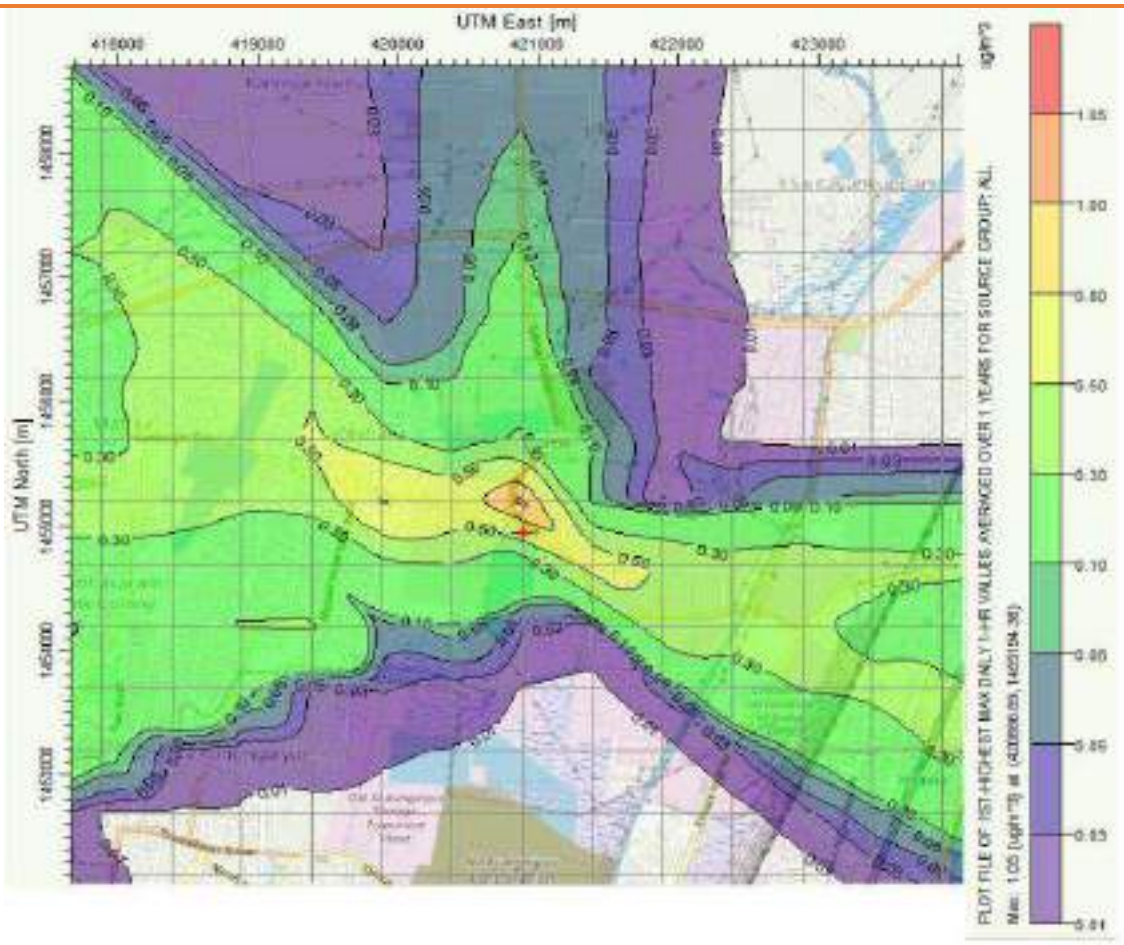
STACK EMISSION DISPERSION MODELLING – Stack 1F3 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
191	0.96	13.1	2.88	0.813

Stack – 1F3 emission of Oxides of Nitrogen concentration is 191mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 13.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.88µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.813µg/m3 and the predominant wind direction is ESE.

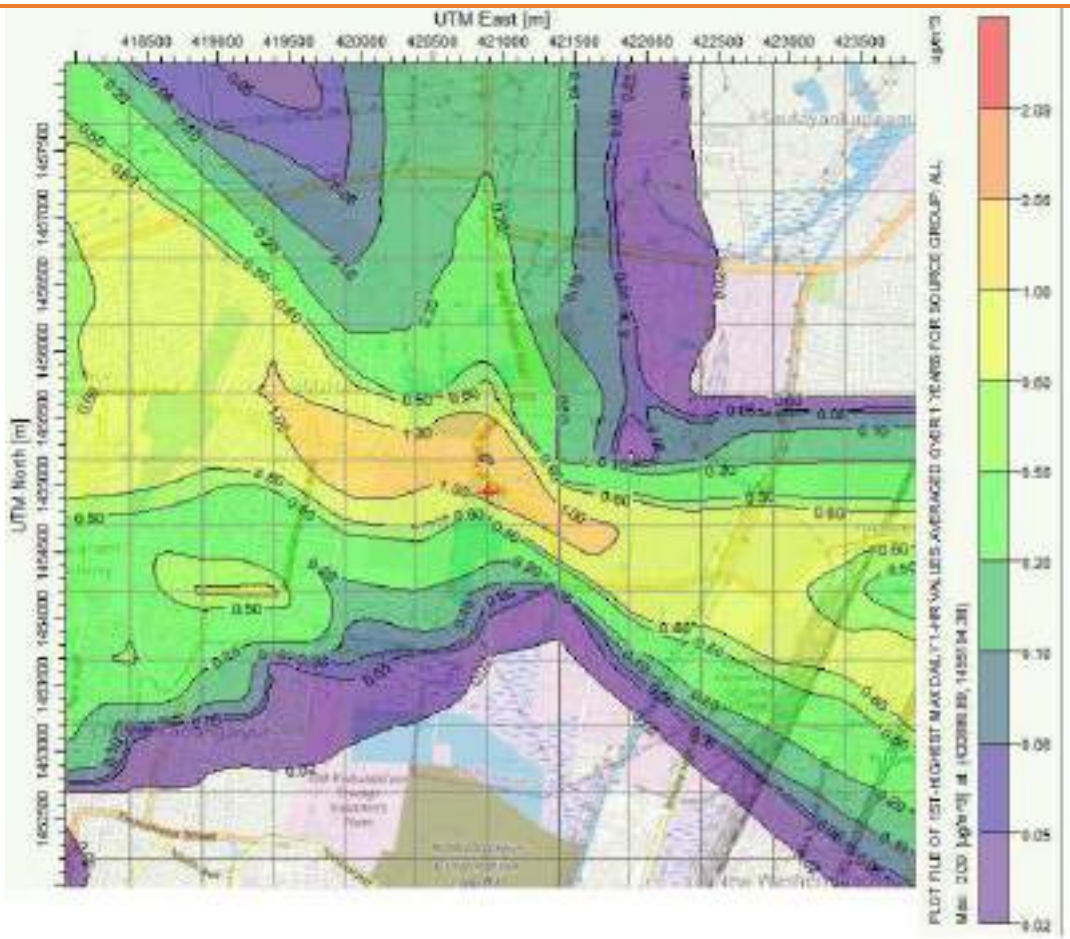
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A EAST @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
14.5	0.874	1.05	0.89	0.078

Stack - 1F1A East emission of Particulate matter concentration is 14.5mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.874km at the concentration of 1.05µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.078µg/m3 and the predominant wind direction is ESE.

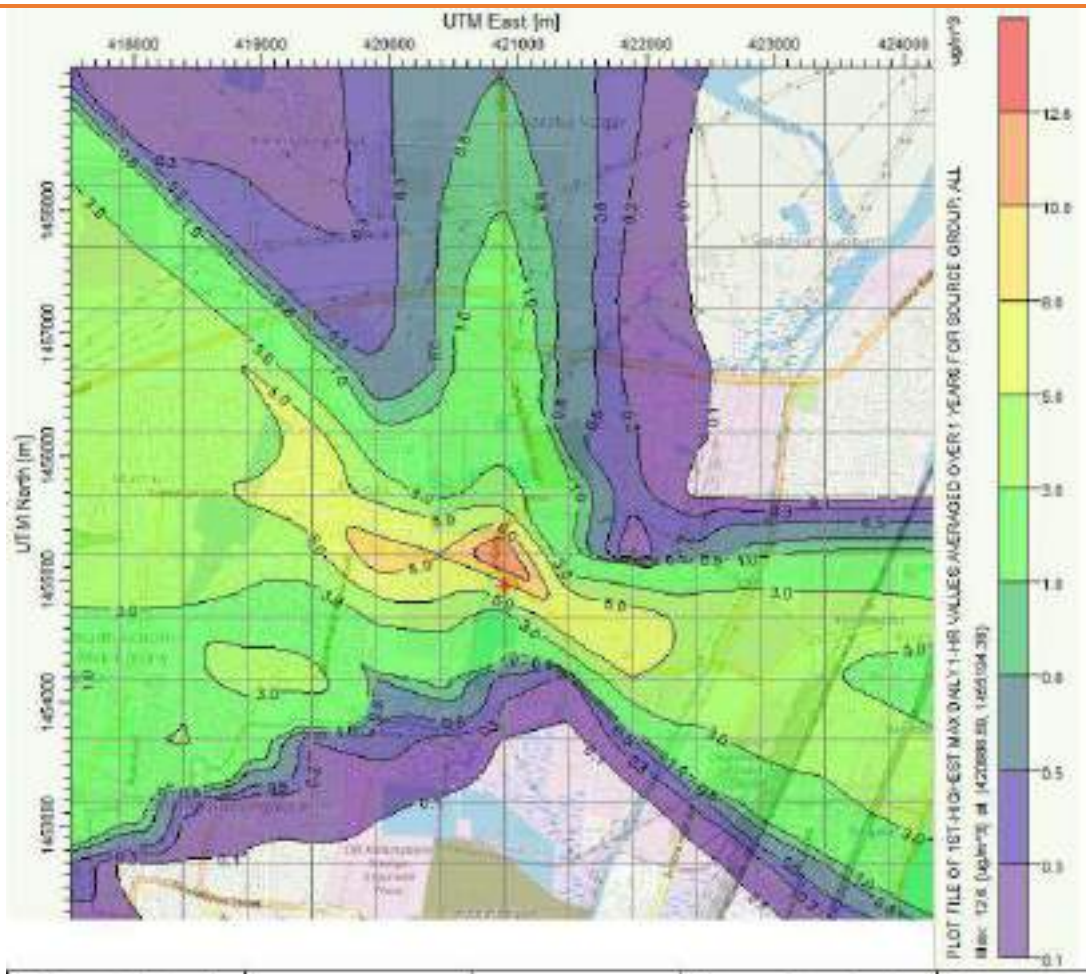
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A EAST @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
164	0.832	2.09	0.27	0.076

Stack - 1F1A East emission of Sulphur dioxide concentration is 164mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.832km at the concentration of 2.09µg/m3 at 2km dispersion Sulphur dioxide is 0.27µg/m3 and at 5km dispersion Sulphur dioxide is 0.076µg/m3 and the predominant wind direction is ESE.

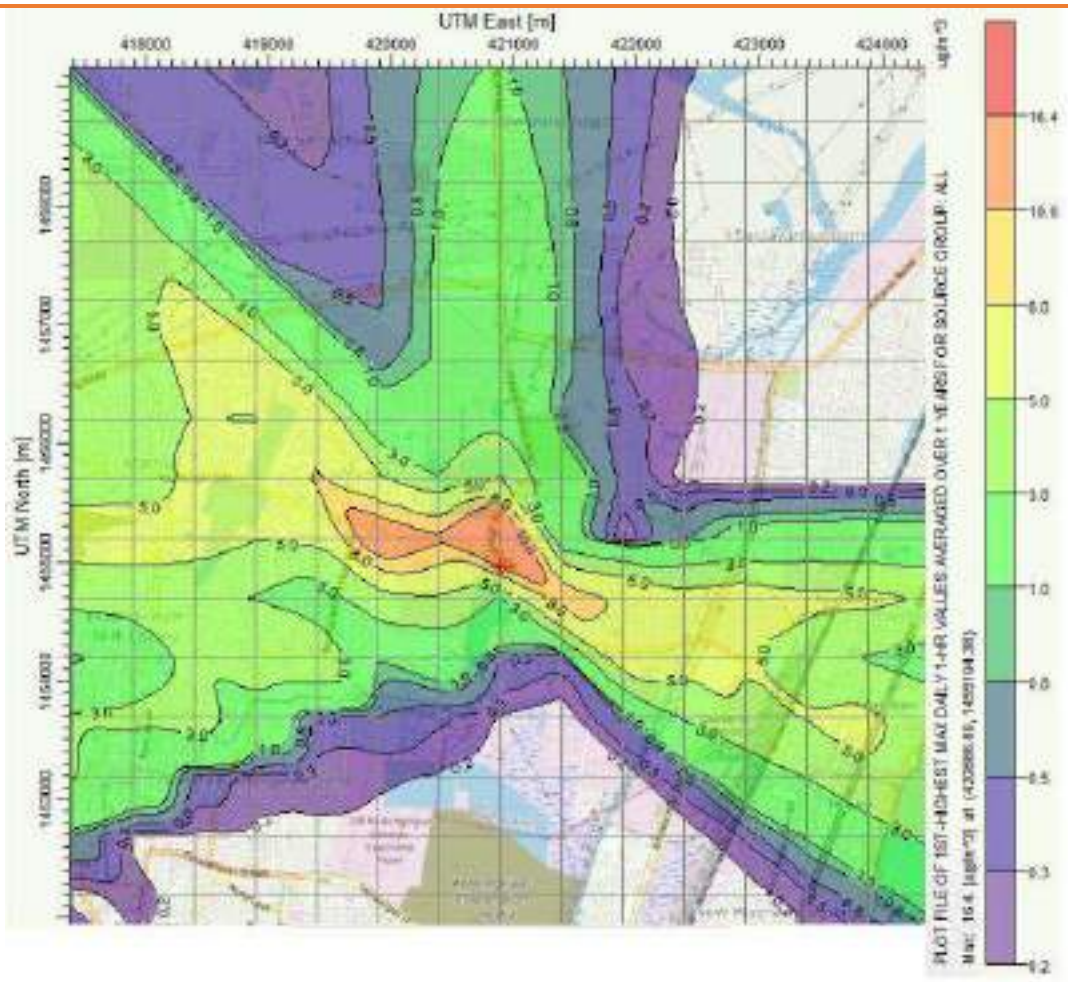
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A EAST @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
125	0.87	12.6	2.18	0.896

Stack - 1F1A East emission of Oxides of Nitrogen concentration is 125mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 12.6µg/m3 at 2km dispersion Oxides of Nitrogen is 2.18µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.896µg/m3 and the predominant wind direction is ESE.

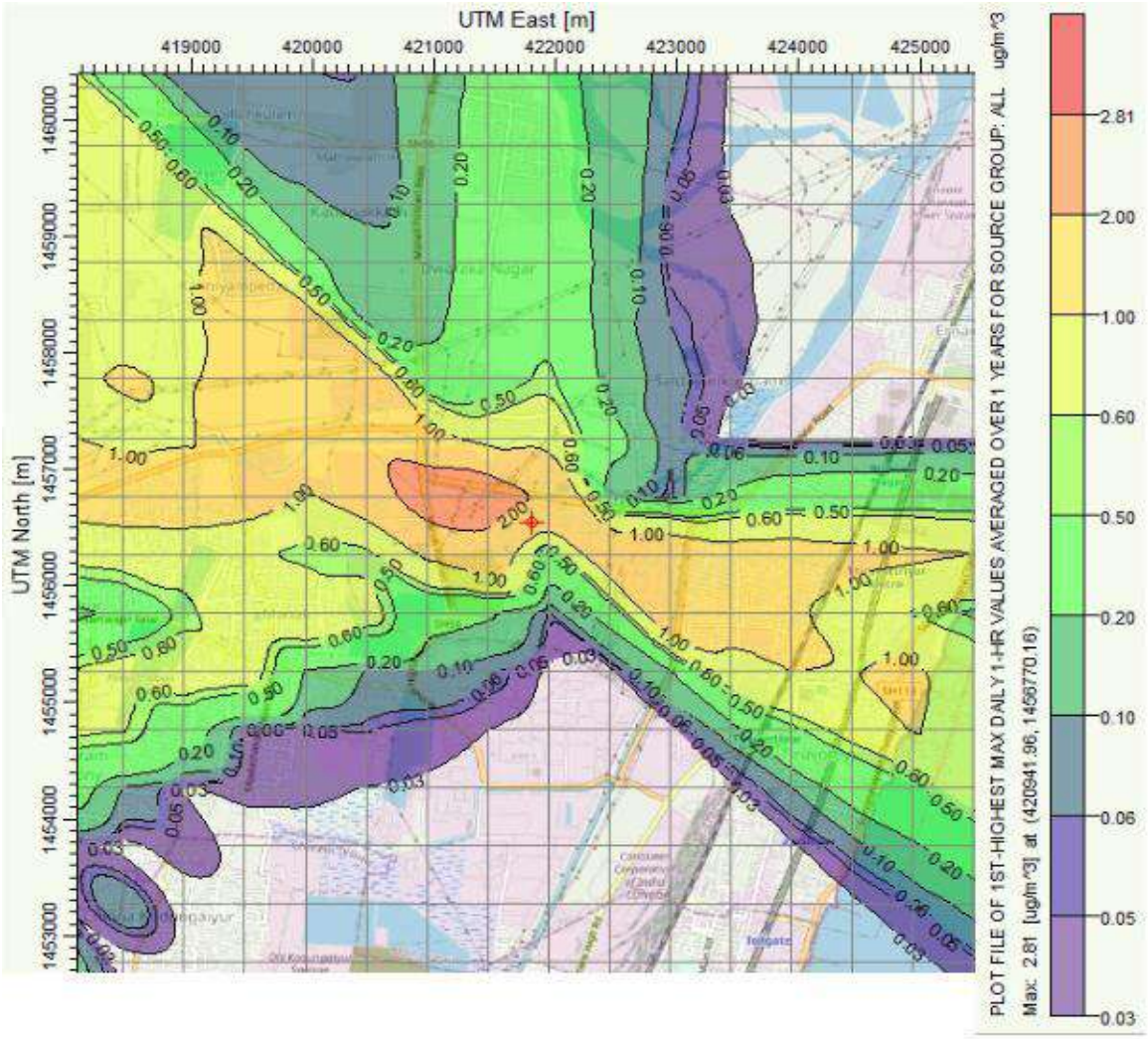
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A WEST @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
56	0.877	16.4	1.87	0.977

Stack - 1F1A west emission of Carbon Monoxide concentration is 56mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.877km at the concentration of 16.4µg/m3 at 2km dispersion Carbon Monoxide is 1.87µg/m3 and at 5km dispersion Carbon Monoxide is 0.977µg/m3 and the predominant wind direction is ESE.

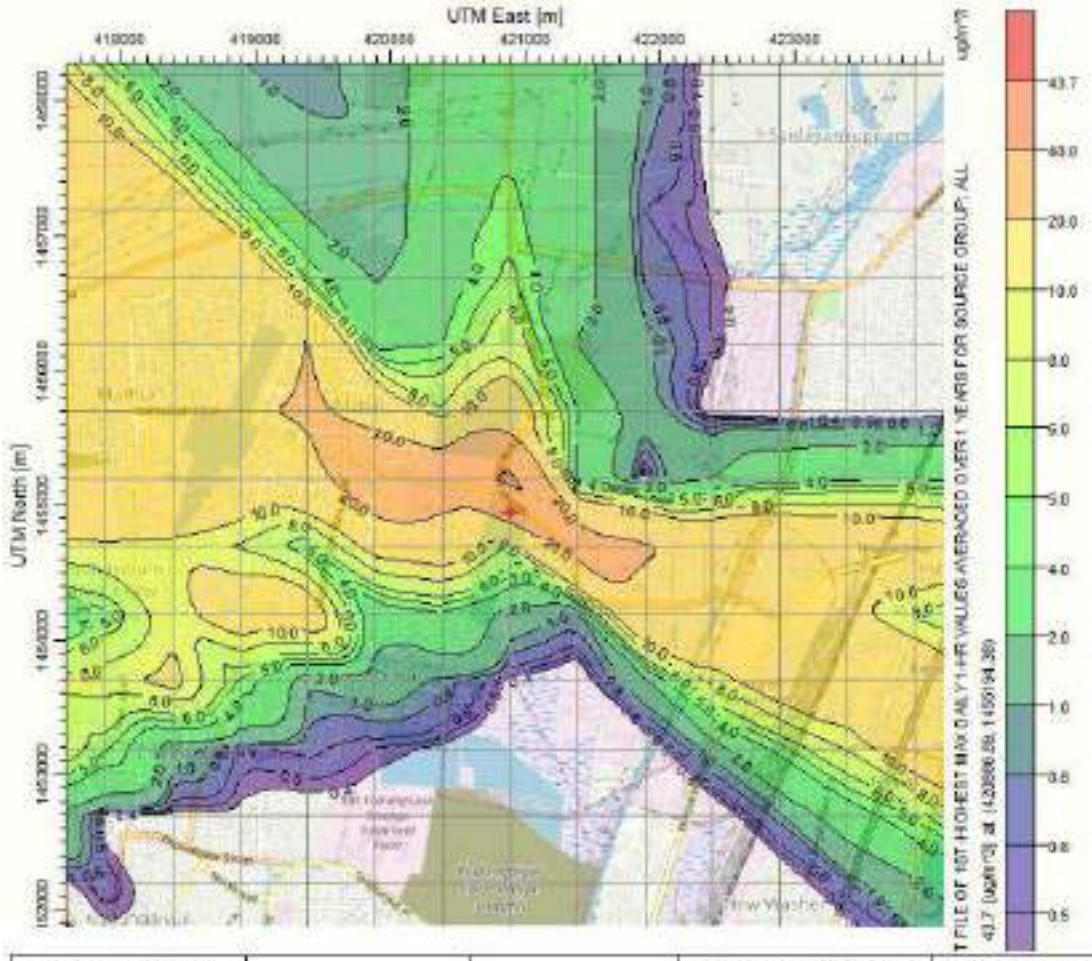
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A WEST @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
12.4	0.911	2.81	0.111	0.0552

Stack - 1F1A west emission of Particulate matter concentration is 12.4mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.911km at the concentration of 2.81µg/m3 at 2km dispersion Particulate matter is 0.111µg/m3 and at 5km dispersion Particulate matter is 0.0552µg/m3 and the predominant wind direction is ESE.

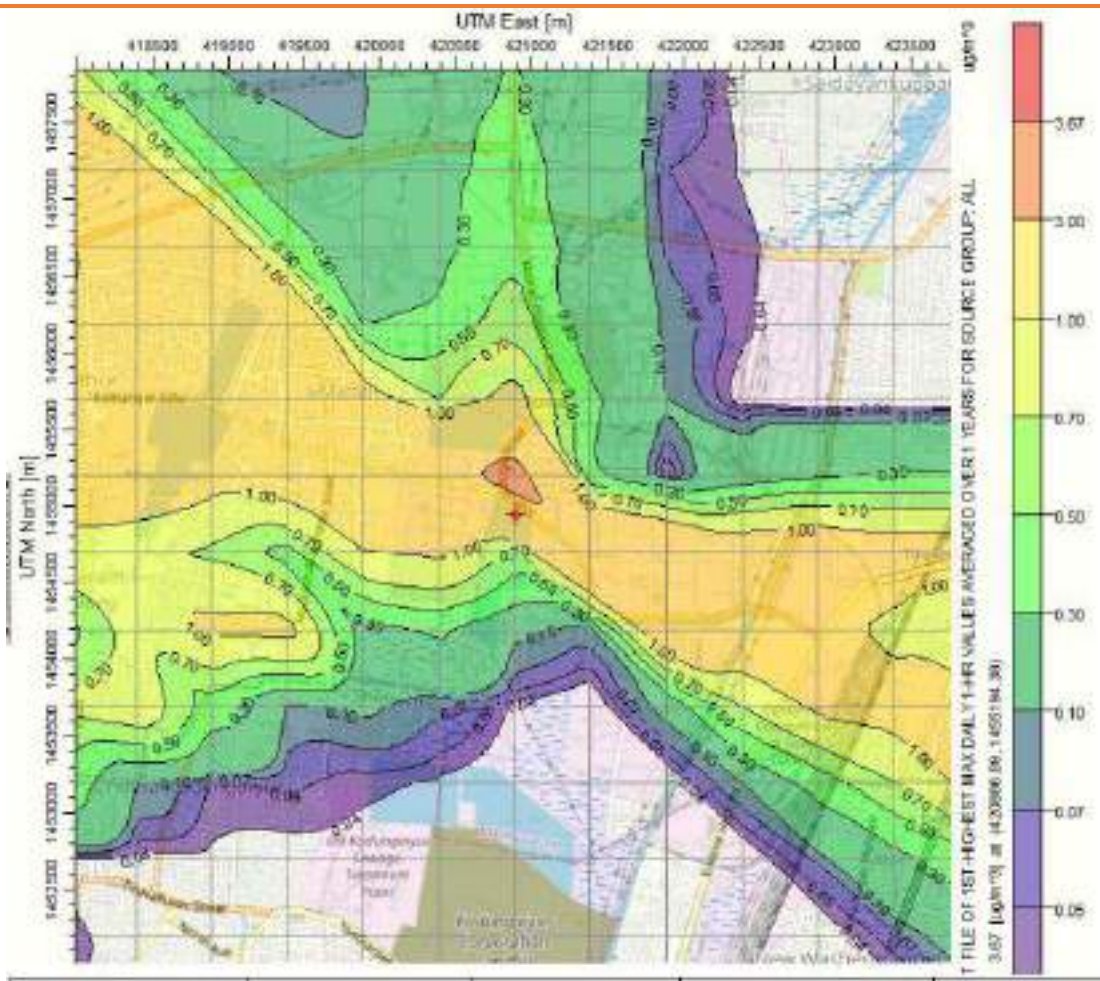
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A WEST @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
149	0.81	43.7	21.2	17.76

Stack - 1F1A west emission of Sulphur dioxide concentration is 149mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 43.7µg/m3 at 2km dispersion Sulphur dioxide is 21.2µg/m3 and at 5km dispersion Sulphur dioxide is 17.76µg/m3 and the predominant wind direction is ESE.

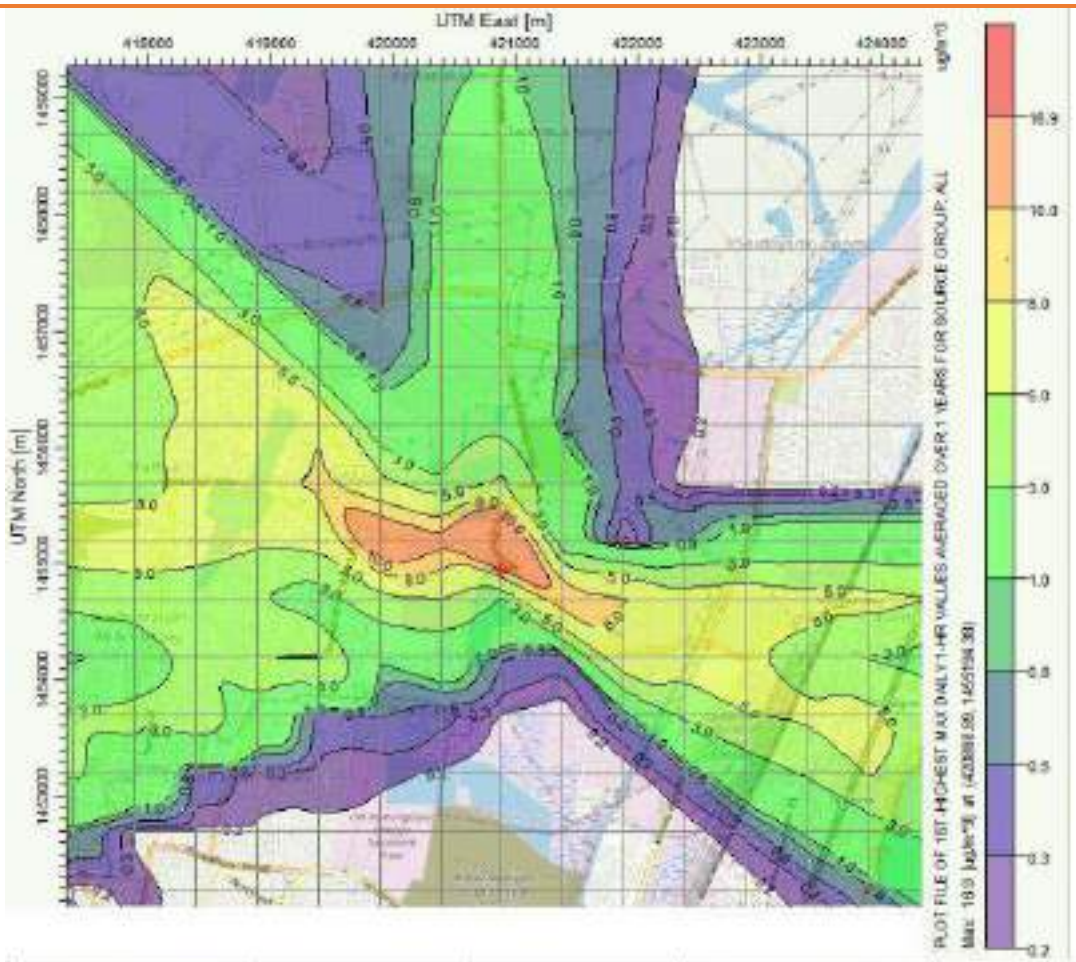
STACK EMISSION DISPERSION MODELLING – Stack - 1F1A WEST @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
101	0.721	3.67	0.41	0.075

Stack - 1F1A west emission of Oxides of Nitrogen concentration is 101mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.721km at the concentration of 3.67µg/m3 at 2km dispersion Oxides of Nitrogen is 0.41µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.075µg/m3 and the predominant wind direction is ESE.

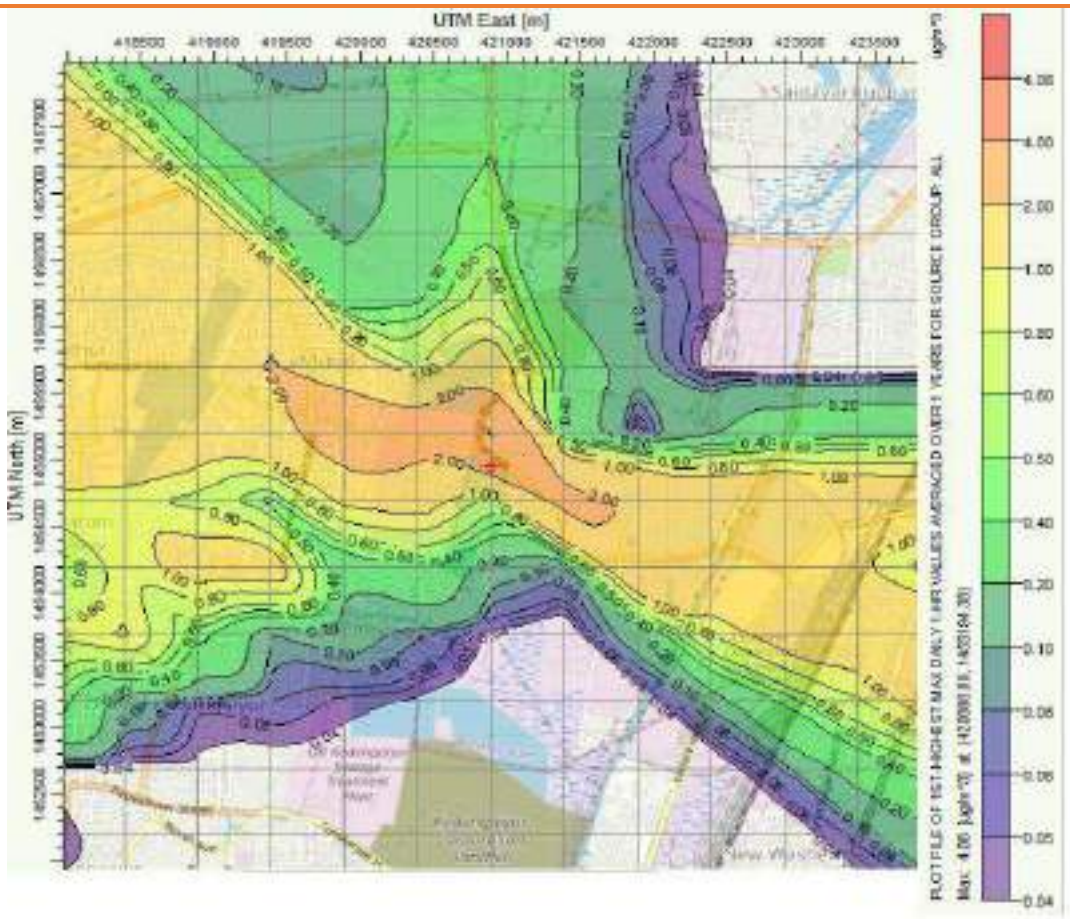
STACK EMISSION DISPERSION MODELLING – Stack - 10F101 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
111	0.73	16.9	5.323	0.927

Stack - 10F101 emission of Carbon Monoxide concentration is 111mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 16.9µg/m3 at 2km dispersion Carbon Monoxide is 5.323µg/m3 and at 5km dispersion Carbon Monoxide is 0.927µg/m3 and the predominant wind direction is ESE.

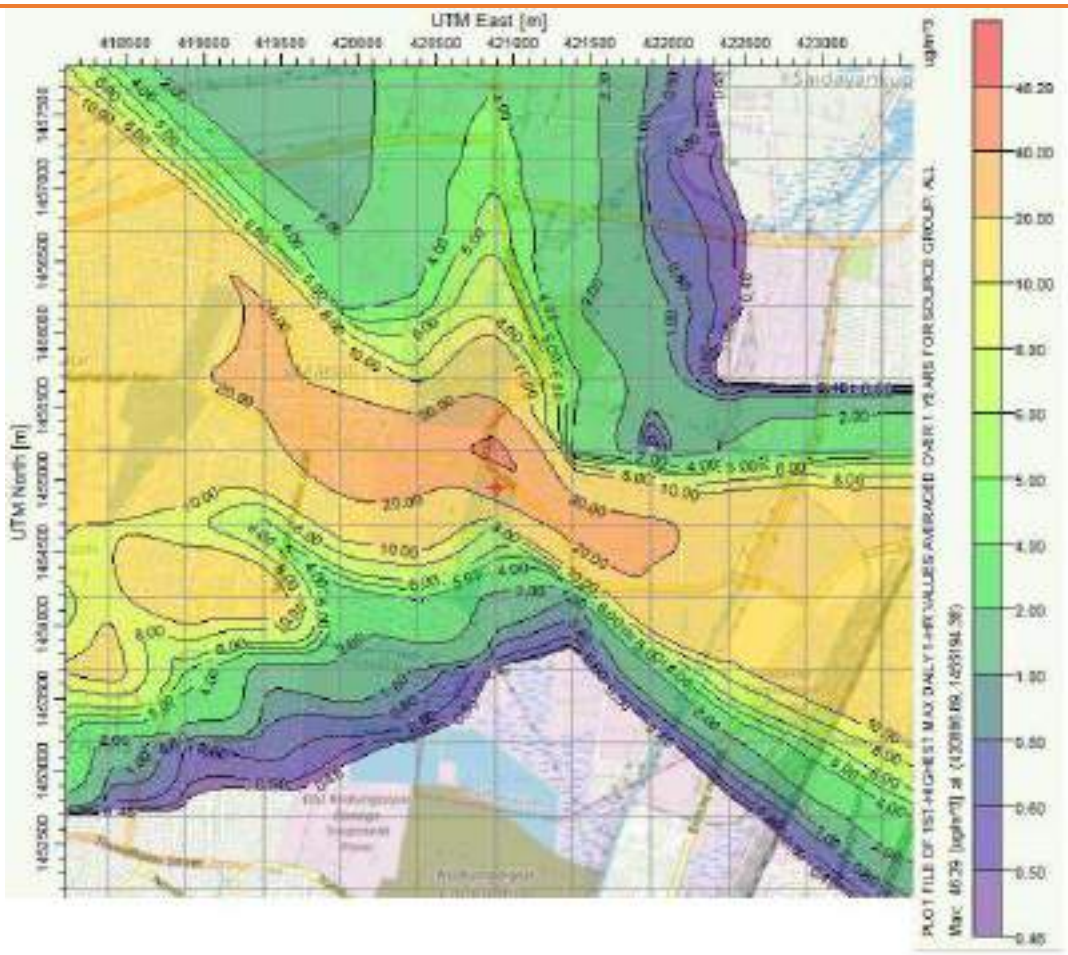
STACK EMISSION DISPERSION MODELLING – Stack - 10F101 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
19.1	0.81	4.08	1.11	0.534

Stack - 10F101 emission of Particulate matter concentration is 19.1mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 4.08µg/m3 at 2km dispersion Particulate matter is 1.11µg/m3 and at 5km dispersion Particulate matter is 0.534µg/m3 and the predominant wind direction is ESE.

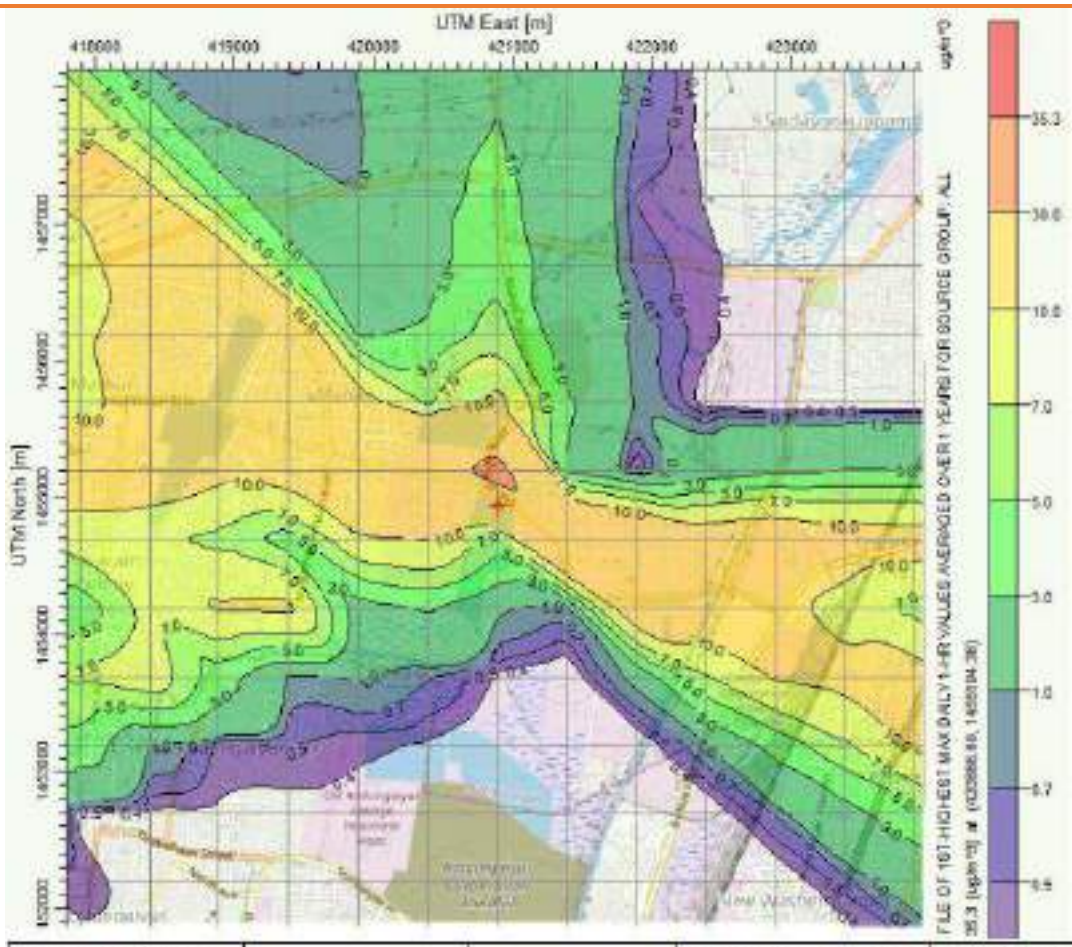
STACK EMISSION DISPERSION MODELLING – Stack - 10F101 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
40.8	0.78	46.29	18.21	8.11

Stack - 10F101 emission of Sulphur dioxide concentration is 40.8mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 46.29µg/m3 at 2km dispersion Sulphur dioxide is 18.21µg/m3 and at 5km dispersion Sulphur dioxide is 8.11µg/m3 and the predominant wind direction is ESE.

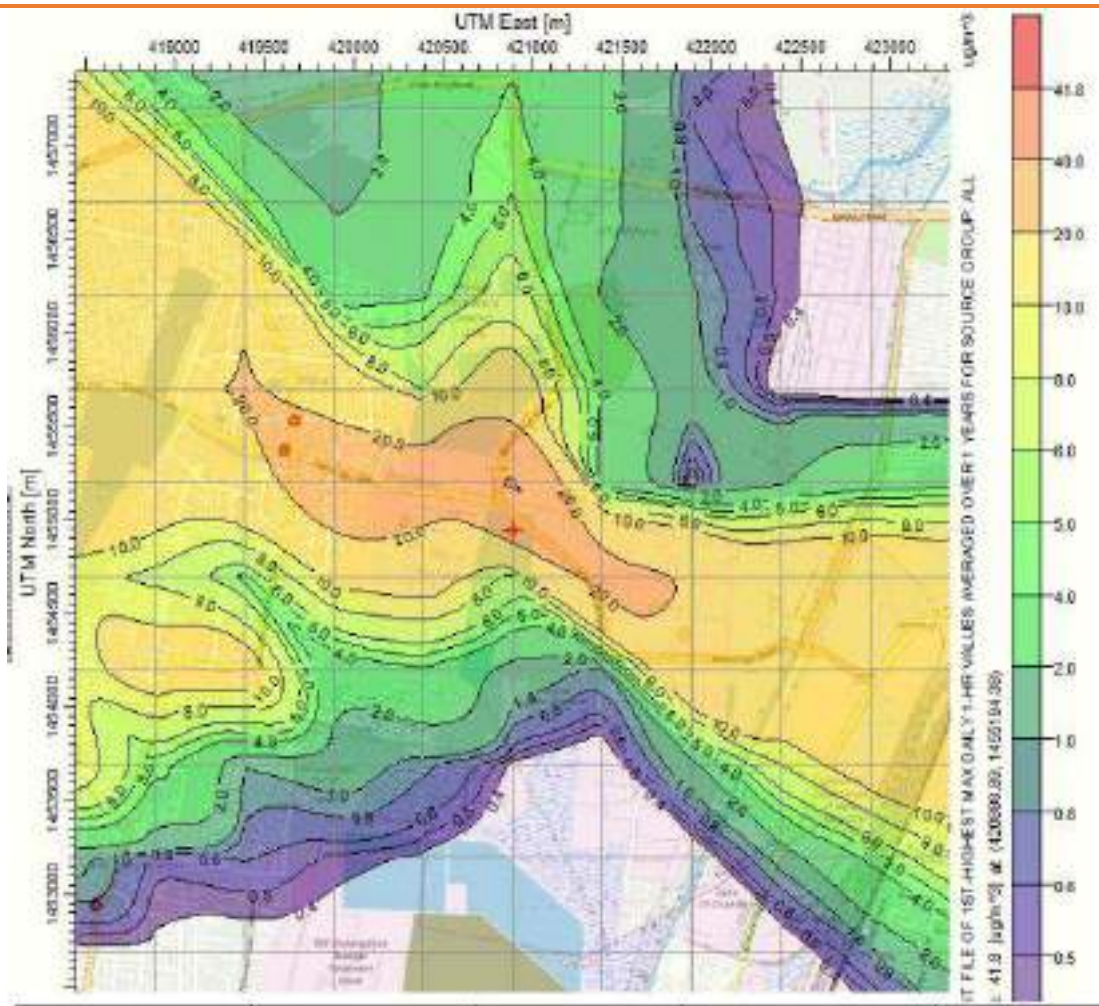
STACK EMISSION DISPERSION MODELLING – Stack - 10F101 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
232	0.77	35.3	15.16	6.61

Stack - 10F101 emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 35.3µg/m3 at 2km dispersion Oxides of Nitrogen is 15.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 6.61µg/m3 and the predominant wind direction is ESE.

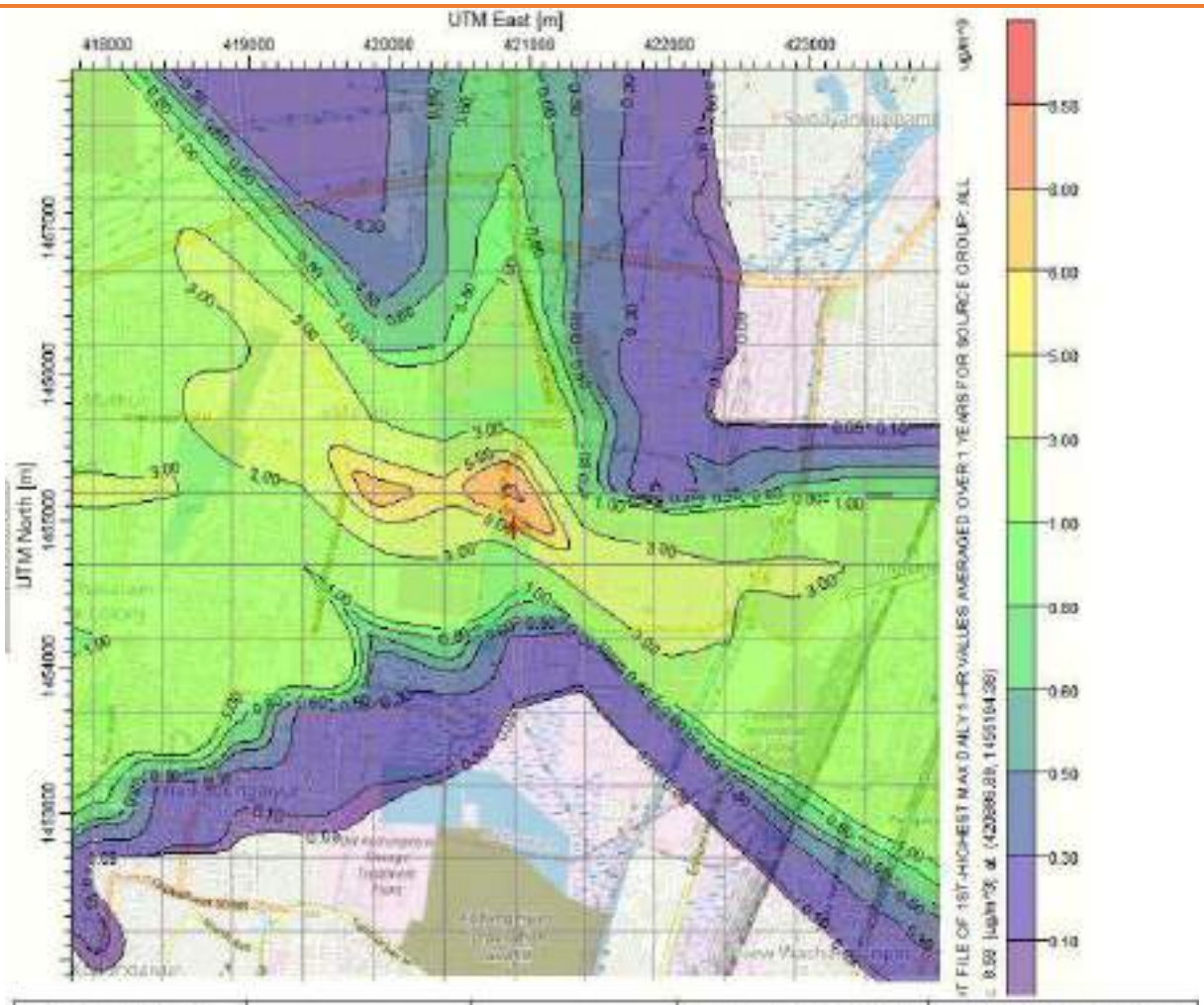
STACK EMISSION DISPERSION MODELLING – Stack – 71F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
143	0.75	41.8	12.78	2.412

Stack - 71F1 emission of Carbon Monoxide concentration is 143mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 41.8µg/m3 at 2km dispersion Carbon Monoxide is 12.78µg/m3 and at 5km dispersion Carbon Monoxide is 2.412µg/m3 and the predominant wind direction is ESE.

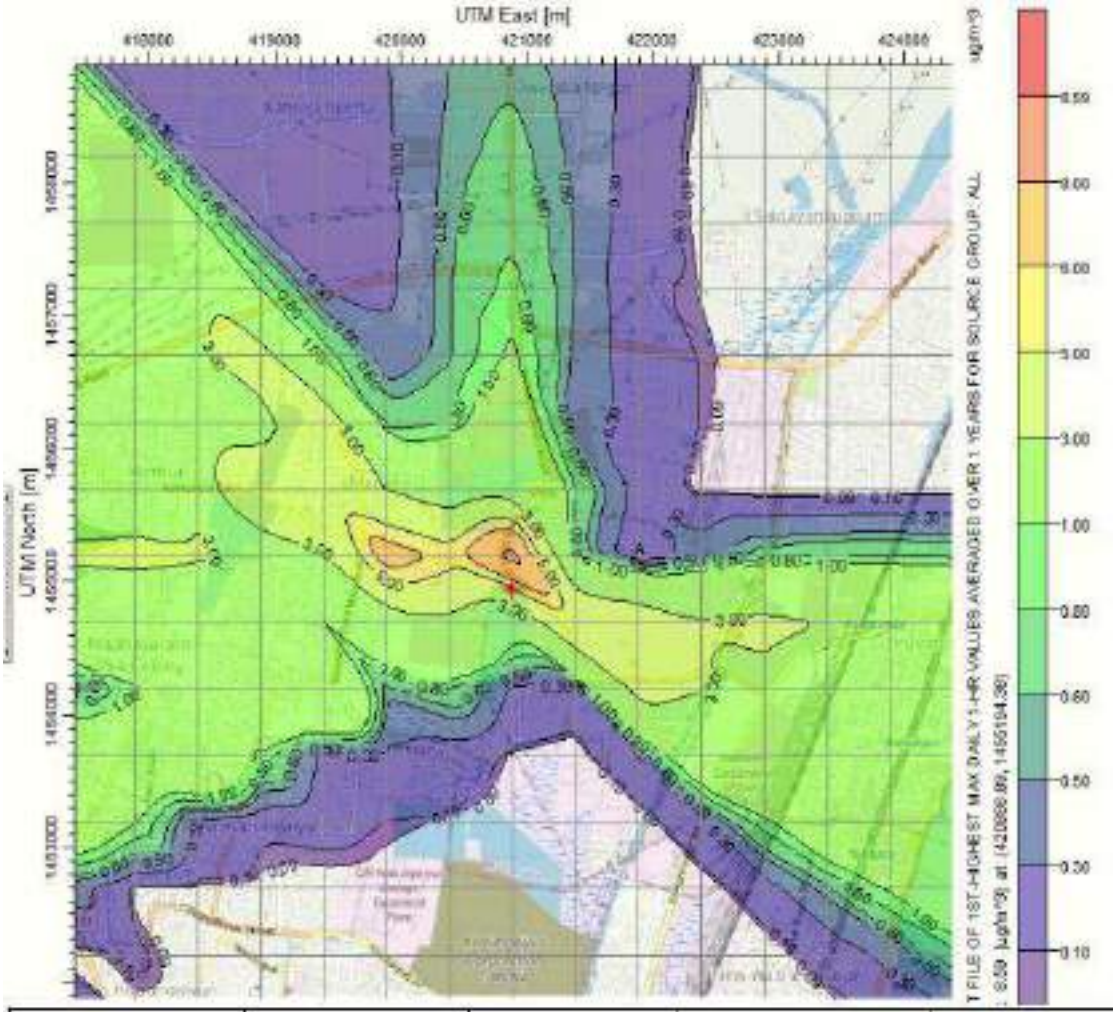
STACK EMISSION DISPERSION MODELLING – Stack – 71F1 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
29.7	0.76	8.58	1.65	0.823

Stack - 71F1 emission of Particulate matter concentration is 29.7mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.58µg/m3 at 2km dispersion Particulate matter is 1.65µg/m3 and at 5km dispersion Particulate matter is 0.823µg/m3 and the predominant wind direction is ESE.

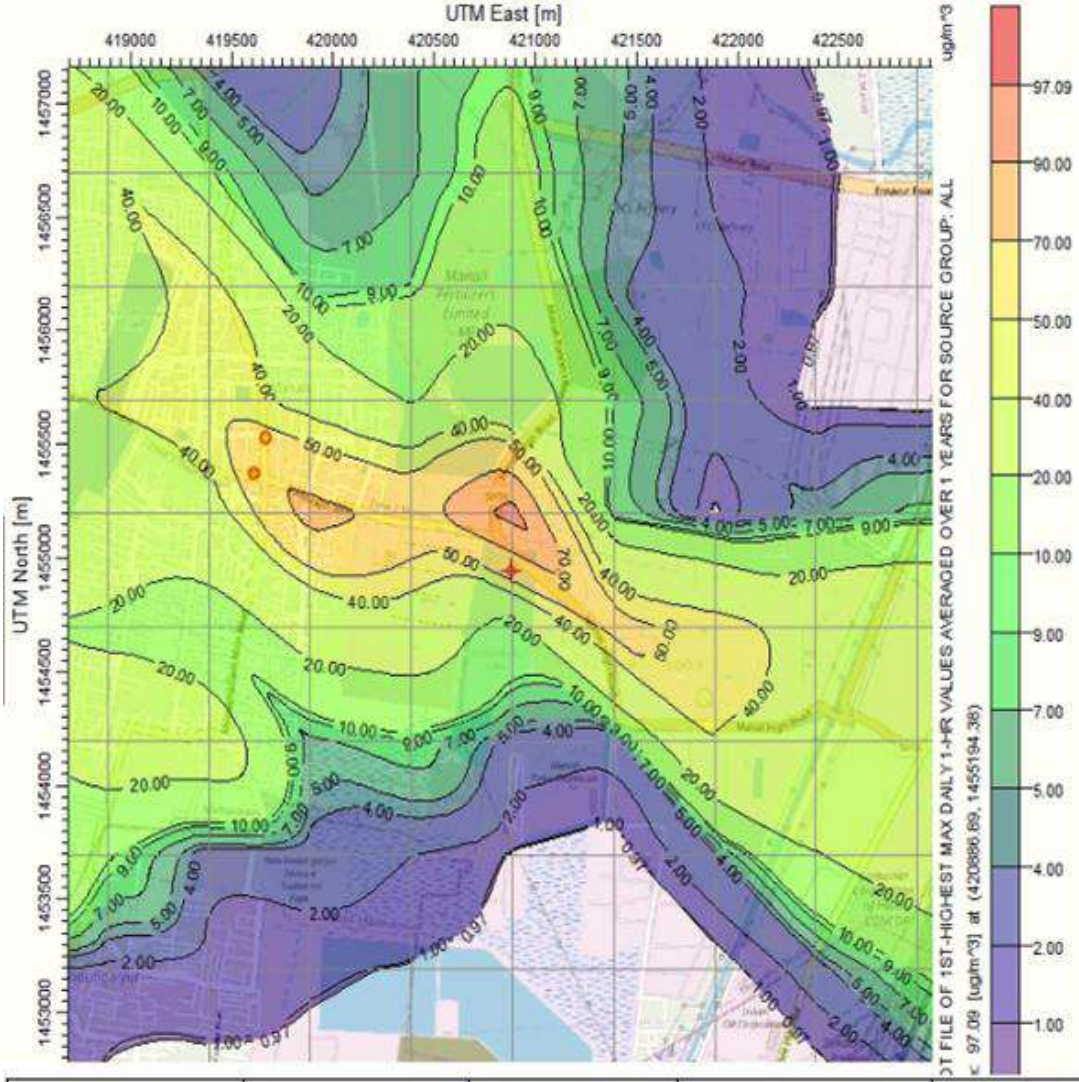
STACK EMISSION DISPERSION MODELLING – Stack – 71F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
157.3	0.66	16.4	4.44	0.76

Stack - 71F1 emission of Sulphur dioxide concentration is 157.3mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 16.4µg/m3 at 2km dispersion Sulphur dioxide is 4.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.76µg/m3 and the predominant wind direction is ESE.

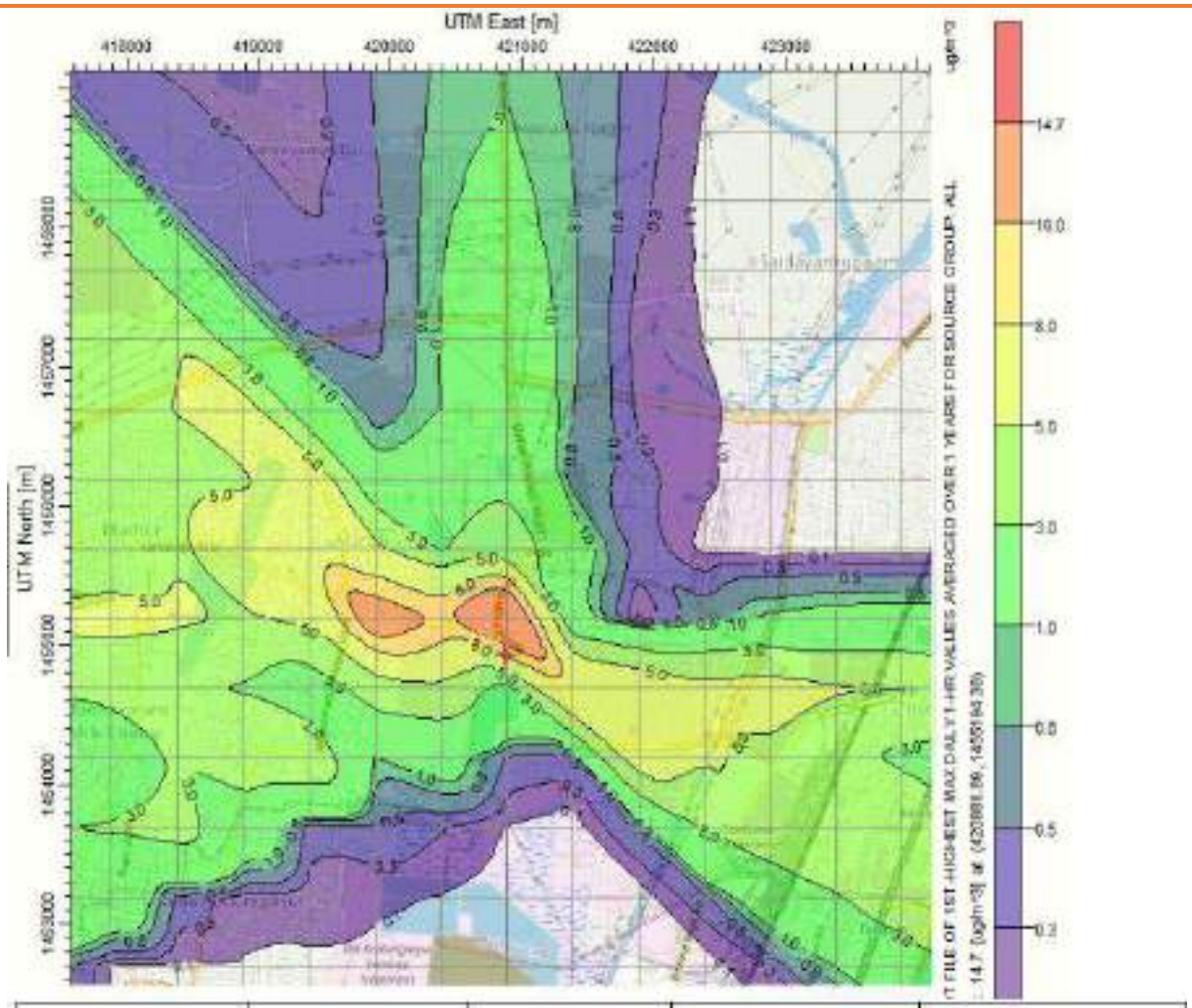
STACK EMISSION DISPERSION MODELLING – Stack – 71F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
335	0.98	97.09	38.91	24.11

Stack - 71F1 emission of Oxides of Nitrogen concentration is 335mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 97.09µg/m3 at 2km dispersion Oxides of Nitrogen is 38.91µg/m3 and at 5km dispersion Oxides of Nitrogen is 24.11µg/m3 and the predominant wind direction is ESE.

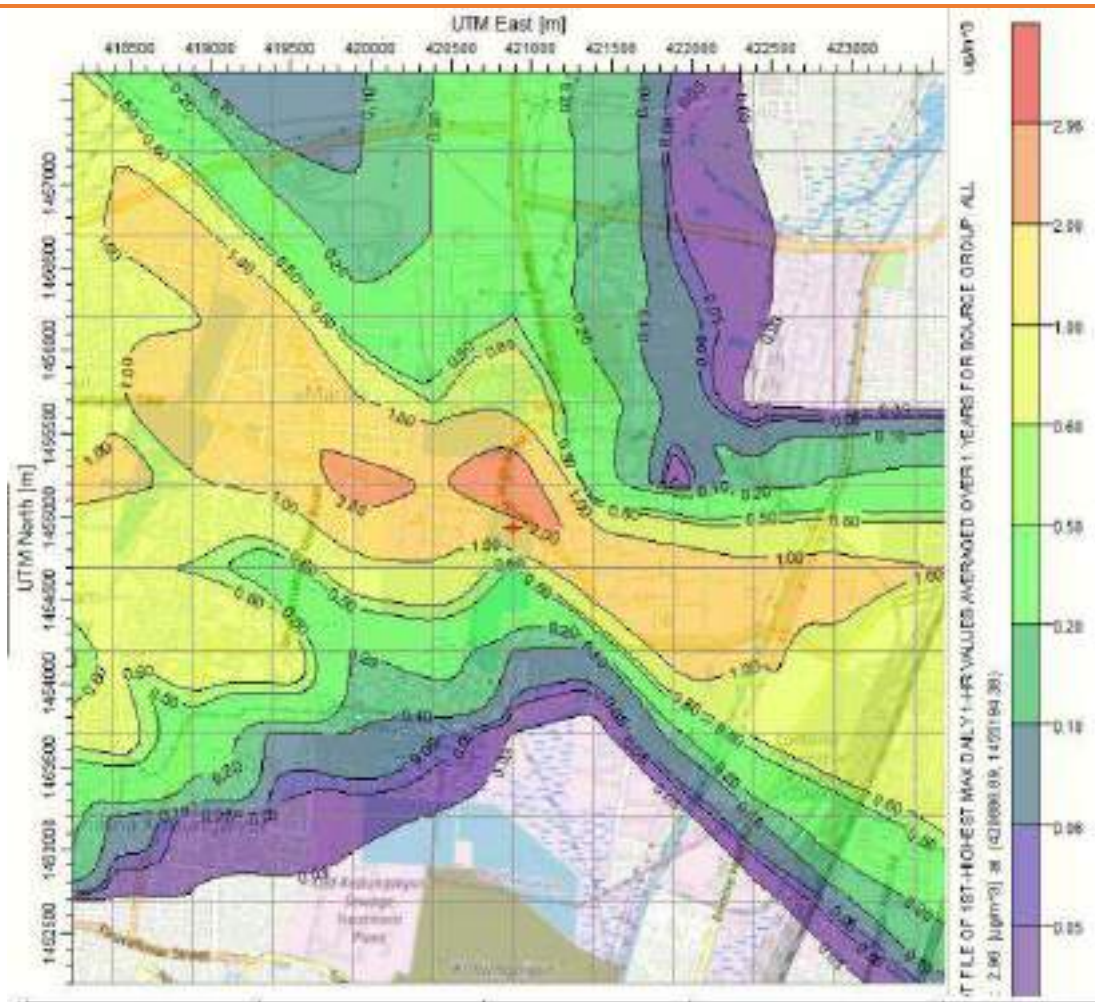
STACK EMISSION DISPERSION MODELLING – Stack – 73F101 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
135	0.68	14.7	3.67	0.781

Stack - 73F101 emission of Carbon Monoxide concentration is 135mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.7µg/m3 at 2km dispersion Carbon Monoxide is 3.67µg/m3 and at 5km dispersion Carbon Monoxide is 0.781µg/m3 and the predominant wind direction is ESE.

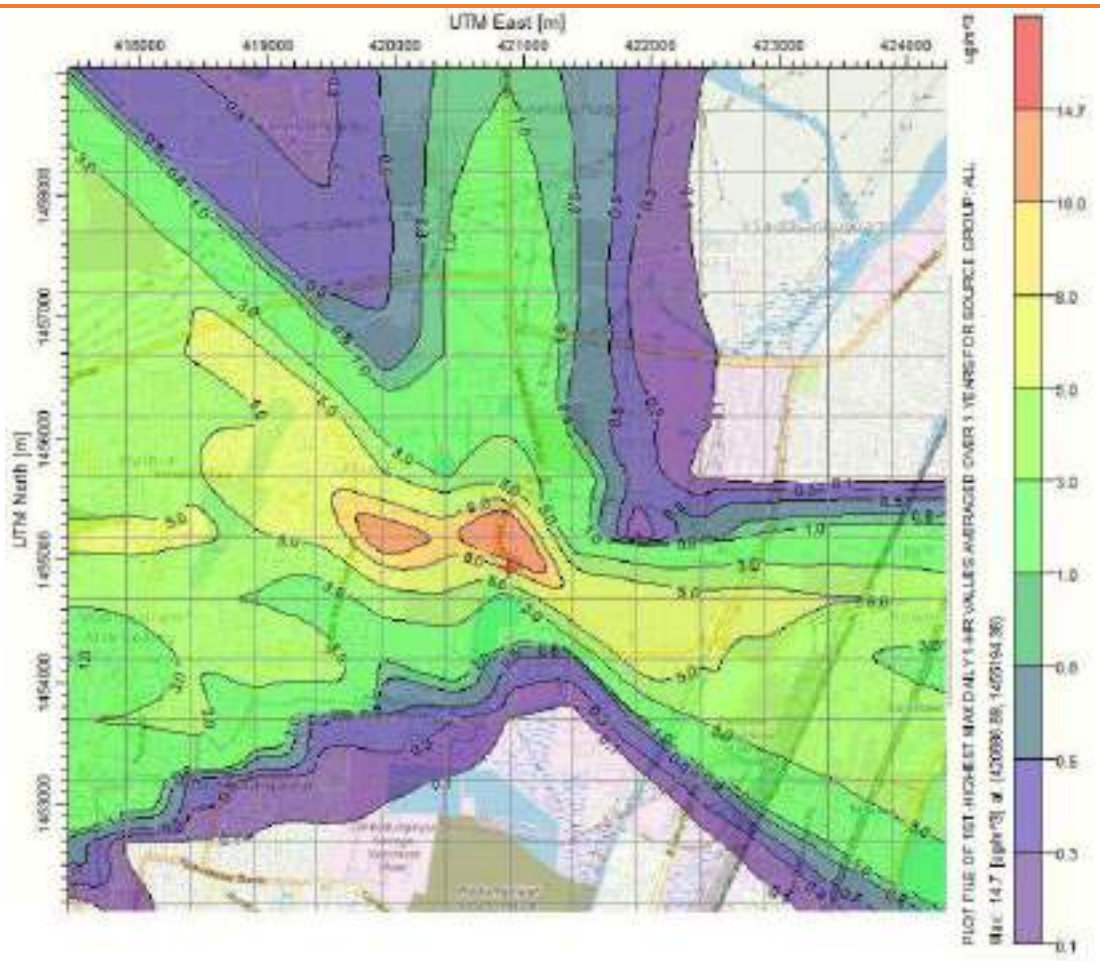
STACK EMISSION DISPERSION MODELLING – Stack – 73F101 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
27	0.87	2.96	0.89	0.075

Stack - 73F101 emission of Particulate matter concentration is 27mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 2.96µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.075µg/m3 and the predominant wind direction is ESE.

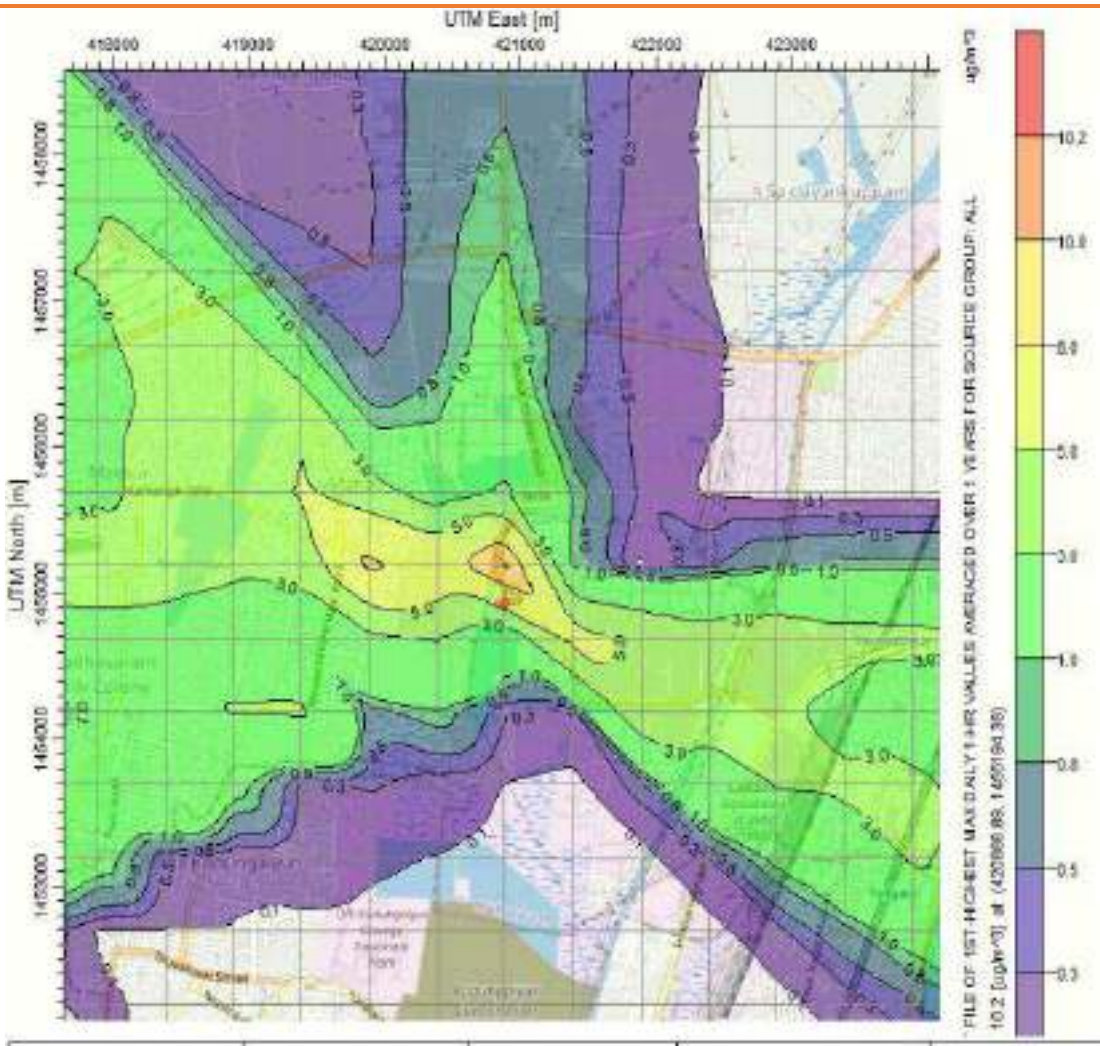
STACK EMISSION DISPERSION MODELLING – Stack – 73F101 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
51	0.88	3.16	1.45	0.86

Stack - 73F101 emission of Sulphur dioxide concentration is 51mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.16µg/m3 at 2km dispersion Sulphur dioxide is 1.45µg/m3 and at 5km dispersion Sulphur dioxide is 0.86µg/m3 and the predominant wind direction is ESE.

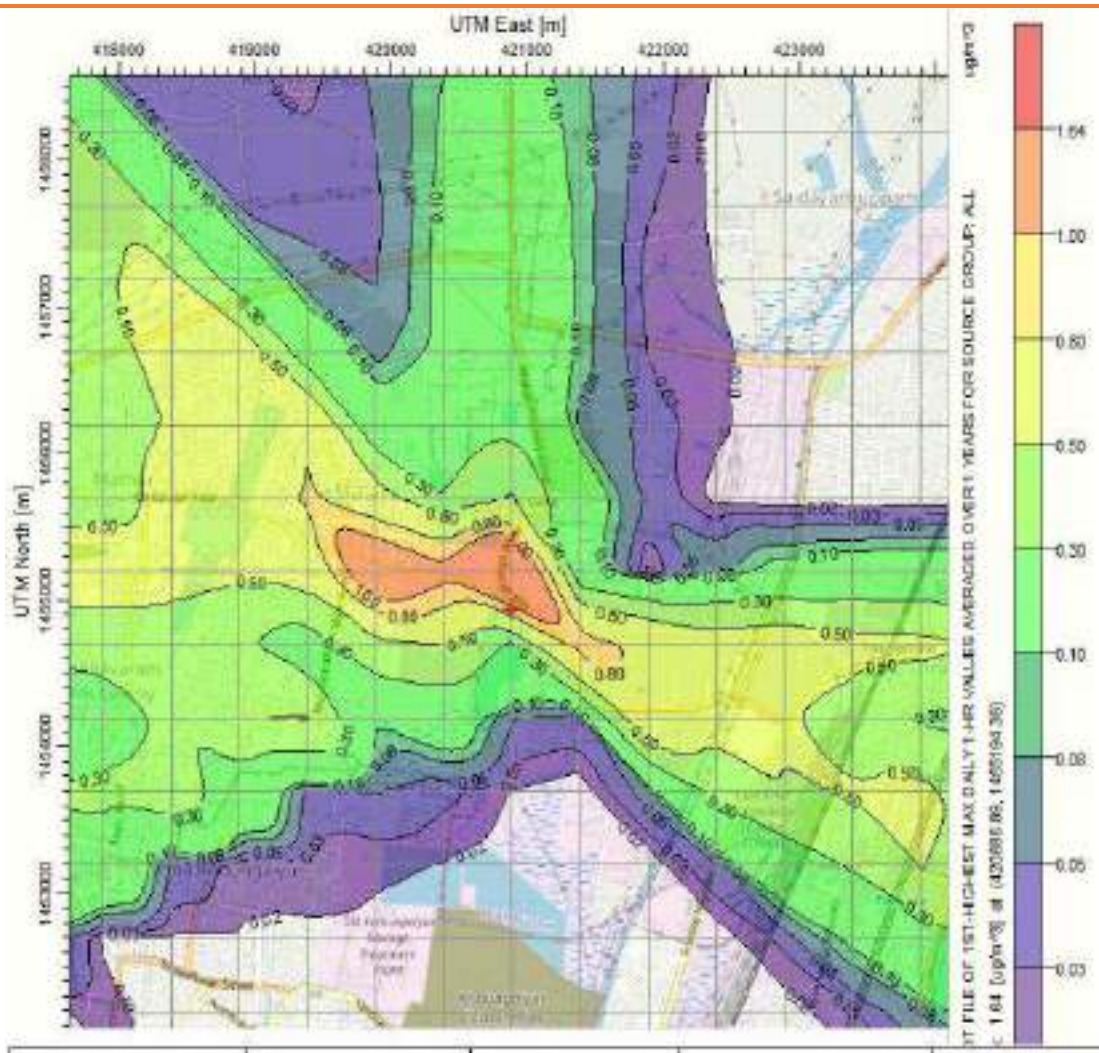
STACK EMISSION DISPERSION MODELLING – Stack – 73F101 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
94	0.77	10.2	2.1	0.64

Stack - 73F101 emission of Oxides of Nitrogen concentration is 94mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 10.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.64µg/m3 and the predominant wind direction is ESE.

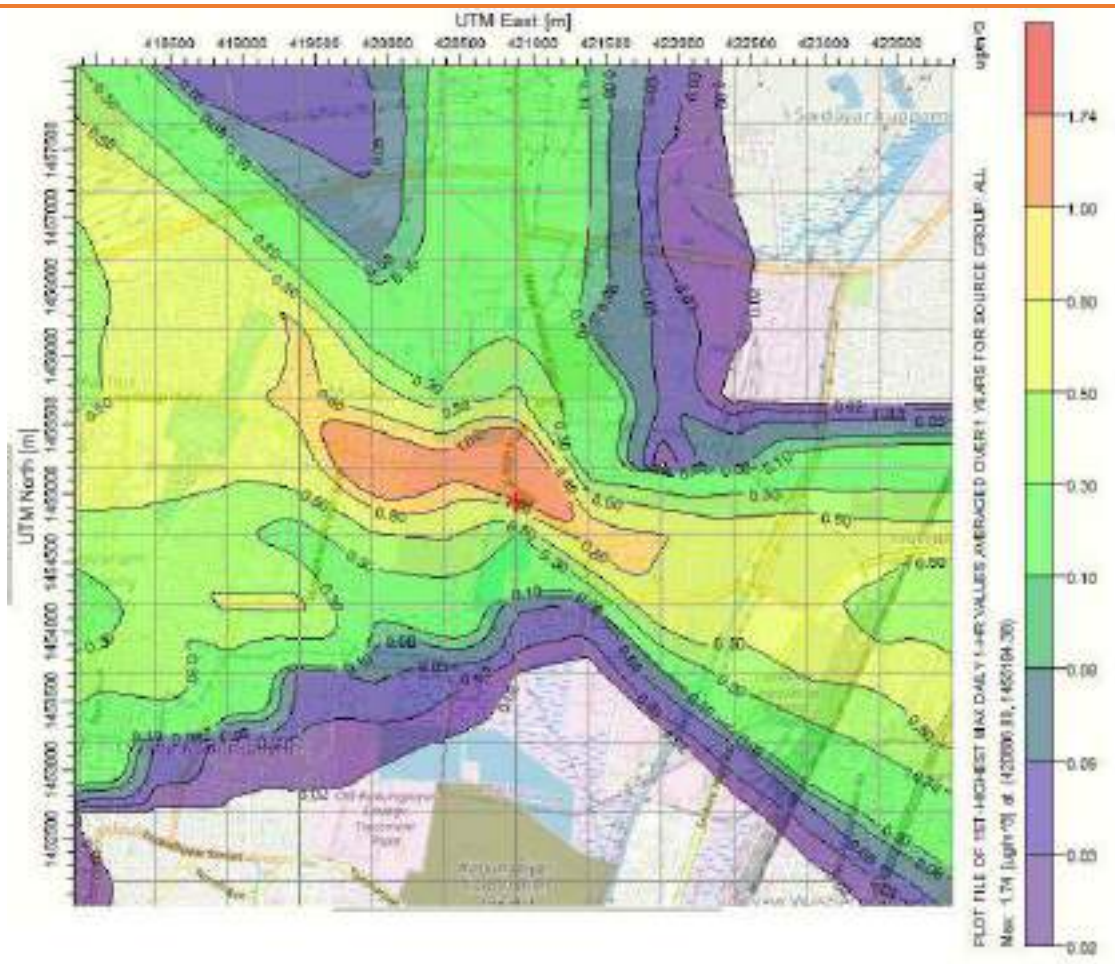
STACK EMISSION DISPERSION MODELLING – Stack – 73F102 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
15	0.66	1.64	0.86	0.0578

Stack - 73F102 emission of Carbon Monoxide concentration is 15mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 1.64µg/m3 at 2km dispersion Carbon Monoxide is 0.86µg/m3 and at 5km dispersion Carbon Monoxide is 0.0578µg/m3 and the predominant wind direction is ESE.

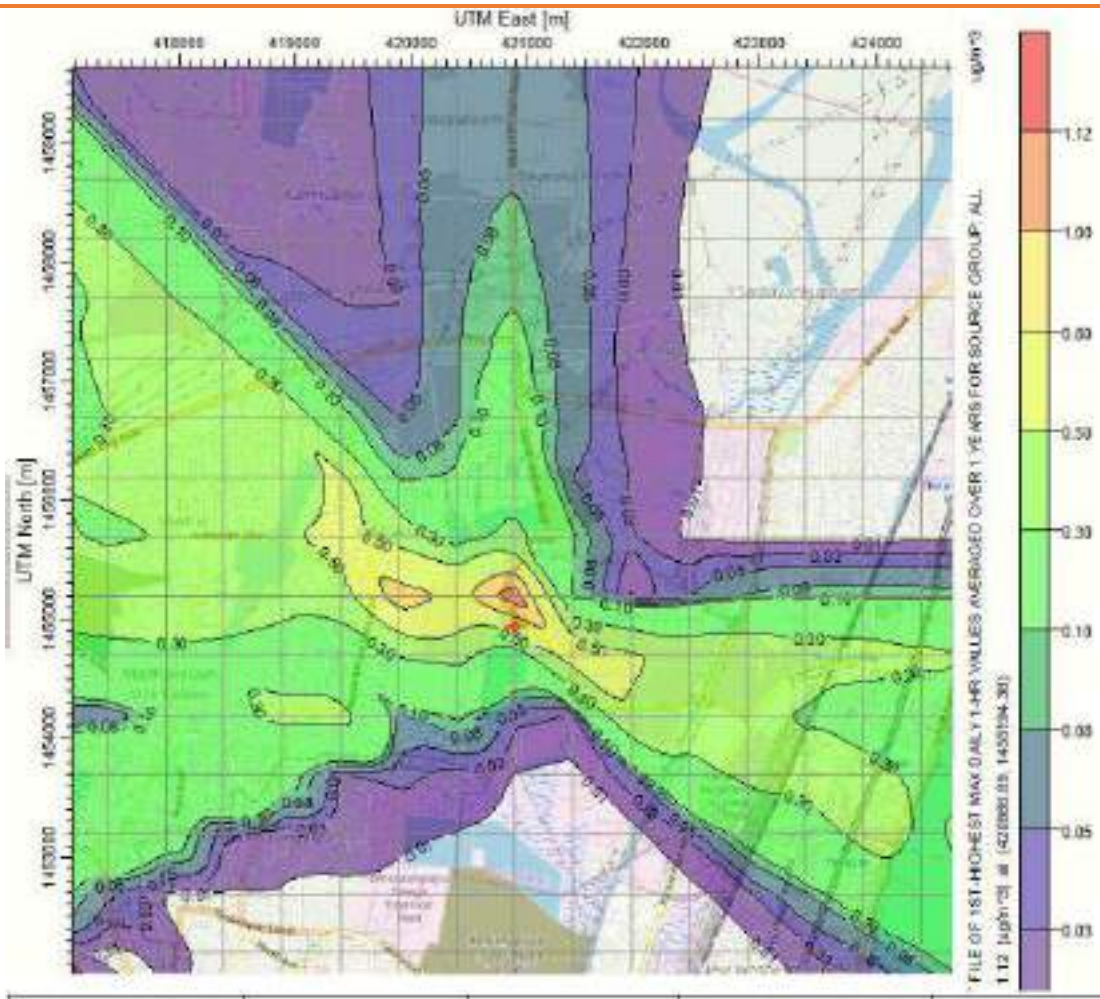
STACK EMISSION DISPERSION MODELLING – Stack – 73F102 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
15.3	0.71	1.74	0.534	0.087

Stack - 73F102 emission of Particulate matter concentration is 15.3mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 1.74µg/m3 at 2km dispersion Particulate matter is 0.534µg/m3 and at 5km dispersion Particulate matter is 0.087µg/m3 and the predominant wind direction is ESE.

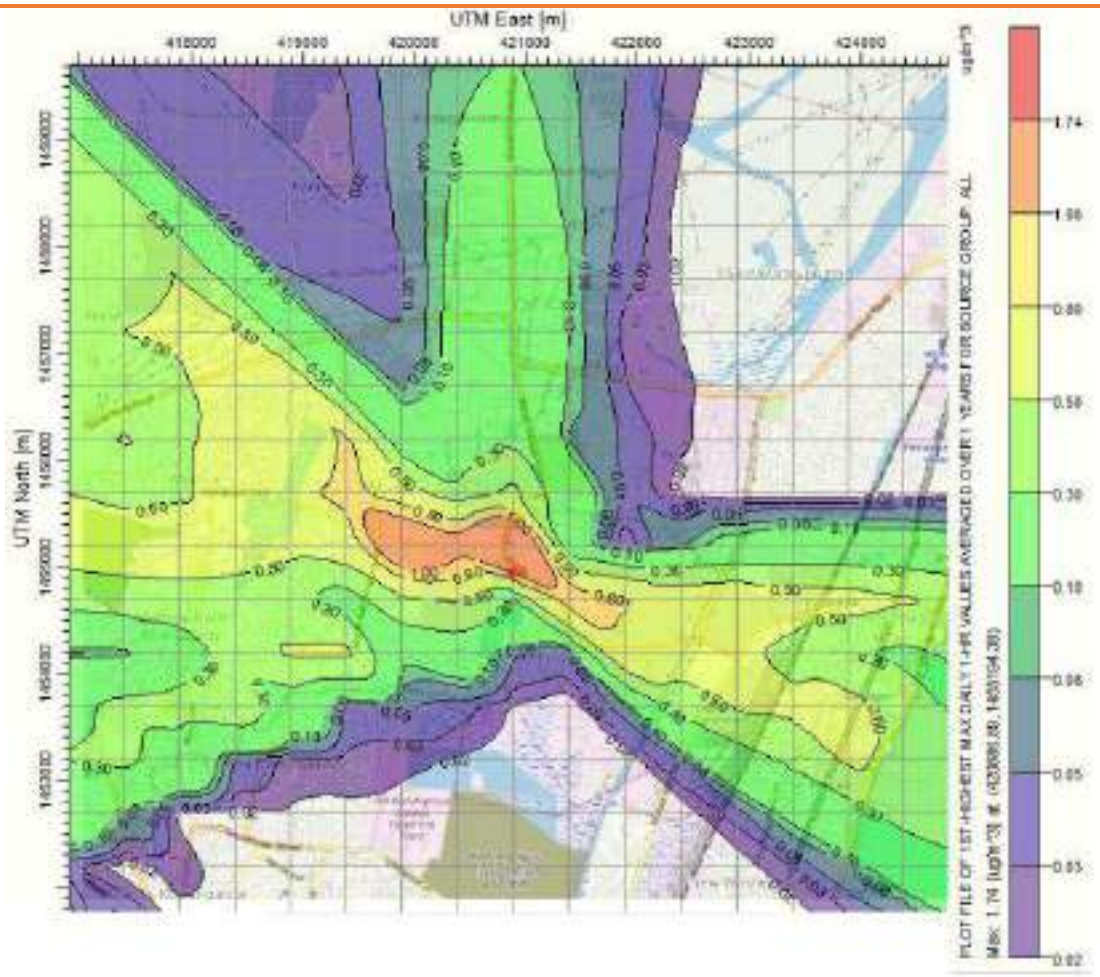
STACK EMISSION DISPERSION MODELLING – Stack – 73F102 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
10	0.77	1.12	0.565	0.089

Stack - 73F102 emission of Sulphur dioxide concentration is 10mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.12µg/m3 at 2km dispersion Sulphur dioxide is 0.565µg/m3 and at 5km dispersion Sulphur dioxide is 0.089µg/m3 and the predominant wind direction is ESE.

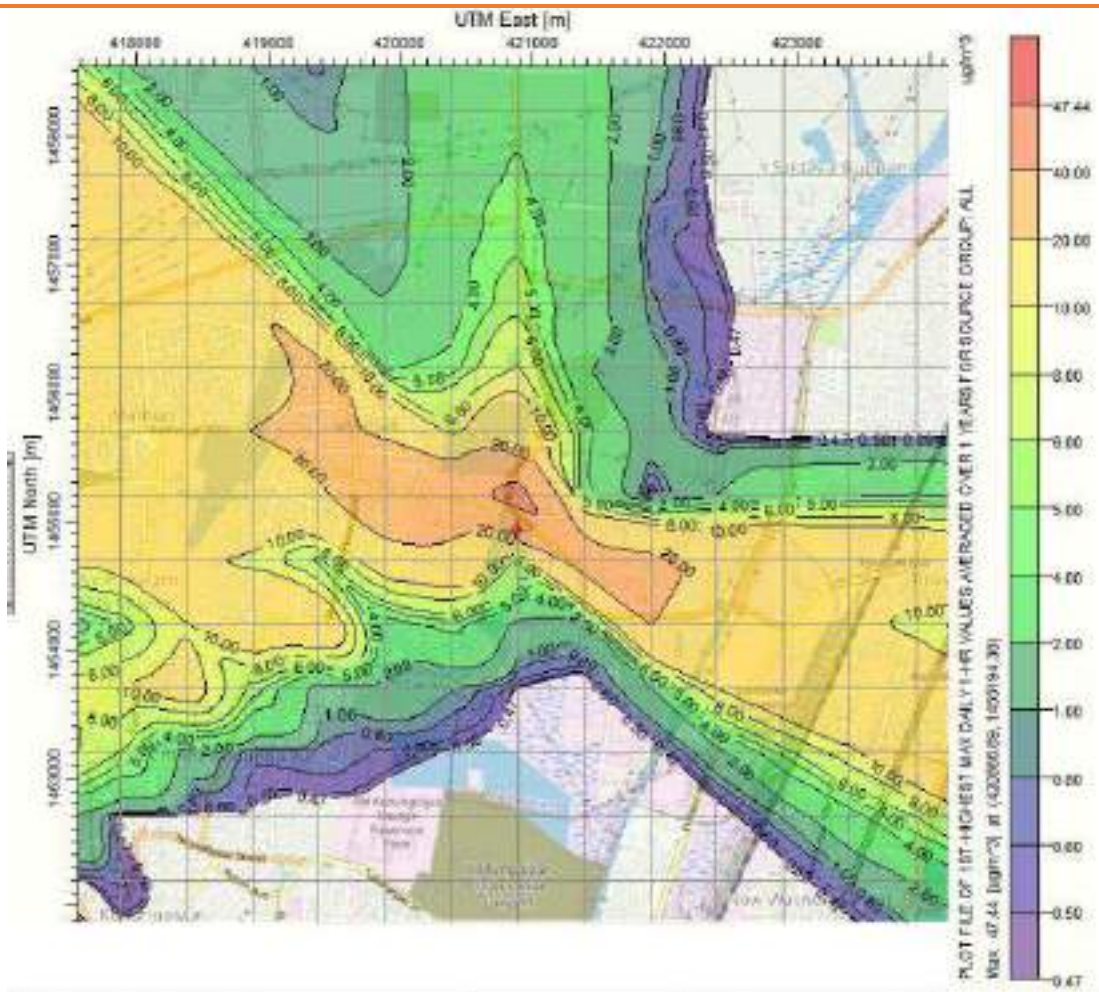
STACK EMISSION DISPERSION MODELLING – Stack – 73F102 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
16	0.7	1.74	0.98	0.11

Stack - 73F102 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 1.74µg/m3 at 2km dispersion Oxides of Nitrogen is 0.98µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.11µg/m3 and the predominant wind direction is ESE.

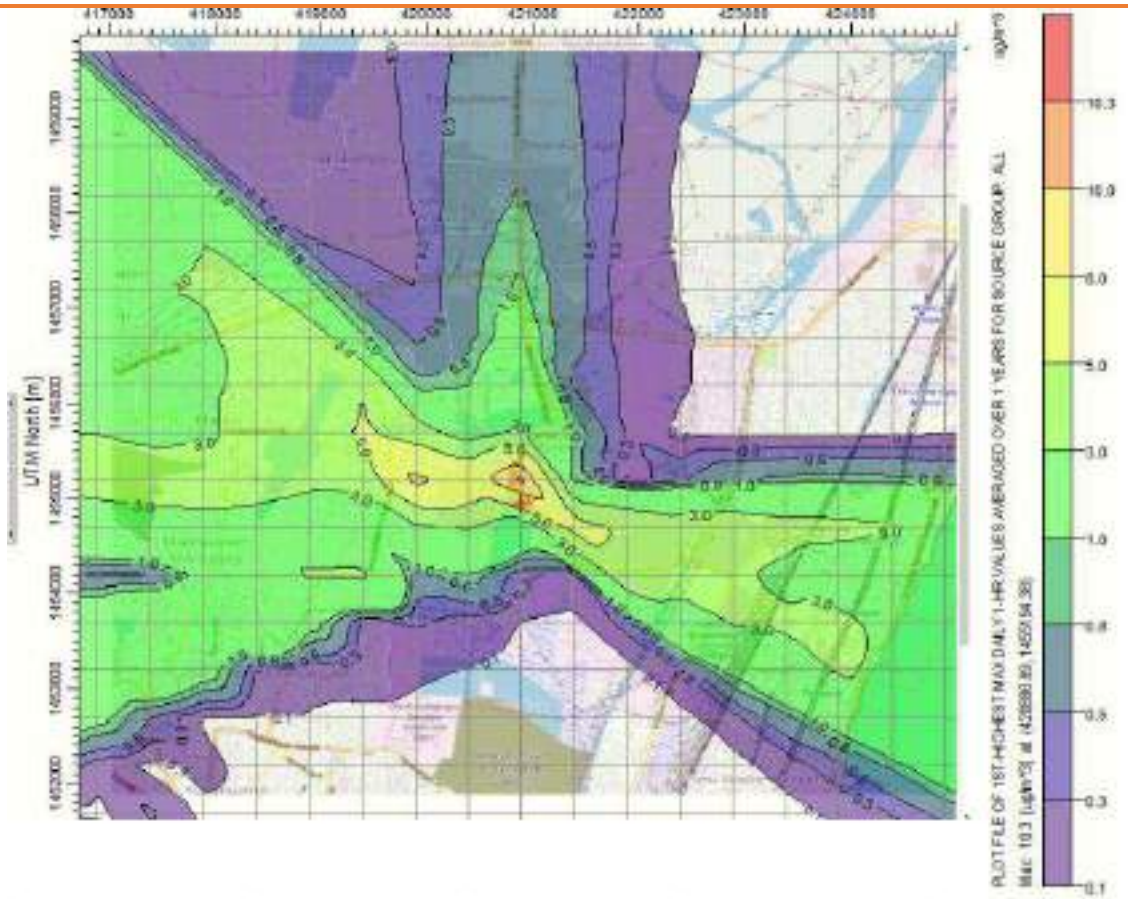
STACK EMISSION DISPERSION MODELLING – Stack – 76F11 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
152	0.76	47.44	8.86	1.32

Stack - 76F11 emission of Carbon Monoxide concentration is 152mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 47.44µg/m3 at 2km dispersion Carbon Monoxide is 8.86µg/m3 and at 5km dispersion Carbon Monoxide is 1.32µg/m3 and the predominant wind direction is ESE.

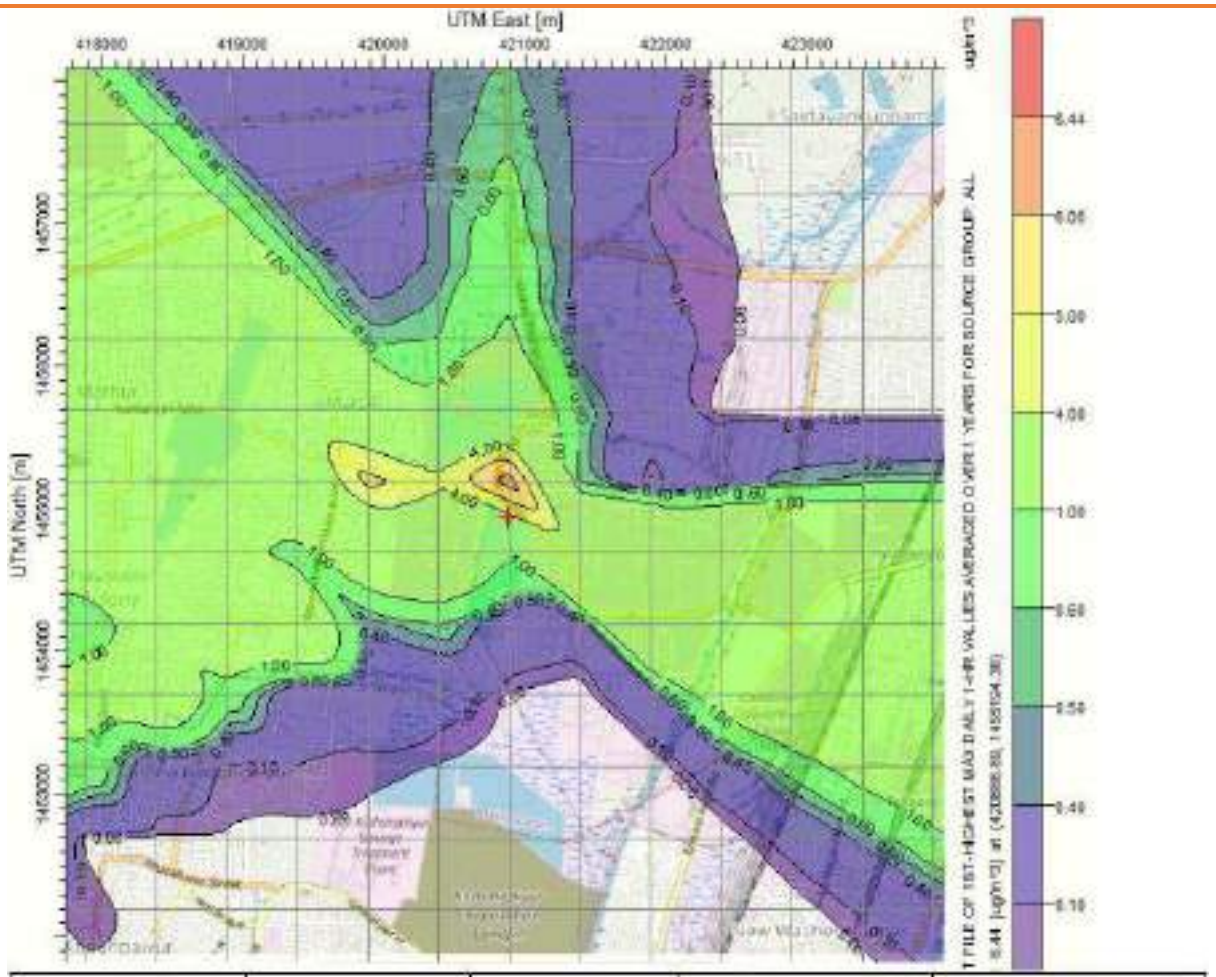
STACK EMISSION DISPERSION MODELLING – Stack – 76F11 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
33.1	0.87	10.3	0.89	0.076

Stack - 76F11 emission of Particulate matter concentration is 33.1mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 10.3µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.076µg/m3 and the predominant wind direction is ESE.

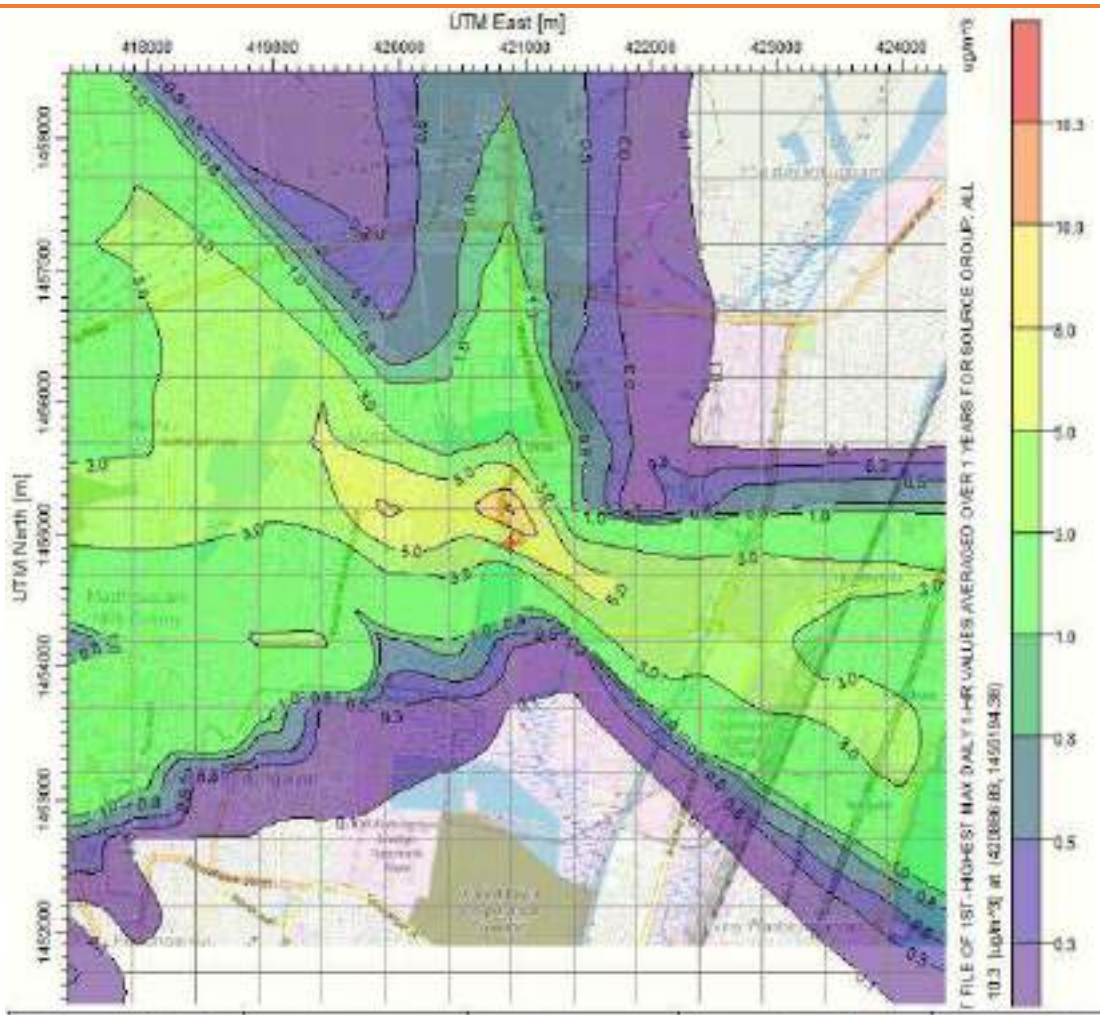
STACK EMISSION DISPERSION MODELLING – Stack – 76F11 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
20.6	0.95	6.44	0.97	0.0318

Stack - 76F11 emission of Sulphur dioxide concentration is 20.6mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 6.44µg/m3 at 2km dispersion Sulphur dioxide is 0.97µg/m3 and at 5km dispersion Sulphur dioxide is 0.0318µg/m3 and the predominant wind direction is ESE.

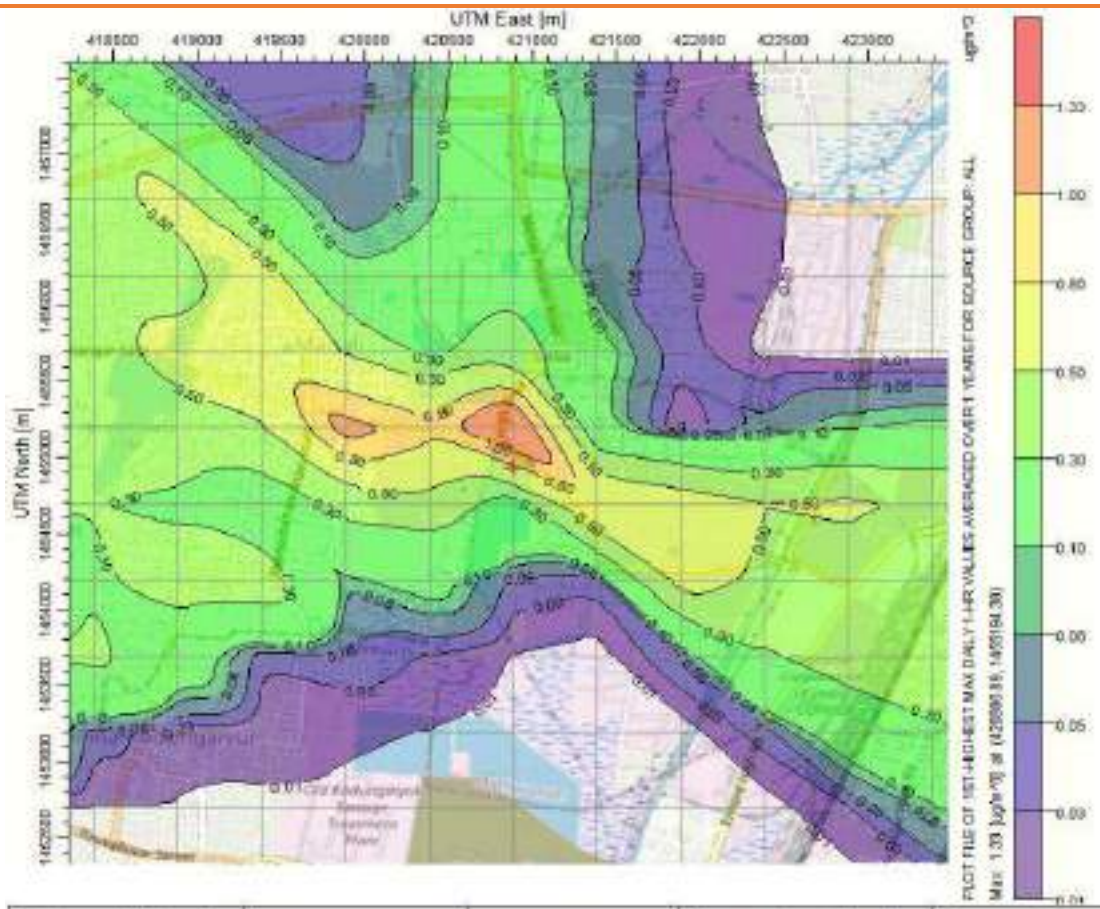
STACK EMISSION DISPERSION MODELLING – Stack – 76F11 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
33	0.86	10.3	2.25	0.341

Stack - 76F11 emission of Oxides of Nitrogen concentration is 33mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 10.3µg/m3 at 2km dispersion Oxides of Nitrogen is 2.25µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.341µg/m3 and the predominant wind direction is ESE.

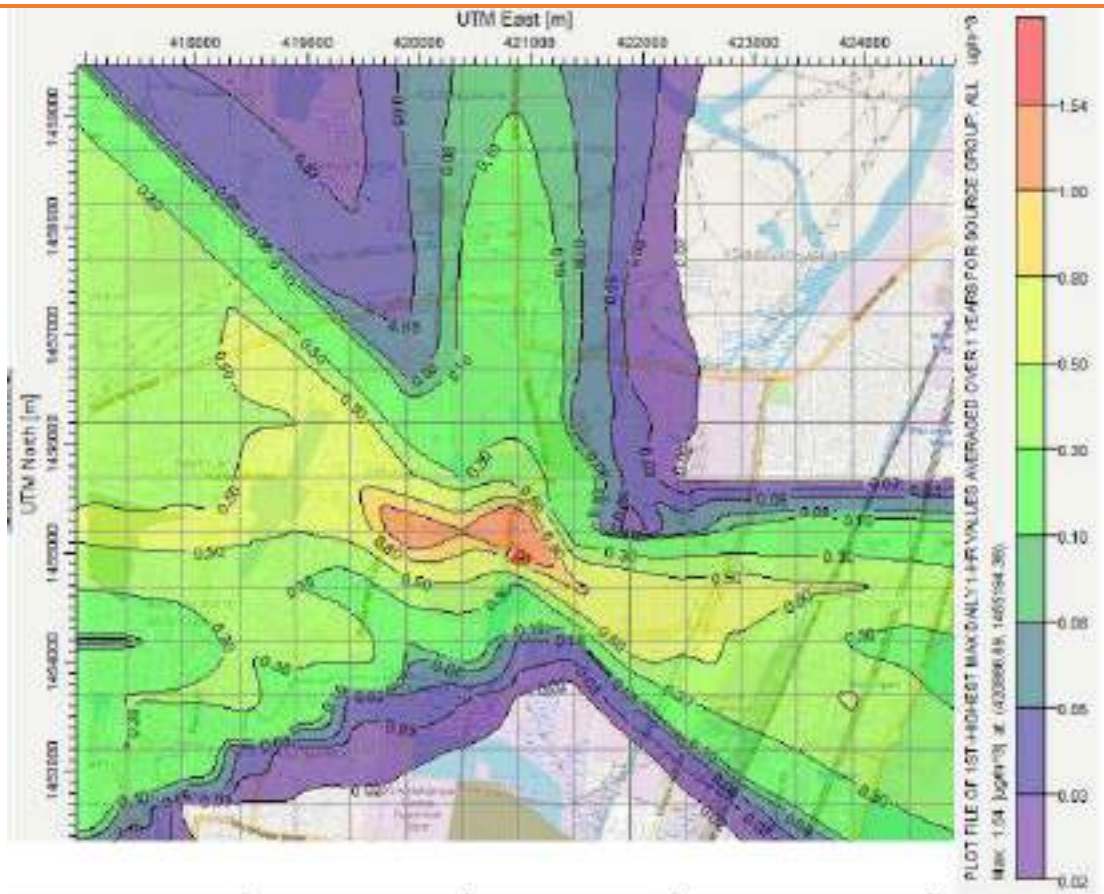
STACK EMISSION DISPERSION MODELLING – Stack – 77F1 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
31	0.8	1.33	0.123	0.057

Stack - 77F1 emission of Carbon Monoxide concentration is 31mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.33µg/m3 at 2km dispersion Carbon Monoxide is 0.123µg/m3 and at 5km dispersion Carbon Monoxide is 0.057µg/m3 and the predominant wind direction is ESE.

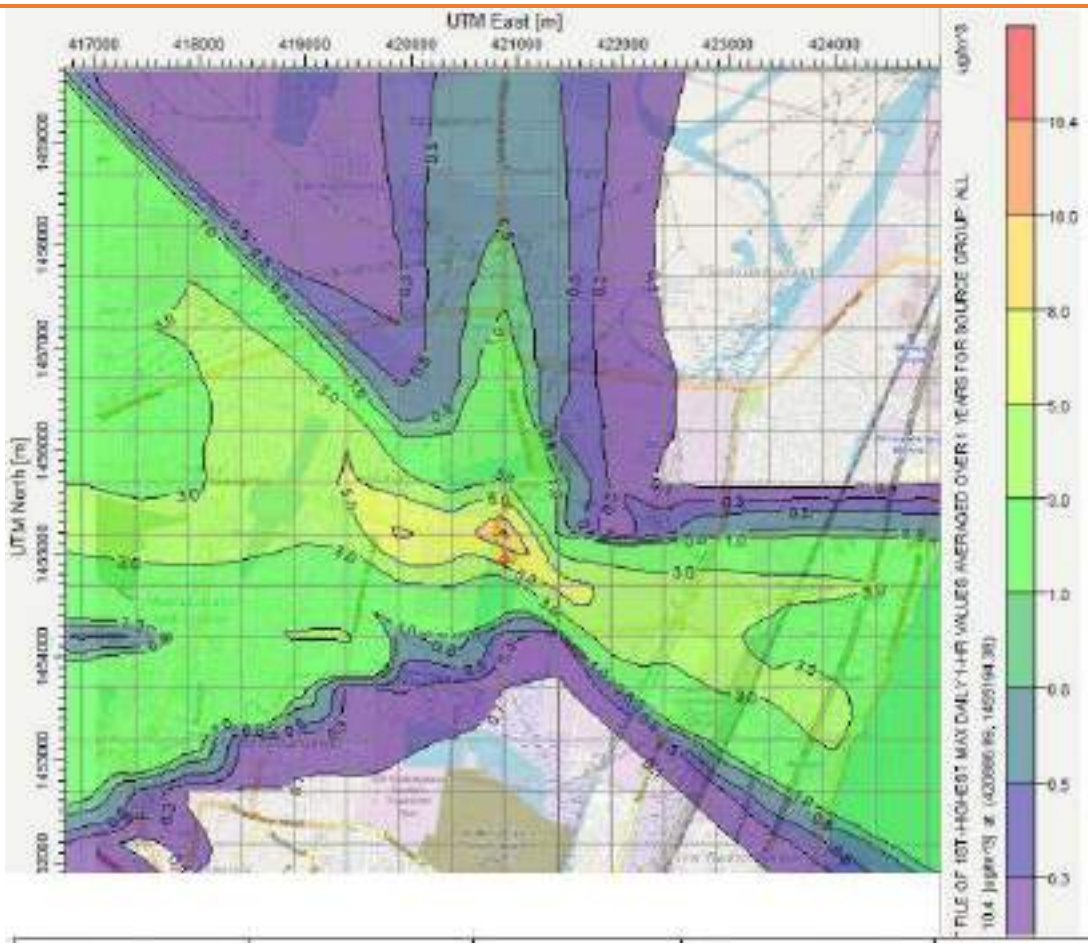
STACK EMISSION DISPERSION MODELLING – Stack – 77F1 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
18.4	0.77	1.54	0.65	0.033

Stack - 77F1 emission of Particulate matter concentration is 18.4mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.54µg/m3 at 2km dispersion Particulate matter is 0.65µg/m3 and at 5km dispersion Particulate matter is 0.033µg/m3 and the predominant wind direction is ESE.

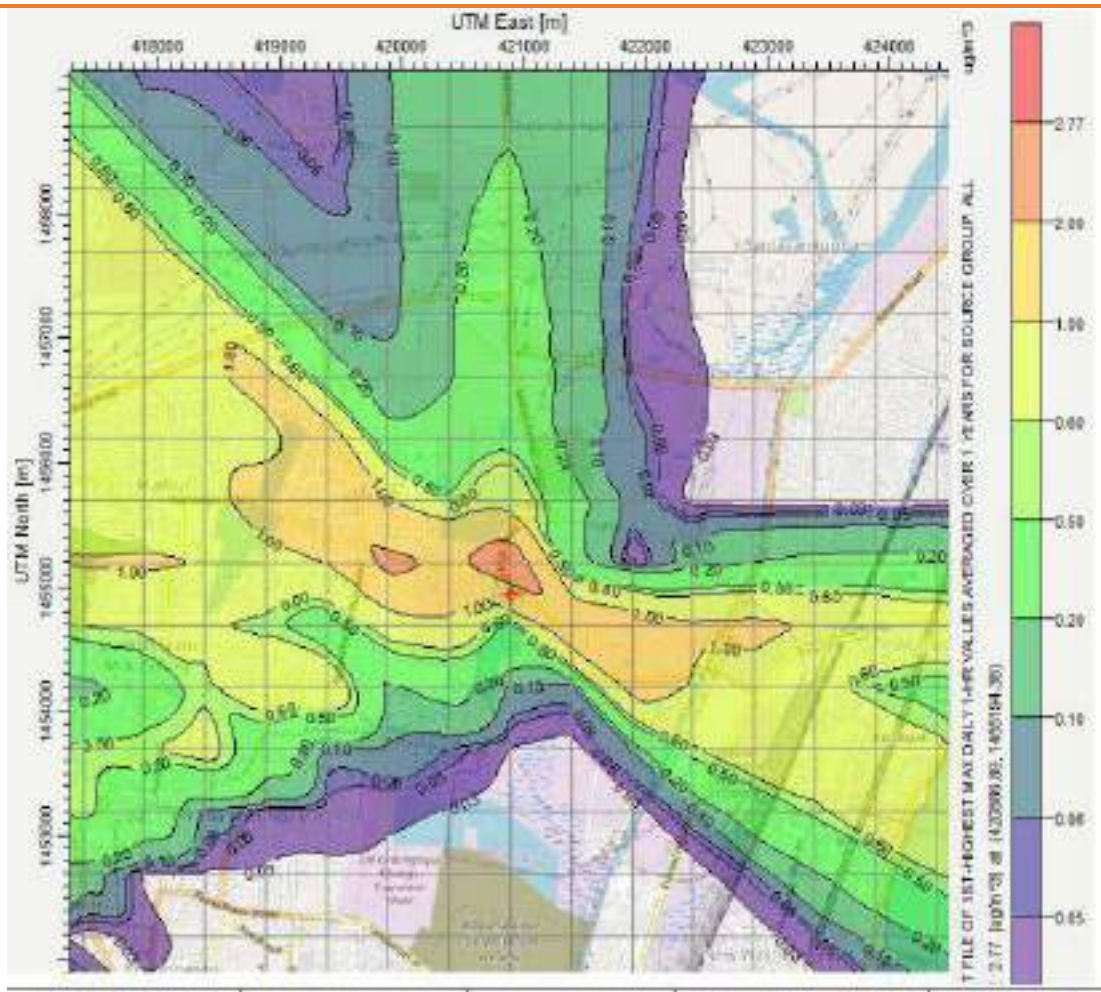
STACK EMISSION DISPERSION MODELLING – Stack – 77F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
21	0.81	10.4	1.99	0.078

Stack - 77F1 emission of Sulphur dioxide concentration is 21mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 10.4µg/m3 at 2km dispersion Sulphur dioxide is 1.99µg/m3 and at 5km dispersion Sulphur dioxide is 0.078µg/m3 and the predominant wind direction is ESE.

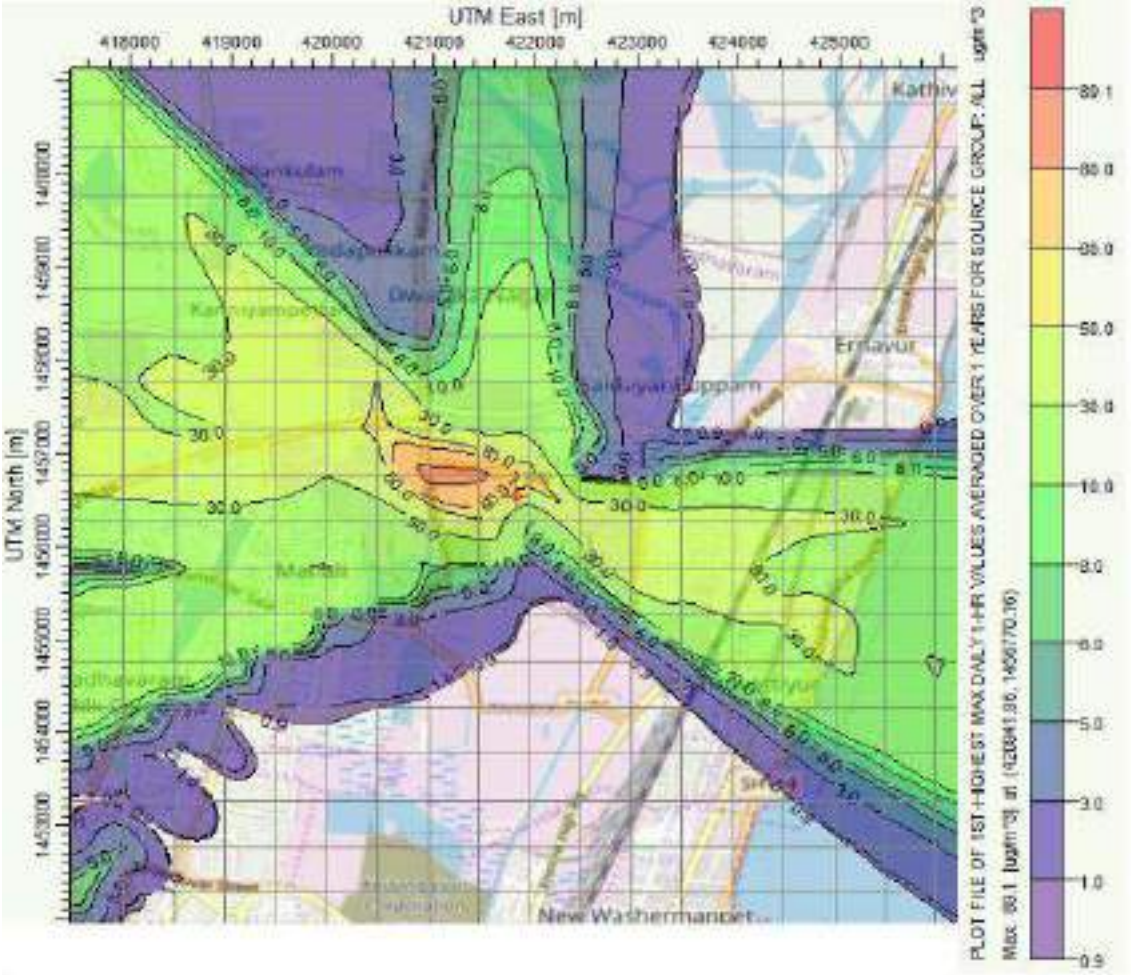
STACK EMISSION DISPERSION MODELLING – Stack – 77F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
60	0.745	2.77	0.752	0.011

Stack - 77F1 emission of Oxides of Nitrogen concentration is 60mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.745km at the concentration of 2.77µg/m3 at 2km dispersion Oxides of Nitrogen is 0.752µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.011µg/m3 and the predominant wind direction is ESE.

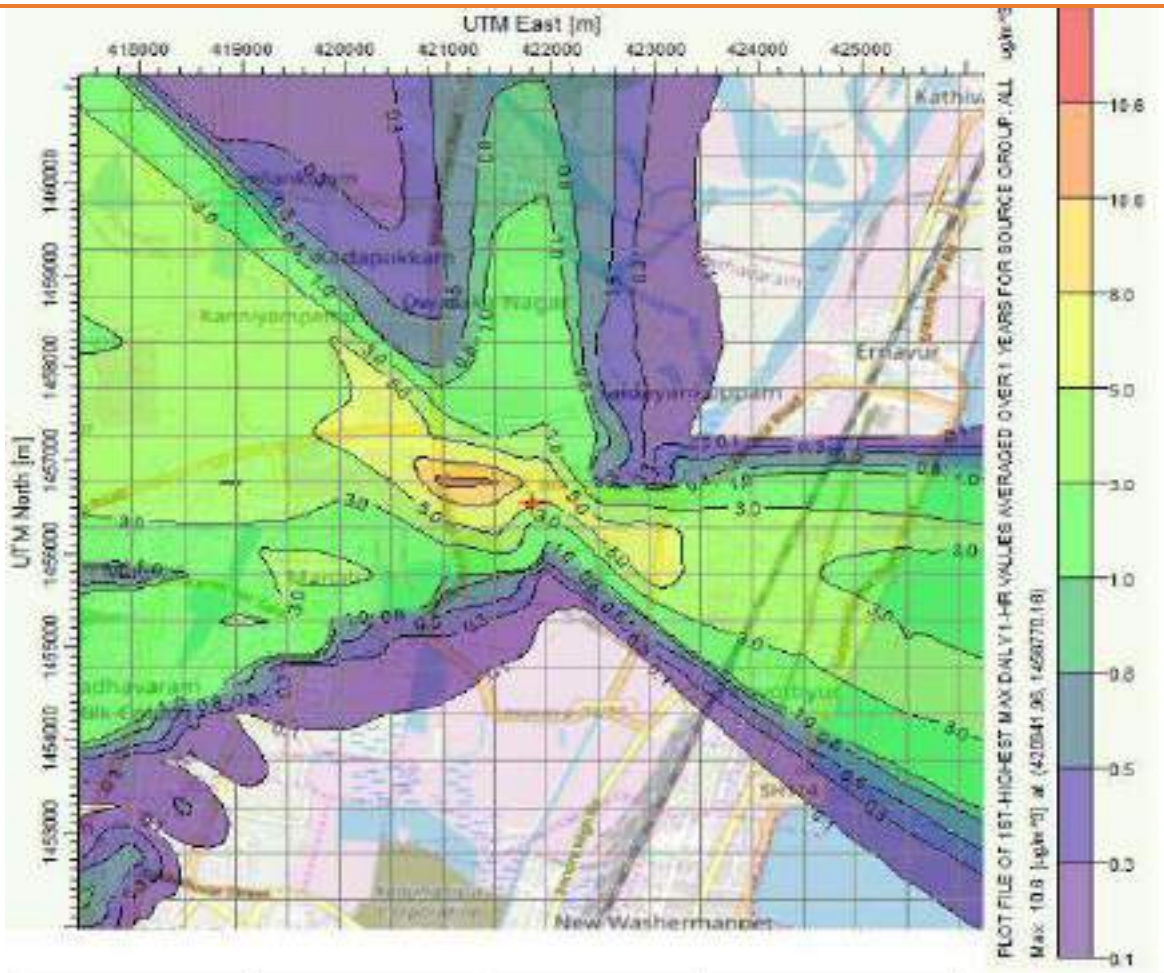
STACK EMISSION DISPERSION MODELLING – Stack – 205F1 @ 2 & 5KM – Carbon Monoxide



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
136	0.736	89.1	7.731	0.8966

Stack - 205F1 emission of Carbon Monoxide concentration is 136mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.736km at the concentration of 89.1µg/m3 at 2km dispersion Carbon Monoxide is 7.731µg/m3 and at 5km dispersion Carbon Monoxide is 0.8966µg/m3 and the predominant wind direction is ESE.

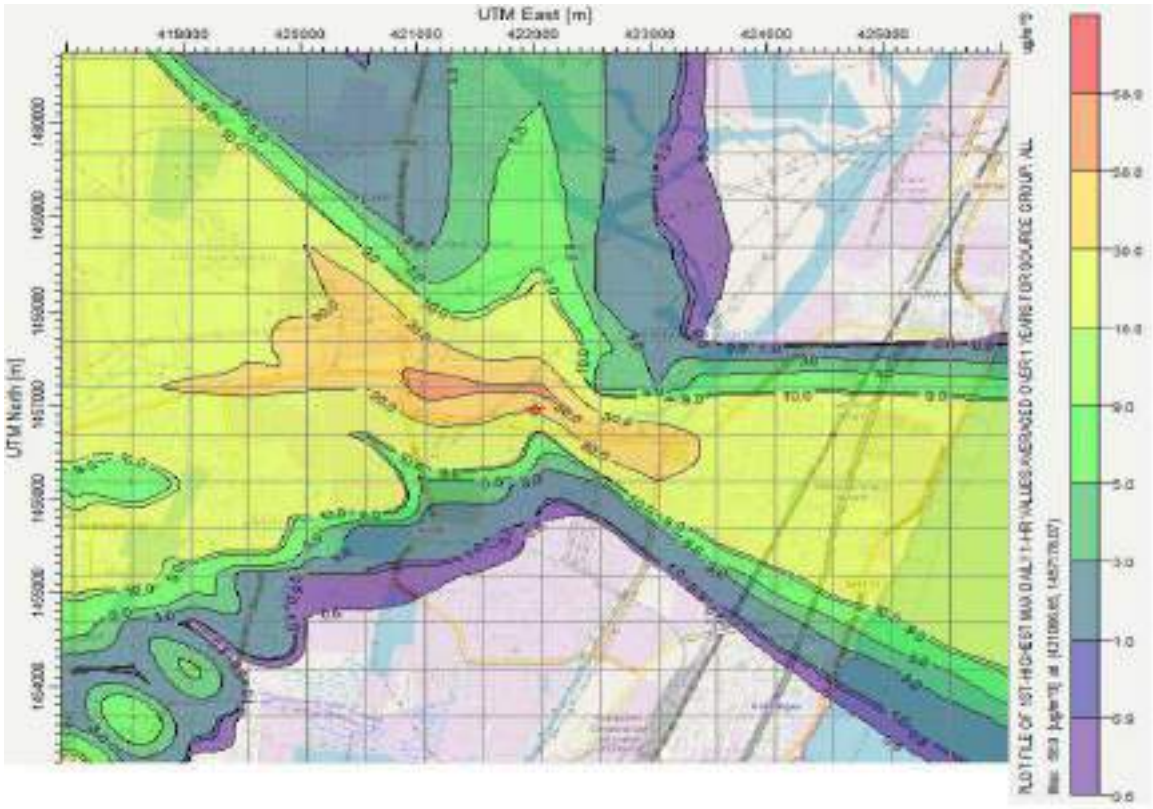
STACK EMISSION DISPERSION MODELLING – Stack – 205F1 @ 2 & 5KM – Particulate matter



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
16.2	0.977	1.32	0.54	0.0865

Stack - 205F1 emission of Particulate matter concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 1.32µg/m3 at 2km dispersion Particulate matter is 0.54µg/m3 and at 5km dispersion Particulate matter is 0.0865µg/m3 and the predominant wind direction is ESE.

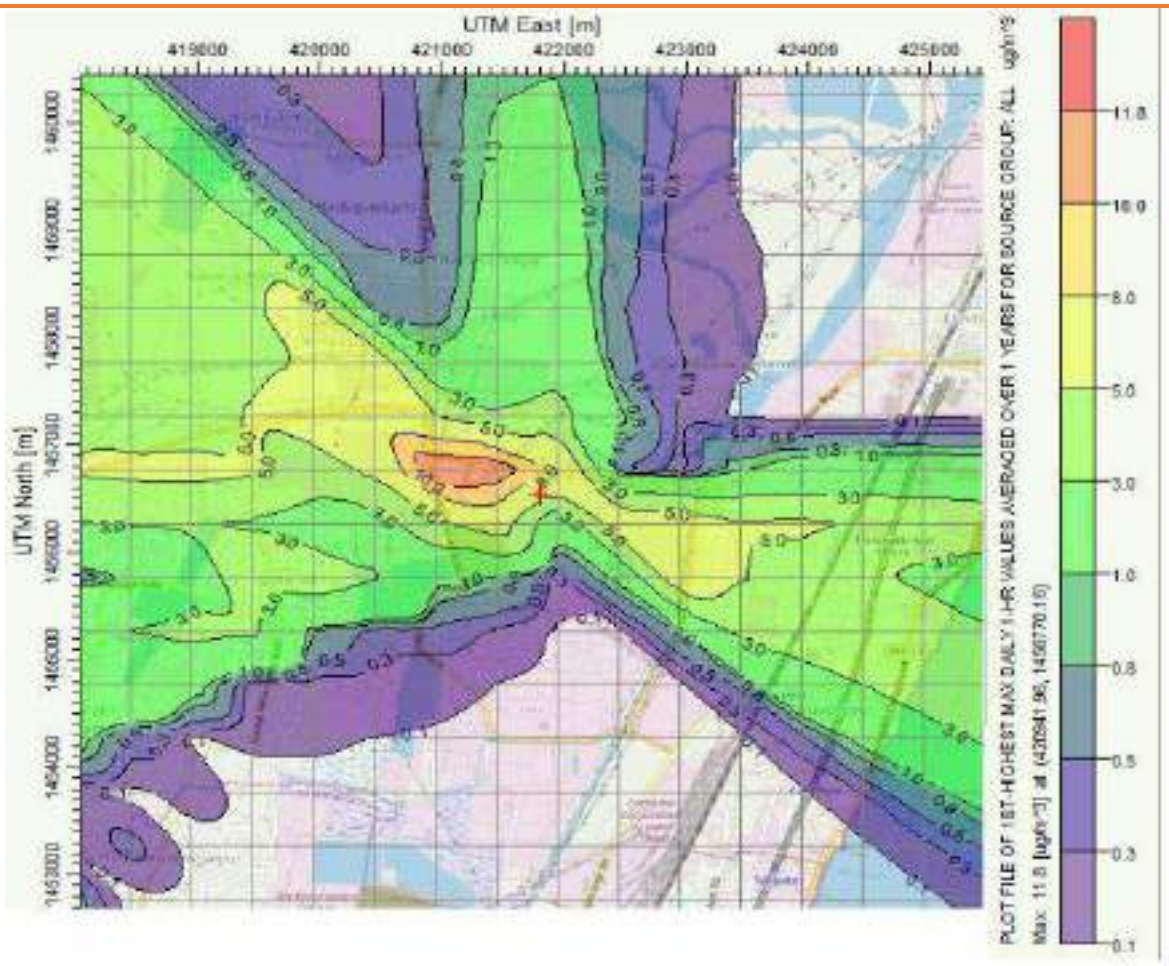
STACK EMISSION DISPERSION MODELLING – Stack – 205F1 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
55	1.01	58.9	16.1	4.58

Stack - 205F1 emission of Oxides of Nitrogen concentration is 55mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 16.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.58µg/m3 and the predominant wind direction is ESE.

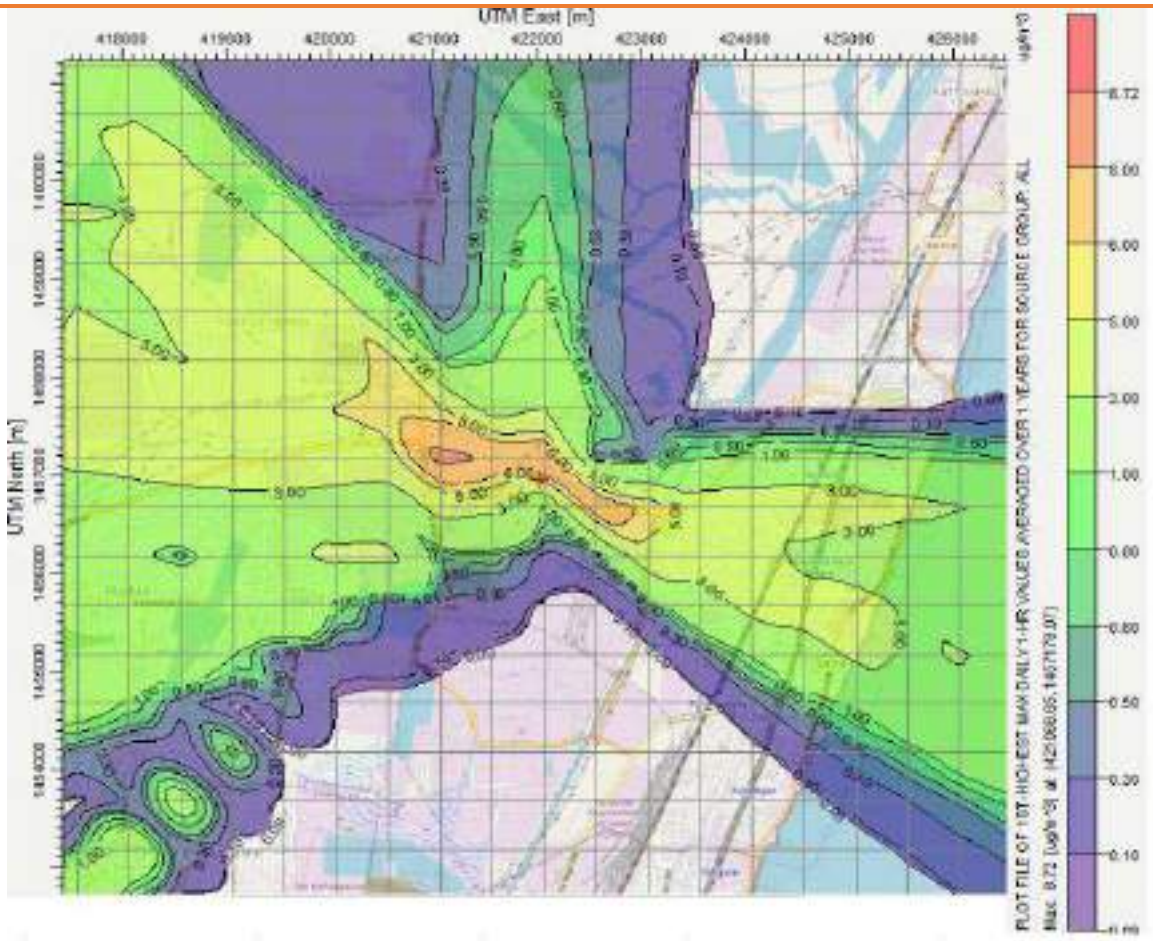
STACK EMISSION DISPERSION MODELLING – Stack – 205F1 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
16.2	0.977	11.8	0.462	0.0756

Stack - 205F1 emission of Sulphur dioxide concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 0.462µg/m3 and at 5km dispersion Sulphur dioxide is 0.0756µg/m3 and the predominant wind direction is ESE.

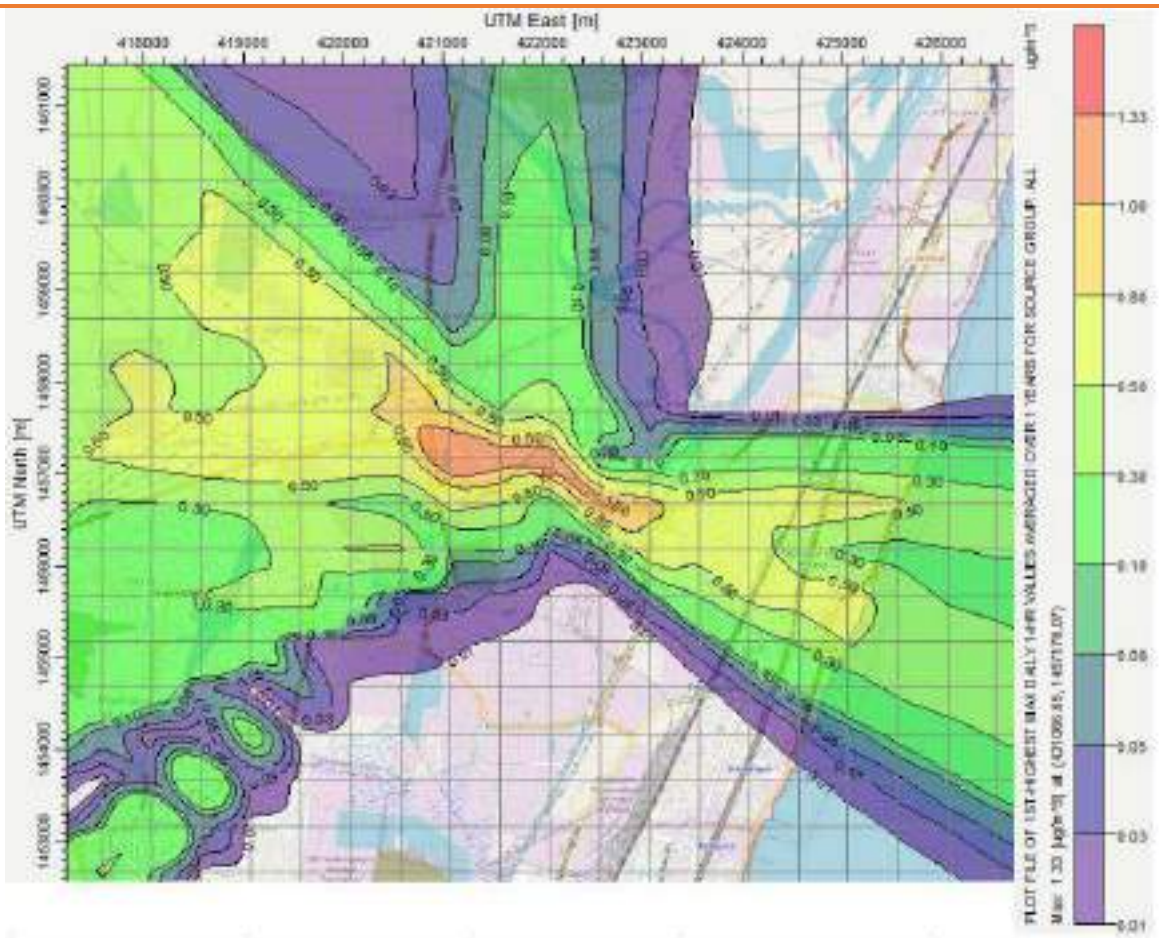
STACK EMISSION DISPERSION MODELLING – Stack – 201F1&F2 @ 2 & 5KM – Carbon Monoxide as CO



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
180	0.8	8.72	0.96	0.078

Stack - 201F1&F2 emission of Carbon Monoxide concentration is 180mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 8.72µg/m3 at 2km dispersion Carbon Monoxide is 0.96µg/m3 and at 5km dispersion Carbon Monoxide is 0.078µg/m3 and the predominant wind direction is ESE.

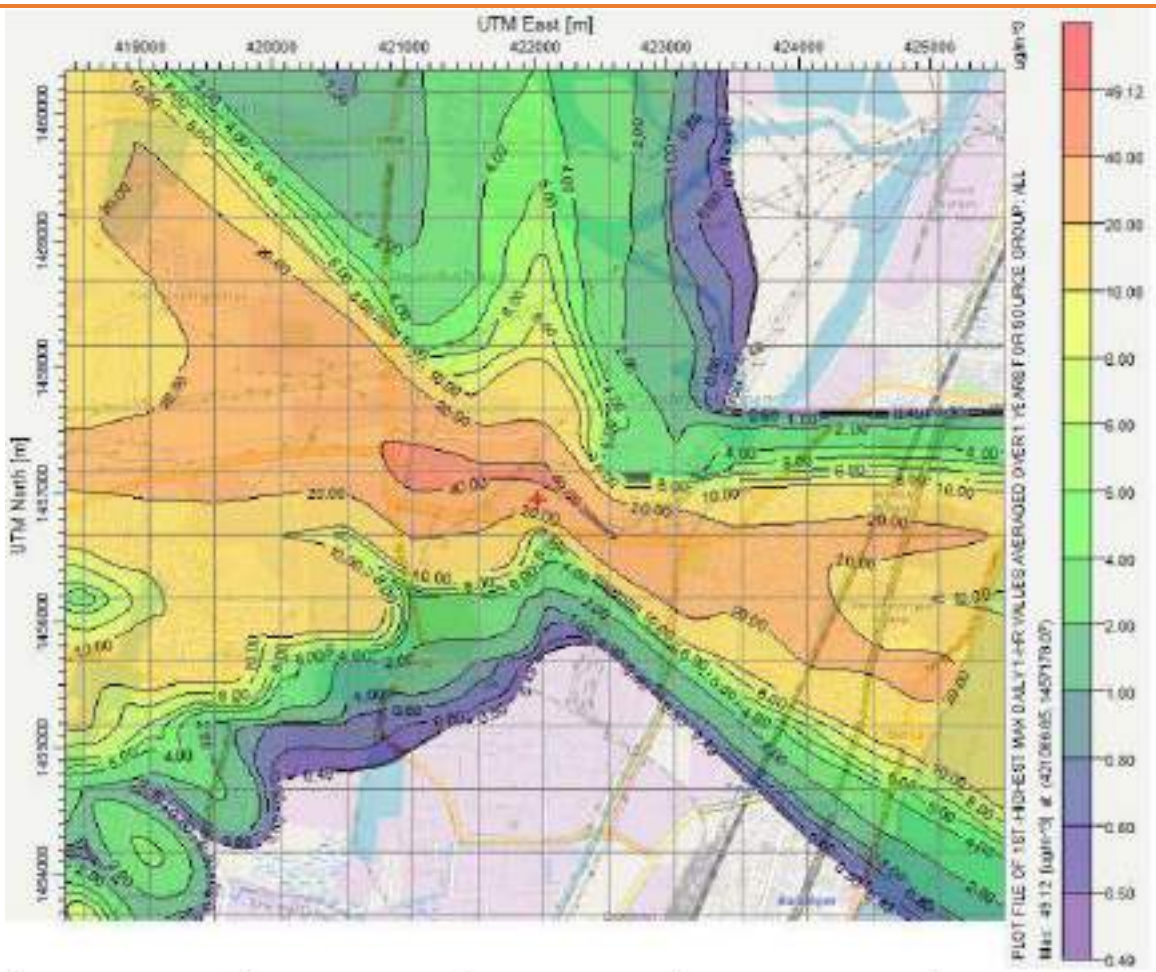
STACK EMISSION DISPERSION MODELLING – Stack – 201F1&F2 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
14.4	0.69	1.33	0.89	0.022

Stack - 201F1&F2 emission of Particulate matter concentration is 14.4mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 1.33µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.022µg/m3 and the predominant wind direction is ESE.

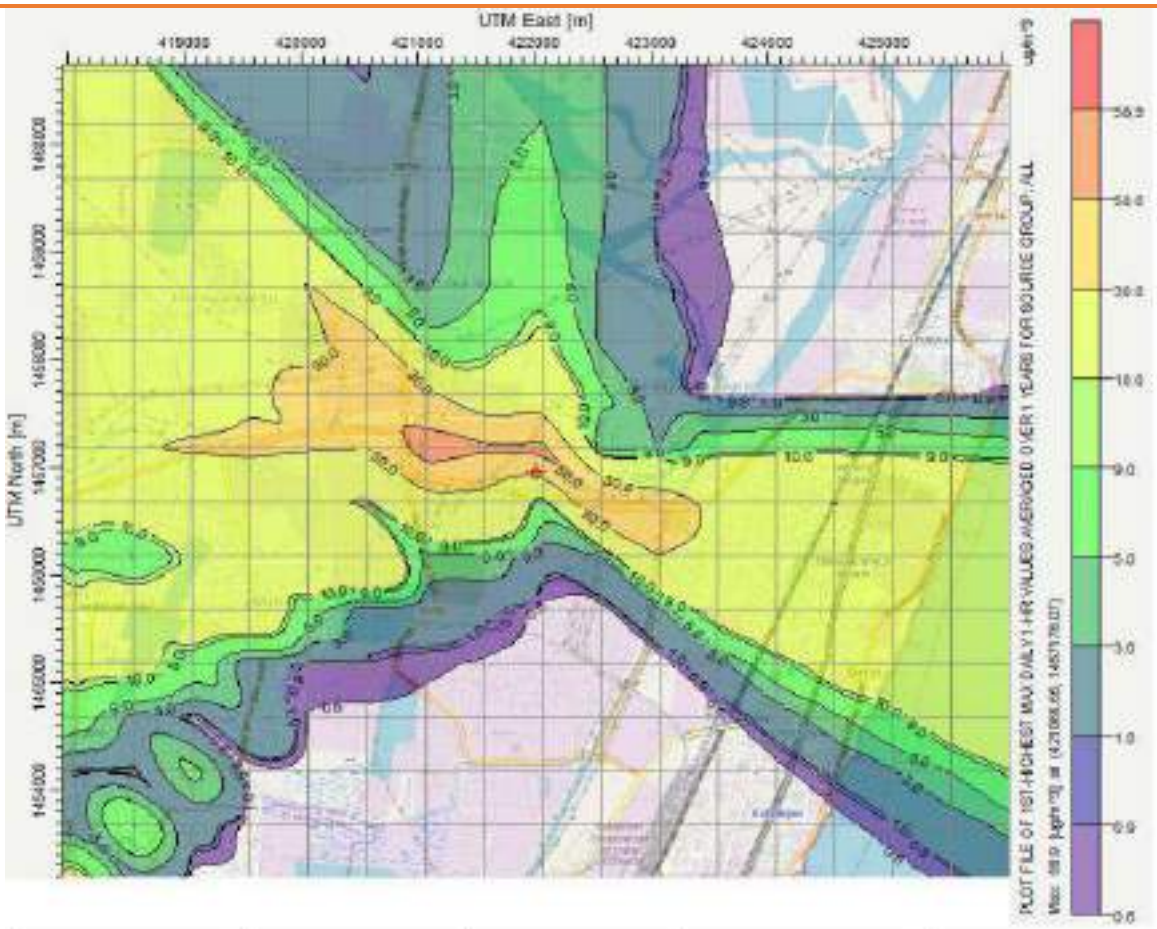
STACK EMISSION DISPERSION MODELLING – Stack – 201F1&F2 @ 2 & 5KM – Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
367	0.91	49.12	8.79	0.97

Stack - 201F1&F2 emission of Sulphur dioxide concentration is 367mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 49.12µg/m3 at 2km dispersion Sulphur dioxide is 8.79µg/m3 and at 5km dispersion Sulphur dioxide is 0.97µg/m3 and the predominant wind direction is ESE.

STACK EMISSION DISPERSION MODELLING – Stack – 201F1&F2 @ 2 & 5KM – Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
239	0.73	58.9	19.96	4.11

Stack - 201F1&F2 emission of Oxides of Nitrogen concentration is 239mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 19.96µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.11µg/m3 and the predominant wind direction is ESE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)
14F1	CO	152	0.78	8.78	0.87	0.0177
14F1	PM	15.4	0.82	0.932	0.155	0.0567
14F1	SO2	116	0.78	6.73	1.23	0.76
14F1	NOx	356	0.85	20.5	2.28	0.776
14F101	CO	140	0.799	6.76	1.786	0.57
14F101	PM	8.2	0.995	0.401	0.0334	0.00631
14F101	SO2	42	0.831	2.005	0.211	0.0856
14F101	NOx	331	0.75	20.8	2.78	0.892
15F1A	CO	149	0.89	20.8	2.22	1.788
15F1A	PM	17.9	0.71	3.002	1.11	0.534
15F1A	SO2	76	0.81	12.6	2.22	0.45
15F1B	CO	103	0.77	9.04	2.8	0.52
15F1B	PM	19.4	0.72	1.51	0.76	0.099
15F1B	SO2	59	0.7	4.583	0.78	0.0753
15F1B	NOX	172	0.89	13.4	4.56	1.11
15F2A	CO	119	0.78	5.78	1.8	0.54
15F2A	PM	18.5	0.73	0.879	0.08	0.005
15F2A	SO2	61	0.82	2.95	0.62	0.0736
15F2A	NOX	306	0.87	14.9	5.55	2.22
15F2B	CO	84	0.89	6.9	0.876	0.07212
15F2B	PM	20.3	0.912	1.68	0.522	0.086
15F2B	SO2	187	0.8657	15.3	0.987	0.0467
15F2B	NOX	192	0.888	15.7	2.2354	0.987

16F1	CO	148	0.97	20.4	8.32	0.952
16F1	PM	17.4	0.78	56.2	9.92	2.19
16F1	SO2	59	0.83	2.49	0.855	0.072
16F1	NOX	408	0.83	56.2	10.11	1.47
16F3	CO	142	0.889	18.7	1.56	0.321
16F3	PM	9.7	0.785	1.28	0.11	0.0693
16F3	NOX	43	0.81	5.52	1.789	0.809
16F3	SO2	10	0.869	1.36	0.19	0.0461
9F201	CO	185	0.789	13.2	1.31	0.0866
9F201	PM	24.4	0.77	5.52	2.16	0.42
9F201	NOX	421	0.88	29.2	2.89	0.75
9F201	SO2	41	0.982	2.97	0.666	0.0231
9F301	CO	159	0.7	5.52	2.42	0.56
9F301	PM	25.6	0.78	5.67	2.11	0.36
9F301	S02	71	0.73	2.49	0.44	0.0925
9F301	NOX	425	0.68	14.8	3.75	0.541
205F2	CO	11	0.91	2.44	0.92	0.0667
205F2	PM	24.9	0.89	5.49	1.05	0.0132
205F2	SO2	7.7	0.65	1.71	0.89	0.064
205F2	NOx	25.0	0.88	5.49	0.43	0.0792
206F1-F2	CO	23.0	0.78	1.21	0.45	0.0697
206F1-F2	PM	15.8	0.9	0.764	0.12	0.097
206F1-F2	SO2	259	0.81	2.11	0.934	0.765
206F1-F2	NOx	217	0.9	2.39	0.875	0.0522
206 F3-F6	CO	49.0	0.98	4.22	0.621	0.022
206 F3-F6	PM	9.8	0.79	1.72	0.89	0.0567

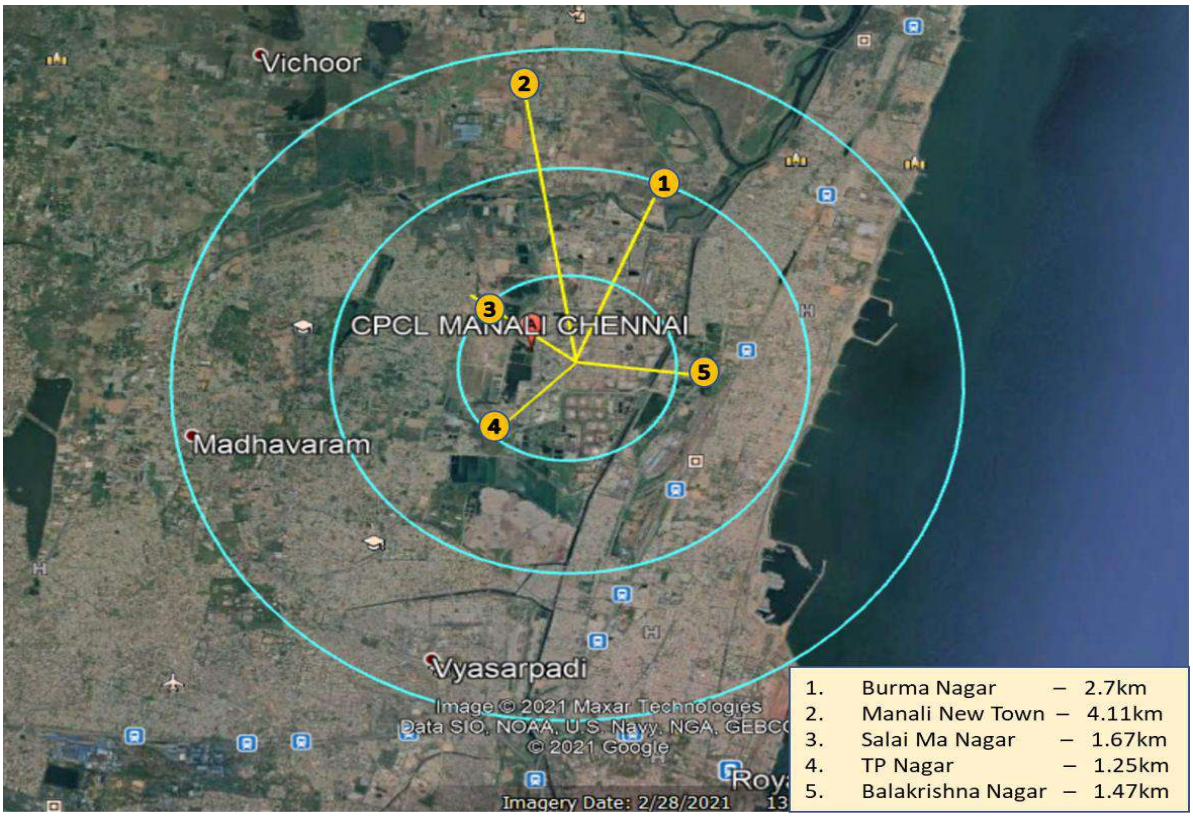
206 F3-F6	SO2	84.4	0.87	7.47	0.841	0.0941
206 F3-F6	NOx	230	0.8	19.8	1.87	0.126
207 F1	CO	13	0.793	1.01	0.14	0.0641
207 F1	PM	9.3	0.879	0.725	0.086	0.0043
207 F1	NOx	31.0	0.77	3.11	0.42	0.0314
207 F1	SO2	7.7	0.824	0.561	0.0431	0.00856
212 F1	NOx	27.0	0.86	3.01	1.03	0.0929
Gas Turbin-1	CO	2.0	0.61	0.415	0.055	0.0097
Gas Turbin-1	PM	28.2	0.7	0.415	0.0735	0.0872
Gas Turbin-1	SO2	12.9	0.69	2.59	0.71	0.088
Gas Turbin-1	NOx	12.0	0.83	2.39	0.13	0.0955
Gas Turbin-2	CO	6.0	0.98	1.21	0.2	0.0785
Gas Turbin-2	PM	22.2	0.89	4.42	0.24	0.098
Gas Turbin-2	SO2	10.3	0.91	2.11	0.865	0.0351
Gas Turbin-2	NOx	10.0	0.78	1.91	0.75	0.0767
Gas Turbin-3	CO	8.0	0.8	1.07	0.124	0.065
Gas Turbin-3	PM	26.9	0.98	3.6	0.97	0.083
Gas Turbin-3	SO2	15.4	0.8	2.07	0.85	0.0963
Gas Turbin-3	NOx	16.0	0.777	2.3	0.83	0.0981
207 F102	CO	17.0	0.84	2.29	0.461	0.0666

207 F102	PM	15.6	0.99	2.06	0.7654	0.0893
207 F102	SO2	437.3	1.19	58.3	14.9	0.98
207 F102	NOx	167.0	0.98	22.2	2.86	0.421
207 F201	NOx	8.9	0.98	0.764	0.0654	0.00331
Boiler-1	CO	40.0	0.98	0.764	0.086	0.00713
Boiler-1	PM	57.3	0.78	11.0	2.768	0.64
Boiler-1	SO2	922.4	1.03	177.0	34.5	4.67
Boiler-3	CO	28.0	0.99	5.41	0.77	0.075
Boiler-3	PM	60.5	0.89	11.6	2.21	0.865
Boiler-3	SO2	998.0	1.34	11.8	1.89	0.536
Boiler-3	NOx	272.0	0.768	52.2	18.16	4.1
Boiler-4	CO	12.0	0.96	23.8	5.34	0.984
Boiler-4	PM	53.0	0.809	105.0	39.5	9.77
Boiler-4	SO2	943.0	1.07	1868.0	454.78	96.456
Boiler-4	NOx	400.0	1.08	792.0	98.7	12.56
Gas Turbin-4	CO	11.0	0.98	2.25	0.45	0.0678
Gas Turbin-4	PM	17.4	0.88	3.55	0.9	0.065
Gas Turbin-4	SO2	5.1	0.95	3.55	0.86	0.094
Gas Turbin-4	NOx	32.0	0.794	3.55	0.85	0.09
86F1	CO	11	0.867	2.005	0.24	0.0357
86F1	PM	8.6	0.789	1.52	0.157	0.0681
86F1	NOx	71.0	0.67	12.3	1.589	0.934
211 F1	CO	124.0	0.623	8.94	1.45	0.456
211 F1	PM	23.7	0.83	1.68	0.2	0.076
211 F1	SO2	49.0	0.931	3.51	0.75	0.0923

211 F1	NOx	29.0	0.97	2.22	0.31	0.0874
1F1B	CO	13.0	0.91	8.94	1.74	0.976
1F1B	PM	22.9	0.91	1.68	0.43	0.0618
1F1B	SO2	48.8	0.76	3.67	0.55	0.0751
1F1B	NOx	232.0	0.8	17.1	2.31	0.551
206 F1	PM	9.4	0.91	2.22	0.59	0.0823
206 F1	SO2	212.0	0.87	5.73	0.356	0.065
206 F1	NOx	193.0	0.98	5.19	0.86	0.0621
206 F2	CO	6.0	0.79	0.153	0.098	0.0113
206 F2	PM	9.8	0.93	0.229	0.0976	0.0034
206 F2	SO2	289.0	0.99	7.79	0.751	0.0134
206 F2	NOx	272.0	0.82	0.73	1.56	0.75
214 F1	CO	7.0	0.78	1.99	0.12	0.0431
214 F1	PM	9.1	0.86	2.29	0.787	0.011
214 F1	NOx	29.0	0.85	8.33	2.21	0.97
1F3	PM	18.2	0.87	1.53	0.53	0.017
1F3	SO2	229.0	0.81	15.7	1.876	0.592
1F3	NOx	191.0	0.96	13.1	2.88	0.813
1F1A East	PM	14.5	0.874	1.05	0.89	0.078
1F1A East	SO2	164	0.832	2.09	0.27	0.076
1F1A East	NOx	125	0.87	12.6	2.18	0.896
1F1A West	CO	56	0.877	16.4	1.87	0.977
1F1A West	PM	12.4	0.911	2.81	0.111	0.0552
1F1A West	SO2	149	0.81	43.7	21.2	17.76

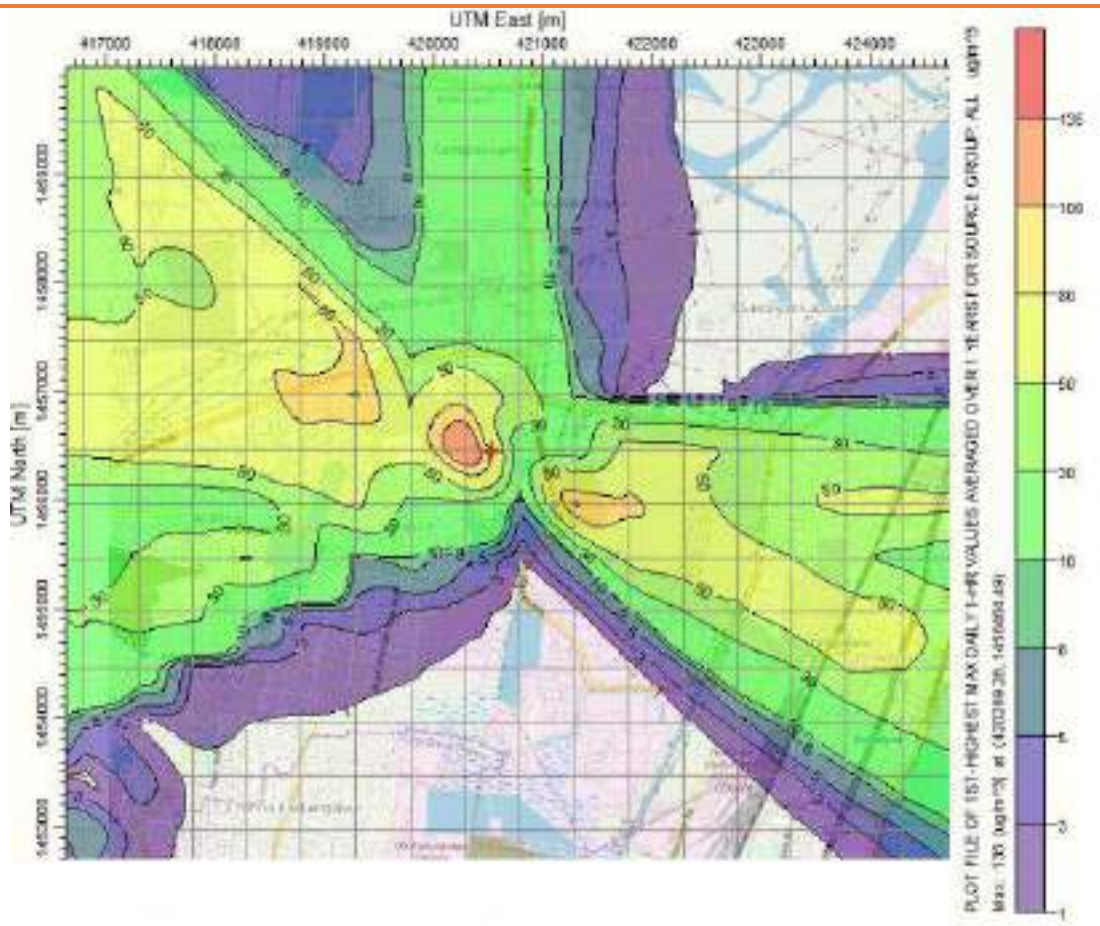
1F1A West	NOx	101	0.721	3.67	0.41	0.075
10F101	CO	111	0.73	16.9	5.323	0.927
10F101	PM	19.1	0.81	4.08	1.11	0.534
10F101	SO2	40.8	0.78	46.29	18.21	8.11
10F101	NOx	232	0.77	35.3	15.16	6.61
71F1	CO	143	0.75	41.8	12.78	2.412
71F1	PM	29.7	0.76	8.58	1.65	0.823
71F1	SO2	157.3	0.66	16.4	4.44	0.76
71F1	NOx	335	0.98	97.09	38.91	24.11
73F101	CO	135	0.68	14.7	3.67	0.781
73F101	PM	27	0.87	2.96	0.89	0.075
73F101	SO2	51	0.88	3.16	1.45	0.86
73F101	NOx	94	0.77	10.2	2.1	0.64
73F102	CO	15	0.66	1.64	0.86	0.0578
73F102	PM	15.3	0.71	1.74	0.534	0.087
73F102	SO2	10	0.77	1.12	0.565	0.089
73F102	NOx	16	0.7	1.74	0.98	0.11
76F11	CO	152	0.76	47.44	8.86	1.32
76F11	PM	33.1	0.87	10.3	0.89	0.076
76F11	SO2	20.6	0.95	6.44	0.97	0.0318
76F11	NOx	33	0.86	10.3	2.25	0.341
77F1	CO	31	0.8	1.33	0.123	0.057
77F1	PM	18.4	0.77	1.54	0.65	0.033
77F1	SO2	21	0.81	10.4	1.99	0.078
77F1	NOx	60	0.745	2.77	0.752	0.011
205F1	CO	136	0.736	89.1	7.731	0.8966
205F1	PM	16.2	0.977	1.32	0.54	0.0865

205F1	NOx	55	1.01	58.9	16.1	4.58
205F1	SO2	16.2	0.977	11.8	0.462	0.0756
201F1&F2	CO	180	0.8	8.72	0.96	0.078
201F1&F2	PM	14.4	0.69	1.33	0.89	0.022
201F1&F2	SO2	367	0.91	49.12	8.79	0.97
201F1&F2	NOx	239	0.73	58.9	19.96	4.11



CUMULATIVE EMISSIONS

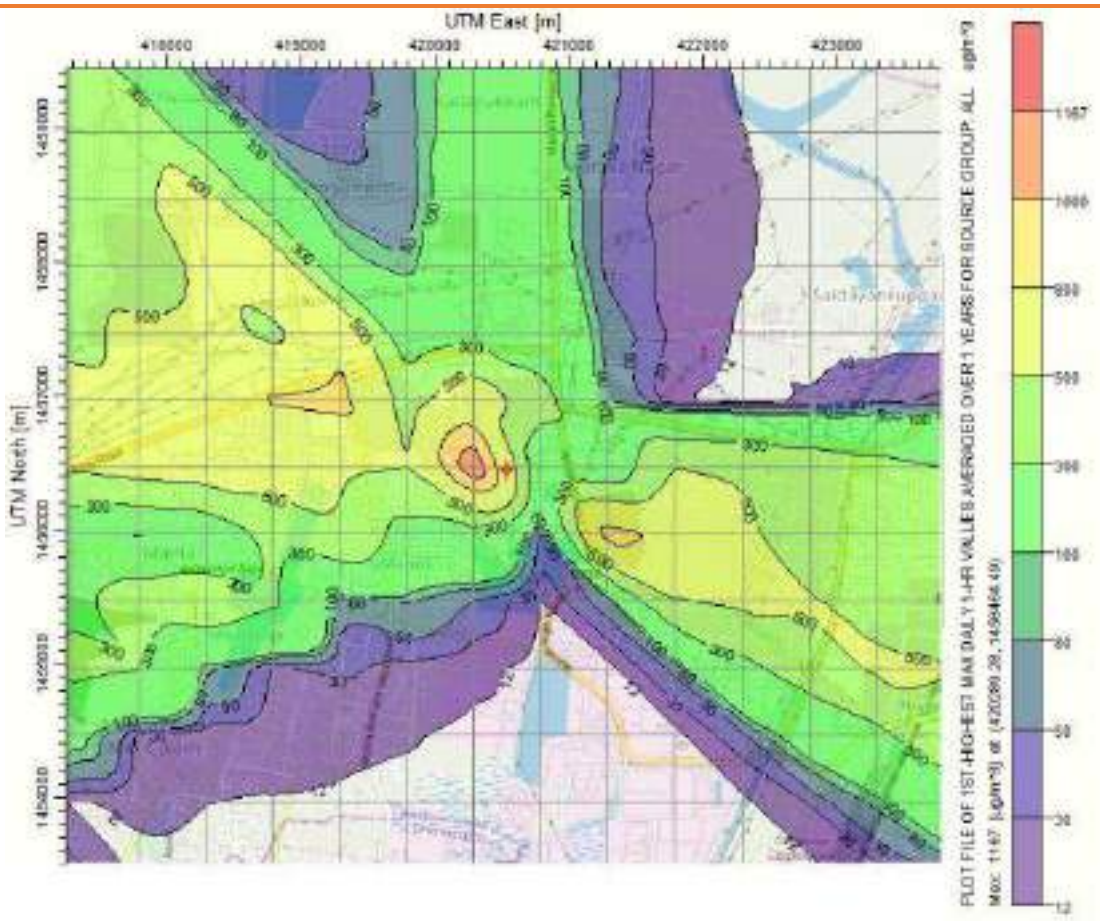
STACK EMISSION DISPERSION MODELLING – Stack – Cumulative @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
799.8	1.01	135	19.6	0.87

Cumulative Emissions of **Particulate matter** concentration is 799.8mg/m3 and dispersed at the effective stack height of 60.1m (Stack height 60.1m + Plume Height 4.0m) with exit velocity of 10.68m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 135µg/m3 at 2km dispersion Particulate matter is 19.6µg/m3 and at 5km dispersion Particulate matter is 0.87µg/m3 and the predominant wind direction is ESE.

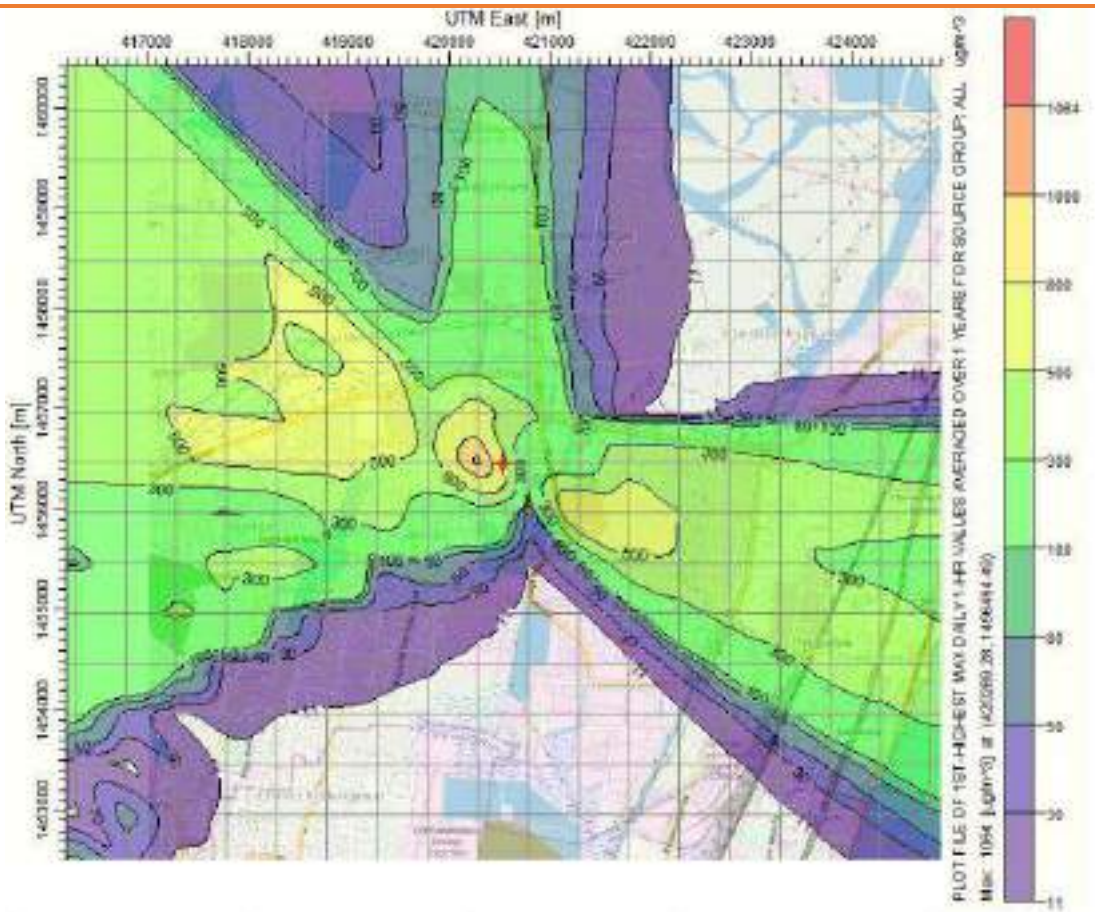
STACK EMISSION DISPERSION MODELLING – Stack – Cumulative @ 2 & 5KM – Nitrogen Dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
6910	1.01	1167	191.68	31.1

Cumulative Emissions of **Nitrogen Dioxide** concentration is 799.8mg/m3 and dispersed at the effective stack height of 60.1m (Stack height 60.1m + Plume Height 4.0m) with exit velocity of 10.68m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 1167µg/m3 at 2km dispersion Nitrogen Dioxide is 191.68µg/m3 and at 5km dispersion Nitrogen Dioxide is 31.1µg/m3 and the predominant wind direction is ESE.

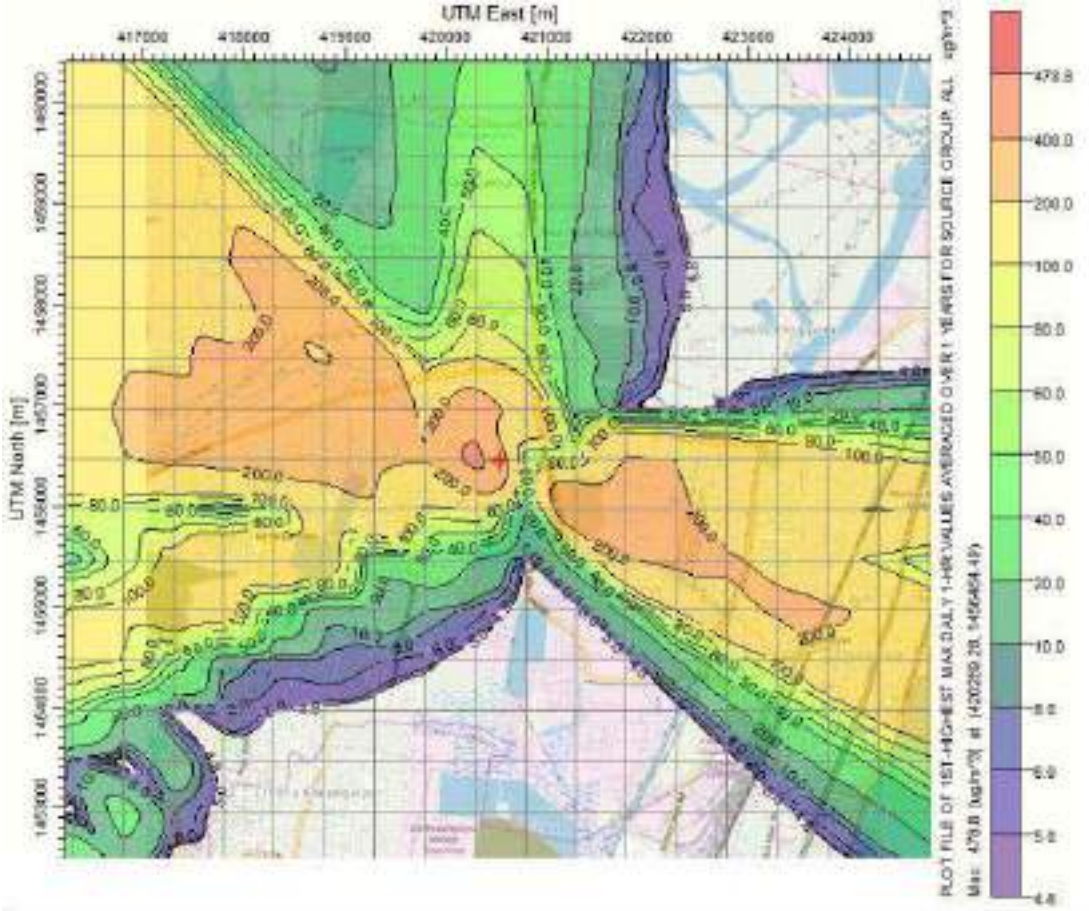
STACK EMISSION DISPERSION MODELLING – Stack – Cumulative @ 2 & 5KM – Sulphur Dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
6300	0.98	1064	237	44.94

Cumulative Emissions of **Sulphur Dioxide** concentration is 6300mg/m3 and dispersed at the effective stack height of 60.1m (Stack height 60.1m + Plume Height 4.0m) with exit velocity of 10.68m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 1064µg/m3 at 2km dispersion Sulphur Dioxide is 237µg/m3 and at 5km dispersion Sulphur Dioxide is 44.94µg/m3 and the predominant wind direction is ESE.

STACK EMISSION DISPERSION MODELLING – Stack – Cumulative @ 2 & 5KM – Carbon monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
2835	0.98	478	81	18.79

Cumulative Emissions of **Carbon monoxide** concentration is 2835mg/m3 and dispersed at the effective stack height of 60.1m (Stack height 60.1m + Plume Height 4.0m) with exit velocity of 10.68m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 478µg/m3 at 2km dispersion Carbon monoxide is 81µg/m3 and at 5km dispersion Carbon monoxide is 18.79µg/m3 and the predominant wind direction is ESE.

10.0 FINDINGS:

10.1 Ambient Air Quality:

In Ambient Air Quality monitoring ten locations were identified as source of emission of Gaseous and Particulate matter. Those are, R & D, SRU, CPP, Temple, SS-5, ETP-2, TTP, Polytanic, Isomer (Cabin) & Refinery 2 Maintains Field Room.

- *Sulphur Dioxide as SO_2 :* Ambient Air Quality values of SO_2 are ranging from 14.7 to 24.7 µg/m^3. Highest value of 24.7 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Nitrogen Dioxide as NO_2 :* Ambient Air Quality values of NO_2 are ranging from 30.2 to 34.6 µg/m^3. Highest value of 37.61 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter (PM_{10}) :* Ambient Air Quality values of PM_{10} are ranging from 43.6 to 57.5 µg/m^3. Highest value of 57.5 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter ($PM_{2.5}$) :* Ambient Air Quality values of $PM_{2.5}$ are ranging from 26 to 35.1 µg/m^3. Highest value of 35.1 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Lead as Pb :* Ambient Air Quality values of Pb are ranging from 0.0 to 0.0295 µg/m^3. Highest value of 0.0295 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Benzene :* Ambient Air Quality values of Benzene are ranging from 0 to 4.4 µg/m^3.

- *Nickel as Ni:* Ambient Air Quality values of Nickel are ranging from 0 to 2.56 µg/m^3.

10.2 FINDINGS ON STACK EMISSION MONITORING:

Stack - 14F1

Stack - 14F1 emission of Carbon Monoxide concentration is 152mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 8.78µg/m3 at 2km dispersion Oxides of Nitrogen is 0.87µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0177µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Particulate matter concentration is 15.4mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 0.932µg/m3 at 2km dispersion Particulate matter Particulate matter isµg/m3 and at 5km dispersion Particulate matter is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Sulphur dioxide concentration is 116mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 6.73µg/m3 at 2km dispersion Sulphur dioxide is 1.23µg/m3 and at 5km dispersion Sulphur dioxide is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Oxides of Nitrogen concentration is 356mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 20.5µg/m3 at 2km dispersion Oxides of Nitrogen is 2.28µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.776µg/m3 and the predominant wind direction is ESE.

Stack - 14F101

Stack - 14F101 emission of Carbon Monoxide concentration is 140mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.799km at the concentration of 6.76µg/m3 at 2km dispersion Carbon Monoxide is 1.786µg/m3 and at 5km dispersion Carbon Monoxide is 0.57µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Particulate matter concentration is 8.1mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.995km at the concentration of 0.401µg/m3 at 2km dispersion Particulate matter is 0.0334µg/m3 and at 5km dispersion Particulate matter is 0.00631µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Oxides of Nitrogen concentration is 331mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 20.8µg/m3 at 2km dispersion Oxides of Nitrogen is 2.78µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.892µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Sulphur dioxide concentration is 42mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.831km at the concentration of 2.005µg/m3 at 2km dispersion Sulphur dioxide is 0.211µg/m3 and at 5km dispersion Sulphur dioxide is 0.0856µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A

Stack - 15F1A emission of Carbon Monoxide is 149mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 20.8µg/m3 at 2km dispersion Carbon Monoxide is 2.22µg/m3 and at 5km dispersion Carbon Monoxide is 1.788µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Particulate matter is 17.9mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 3.002µg/m3 at 2km dispersion Particulate matter is 1.11µg/m3 and at 5km dispersion Particulate matter is 0.534µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Sulphur dioxide is 76mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 12.6µg/m3 at 2km dispersion Sulphur dioxide is 2.22µg/m3 and at 5km dispersion Sulphur dioxide is 0.45µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Oxides of Nitrogen is 12.4 mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8 km at the concentration of 30.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.38µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.782µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Carbon Monoxide is 103mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling

parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 9.04µg/m3 at 2km dispersion Carbon Monoxide is 2.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.52µg/m3 and the predominant wind direction is ESE.

Stack - 15F1B

Stack - **15F1B** emission of Particulate matter is 19.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.72km at the concentration of 1.51µg/m3 at 2km dispersion Carbon Monoxide is 0.76µg/m3 and at 5km dispersion Carbon Monoxide is 0.099µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 4.583µg/m3 at 2km dispersion Sulphur dioxide is 0.78µg/m3 and at 5km dispersion Sulphur dioxide is 0.0753µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Oxides of Nitrogen is 172mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack

diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 13.4µg/m3 at 2km dispersion Oxides of Nitrogen is 4.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.11µg/m3 and the predominant wind direction is ESE.

Stack - 15F2A

Stack - **15F2A** emission of Carbon Monoxide is 119mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.78µg/m3 at 2km dispersion Carbon Monoxide is 1.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.54µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Particulate matter is 18.5mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 0.879µg/m3 at 2km dispersion Particulate matter is 0.08µg/m3 and at 5km dispersion Particulate matter is 0.005µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Sulphur dioxide is 61mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack

diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 2.95µg/m3 at 2km dispersion Sulphur dioxide is 0.62µg/m3 and at 5km dispersion Sulphur dioxide is 0.0736µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Oxides of Nitrogen is 306mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 14.9µg/m3 at 2km dispersion Oxides of Nitrogen is 5.55µg/m3 and at 5km dispersion Oxides of Nitrogen is 2.22µg/m3 and the predominant wind direction is ESE.

Stack - 15F2B

Stack - **15F2B** emission of Carbon Monoxide is 84mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 6.9µg/m3 at 2km dispersion Carbon Monoxide is 0.876µg/m3 and at 5km dispersion Carbon Monoxide is 0.07212µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Particulate matter is 20.3mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack

diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.912km at the concentration of 1.68µg/m3 at 2km dispersion Particulate matter is 0.522µg/m3 and at 5km dispersion Particulate matter is 0.086µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Sulphur dioxide is 187mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8657km at the concentration of 15.3µg/m3 at 2km dispersion Sulphur dioxide is 0.987µg/m3 and at 5km dispersion Sulphur dioxide is 0.0467µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Oxides of Nitrogen is 192mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.888km at the concentration of 15.7µg/m3 at 2km dispersion Oxides of Nitrogen is 2.2354µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.987µg/m3 and the predominant wind direction is ESE.

Stack - 16F1

Stack - **16F1** emission of Carbon Monoxide is 148mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack

diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 20.4µg/m3 at 2km dispersion Oxides of Nitrogen is 8.32µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.952µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Particulate matter is 17.4mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 56.2µg/m3 at 2km dispersion Particulate matter is 9.91µg/m3 and at 5km dispersion Particulate matter is 2.19µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.855µg/m3 and at 5km dispersion Sulphur dioxide is 0.072µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Oxides of Nitrogen is 408mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at

the concentration of 56.2µg/m3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m3 and the predominant wind direction is ESE.

Stack - 16F3

Stack - **16F3** emission of Carbon Monoxide is 142mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.889km at the concentration of 18.7µg/m3 at 2km dispersion Carbon Monoxide is 1.56µg/m3 and at 5km dispersion Carbon Monoxide is 0.321µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Particulate matter is 9.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.785km at the concentration of 1.28µg/m3 at 2km dispersion Particulate matter is 0.11µg/m3 and at 5km dispersion Particulate matter is 0.0693µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Oxides of Nitrogen is 43mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at

the concentration of 5.52µg/m3 at 2km dispersion Oxides of Nitrogen is 1.789µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.809µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Sulphur dioxide is 10mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.869km at the concentration of 1.36µg/m3 at 2km dispersion Sulphur dioxide is 0.19µg/m3 and at 5km dispersion Sulphur dioxide is 0.0461µg/m3 and the predominant wind direction is ESE.

Stack - 9F201

Stack - **9F201** emission of Particulate matter is 24.4mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 5.52µg/m3 at 2km dispersion Particulate matter is 2.16µg/m3 and at 5km dispersion Particulate matter is 0.42µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Oxides of Nitrogen is 421mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 29.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.89µg/m3

and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Carbon Monoxide is 185 mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.789km at the concentration of 13.2µg/m3 at 2km dispersion Carbon Monoxide is 1.31µg/m3 and at 5km dispersion Carbon Monoxide is 0.0866µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Sulphur dioxide is 41mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.982km at the concentration of 2.97µg/m3 at 2km dispersion Sulphur dioxide is 0.666µg/m3 and at 5km dispersion Sulphur dioxide is 0.0231µg/m3 and the predominant wind direction is ESE.

Stack - 9F301

Stack - **9F301** emission of Carbon Monoxide is 159mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 5.52µg/m3 at 2km dispersion Oxides of Nitrogen is 2.42µg/m3 and

at 5km dispersion Oxides of Nitrogen is 0.56µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Particulate matter is 25.6mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.67µg/m3 at 2km dispersion Particulate matter is 2.11µg/m3 and at 5km dispersion Particulate matter is 0.36µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Sulphur dioxide is 71.4mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.0925µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Oxides of Nitrogen is 425mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.8µg/m3 at 2km dispersion Oxides of Nitrogen is 3.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.541µg/m3 and the predominant wind direction is ESE.

Stack – 205F2

Stack – 205F2 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.44µg/m3 at 2km dispersion Carbon Monoxide is 0.92µg/m3 and at 5km dispersion Carbon Monoxide is 0.0667µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Particulate matter concentration is 24.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 5.49µg/m3 at 2km dispersion Particulate matter is 1.05µg/m3 and at 5km dispersion Particulate matter is 0.0132µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.65km at the concentration of 1.71µg/m3 at 2km dispersion Sulphur dioxide is 0.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.064µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Oxides of Nitrogen concentration is 25.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 5.49µg/m3 at 2km dispersion Oxides of Nitrogen is 0.43µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0792µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2

Stack – 206F1-F2 emission of Carbon Monoxide concentration is 23.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.0697µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Particulate matter concentration is 15.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 0.764µg/m3 at 1km dispersion Particulate matter is 0.12µg/m3 and

at 2km dispersion Particulate matter is 0.097µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Sulphur dioxide concentration is 259mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.934µg/m3 and at 5km dispersion Sulphur dioxide is 0.765µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Oxides of Nitrogen concentration is 217mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.875µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0522µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6

Stack – 206F3-F6 emission of Carbon Monoxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 4.22µg/m3 at 2km dispersion Carbon Monoxide is 0.621µg/m3

and at 5km dispersion Carbon Monoxide is 0.022µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Sulphur dioxide concentration is 84.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 7.47µg/m3 at 2km dispersion Sulphur dioxide is 0.841µg/m3 and at 5km dispersion Sulphur dioxide is 0.0941µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Particulate matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 1.72µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.0567µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Oxides of Nitrogen concentration is 230mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 19.8µg/m3 at 2km dispersion Oxides of Nitrogen is 1.87µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.126µg/m3 and the predominant wind direction is ESE.

Stack – 207F1

Stack – 207F1 emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.793km at the concentration of 1.01µg/m3 at 2km dispersion Carbon Monoxide is 0.14µg/m3 and at 5km dispersion Carbon Monoxide is 0.0641µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Particulate matter concentration is 9.3mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.879km at the concentration of 0.725µg/m3 at 2km dispersion Particulate matter is 0.086µg/m3 and at 5km dispersion Particulate matter is 0.0043µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Oxides of Nitrogen concentration is 31mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 3.11µg/m3 at 2km dispersion Oxides of Nitrogen is 0.42µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0314µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.824km at the concentration of 0.561µg/m3 at 2km dispersion Sulphur dioxide is 0.0431µg/m3 and at 5km dispersion Sulphur dioxide is 0.00856µg/m3 and the predominant wind direction is ESE.

Stack 212F1

Stack – 212F1 emission of Carbon Monoxide concentration is 54mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.57km at the concentration of 4.731µg/m3 at 2km dispersion Carbon Monoxide is 0.681µg/m3 and at 5km dispersion Carbon Monoxide is 0.8654µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Particulate matter concentration is 8.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 0.802µg/m3 at 2km dispersion Particulate matter is 0.0766µg/m3 and at 5km dispersion Particulate matter is 0.00599µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Oxides of Nitrogen concentration is 27mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 3.01µg/m3 at 2km dispersion Oxides of Nitrogen is 1.03µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0929µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Sulphur dioxide concentration is 47mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.09µg/m3 at 2km dispersion Sulphur dioxide is 0.261µg/m3 and at 5km dispersion Sulphur dioxide is 0.07867µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-1

Stack – Gas Turbin-1 emission of Carbon Monoxide concentration is 2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.61km at the concentration of 0.415µg/m3 at 2km dispersion Carbon Monoxide is 0.055µg/m3 and at 5km dispersion Carbon Monoxide is 0.0097µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-1 emission of Particulate Matter concentration is 28.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 0.415µg/m3 at 2km dispersion Particulate Matter is 0.0735µg/m3 and at 5km dispersion Particulate Matter is 0.0872µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-1 emission of Sulphur dioxide concentration is 12.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 2.59µg/m3 at 2km dispersion Sulphur dioxide is 0.71µg/m3 and at 5km dispersion Sulphur dioxide is 0.088µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-1 emission of Oxides of Nitrogen concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.13µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0955µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-2

Stack – Gas Turbin-2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.2µg/m3 and at 5km dispersion Carbon Monoxide is 0.0785µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-2 emission of Particulate Matter concentration is 22.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 4.42µg/m3 at 2km dispersion Particulate Matter is 0.24µg/m3 and at 5km dispersion Particulate Matter is 0.098µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-2 emission of Sulphur dioxide concentration is 10.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.865µg/m3 and at 5km dispersion Sulphur dioxide is 0.0351µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-2 emission of Oxides of Nitrogen concentration is 10mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height

3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.91µg/m3 at 2km dispersion Oxides of Nitrogen is 0.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0767µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-3

Stack – Gas Turbin-3 emission of Carbon Monoxide concentration is 8mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.07µg/m3 at 2km dispersion Carbon Monoxide is 0.124µg/m3 and at 5km dispersion Carbon Monoxide is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-3 emission of Particulate Matter concentration is 26.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 3.6µg/m3 at 2km dispersion Particulate Matter is 0.97µg/m3 and at 5km dispersion Particulate Matter is 0.083µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-3 emission of Sulphur dioxide concentration is 15.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height,

stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 2.07µg/m3 at 2km dispersion Sulphur dioxide is 0.85µg/m3 and at 5km dispersion Sulphur dioxide is 0.0963µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbin-3 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.777km at the concentration of 2.3µg/m3 at 2km dispersion Oxides of Nitrogen is 0.83µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0981µg/m3 and the predominant wind direction is ESE.

Stack – 207F102

Stack – 207F102 emission of Carbon Monoxide concentration is 17mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 2.29µg/m3 at 2km dispersion Carbon Monoxide is 0.461µg/m3 and at 5km dispersion Carbon Monoxide is 0.0666µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Particulate Matter concentration is 15.6mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 2.06µg/m3 at 2km dispersion Particulate Matter is 0.7654µg/m3 and at 5km dispersion Particulate Matter is 0.0893µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Sulphur dioxide concentration is 437.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.19km at the concentration of 58.3µg/m3 at 2km dispersion Sulphur dioxide is 14.9µg/m3 and at 5km dispersion Sulphur dioxide is 0.98µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Oxides of Nitrogen concentration is 167mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 22.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.421µg/m3 and the predominant wind direction is ESE.

Stack – 207F201

Stack – 207F201 emission of Oxides of Nitrogen concentration is 8.9mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 6.14m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Oxides of Nitrogen is 0.0654µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.00331µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-1

Stack – Boiler-1 emission of Carbon Monoxide concentration is 40mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Carbon Monoxide is 0.086µg/m3 and at 5km dispersion Carbon Monoxide is 0.00713µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-1 emission of Particulate Matter concentration is 57.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 11µg/m3 at 2km dispersion Particulate Matter is 2.768µg/m3 and at 5km dispersion Particulate Matter is 0.64µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-1 emission of Sulphur dioxide concentration is 922.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 1.03km at the concentration of 177µg/m3 at 2km dispersion Sulphur dioxide is 34.5µg/m3 and at 5km dispersion Sulphur dioxide is 4.67µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3

Stack – Boiler-3 emission of Carbon Monoxide concentration is 28mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 5.41µg/m3 at 2km dispersion Carbon Monoxide is 0.77µg/m3 and at 5km dispersion Carbon Monoxide is 0.075µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Particulate Matter concentration is 60.5mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 11.6µg/m3 at 2km dispersion Particulate Matter is 2.21µg/m3 and at 5km dispersion Particulate Matter is 0.865µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Sulphur dioxide concentration is 998mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 1.34km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 1.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.536µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.768km at the concentration of 52.2µg/m3 at 2km dispersion Oxides of Nitrogen is 18.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.1µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4

Stack – Boiler-4 emission of Carbon Monoxide concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 23.8µg/m3 at 2km dispersion Carbon Monoxide is 5.34µg/m3 and at 5km dispersion Carbon Monoxide is 0.984µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Particulate Matter concentration is 53mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 0.809km at the concentration of 105µg/m3 at 2km dispersion Particulate Matter is 39.5µg/m3 and at 5km dispersion Particulate Matter is 9.77µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Sulphur dioxide concentration is 943mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.07km at the concentration of 1868µg/m3 at 2km dispersion Sulphur dioxide is 454.78µg/m3 and at 5km dispersion Sulphur dioxide is 96.456µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Oxides of Nitrogen concentration is 400mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.08km at the concentration of 792µg/m3 at 2km dispersion Oxides of Nitrogen is 98.7µg/m3 and at 5km dispersion Oxides of Nitrogen is 12.56µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-4

Stack – Gas Turbine-4 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 2.25µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3

and at 5km dispersion Carbon Monoxide is 0.0678µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-4 emission of Particulate Matter concentration is 17.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.55µg/m3 at 2km dispersion Particulate Matter is 0.9µg/m3 and at 5km dispersion Particulate Matter is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-4 emission of Sulphur dioxide concentration is 5.1mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 3.55µg/m3 at 2km dispersion Sulphur dioxide is 0.86µg/m3 and at 5km dispersion Sulphur dioxide is 0.094µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-4 emission of Oxides of Nitrogen concentration is 32mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.794km at the concentration of 3.55µg/m3 at 2km dispersion Oxides of Nitrogen is 0.85µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.09µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-4 emission of Oxides of Nitrogen concentration is 71mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant

emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.67km at the concentration of 12.3µg/m3 at 2km dispersion Oxides of Nitrogen is 1.589µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.934µg/m3 and the predominant wind direction is ESE.

Stack – 86F1

Stack – 86F1 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.867km at the concentration of 2.005µg/m3 at 2km dispersion Carbon Monoxide is 0.24µg/m3 and at 5km dispersion Carbon Monoxide is 0.0357µg/m3 and the predominant wind direction is ESE.

Stack – 86F1 emission of Oxides of Nitrogen concentration is 11mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0867km at the concentration of 2.005µg/m3 at 2km dispersion Oxides of Nitrogen is 0.24µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0357µg/m3 and the predominant wind direction is ESE.

Stack – 86F1 emission of Particulate matter concentration is 8.6mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 0.789km at the concentration of 1.52µg/m3 at 2km dispersion Particulate matter is 0.157µg/m3 and at 5km dispersion Particulate matter is 0.0681µg/m3 and the predominant wind direction is ESE.

Stack – 211F1

Stack – 211F1 emission of Carbon Monoxide concentration is 124mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.623km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.456µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Particulate Matter concentration is 23.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.2µg/m3 and at 5km dispersion Particulate Matter is 0.076µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Sulphur dioxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.931km at the concentration of 3.51µg/m3 at 2km dispersion Sulphur dioxide is 0.75µg/m3 and at 5km dispersion Sulphur dioxide is 0.0923µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 2.22µg/m3 at 2km dispersion Oxides of Nitrogen is 0.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0874µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B

Stack – 1F1B emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.74µg/m3 and at 5km dispersion Carbon Monoxide is 0.976µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Particulate Matter concentration is 22.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.43µg/m3 and at 5km dispersion Particulate Matter is 0.0618µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Sulphur dioxide concentration is 48.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively

emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 3.67µg/m3 at 2km dispersion Sulphur dioxide is 0.55µg/m3 and at 5km dispersion Sulphur dioxide is 0.0751µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 17.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.551µg/m3 and the predominant wind direction is ESE.

Stack – 206F1

Stack – 206F1 emission of Particulate Matter concentration is 9.4mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.22µg/m3 at 2km dispersion Particulate Matter is 0.59µg/m3 and at 5km dispersion Particulate Matter is 0.0823µg/m3 and the predominant wind direction is ESE.

Stack – 206F1 emission of Sulphur dioxide concentration is 212mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 5.73µg/m3 at 2km dispersion Sulphur dioxide is 0.356µg/m3 and at 5km dispersion Sulphur dioxide is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – 206F1 emission of Oxides of Nitrogen concentration is 193mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m)

with exit velocity of 5.66m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 5.19µg/m3 at 2km dispersion Oxides of Nitrogen is 0.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0621µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 0.153µg/m3 at 2km dispersion Carbon Monoxide is 0.098µg/m3 and at 5km dispersion Carbon Monoxide is 0.0113µg/m3 and the predominant wind direction is ESE.

Stack – 206F2

Stack – 206F2 emission of Particulate Matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.93km at the concentration of 0.229µg/m3 at 2km dispersion Particulate Matter is 0.0976µg/m3 and at 5km dispersion Particulate Matter is 0.0034µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Sulphur dioxide concentration is 289mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 7.79µg/m3 at 2km dispersion Sulphur dioxide is 0.751µg/m3

and at 5km dispersion Sulphur dioxide is 0.0134µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 7.33µg/m3 at 2km dispersion Oxides of Nitrogen is 1.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

Stack – 214F1

Stack – 214F1 emission of Carbon Monoxide concentration is 7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.99µg/m3 at 2km dispersion Carbon Monoxide is 0.12µg/m3 and at 5km dispersion Carbon Monoxide is 0.0431µg/m3 and the predominant wind direction is ESE.

Stack – 214F1 emission of Particulate Matter concentration is 9.1mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 2.29µg/m3 at 2km dispersion Particulate Matter is 0.787µg/m3 and at 5km dispersion Particulate Matter is 0.011µg/m3 and the predominant wind direction is ESE.

Stack – 214F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height,

stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 2.21µg/m3 at 2km dispersion Oxides of Nitrogen is 2.21µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.97µg/m3 and the predominant wind direction is ESE.

Stack – 1F3

Stack – 1F3 emission of Particulate Matter concentration is 18.2mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 1.53µg/m3 at 2km dispersion Particulate Matter is 0.53µg/m3 and at 5km dispersion Particulate Matter is 0.017µg/m3 and the predominant wind direction is ESE.

Stack – 1F3 emission of Sulphur dioxide concentration is 222.9mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 15.7µg/m3 at 2km dispersion Sulphur dioxide is 1.876µg/m3 and at 5km dispersion Sulphur dioxide is 0.592µg/m3 and the predominant wind direction is ESE.

Stack – 1F3 emission of Oxides of Nitrogen concentration is 191mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 13.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.88µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.813µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A East

Stack - 1F1A East emission of Particulate matter concentration is 14.5mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.874km at the concentration of 1.05µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A East emission of Sulphur dioxide concentration is 164mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.832km at the concentration of 2.09µg/m3 at 2km dispersion Sulphur dioxide is 0.27µg/m3 and at 5km dispersion Sulphur dioxide is 0.076µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A East emission of Oxides of Nitrogen concentration is 125mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 12.6µg/m3 at 2km dispersion Oxides of Nitrogen is 2.18µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.896µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A WEST

Stack - 1F1A west emission of Carbon Monoxide concentration is 56mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.877km at the concentration of 16.4µg/m3 at 2km dispersion Carbon Monoxide is 1.87µg/m3 and at 5km dispersion Carbon Monoxide is 0.977µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Particulate matter concentration is 12.4mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.911km at the concentration of 2.81µg/m3 at 2km dispersion Particulate matter is 0.111µg/m3 and at 5km dispersion Particulate matter is 0.0552µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Sulphur dioxide concentration is 149mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 43.7µg/m3 at 2km dispersion Sulphur dioxide is 21.2µg/m3 and at 5km dispersion Sulphur dioxide is 17.76µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Oxides of Nitrogen concentration is 101mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.721km at the concentration of 3.67µg/m3 at 2km dispersion Oxides of Nitrogen is 0.41µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.075µg/m3 and the predominant wind direction is ESE.

Stack - 10F101

Stack - 10F101 emission of Carbon Monoxide concentration is 111mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 16.9µg/m3 at 2km dispersion Carbon Monoxide is 5.323µg/m3 and at 5km dispersion Carbon Monoxide is 0.927µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Particulate matter concentration is 19.1mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 4.08µg/m3 at 2km dispersion Particulate matter is 1.11µg/m3 and at 5km dispersion Particulate matter is 0.534µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Sulphur dioxide concentration is 40.8mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 46.29µg/m3 at 2km dispersion Sulphur dioxide is 18.21µg/m3 and at 5km dispersion Sulphur dioxide is 8.11µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 35.3µg/m3 at 2km dispersion Oxides of Nitrogen is 15.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 6.61µg/m3 and the predominant wind direction is ESE.

Stack - 71F1

Stack - 71F1 emission of Carbon Monoxide concentration is 143mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 41.8µg/m3 at 2km dispersion Carbon Monoxide is 12.78µg/m3 and at 5km dispersion Carbon Monoxide is 2.412µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Particulate matter concentration is 29.7mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.58µg/m3 at 2km dispersion Particulate matter is 1.65µg/m3 and at 5km dispersion Particulate matter is 0.823µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Sulphur dioxide concentration is 157.3mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 16.4µg/m3 at 2km dispersion Sulphur dioxide is 4.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Oxides of Nitrogen concentration is 335mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 97.09µg/m3 at 2km dispersion Oxides of Nitrogen is 38.91µg/m3 and at 5km dispersion Oxides of Nitrogen is 24.11µg/m3 and the predominant wind direction is ESE.

Stack - 73F101

Stack - 73F101 emission of Carbon Monoxide concentration is 135mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.7µg/m3 at 2km dispersion Carbon Monoxide is 3.67µg/m3 and at 5km dispersion Carbon Monoxide is 0.781µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Particulate matter concentration is 27mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 2.96µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.075µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Sulphur dioxide concentration is 51mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.16µg/m3 at 2km dispersion Sulphur dioxide is 1.45µg/m3 and at 5km dispersion Sulphur dioxide is 0.86µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Oxides of Nitrogen concentration is 94mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 10.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.64µg/m3 and the predominant wind direction is ESE.

Stack - 73F102

Stack - 73F102 emission of Carbon Monoxide concentration is 15mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 1.64µg/m3 at 2km dispersion Carbon Monoxide is 0.86µg/m3 and at 5km dispersion Carbon Monoxide is 0.0578µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Particulate matter concentration is 15.3mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 1.74µg/m3 at 2km dispersion Particulate matter is 0.534µg/m3 and at 5km dispersion Particulate matter is 0.087µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Sulphur dioxide concentration is 10mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.12µg/m3 at 2km dispersion Sulphur dioxide is 0.565µg/m3 and at 5km dispersion Sulphur dioxide is 0.089µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 1.74µg/m3 at 2km dispersion Oxides of Nitrogen is 0.98µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.11µg/m3 and the predominant wind direction is ESE.

Stack - 76F11

Stack - 76F11 emission of Carbon Monoxide concentration is 152mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 47.44µg/m3 at 2km dispersion Carbon Monoxide is 8.86µg/m3 and at 5km dispersion Carbon Monoxide is 1.32µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Particulate matter concentration is 33.1mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 10.3µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.076µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Sulphur dioxide concentration is 20.6mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 6.44µg/m3 at 2km dispersion Sulphur dioxide is 0.97µg/m3 and at 5km dispersion Sulphur dioxide is 0.0318µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Oxides of Nitrogen concentration is 33mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 10.3µg/m3 at 2km dispersion Oxides of Nitrogen is 2.25µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.341µg/m3 and the predominant wind direction is ESE.

Stack - 77F1

Stack - 77F1 emission of Carbon Monoxide concentration is 31mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.33µg/m3 at 2km dispersion Carbon Monoxide is 0.123µg/m3 and at 5km dispersion Carbon Monoxide is 0.057µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Particulate matter concentration is 18.4mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.54µg/m3 at 2km dispersion Particulate matter is 0.65µg/m3 and at 5km dispersion Particulate matter is 0.033µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Sulphur dioxide concentration is 21mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 10.4µg/m3 at 2km dispersion Sulphur dioxide is 1.99µg/m3 and at 5km dispersion Sulphur dioxide is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Oxides of Nitrogen concentration is 21mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.745km at the concentration of 2.77µg/m3 at 2km dispersion Oxides of Nitrogen is 0.752µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.011µg/m3 and the predominant wind direction is ESE.

Stack - 205F1

Stack - 205F1 emission of Carbon Monoxide concentration is 136mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.736km at the concentration of 89.1µg/m3 at 2km dispersion Carbon Monoxide is 7.731µg/m3 and at 5km dispersion Carbon Monoxide is 0.8966µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Particulate matter concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 1.32µg/m3 at 2km dispersion Particulate matter is 0.54µg/m3 and at 5km dispersion Particulate matter is 0.0865µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Oxides of Nitrogen concentration is 55mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 16.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.58µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Sulphur dioxide concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 0.462µg/m3 and at 5km dispersion Sulphur dioxide is 0.0756µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2

Stack - 201F1&F2 emission of Carbon Monoxide concentration is 180mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 8.72µg/m3 at 2km dispersion Carbon Monoxide is 0.96µg/m3 and at 5km dispersion Carbon Monoxide is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2 emission of Particulate matter concentration is 14.4mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 1.33µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.022µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2 emission of Sulphur dioxide concentration is 367mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 49.12µg/m3 at 2km dispersion Sulphur dioxide is 8.79µg/m3 and at 5km dispersion Sulphur dioxide is 0.97µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2 emission of Oxides of Nitrogen concentration is 239mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 19.96µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.11µg/m3 and the predominant wind direction is ESE.

10.3 Overall Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from CPCL – Manali specific to Particulate Matter to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit values but the combined concentration for Nitrogen Dioxide and Sulfur Dioxide is exceeding the NAAQM standards and there is no further carrying capacity for these two parameters in manali industrial area available. The CPCL – Manali plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From CPCL to Burma Nagar aerial distance is 2.7km, to Manali New Town is 4.11km, to Salai Ma Nagar is 1.67km, to Thanthai Periyar Nagar is 1.25km and to Balakrishna Nagar is 1.47km.

The combined particulate matter emissions of all stacks from CPCL – Manali is 799.8 mg/m3. The average ground level concentration achieves at an average distance of 1.01km and the sum of PM concentration at GLC is 135 µg/m3 which includes all the stacks at CPCL – Manali. The total particulate matter emissions reached at 1.01km at the concentration of 135 µg/m3 which is more than NAAQM specification standard. But most of the residential areas are in the distance between 1.25 to 4km and more. It clearly indicates the PM10 and PM2.5 contribution to the nearby communities are minimum since the residential areas are more than 1.25km radius from the CPCL plant centre and it is below the National Ambient Air Quality Standards.

The combined Sulphur Dioxide emissions from CPCL – Manali through stacks is 6300mg/m^3. The average ground level concentration achieves at an average distance of 0.98km and the sum of Sulphur Dioxide concentration at GLC is 1064 µg/m^3 which includes all the stacks at CPCL – Manali. It clearly indicates the SO_2 contribution to the nearby communities and Manali industrial area are exceeding the National Ambient Air Quality Standards (80 µg/m^3) up to 2km radius and more than 2km radius is below the NAAQM standards. The carrying capacity within 2km radius of CPCL is not available pertaining to SO2 since the maximum ground level concentration is exceeding 13.3 times of NAAQM standards.

The combined Nitrogen Oxides emissions from CPCL – Manali through stacks is 6910 mg/m3. The average ground level concentration achieves at an average distance of

1.01km and the sum of Nitrogen Oxides concentration at GLC is 1167 µg/m3 which includes all the stacks at CPCL – Manali. It clearly indicates the NO_2 contribution to the nearby communities and Manali industrial area are exceeding the National Ambient Air Quality Standards (80 µg/m^3) up to 2km radius and more than 2km radius is below the NAAQM standards. The carrying capacity within 2km radius of CPCL is not available pertaining to NO2 since the maximum ground level concentration is exceeding 14.6 times of NAAQM standards.

The cumulative Carbon monoxide emissions from CPCL – Manali through stacks is 2835mg/m3. The average ground level concentration achieves at an average distance of 0.98km and the sum of Carbon Monoxide concentration at GLC is 478 µg/m3 which includes all the stacks at CPCL – Manali. It clearly indicates the CO contribution to the nearby communities and Manali industrial area are minimum and it is well below within the National Ambient Air Quality Standards (2000 µg/m^3). The carrying capacity of CO in CPCL available since the maximum ground level concentration is below 4.2 times of NAAQM standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM and CO. Results from AERMOD simulation indicated that PM and CO emissions from the CPCL had no significant impact on nearby communities and Manali Industrial complex. But for the predicted concentrations of SO2 and NO2 were exceeding the NAAQM standard and the results from AERMOD simulation indicated that these emissions from the CPCL had significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of SO_2 and NO_2 with the maximum ground level concentrations are exceeding the national ambient air quality standards and carrying capacity for these two parameters is not further available in nearby communities and Manali industrial area pertaining to this industry source emission load.

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Annexure-VI

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Tamilnadu Petroproducts Ltd, PO Division, Manali

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. ABOUT INDUSTRY

TPL is a joint venture between Tamil Nadu Industrial Development Corporation Limited (TIDCO), wholly owned by the Government of Tamilnadu and Southern Petrochemical Industries Corporation Ltd. (SPIC) with more than 80,000 shareholders. TPL is a listed company on Bombay Stock Exchange and National Stock Exchange. M/s. SPIC Limited, has diverse interest in fertilizers and other services. TIDCO is a public financial institution engaged in promoting industries in the State of Tamil Nadu.

Tamilnadu Petroproducts Limited (TPL) was established in 1984 at Manali, Thiruvallur district in Tamilnadu State to manufacture industrial intermediary Chemicals. TPL went into stream in the year 1989 with manufacturing facility for Linear Alkyl Benzene (LAB), finding application in manufacture of detergents and cleaning agents.

Heavy Chemicals Division was established by M/s. Kothari Chemicals ltd in 1978 and subsequently it was taken over by M.s SPIC during 1988.
TPL acquired the Heavy Chemicals Division (HCD) from SPIC in the Year 2000 which manufactures Chloro Alkali comprising Caustic Soda & Chlorine which are most commonly used industrial chemicals in Textile, Paper and Pulp, Soaps & Detergents and Aluminium industries in India.

TPL established a facility to make Epichlorohydrin (ECH) in the year 1995 which is a key raw material in the manufacture of epoxy resins, pesticides and certain pharmaceutical formulations. However, the unit is not in operation since 1st April 2013 owing to unviable business opportunities for the product and huge losses incurred during the past 10 years.
Environmental Clearance obtained during 2015 to manufacture propylene Oxide and Chlorinated Organics in the exiting Epichlorohydrin (ECH) Plant.

ECH – PO plant was installed during 2019 and commissioned for operation from Jan 2019

Propylene Oxide Production – Process Description.

Propylene oxide is produced utilizing the chlorohydrin technology. In a titanium hollow vessel filled with water, chlorine is injected at the bottom, which immediately forms

hypochlorous acid and propylene vapour is injected in this zone and it is converted to propylene chlorohydrin (PCH). By-product Dichloropropane is also produced in small quantities. Always excess of propylene is maintained in the reactor and hence the entire chlorine is converted into propylene chlorohydrin and dichloropropane. The unreacted propylene is recycled back to reactor.

The reactor operates at 1.7 ksc and at around 55 to 60°C. It is a simple vessel without any internals and no catalysts or any other additive are used in the reaction process. The reactor relies on good upward velocity provided by the circulating gas and incoming process water to move the produced chlorohydrin from the place of injection to maximize the production efficiency.

Propylene chlorohydrin overflows from the reactor and is pumped into a saponifier along with Milk of Lime. Saponifier is steam stripped from the bottom to remove the "PO" formed from the reaction zone. The PO along with the excess and entire quantity of DCP present in the reactor overflow enters a distillation column where PO is removed as top product as it boils at 34 °C at atmospheric pressure and the high boiling DCP and water moves to the bottom of distillation column. PO is condensed with cooling water and sent to the storage tank.

The DCP liquid and water enter the decanter where water is decanted and recycled back to the reactor. The DCP liquid is sent to the storage tank for marketing. Thus it could be seen that this process does not utilize equipment's like furnace, heaters nor use any catalytic reaction process. It does not produce any listed hazardous waste.

The Saponifier bottom waste water is pumped to a High rate Thickener after heat recovery where all unreacted inert in the milk of lime are settled and sent to a rotary vacuum filter, the solid is washed and removed for disposal as a landfill or in the manufacture of low cost lime bricks.

TAMILNADU PETROPRODUCTS LTD

Tamilnadu Petroproducts Limited
Elandancheri
Google

2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

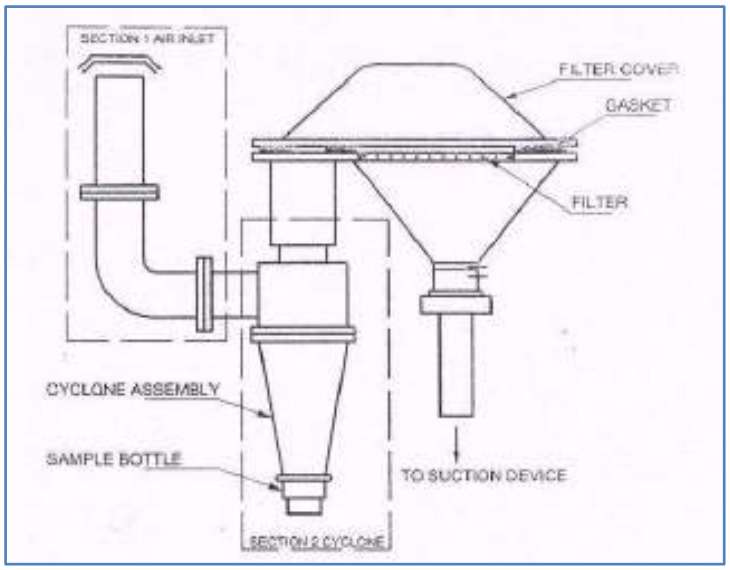
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, $\mu g/m^3$	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter

Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (µg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages ⇩

Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.

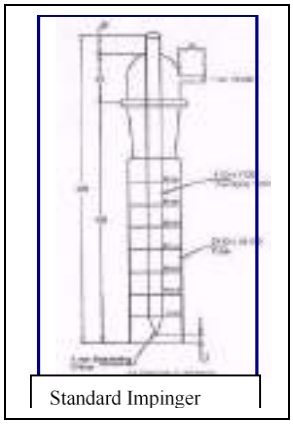
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6%

sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (As - Ab) \times CF \times Vs/Va \times Vt$$

Where,

C SO_2 = Concentration of Nitrogen dioxide, µg/m^3
As = Absorbance of sample
Ab = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m^3

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger ⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS). ⇩

⇩

Draw air at a sampling rate of 0.5 lpm for eight hours
Check the volume of sample at the end of sampling and record it
Transfer the exposed samples in storage bottle and preserve
Prepare calibration graph as recommended in method
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
Add 1 ml Sulphamic acid. Keep it 10 minutes
Add 2 ml formaldehyde
Add 2 ml working PRA
Make up to mark (25 ml.) with distilled water.
Keep it 30 minutes for reaction
Set Zero of spectrophotometer with Distilled water
Measure absorbance at 560 nm
Calculate concentration using calibration graph
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩

Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), µg/m3	8 Hours *	100	100
	1 Hour **	180	180

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 1 lpm for 60 minutes
⇩
Do not expose the absorbing reagent to direct sunlight
⇩
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
⇩
Prepare calibration graph as recommended in method
⇩
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Ozone in $\mu g/m^3$
⇩

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN

AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH3), µg/m^3	Annual *	100	100
	24 Hours **	400	400
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ )\ =\ (A_s - A_b)\ x\ CF\ /\ V_a$$

Where,

$C\ NH_3$	=	Concentration of Ammonia in $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3

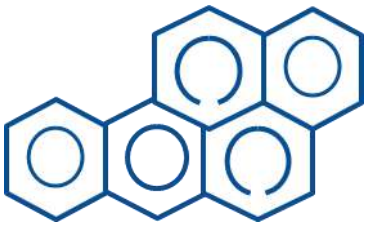
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

8 Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various

PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
Ultrasonic extraction with Toluene (50 ml × 3 times)
Filter & dry with Anhydrous Sodium Sulphate
Concentration with Rotary Evaporator
Clean up with Silica Gel Column Chromatography
Elution with Cyclo-Hexane (5 ml × 3 times)
Evaporate to nearly dryness under Nitrogen
Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN

AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction

(Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps

Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{\text{(Spiked sample concentration - sample concentration) x100}}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V = Volume of air, m^3

Q = Average sampling rate, m^3/min.

T = Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C = Concentration, µg Metal/M^3.
Ms = Metal Concentration µg/ml
Mb = Blank Concentration µg/ml
Vs = Total Volume of Extraction in ml

Fa = Total Area of Exposed Filter in Cm^2
V = Volume of Air Sampled in M^3
Ft = Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique.

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greek method -Ultraviolet Fluorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

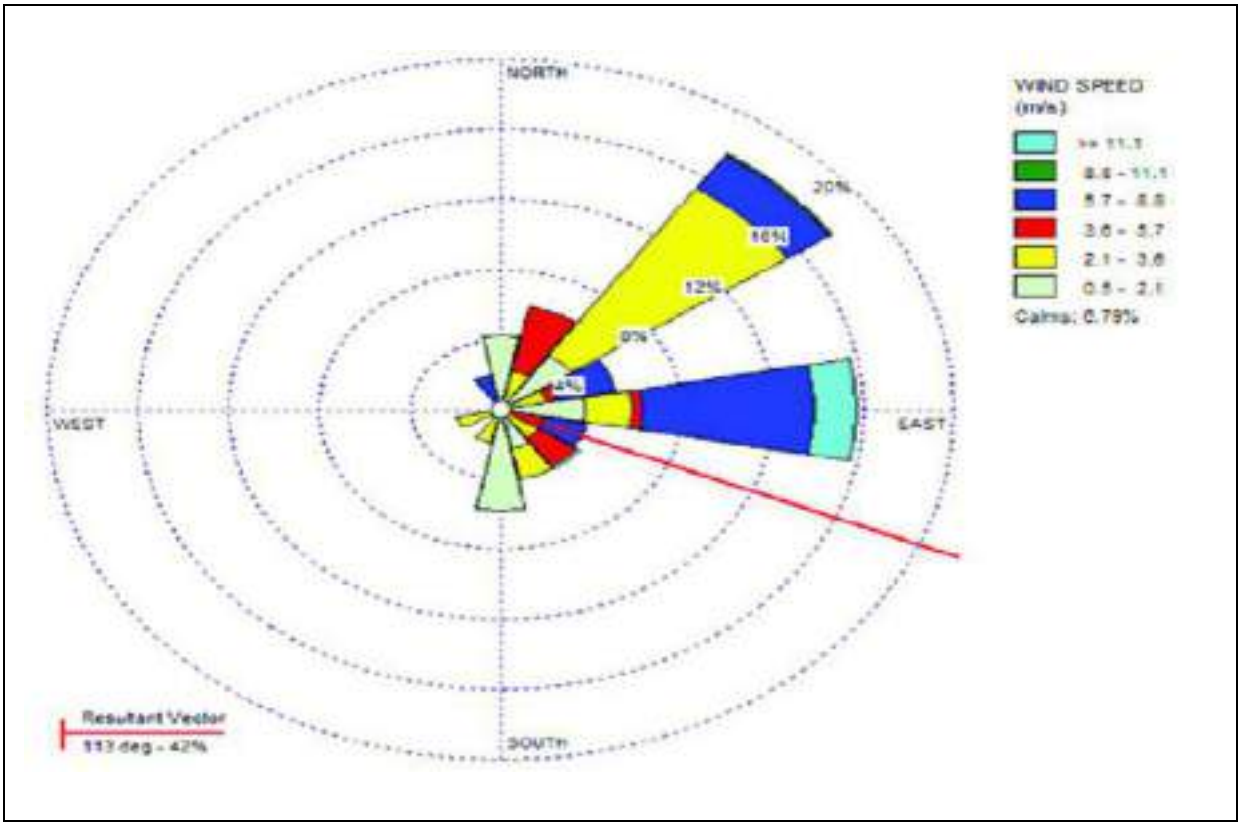
**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT TPL - 18.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
18.02.2021	1:00 AM	22.2	83	3	ENE
18.02.2021	2:00 AM	22.2	83	2	N
18.02.2021	3:00 AM	23.9	78	2	N
18.02.2021	4:00 AM	27.2	61	9	E
18.02.2021	5:00 AM	28.9	51	12	E
18.02.2021	6:00 AM	28.9	51	12	E
18.02.2021	6:00 AM	28.9	51	12	E
18.02.2021	7:00 AM	30.0	51	10	E
18.02.2021	8:00 AM	30.0	51	12	E
18.02.2021	9:00 AM	28.9	51	13	E
18.02.2021	10:00 AM	28.9	51	12	E
18.02.2021	11:00 AM	27.8	54	12	E
18.02.2021	12:00 PM	27.2	51.0	10.0	E
18.02.2021	1:00 PM	26.1	65	9	E
18.02.2021	2:00 PM	26.1	65	6	E
18.02.2021	3:00 PM	26.1	69	7	E
18.02.2021	4:00 PM	26.1	65	8	ESE
18.02.2021	5:00 PM	25.0	69	6	E
18.02.2021	6:00 PM	23.9	73	3	E
18.02.2021	7:00 PM	23.9	73	3	E
18.02.2021	8:00 PM	22.8	78	2	N
18.02.2021	9:00 PM	22.2	83	2	N
18.02.2021	10:00 PM	22.2	83	2	N
18.02.2021	11:00 PM	21.1	88	3	NE
18.02.2021	12:00 AM	21.1	88	3	NNE
MIN		21.1	51.0	2.0	E
MAX		30.0	88.0	13.0	
AVG		25.7	66.6	7.0	

WEATHER MONITORING DATA AT TPL - 19.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
19.02.2021	1:00 AM	23.9	83	0	CALM
19.02.2021	2:00 AM	23.9	88	0	CALM
19.02.2021	3:00 AM	25.0	78	3	N
19.02.2021	4:00 AM	26.1	74	6	NNE
19.02.2021	5:00 AM	27.8	70	7	NE
19.02.2021	6:00 AM	27.8	66	7	NNE
19.02.2021	6:00 AM	27.8	70	7	ENE
19.02.2021	7:00 AM	27.8	70	8	NE
19.02.2021	8:00 AM	28.9	62	12	E
19.02.2021	9:00 AM	27.8	70	14	ENE
19.02.2021	10:00 AM	27.8	66	14	E
19.02.2021	11:00 AM	27.8	66	14	E
19.02.2021	12:00 PM	27.2	74.0	12.0	ENE
19.02.2021	1:00 PM	27.2	74	16	E
19.02.2021	2:00 PM	26.1	78	12	E
19.02.2021	3:00 PM	26.1	83	12	E
19.02.2021	4:00 PM	25.0	89	12	ESE
19.02.2021	5:00 PM	25.0	83	9	E
19.02.2021	6:00 PM	25.0	74	5	E
19.02.2021	7:00 PM	23.9	78	2	VAR
19.02.2021	8:00 PM	23.9	78	0	CALM
19.02.2021	9:00 PM	22.8	83	2	VAR
19.02.2021	10:00 PM	23.9	78	0	CALM
19.02.2021	11:00 PM	22.8	88	0	CALM
19.02.2021	12:00 AM	22.8	88	0	CALM
MIN		22.8	62.0	0.0	E
MAX		28.9	89.0	16.0	
AVG		25.8	76.4	7.0	



4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Stack Emission Monitoring Locations

AAQ-3
AAQ 5
AAQ 4
AAQ-2
AAQ 6
AAQ 7
AAQ-1
Image © 2021 Maxar Technologies
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5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR MAIN GATE 3

LOCATION - NEAR MAIN GATE 3,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:10 Hrs] – 19.02.2021 [18:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	23.8
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	30.4
3	Particulate Matter (PM_{10})	$\mu g/m^3$	91.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	44.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR FIRE WATER PUMP HOUSE

LOCATION - NEAR FIRE WATER PUMP HOUSE,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:20 Hrs] – 19.02.2021 [18:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	21.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.1
3	Particulate Matter (PM_{10})	$\mu g/m^3$	78.7
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.4
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR AMBIENT AIR STATION

LOCATION - NEAR AMBIENT AIR STATION,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:30 Hrs] – 19.02.2021 [18:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	15.8
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	19.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	58.4
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR SUB STATION

LOCATION - NEAR SUB STATION,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:35 Hrs] – 19.02.2021 [18:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	19.6
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	27.3
3	Particulate Matter (PM_{10})	$\mu g/m^3$	67.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31.5
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR PO BULLET SOUTH

LOCATION - NEAR PO BULLET SOUTH,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:40 Hrs] – 19.02.2021 [18:40 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	18.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	25.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	55.2
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	34.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, NEAR GATE 4

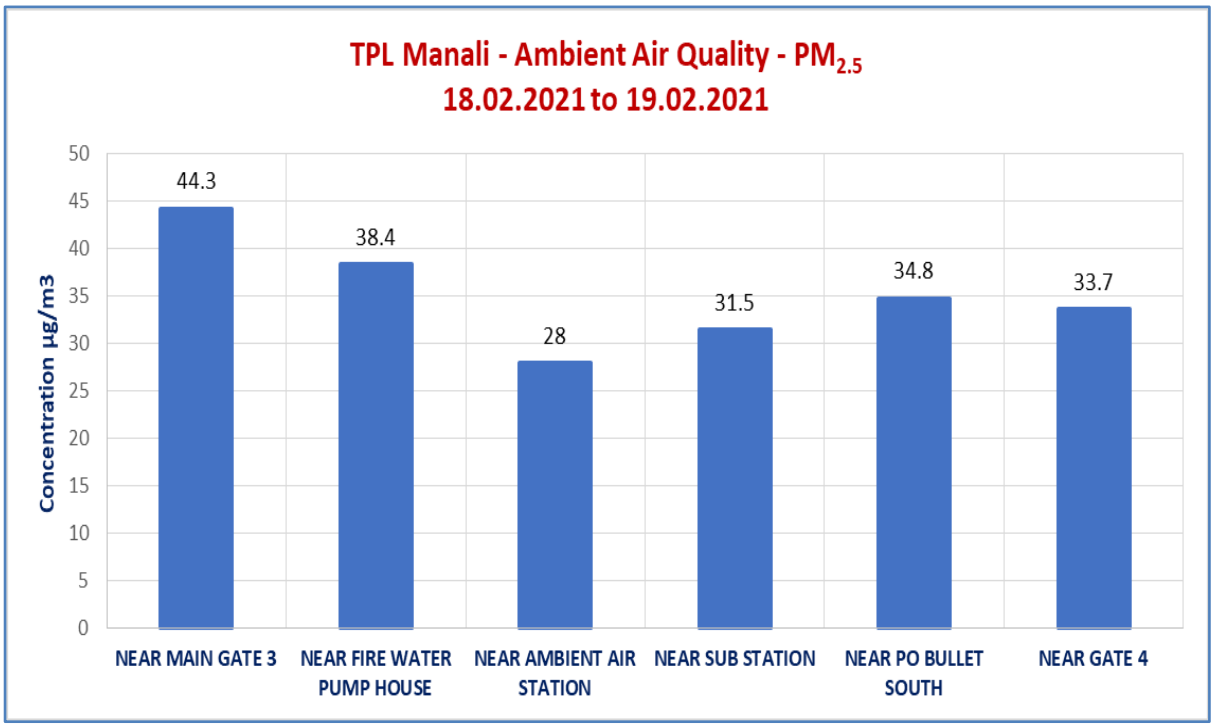
LOCATION - NEAR GATE 4,MANALI			
SAMPLING DATE & TIME 18.02.2021 [18:50 Hrs] – 19.02.2021 [18:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	26.3
2	Nitrogen Dioxide as NO_2	µg/m^3	29.2
3	Particulate Matter (PM_{10})	µg/m^3	88.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	33.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

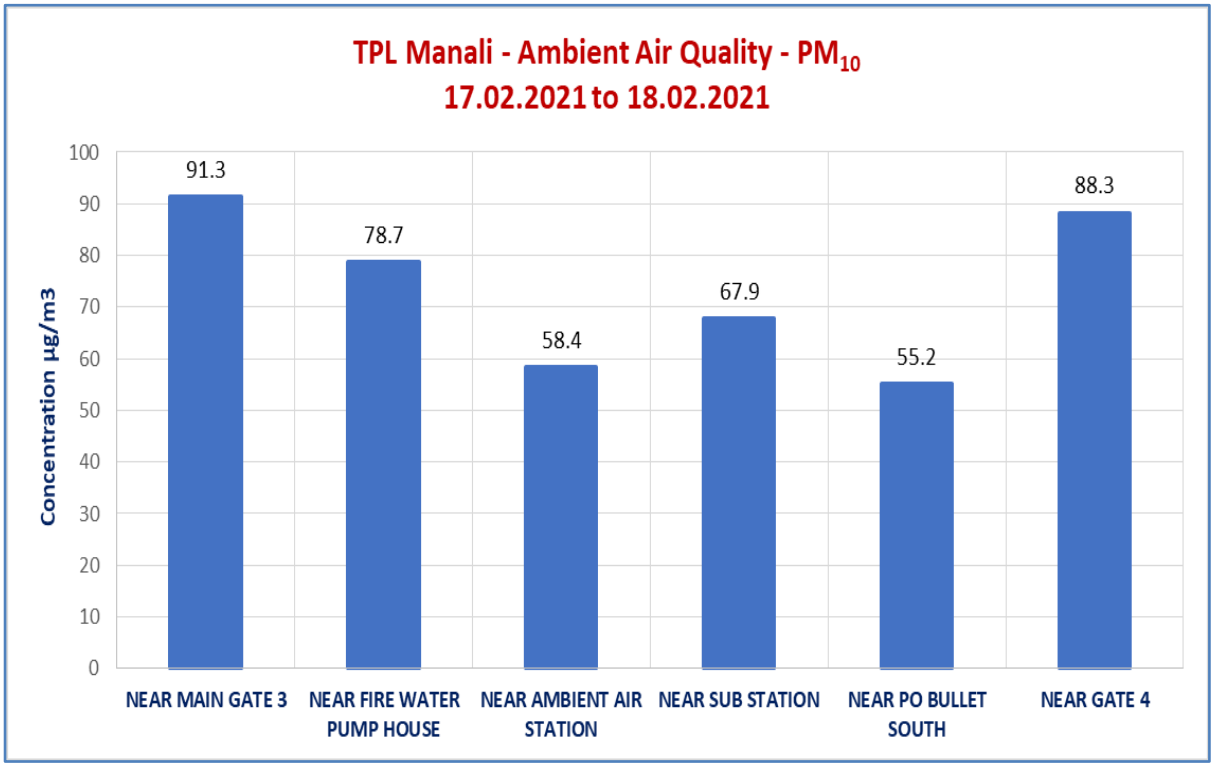
AAQ- 7: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, PLANT OUTSIDE

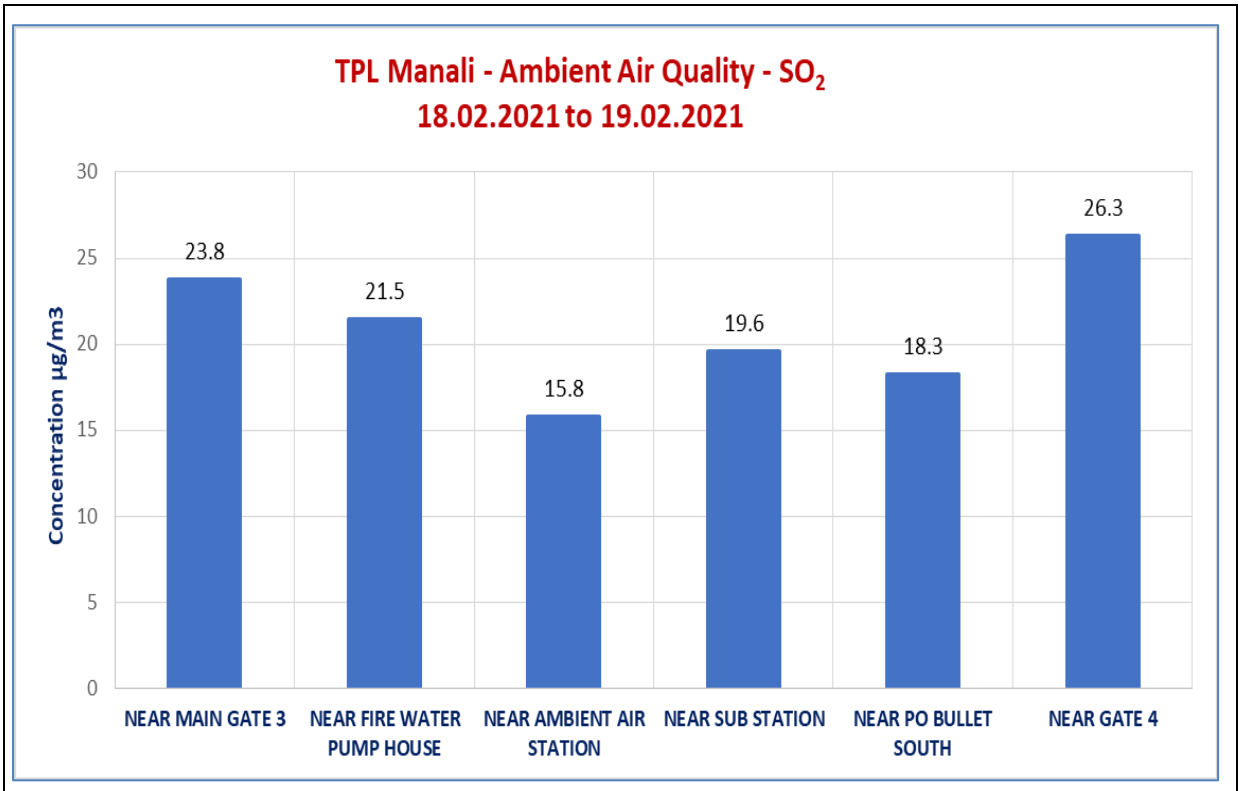
LOCATION – PLANT OUTSIDE ,MANALI				
SAMPLING DATE & TIME 18.02.2021 [19:00 Hrs] – 19.02.2021 [19:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	07:00 – 08:00	$\mu g/m^3$	855.77	1089.50
2	08:00 – 09:00	$\mu g/m^3$	104.49	154.89
3	09:00 – 10:00	$\mu g/m^3$	49.26	98.31
4	10:00 – 11:00	$\mu g/m^3$	43.20	99.74
5	11:00 –12:00	$\mu g/m^3$	31.96	70.92
6	12:01 – 01:00	$\mu g/m^3$	31.10	61.20
7	01:00 – 02:00	$\mu g/m^3$	31.75	64.15
8	02:00 – 03:00	$\mu g/m^3$	35.81	74.12
8 HOURS AVERAGE			**135.55**	**197.80**

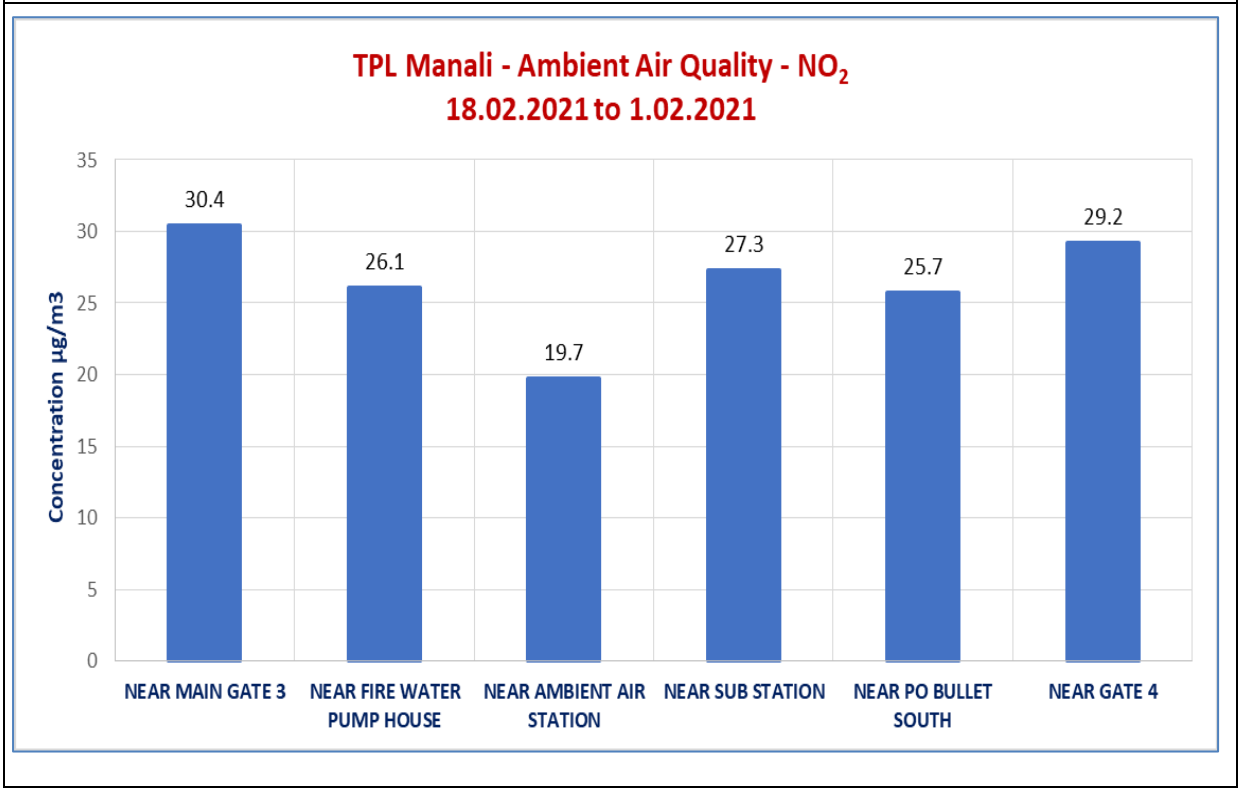
Consolidated Monitoring Results

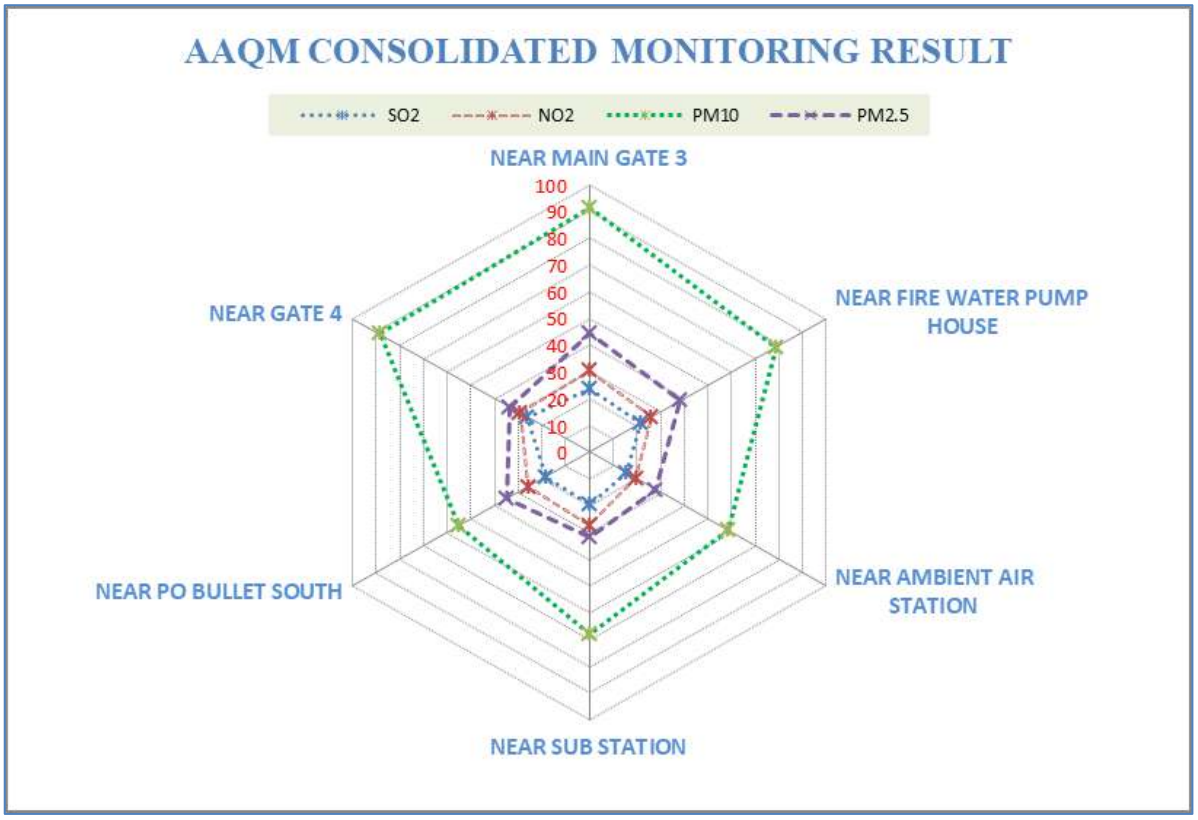
AAQM Consolidated Monitoring Results (µg/m3)				
Sampling Date [18.02.2021 to 19.02.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
NEAR MAIN GATE 3	23.8	30.4	91.3	44.3
NEAR FIRE WATER PUMP HOUSE	21.5	26.1	78.7	38.4
NEAR AMBIENT AIR STATION	15.8	19.7	58.4	28
NEAR SUB STATION	19.6	27.3	67.9	31.5
NEAR PO BULLET SOUTH	18.3	25.7	55.2	34.8
NEAR GATE 4	26.3	29.2	88.3	33.7

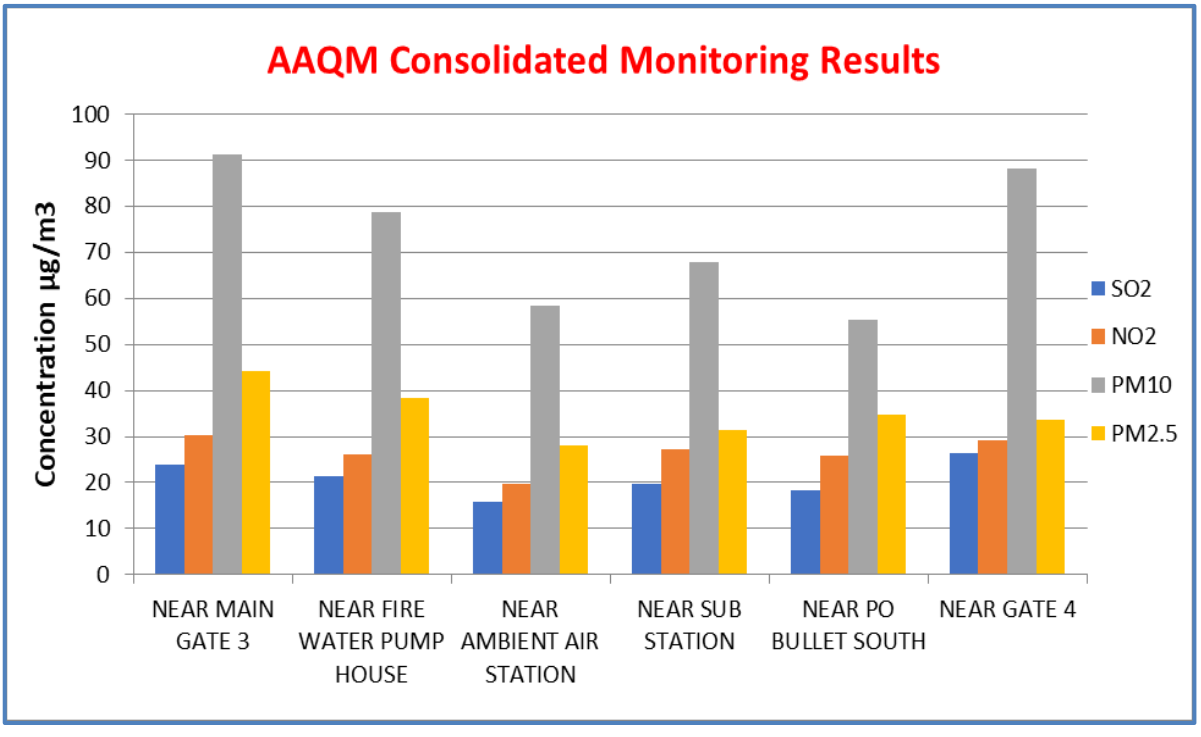

TPL Manali - Ambient Air Quality - PM2.5
18.02.2021 to 19.02.2021
Concentration µg/m3
50
45
40
35
30
25
20
15
10
5
0
44.3
38.4
28
31.5
34.8
33.7
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4

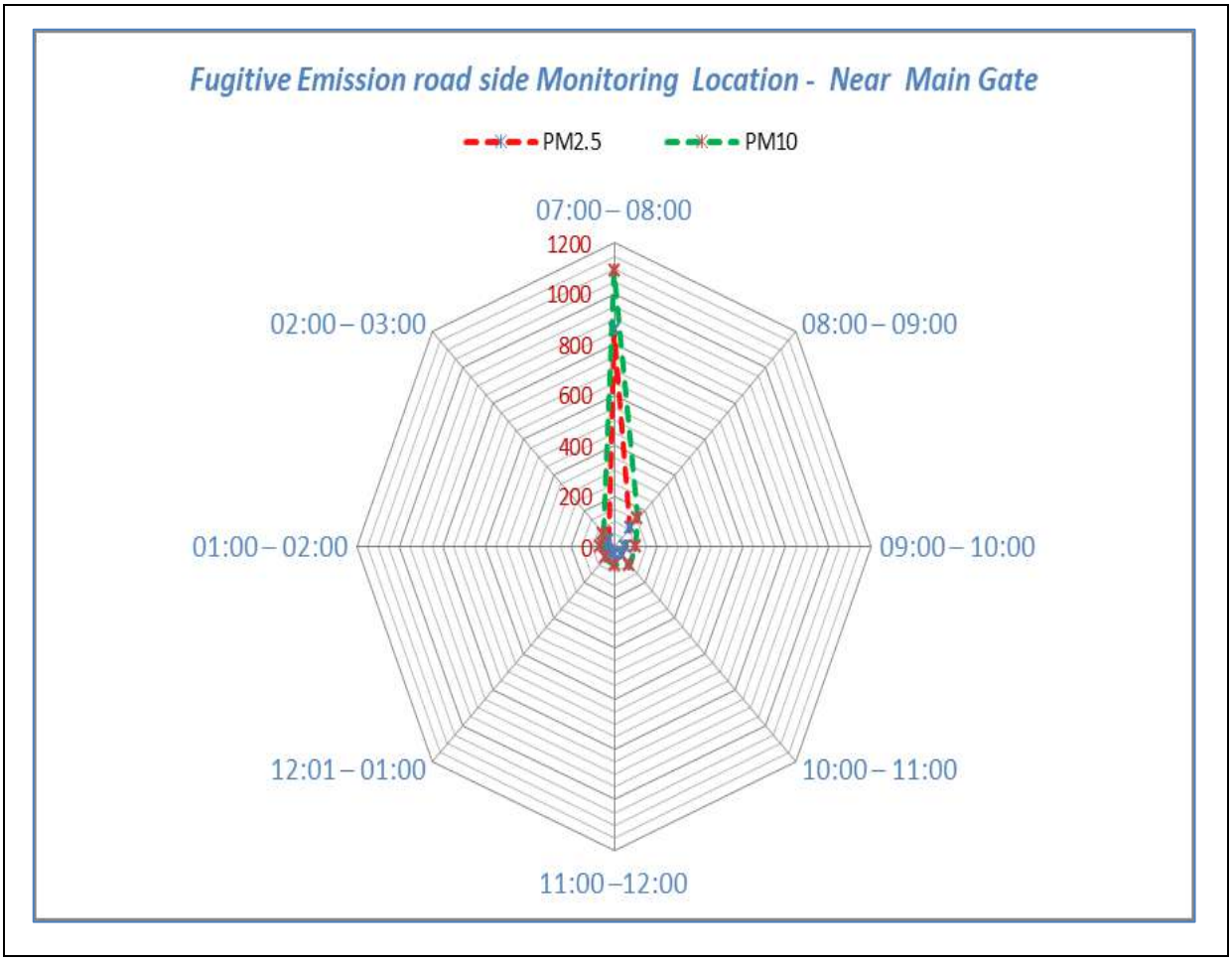

TPL Manali - Ambient Air Quality - PM10
17.02.2021 to 18.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
91.3
78.7
58.4
67.9
55.2
88.3
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4


TPL Manali - Ambient Air Quality - SO2
18.02.2021 to 19.02.2021
Concentration µg/m3
30
25
20
15
10
5
0
23.8
21.5
15.8
19.6
18.3
26.3
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4


TPL Manali - Ambient Air Quality - NO2
18.02.2021 to 1.02.2021
Concentration µg/m3
35
30
25
20
15
10
5
0
30.4
26.1
19.7
27.3
25.7
29.2
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4
100
90
80
70
60
50
40
30
20
10
0


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NEAR MAIN GATE 3
NEAR FIRE WATER PUMP HOUSE
NEAR AMBIENT AIR STATION
NEAR SUB STATION
NEAR PO BULLET SOUTH
NEAR GATE 4
SO2
NO2
PM10
PM2.5


Fugitive Emission road side Monitoring Location - Near Main Gate
PM2.5
PM10
07:00 – 08:00
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 –12:00
12:01 – 01:00
01:00 – 02:00
02:00 – 03:00
1200
1000
800
600
400
200
0

CONCLUSION:

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Main Gate 3, Near Fire Water Pump House, Near Ambient Air Station, Near Sub Station, Near PO Bullet South, Near Gate 4, Plant outside Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.8 to 26.3µg/m^3. Highest value of 26.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 19.7 to 30.4µg/m^3. Highest value of 30.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 55.2 to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 16.1 to 4771.1µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.

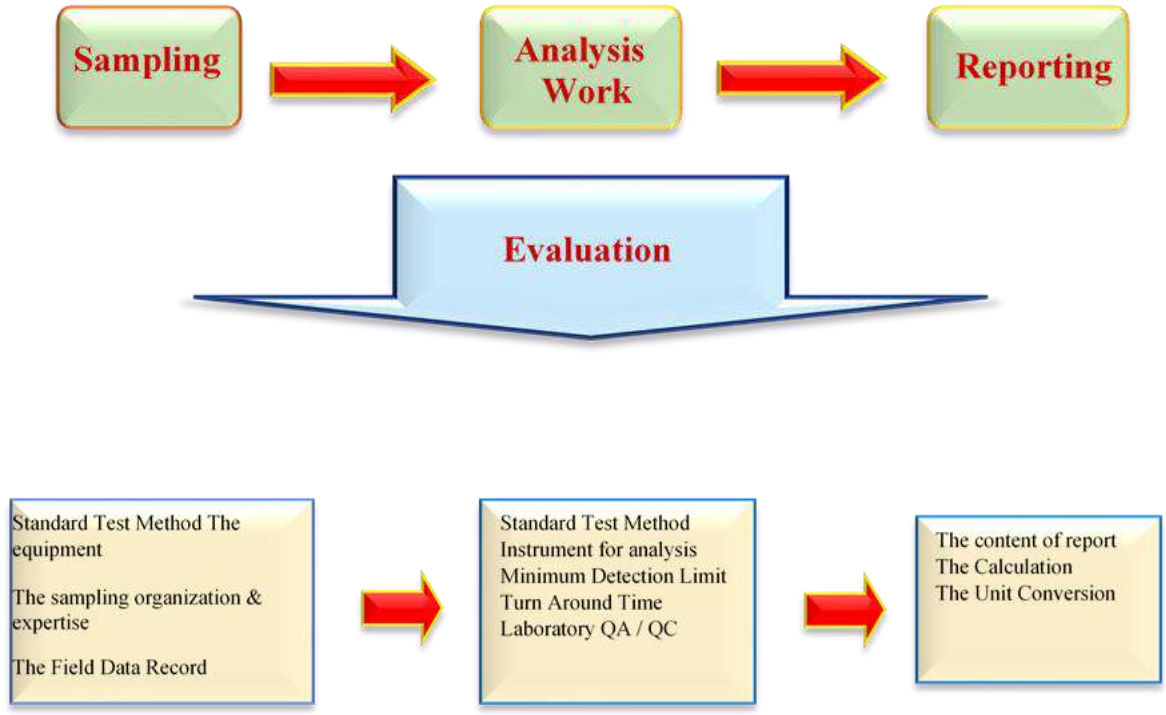
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 17 to 8657.8µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

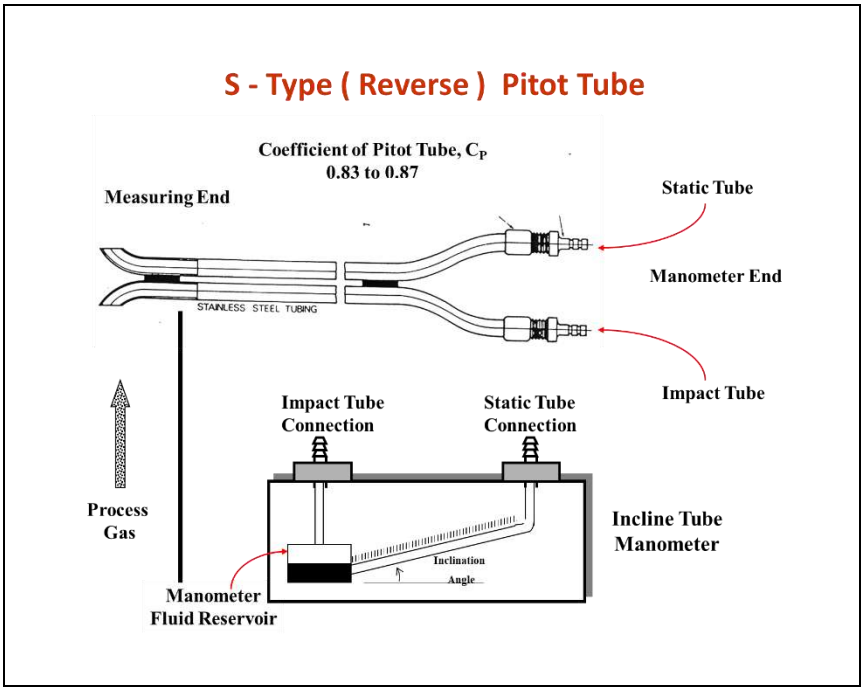


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

- ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points:

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

2. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, Nm3$_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

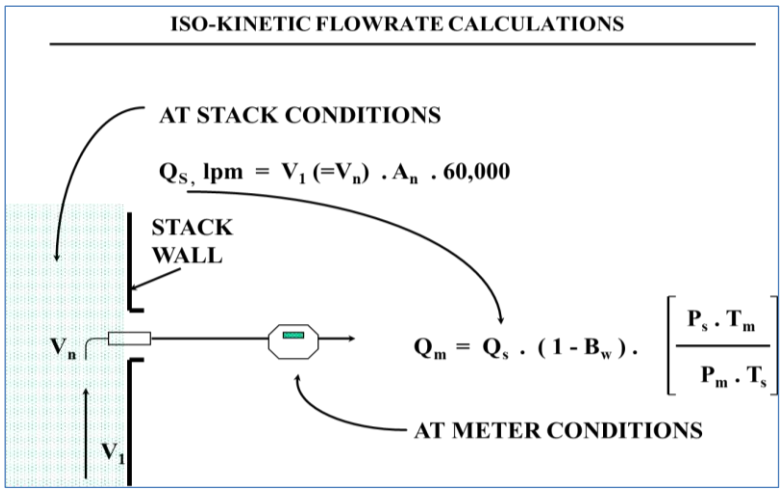
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

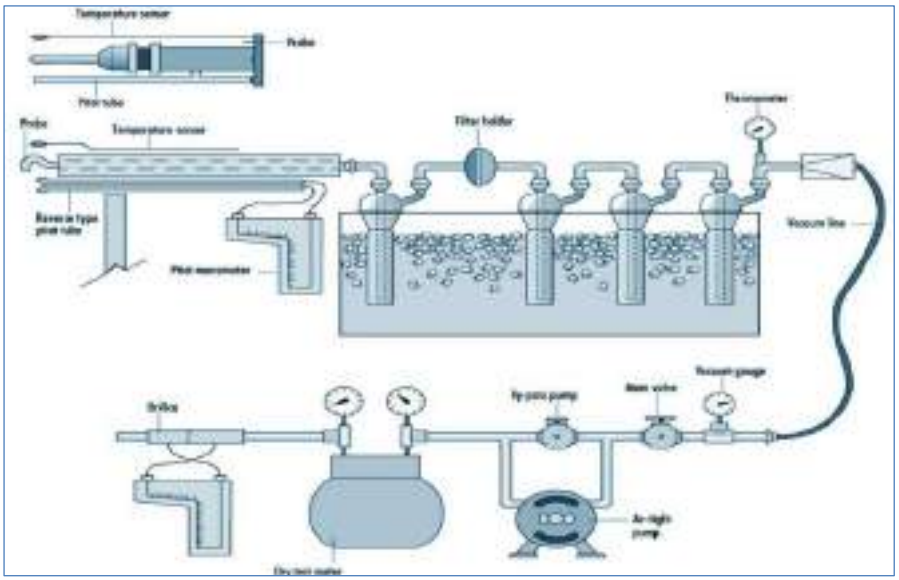
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



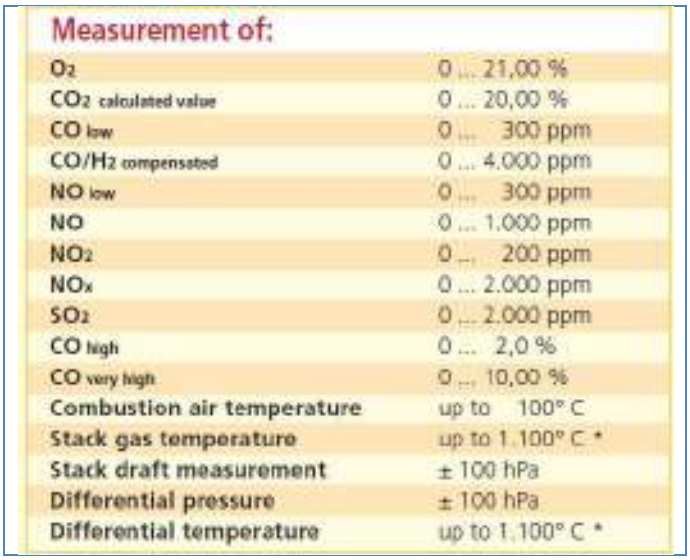
Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.



Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The SO_2 is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. SO_2 is absorbed in the impingers and converted to form H_2SO_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_2O_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading; meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers. Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

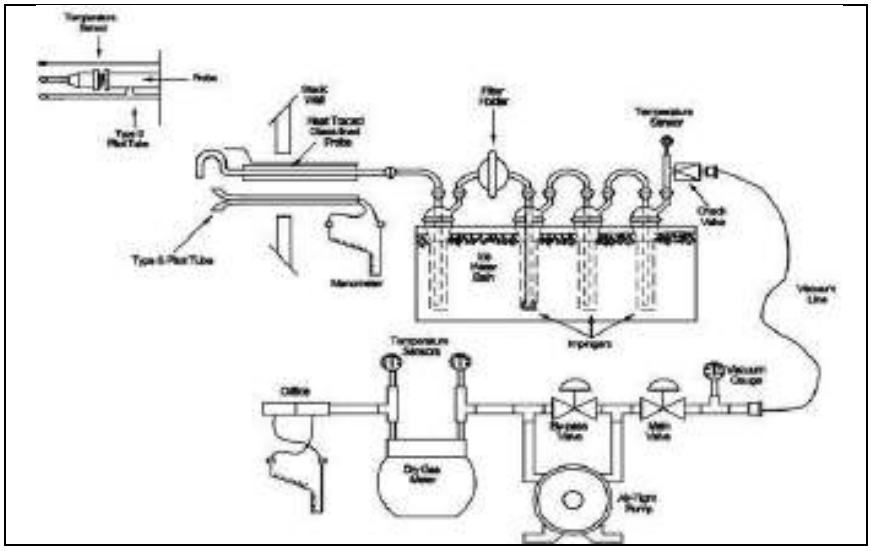
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

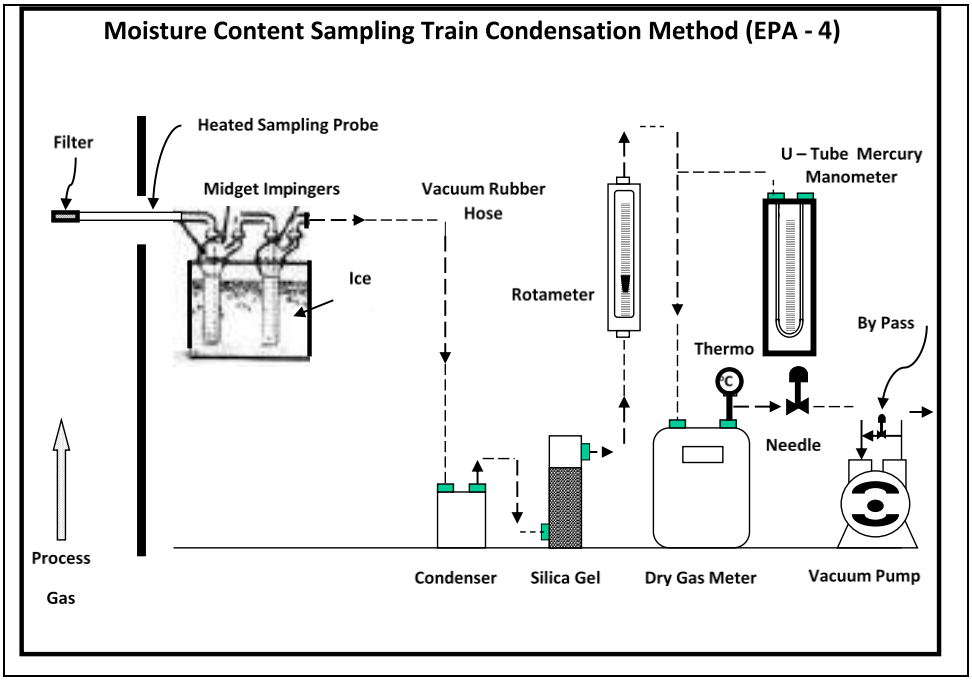
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.


Moisture Content Sampling Train Condensation Method (EPA - 4)
Filter
Heated Sampling Probe
Midget Impingers
Vacuum Rubber Hose
Ice
Rotameter
U – Tube Mercury Manometer
Thermo
By Pass
Needle
Process Gas
Condenser
Silica Gel
Dry Gas Meter
Vacuum Pump

7.0 STACK EMISSION RESULTS: MANALI, TAMILNADU

STACK- 1: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, BOILER 12.5 TON

LOCATION - BOILER 12.5 TON, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	445	NA
2	Velocity	m/sec	12.80	NA
3	Volume of Gas Discharge	Nm^3/hr	10214	NA
4	Oxygen as O_2	%	9.0	NA
5	Carbon Monoxide as CO	mg/Nm^3	31	150
6	Carbon Dioxide as CO_2	%	6.7	NA
7	Particulate Matter	mg/Nm^3	8.2	10
8	Sulphur Dioxide as SO_2	mg/Nm^3	BDL(DL:3.0)	50
9	Oxides of Nitrogen as NO_2	mg/Nm^3	BDL(DL:2.0)	350

In Stack Emission monitoring at 12.5 ton boiler stack complies as per CPCB limit.

STACK- 2: M/s. TAMILNADU PETROPRODUCTS LTD, ECH - PO DIVISION, SCRUBBER CHLORINE,

LOCATION - BOILER – SCRUBBER CHLORINE, MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Chloride	mg/m^3	2.6
2	Stack Temperature	K	306
3	Velocity	m/sec	11.89
4	Volume of Gas Discharge	Nm^3/hr	800

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential preprocessed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modeling system consists of two preprocessors and a core dispersion model. AERMET is the meteorological preprocessor for the AERMOD while AERMAP is the terrain preprocessor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

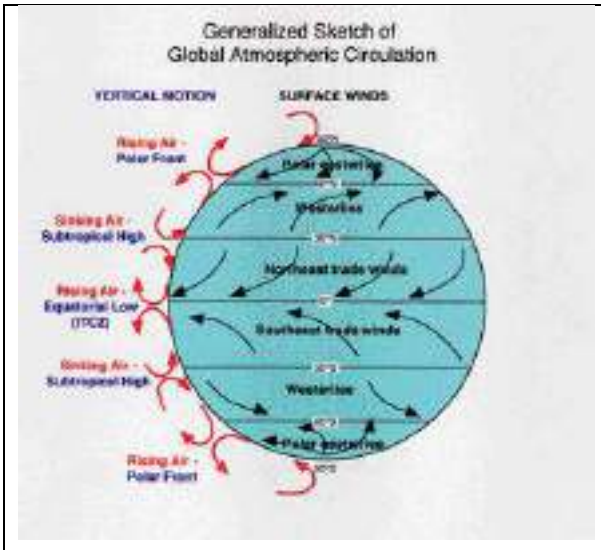
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from TPL Monitoring, Manali. For our simulations, the required source

data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

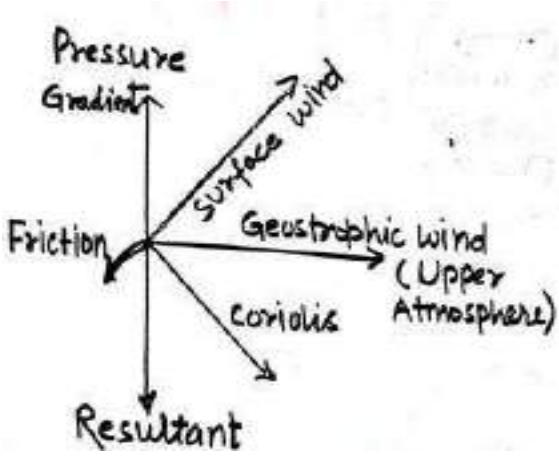
The AERMOD model was applied to study the diffusion of pollutants from TPL Monitoring, Manali and other sources in two days from 18.02.2021 to 19.02.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

TAMILNADU PETROPRODUCTS LTD – ECH PO DIVISION

1 Boiler:

Particulate matter:

Stack Height, m	-	47.4
Exit Velocity, m/Sec	-	12.8
PM Concentration, mg/m3	-	8.2
Emission load, gm/Sec	-	0.0233
Plume rise, m	-	3

Carbon Monoxide as CO:

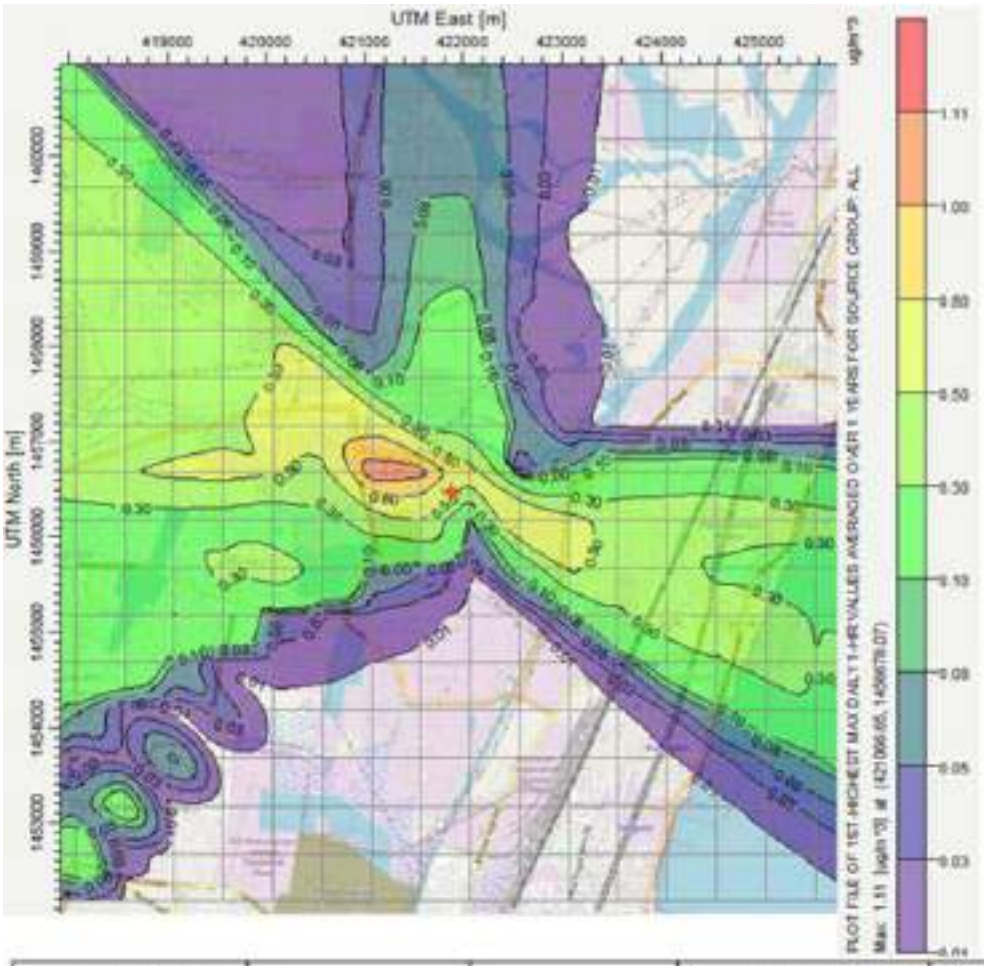
Stack Height, m	-	47.4
Exit Velocity, m/Sec	-	12.8
CO Concentration, mg/m3	-	31
Emission load, gm/Sec	-	0.088
Plume rise, m	-	3

Chlorine Scrubber

Chlorine:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	11.89
Cl2 Concentration, mg/m3	-	2.6
Emission load, gm/Sec	-	0.00058
Plume rise, m	-	2

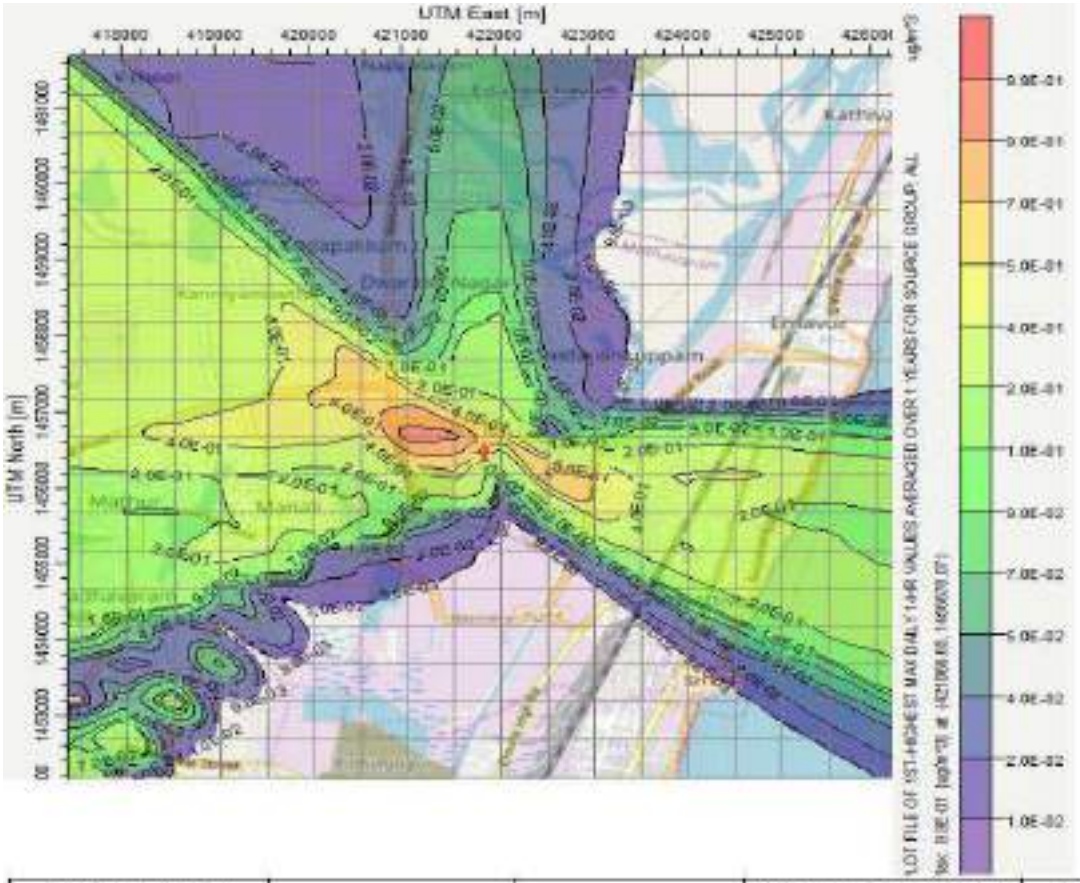
STACK EMISSION DISPERSION MODELLING –ECH Division Boiler @2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.6	0.71	0.481	0.354	0.00878

ECH Division Boiler of Particulate matter concentration is 9.6mg/m^3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 0.481µg/m^3 at 2km dispersion Particulate matter is 0.354µg/m^3 and at 5km dispersion Particulate matter is 0.00878µg/m^3 and the predominant wind direction is SSE.

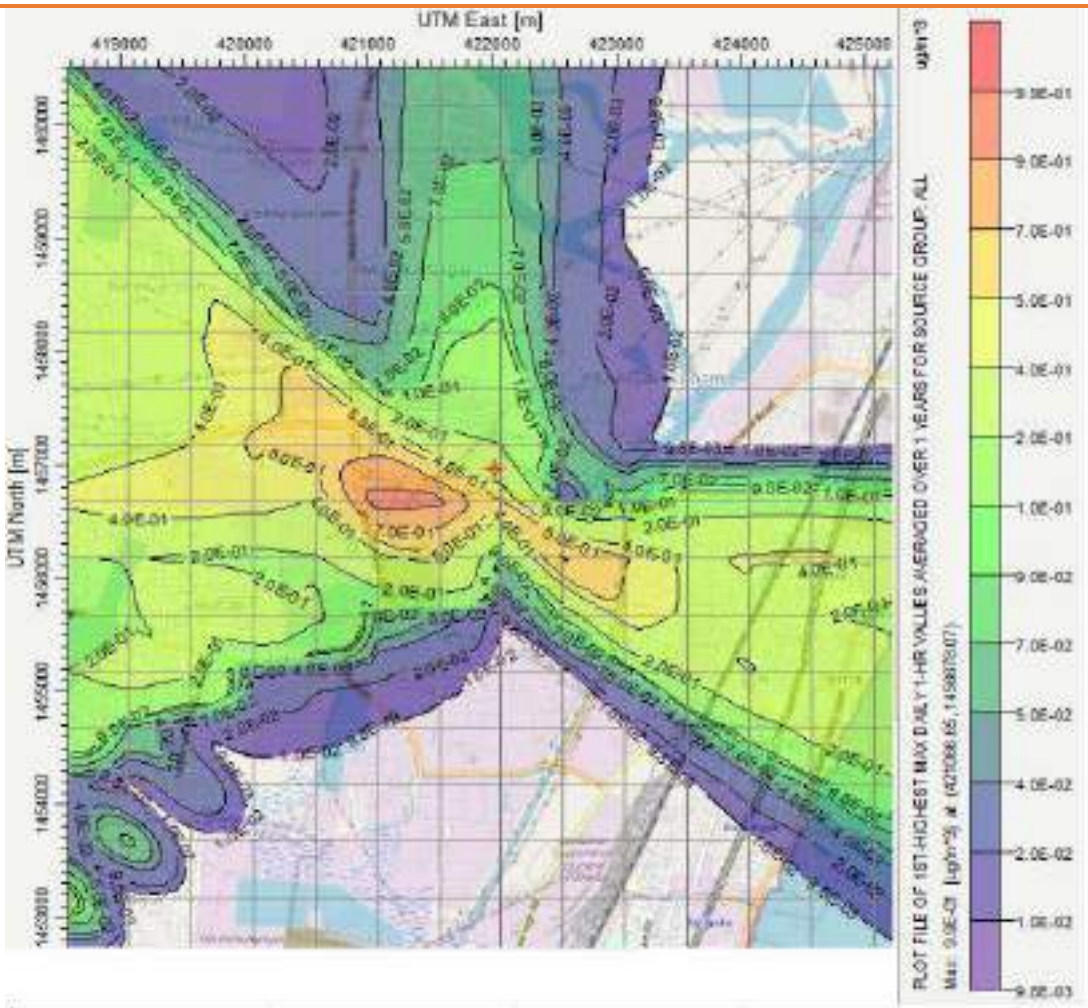
STACK EMISSION DISPERSION MODELLING –ECH Division Boiler @2 & 5 KM- Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
31	0.85	0.99	0.0961	0.00667

ECH Division Boiler of Carbon Monoxide concentration is 31 mg/m^3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.99µg/m^3 at 2km dispersion Carbon Monoxide is 0.0961µg/m^3 and at 5km dispersion Carbon Monoxide is 0.00667µg/m^3 and the predominant wind direction is SSE.

STACK EMISSION DISPERSION MODELLING –ECH Division Boiler @2 & 5 KM- Chlorine

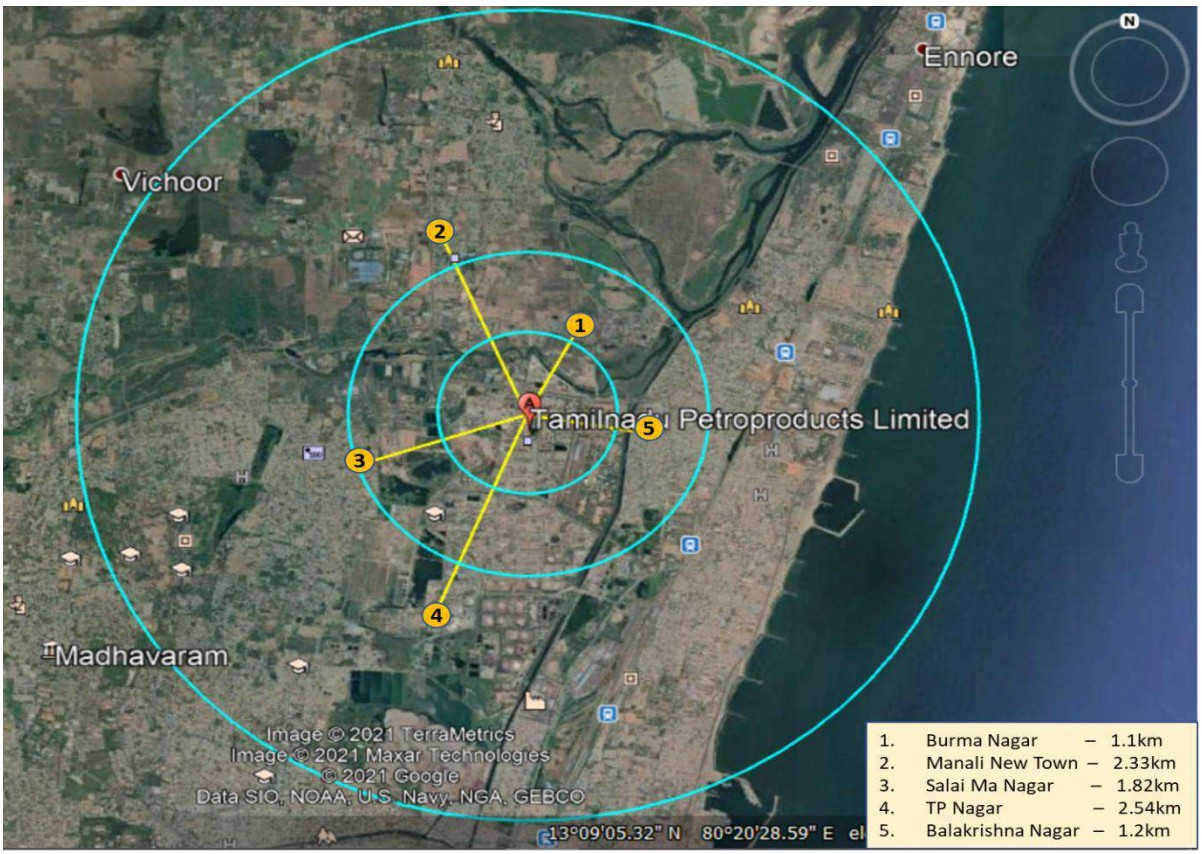


Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
2.6	0.76	0.09	0.0115	0.00543

ECH Division Boiler of Chlorine concentration is 2.6 mg/m^3 and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 11.89m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 0.09µg/m^3 at 2km dispersion Chlorine is 0.0115µg/m^3 and at 5km dispersion Chlorine is 0.00543µg/m^3 and the predominant wind direction is SSE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)
TPL - ECH PO DIVISION						
Boiler	PM	9.6	0.71	0.481	0.354	0.00878
Boiler	CO	31	0.85	0.99	0.0961	0.00667
Chlorine Scrubber	Cl2	2.6	0.76	0.09	0.0115	0.00543



10 FINDINGS:

10.1 Ambient Air Quality Monitoring Results

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Main Gate 3, Near Fire Water Pump House, Near Ambient Air Station, Near Sub Station, Near PO Bullet South, Near Gate 4, Plant outside Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.8 to 26.3µg/m^3. Highest value of 26.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 19.7 to 30.4µg/m^3. Highest value of 30.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 55.2 to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 16.1 to 4771.1µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 17 to 8657.8µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

10.2 STACK EMISSION AND AERMOD DISPERSION MODELLING RESULTS:

10.2.1 Boiler Stack:

ECH Division Boiler of Particulate matter concentration is 9.6mg/m^3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 0.481µg/m^3 at 2km dispersion Particulate matter is 0.354µg/m^3 and at 5km dispersion Particulate matter is 0.00878µg/m^3 and the predominant wind direction is SSE.

ECH Division Boiler of Carbon Monoxide concentration is 31 mg/m^3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.99µg/m^3 at 2km dispersion Carbon Monoxide is 0.0961µg/m^3 and at 5km dispersion Carbon Monoxide is 0.00667µg/m^3 and the predominant wind direction is SSE.

10.2.2 Chlorine Scrubber

ECH Division Chlorine Scrubber of Chlorine concentration is 2.6 mg/m^3 and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 11.89m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 0.09µg/m^3 at 2km dispersion Chlorine is 0.0115µg/m^3 and at 5km dispersion Chlorine is 0.00543µg/m^3 and the predominant wind direction is SSE.

11.0 Overall Findings on Source Dispersion Modelling and Carrying Capacity

The source dispersion modelling output results showed the pollutants contribution from TPL – PO Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma

Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – PO division through stacks is 35 mg/m^3. The average ground level concentration achieves at an average distance of 0.71km and the sum of PM concentration at GLC is 1.11 $\mu g/m^3$ which includes all the stacks at TPL – PO division. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from TPL – PO division through stacks is 31 mg/m^3. The average ground level concentration achieves at an average distance of 0.85km and the sum of Nitrogen Oxides concentration at GLC is 0.99 $\mu g/m^3$ which includes all the stacks at TPL – PO division. It clearly indicates the CO contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative chlorine emissions from TPL – PO division through stacks is 2.6 mg/m^3. The average ground level concentration achieves at an average distance of 0.76km and the sum of chlorine concentration at GLC is 0.09 $\mu g/m^3$ which includes all the stacks at TPL – PO division. It clearly indicates the Cl_2 contribution to the nearby residential areas are minimum and there is no limit for the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM and CO. Results from AERMOD simulation indicated that PM and CO emissions from the TPL PO division had no significant impact on nearby communities and Manali Industrial complex. For Chlorine there is no ambient air quality standard and the predicted concentrations also in trace level so that the impact on nearby communities and Manali Industrial complex is negligible.

The overall combined source mass emission load of PM and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industries source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are very much less.

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Annexure-VII

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Tamilnadu Petroproducts Ltd, HCD Division, Manali

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. ABOUT INDUSTRY

TPL is a joint venture between Tamil Nadu Industrial Development Corporation Limited (TIDCO), wholly owned by the Government of Tamilnadu and Southern Petrochemical Industries Corporation Ltd. (SPIC) with more than 80,000 shareholders. TPL is a listed company on Bombay Stock Exchange and National Stock Exchange. M/s. SPIC Limited, has diverse interest in fertilizers and other services. TIDCO is a public financial institution engaged in promoting industries in the State of Tamil Nadu.

Tamilnadu Petroproducts Limited (TPL) was established in 1984 at Manali, Thiruvallur district in Tamilnadu State to manufacture industrial intermediary Chemicals. TPL went into stream in the year 1989 with manufacturing facility for Linear Alkyl Benzene (LAB), finding application in manufacture of detergents and cleaning agents.

Heavy Chemicals Division was established by M/s. Kothari Chemicals ltd in 1978 and subsequently it was taken over by M.s SPIC during 1988.
TPL acquired the Heavy Chemicals Division (HCD) from SPIC in the Year 2000 which manufactures Chloro Alkali Comprising Caustic Soda & Chlorine which are most commonly used industrial chemicals in Textile, Paper and Pulp, Soaps & Detergents and Aluminium industries in India.

TPL established a facility to make Epichlorohydrin (ECH) in the year 1995 which is a key raw material in the manufacture of epoxy resins, pesticides and certain pharmaceutical formulations. However, the unit is not in operation since 1st April 2013 owing to unviable business opportunities for the product and huge losses incurred during the past 10 years.
Environmental Clearance obtained during 2015 to manufacture propylene Oxide and Chlorinated Organics in the exiting Epichlorohydrin (ECH) Plant.
ECH – PO plant was installed during 2019 and commissioned for operation from Jan 2019.

HCD Plant - Manufacturing Process

Process Description

TPL-HCD employs electrolysis of pure brine using membrane cells to produce 32 % lye and > 99% pure Chlorine and Hydrogen gases as co-products.

This 32% Caustic Soda Lye is further concentrated to 48% in the Caustic Evaporation Plant.

The Plant operations have been divided into the following sections:

1. Salt Storage and Handling and brine saturation.
2. Membrane Plant
    a. Brine Purification
    b. Cell house
    c. Brine dechlorination, Chlorine treatment, drying & compression
    d. Hydrogen treatment
    e. Hydrochloric Acid Plant
    f. Waste air dechlorination
    g. Chlorine Storage & filling
3. Ammonium Chloride Plant
4. Fusion Plant
5. Utilities
6. Storages
7. Captive Power Plant

1. Salt Storage and Brine saturation:

Raw salt procured from coastal areas is brought through trucks and stored in the salt yard in the form of heaps. In the Horizontal saturators lean brine from the plant gets saturated with salt fed from the heap using Pay loader / JCB.

2. Membrane Plant:

a) Brine Purification:

The concentrated sodium chloride is treated with Sodium Carbonate, Sodium Hydroxide and Barium Carbonate to remove Calcium, Magnesium, Sulphate impurities present in salt.

These impurities are removed as sludge from clarifier bottom and clarifier over flow is filtered through anthracite filter beds. The filtered brine is further polished in two sets of candle filters for removal of suspended impurities. The membrane is sensitive to any cation impurity like Calcium and Magnesium. The dissolved impurities of Calcium and Magnesium are removed to less than 20 ppb in two sets of ion exchange beds and stored in a head tank.

b) Cell House:

There are 44 twin electrolysers in series. The DC current is supplied by a 56 KA, 300 Volts rectifier. The brine is fed to the anode side from the head tank and 28% caustic is fed to the cathode side. Electrolysers employed are monopolar, DCM 405 * 2, the digit 2 denoting twin cell. One electrolyser consists of four anodes, four cathodes, two half anodes and two half cathode elements of membranes are positioned between the cathode and anode elements.

The electrolysers are arranged in two rows to form a series circuit with the rectifier. The individual electrolysers are electrically connected thro' inter-cell busbars and the rows by cross over busbars. The current flows from the rectifier positive side to the anode of first electrolyser, returning from the cathode of last electrolyser to the rectifier negative side.

In the anode side, the two phase stream of depleted brine and wet chlorine gas at 80 – 90 °C overflows from each anode chamber of the electrolysers and flows by gravity to the anolyte tank where brine & chlorine gas are separated. In the cathode side, the two phase stream of caustic and hydrogen overflows from each cathode chamber of the electrolysers and flows by gravity to the catholyte tank where caustic and hydrogen gas are separated. Chlorine Destruction unit is provided to reduce the chlorate content in the depleted brine by adding concentrated Hydrochloric acid at 90 °C.

c) **Chlorine Treatment, drying, Compression and Liquefaction:**

The chlorine in the depleted brine is removed by addition of Hydrochloric acid to reduce pH and by applying flash distillation under vacuum. Any further traces of chlorine in the depleted brine are removed by the addition of Sodium Sulphite. After complete dechlorination, the depleted brine is pumped to the saturators. The wet chlorine after getting separated in the anolyte tank is cooled by cooling water. A portion of the chlorine is fed to the HCl unit and the rest is chilled, dried and compressed. A portion of the dry compressed Chlorine is sent to MPL through pipeline and the balance is sent to liquefaction system for liquefaction. Chlorine recuperator is installed to reduce the cooling water and steam consumption.

d) Hydrogen Treatment:

After cooling the hydrogen is pressurised to 2000mm WC by a blower and sent to hydrogen unit for distributing to various sections. A portion of the membrane hydrogen is utilised for production of Hydrochloric acid in the HCl synthesis unit

e) Hydrochloric Acid synthesis Unit:

There are two HCL synthesis units available supplied by M/s.Sigri are of 40 MTPD of chlorine burning capacity each.

Wet Chlorine and hydrogen gases are burnt in reactors to form HCL gas which is absorbed by demineralised water to form 33% acid. The heat liberated by the exothermic reaction is removed by circulating cooling water, flowing through the outer side of the reactor. The 32 % acid leaves the reactor from the bottom and is collected in receiver tanks.

Off gas from synthesis unit is let out to atmosphere after passing thro' a dilute caustic scrubber to ensure no chlorine and acid vapours are let out.

f) Waste Air dechlorination:

The chlorine gas released from the electrolyser and chlorine treatment section during normal and emergency operation is scrubbed with circulated caustic soda solution in two scrubbing towers. The circulated liquid has to be maintained at low temperature and for this chilled water coolers are employed to keep the circulated liquid temperature at about 20 ~ 25 °C. The product formed by this reaction is sodium hypo.

g) Chlorine Storage & Filling:

Liquefied Chlorine is received in storage tanks and filled in Chlorine cylinders (Tonners).

3. Ammonium Chloride Unit:

This plant was designed by M/s FEDO to produce 30 TPD of Ammonium Chloride crystals with a reactors and a centrifuging and drying system. Hydrogen Chloride gas from HCl unit is combined with gaseous Ammonia and DM water in brick lined reactor to form Ammonium Chloride. The reaction is carried out under vacuum (300 to 340mm Hg) in the reactor. The reaction is instantaneous and Ammonium Chloride formed develops as crystals over the existing ones in the slurry. The slurry is centrifuged and dried to form 99% pure crystals, while the vapours containing traces of Ammonia is scrubbed in a wash tower.

4. Fusion Plant:

The process technology and equipment for fusion Plant was supplied by M/s.Bertrams, Swiss. The plant is capable of producing 85 TPD Flakes. The concentration of 48% to 98.5 % Caustic is done in three stages. In the first stage the Caustic Lye is concentrated to around 55% in the pre concentrator using the heat from exhaust vapours from the final concentrator. Then it is further concentrated to 76% in the rising Film evaporator using steam as the heating medium. Then finally it is concentrated from 76% to 98.5 % in the final concentrator (falling film evaporator) by circulating heat transfer salt at 425°C. The heat transfer salt (mixture of KNO_3, $NaNO_2$ & $NaNO_3$) is heated in a vertical furnace where R-LNG and hydrogen are used as fuel in the burner. Molten caustic from the final concentrator is taken to Flaker, where the Flaker drum picks up a thin film of molten caustic which is removed by flaker blades to get Caustic Flakes. The Flaker Drum is cooled internally by cooling water. The flakes are filled in bags.

5. Utilities:

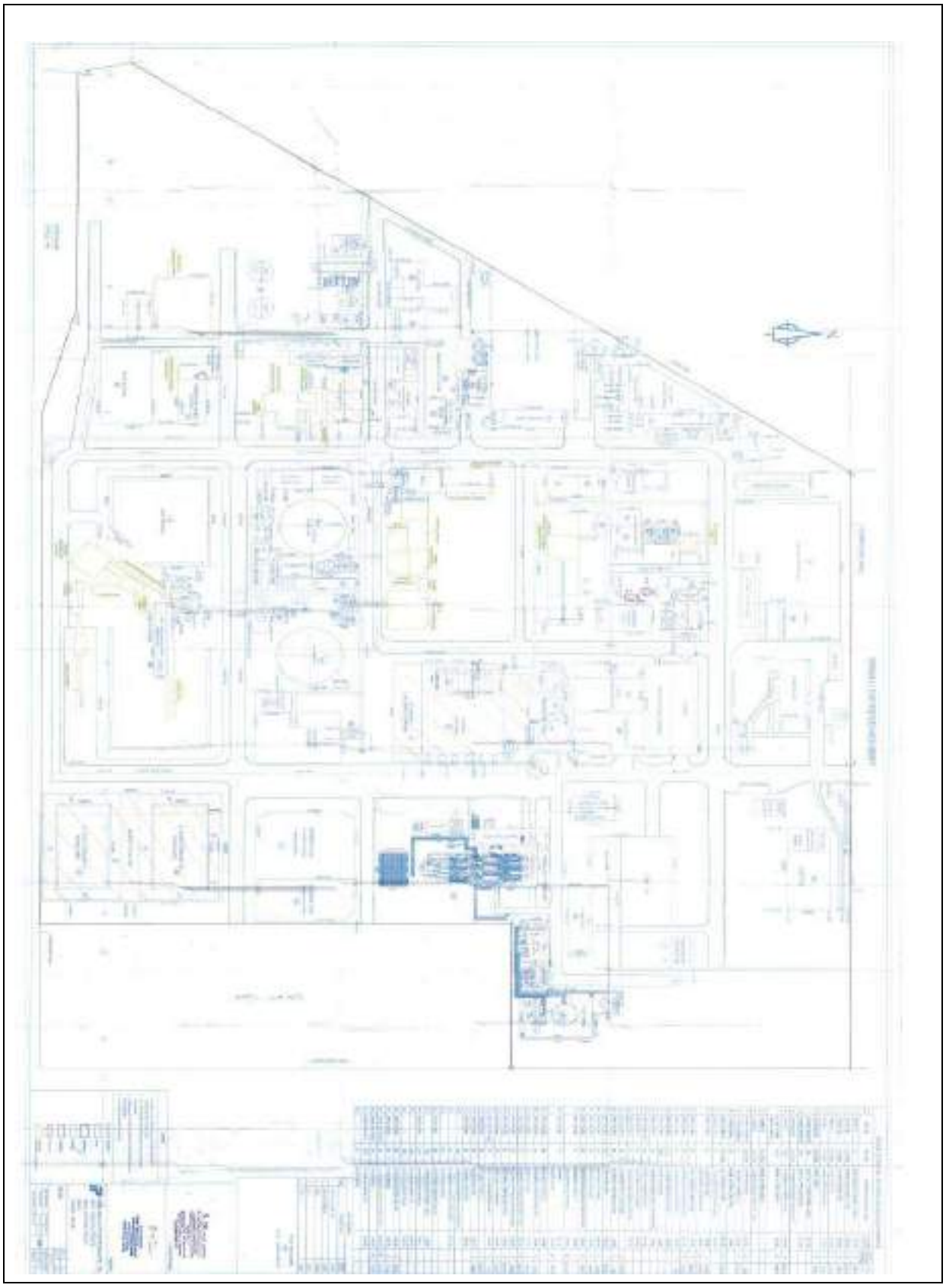
The Utilities Section comprises of Water treatment Plant, Boilers, Cooling Towers, Instrument Air, Service Air and Chilled water system. The water treatment plant generates, Demineralised and Polished Water. Two sets of atmospheric cooling towers for Membrane Plant are available to supply cooling water at a temperature of 30 °C to the heat exchangers. The chilled water system provides Chilled water to the Plant at 10 °C. Two fire tube boilers, one of 4 TPH and one of 5 TPH capacities are available. R-LNG and Hydrogen are used as fuel for the Boiler.

6. Storages:

The hazardous chemicals that are normally stored and their storage capacities are furnished below:

1. For Caustic Soda Lye, three storage tanks, of 1000 $m^3$and one storage tanks of 500 m^3 and two storages of 250 m^3capacities are available.
2. For Liquid Chlorine, five tanks, three of which are of 100 MT, and the other two of 75 MT capacity are available. Always one tank is kept empty as buffer tank.
3. For HCL, two storage tanks of 100 MT and 150 MT respectively.
4. For Ammonia, two storage bullets of 75 MT each capacity are available.

PLANT LAYOUT



2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.
** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM_{10} in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM_{10} in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM_{10}

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

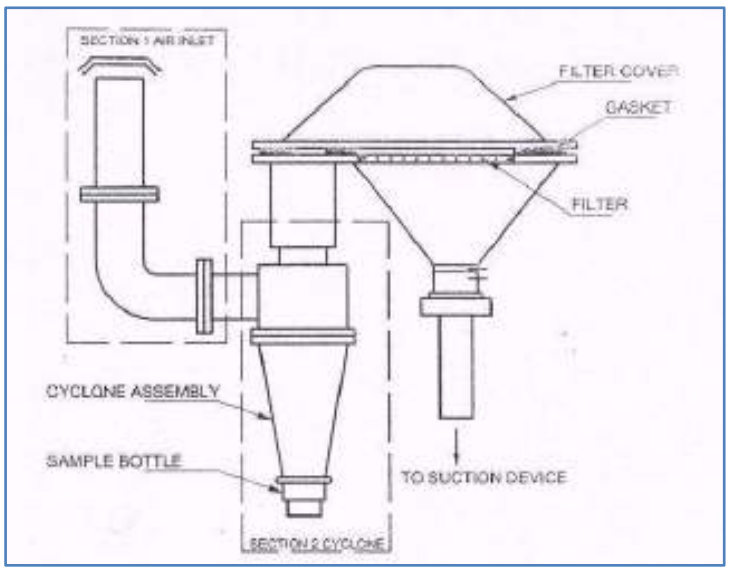
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = $(Wf - Wi) \times 10^6 / V$

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the

preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flowrate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended

Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, µg/m^3	Annual *	40	40
	24 Hours **	60	60
*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).

- Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).
- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), µg/m^3	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting

50 ml of stock solution to 500 ml with distilled water.

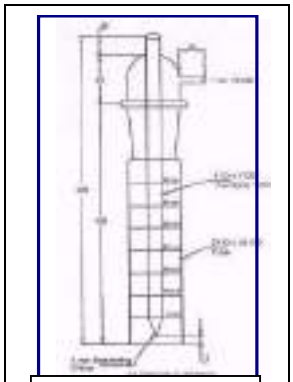
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and

transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO2 = Concentration of Nitrogen dioxide, $\mu g/m^3$

As = Absorbance of sample

Ab = Absorbance of reagent blank

CF = Calibration factor

Va = Volume of air sampled, m^3

Vs = Volume of sample, ml

Vt = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 0.5 lpm for eight hours
Check the volume of sample at the end of sampling and record it
Transfer the exposed samples in storage bottle and preserve
Prepare calibration graph as recommended in method
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
Add 1 ml Sulphamic acid. Keep it 10 minutes
Add 2 ml formaldehyde
Add 2 ml working PRA
Make up to mark (25 ml.) with distilled water.
Keep it 30 minutes for reaction
Set Zero of spectrophotometer with Distilled water
Measure absorbance at 560 nm
Calculate concentration using calibration graph
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I_2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (NH_3\ \mu g/m^3) = (A_s - A_b) \times CF / V_a$$

Where,

$C\ NH_3$	=	Concentration of Ammonia in $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3

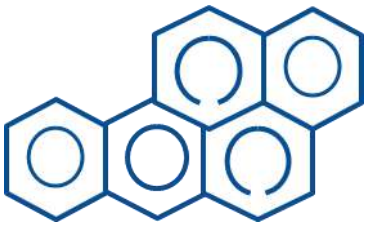
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water ⇩
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx ⇩
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration ⇩
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis ⇩
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution ⇩
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer ⇩
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank. ⇩
Plot the calibration curve ⇩
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various

PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
⇩
Ultrasonic extraction with Toluene (50 ml × 3 times)
⇩
Filter & dry with Anhydrous Sodium Sulphate
⇩
Concentration with Rotary Evaporator
⇩
Clean up with Silica Gel Column Chromatography
⇩
Elution with Cyclo-Hexane (5 ml × 3 times)
⇩
Evaporate to nearly dryness under Nitrogen
⇩
Re-dissolved in 0.5 to 1.0 ml Toluene
⇩
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper**:** EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.

Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{\text{(Spiked sample concentration - sample concentration) x100}}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V	=	Volume of air, m^3
Q	=	Average sampling rate, m^3/min.
T	=	Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greek method
		24 hours	80 µg/ m^3	80 µg/ m^3	-Ultraviolet Fluorescence
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

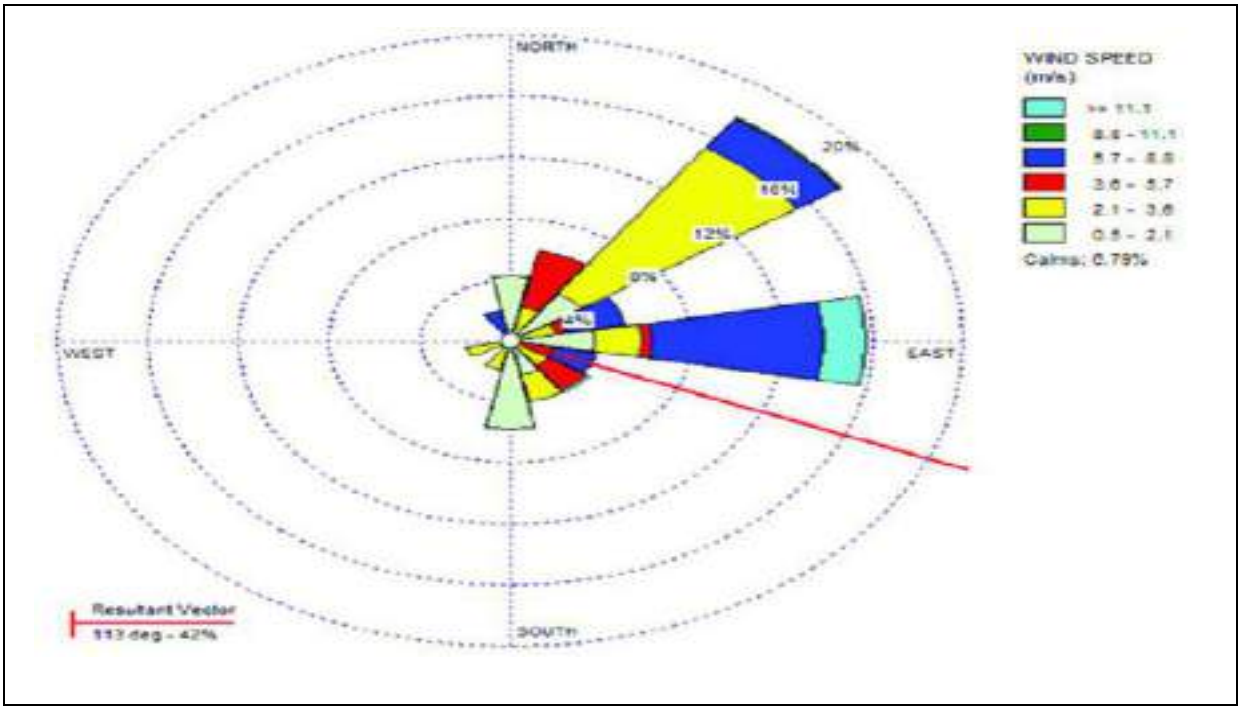
**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT TPL - 17.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
17.02.2021	1:00 AM	22.2	94	2	N
17.02.2021	2:00 AM	22.2	88	0	CALM
17.02.2021	3:00 AM	22.8	88	0	CALM
17.02.2021	4:00 AM	25.0	74	2	VAR
17.02.2021	5:00 AM	27.2	61	3	NE
17.02.2021	6:00 AM	28.9	51	6	SE
17.02.2021	6:00 AM	28.9	55	10	E
17.02.2021	7:00 AM	28.9	55	8	ESE
17.02.2021	8:00 AM	28.9	55	9	E
17.02.2021	9:00 AM	28.9	51	9	E
17.02.2021	10:00 AM	27.8	54	9	E
17.02.2021	11:00 AM	27.8	58	9	ESE
17.02.2021	12:00 PM	26.1	61	9	ESE
17.02.2021	1:00 PM	26.1	65	8	E
17.02.2021	2:00 PM	26.1	65	7	E
17.02.2021	3:00 PM	25.0	69	6	E
17.02.2021	4:00 PM	25.0	69	3	E
17.02.2021	5:00 PM	23.9	73	3	E
17.02.2021	6:00 PM	23.9	73	5	E
17.02.2021	7:00 PM	22.8	78	0	CALM
17.02.2021	8:00 PM	22.8	78	0	CALM
17.02.2021	9:00 PM	22.2	88	0	CALM
17.02.2021	10:00 PM	22.2	88	2	VAR
17.02.2021	11:00 PM	22.2	88	0	CALM
17.02.2021	12:00 AM	22.2	88	2	VAR
MIN		22.2	51.0	0.0	ENE
MAX		28.9	94.0	10.0	
AVG		25.2	70.7	4.5	

WEATHER MONITORING DATA AT TPL - 18.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
18.02.2021	1:00 AM	22.2	83	3	ENE
18.02.2021	2:00 AM	22.2	83	2	N
18.02.2021	3:00 AM	23.9	78	2	N
18.02.2021	4:00 AM	27.2	61	9	E
18.02.2021	5:00 AM	28.9	51	12	E
18.02.2021	6:00 AM	28.9	51	12	E
18.02.2021	6:00 AM	28.9	51	12	E
18.02.2021	7:00 AM	30.0	51	10	E
18.02.2021	8:00 AM	30.0	51	12	E
18.02.2021	9:00 AM	28.9	51	13	E
18.02.2021	10:00 AM	28.9	51	12	E
18.02.2021	11:00 AM	27.8	54	12	E
18.02.2021	12:00 PM	27.2	51.0	10.0	E
18.02.2021	1:00 PM	26.1	65	9	E
18.02.2021	2:00 PM	26.1	65	6	E
18.02.2021	3:00 PM	26.1	69	7	E
18.02.2021	4:00 PM	26.1	65	8	ESE
18.02.2021	5:00 PM	25.0	69	6	E
18.02.2021	6:00 PM	23.9	73	3	E
18.02.2021	7:00 PM	23.9	73	3	E
18.02.2021	8:00 PM	22.8	78	2	N
18.02.2021	9:00 PM	22.2	83	2	N
18.02.2021	10:00 PM	22.2	83	2	N
18.02.2021	11:00 PM	21.1	88	3	NE
18.02.2021	12:00 AM	21.1	88	3	NNE
MIN		21.1	51.0	2.0	E
MAX		30.0	88.0	13.0	
AVG		25.7	66.6	7.0	



4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Stack Emission Monitoring Locations

Ambient Air Quality Monitoring Sampling Location

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, NEAR SECURITY GATE

LOCATION - NEAR SECURITY GATE,MANALI			
SAMPLING DATE & TIME 17.02.2021 [17:10 Hrs] – 18.02.2021 [17:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	22.9
2	Nitrogen Dioxide as NO_2	µg/m^3	27.8
3	Particulate Matter (PM_{10})	µg/m^3	88.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	42.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, NEAR METRO WATER STORAGE TANK

LOCATION - NEAR METRO WATER STORAGE TANK,MANALI			
SAMPLING DATE & TIME 17.02.2021 [17:20 Hrs] – 18.02.2021 [17:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	17.7
2	Nitrogen Dioxide as NO_2	µg/m^3	23.7
3	Particulate Matter (PM_{10})	µg/m^3	76.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	35.3
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, NEAR CPP RADIATOR

LOCATION - NEAR CPP RADIATOR,MANALI			
SAMPLING DATE & TIME 17.02.2021 [17:30 Hrs] – 18.02.2021 [17:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	24.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	30.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	64.7
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	29.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, SALT YARD SOUTH SIDE

LOCATION - SALT YARD SOUTH SIDE,MANALI			
SAMPLING DATE & TIME 17.02.2021 [17:40 Hrs] – 18.02.2021 [17:40 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	18.6
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	25.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	52.87
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31.7
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, NEAR FABRICATION YARD

LOCATION - NEAR FABRICATION YARD,MANALI			
SAMPLING DATE & TIME 17.02.2021 [17:50 Hrs] - 18.02.2021 [17:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	20.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.6
3	Particulate Matter (PM_{10})	$\mu g/m^3$	50.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, WARD PLANT - WEST SIDE

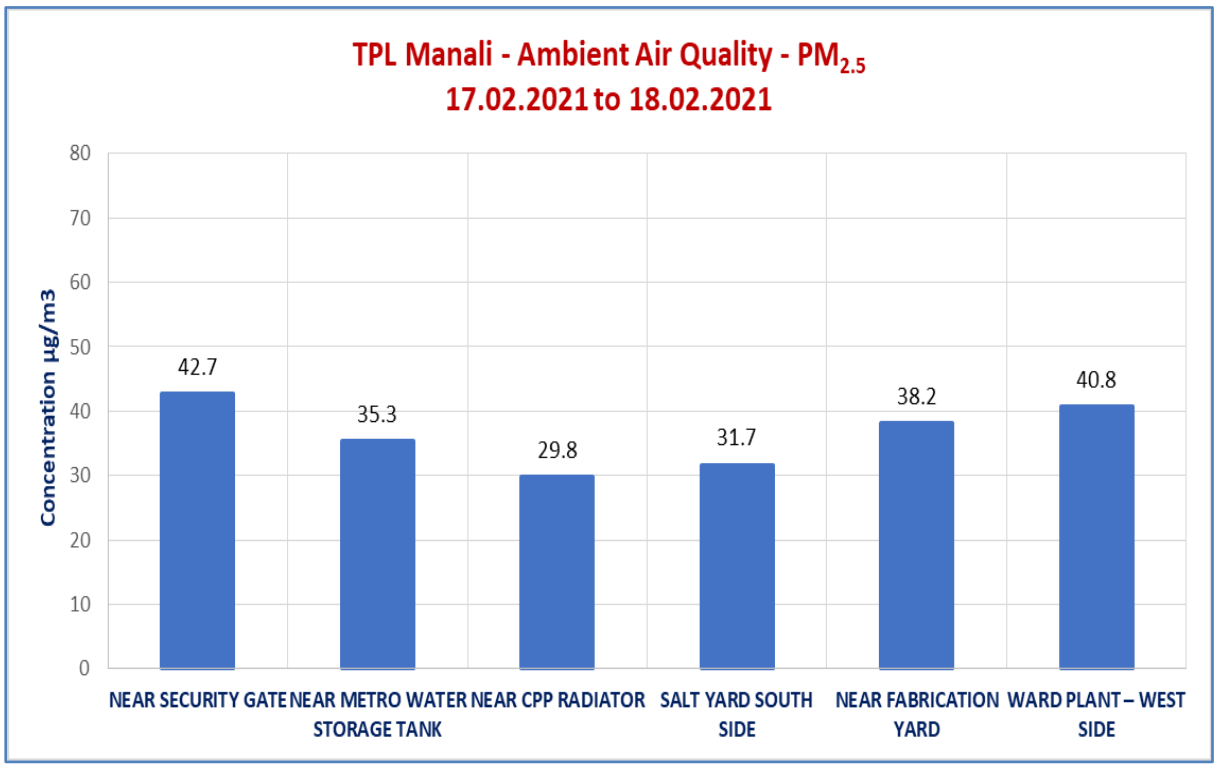
LOCATION - WARD PLANT - WEST SIDE,MANALI			
SAMPLING DATE & TIME 17.02.2021 [18:00 Hrs] - 18.02.2021 [18:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	15.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	23.8
3	Particulate Matter (PM_{10})	$\mu g/m^3$	81.1
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	40.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

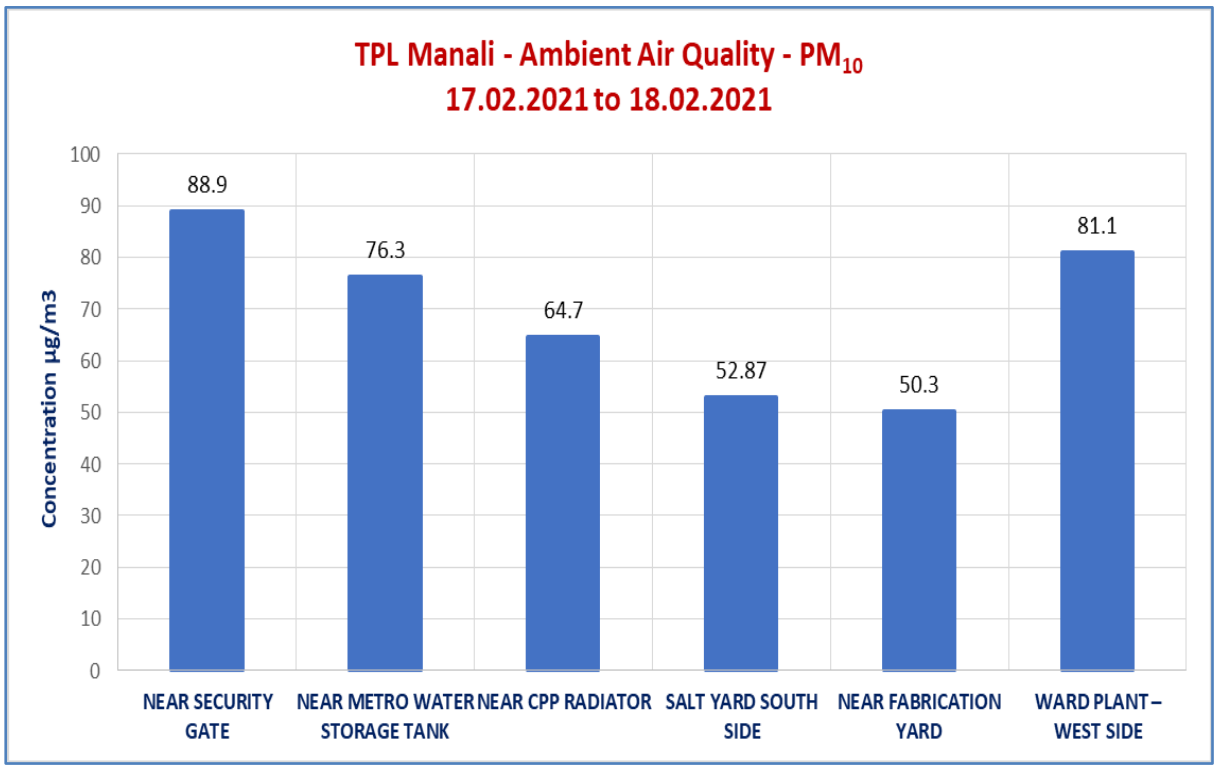
AAQ- 7: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, WARD PLANT – PLANT OUTSIDE – MAIN GATE HCD

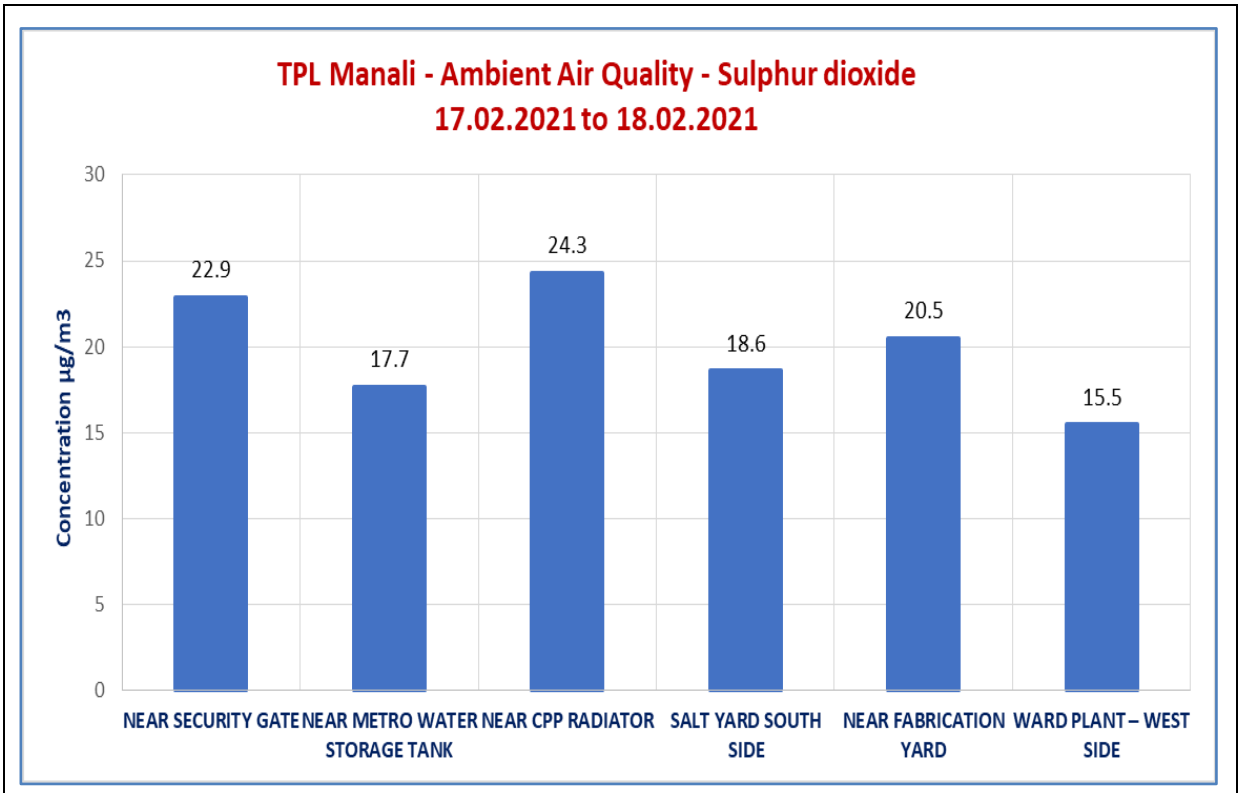
LOCATION - PLANT OUTSIDE – MAIN GATE HCD, MANALI				
SAMPLING DATE & TIME 18.02.2021 [07:00 Hrs] – 18.02.2021 [15:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	07:00 – 08:00	µg/m^3	39.68	129.39
2	08:00 – 09:00	µg/m^3	29.69	135.51
3	09:00 – 10:00	µg/m^3	21.11	75.91
4	10:00 – 11:00	µg/m^3	24.03	117.84
5	11:00 –12:00	µg/m^3	22.60	105.72
6	12:01 – 01:00	µg/m^3	22.60	105.72
7	01:00 – 02:00	µg/m^3	21.29	95.12
8	02:00 – 03:00	µg/m^3	28.40	138.21
8 HOURS AVERAGE			**26.17**	**112.93**

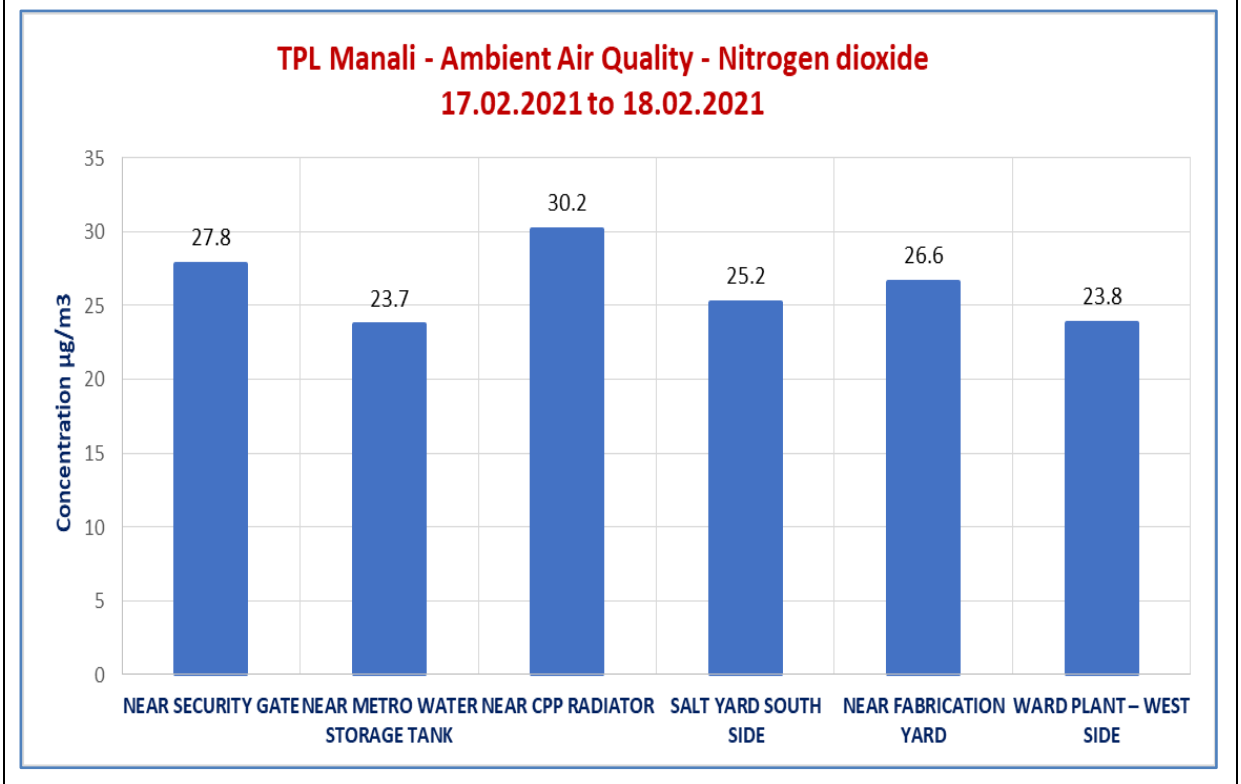
Consolidated Monitoring Results

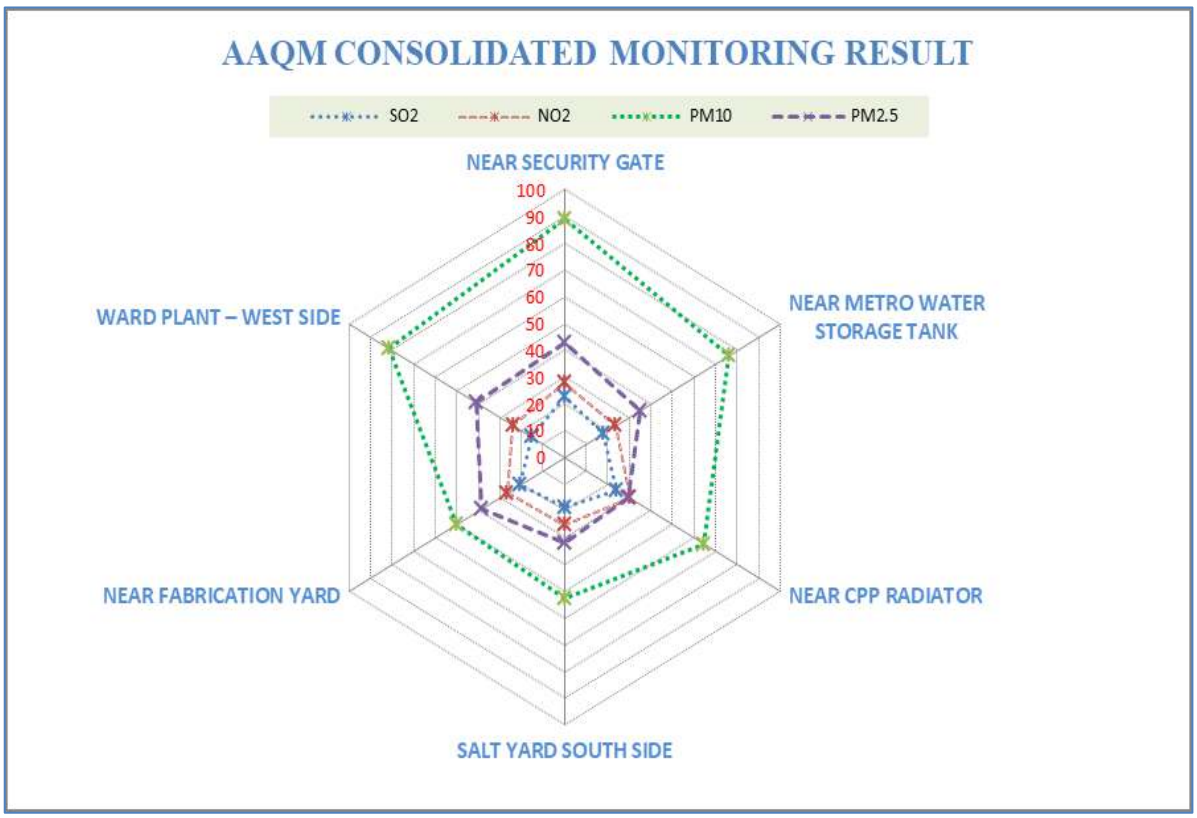
AAQM Consolidated Monitoring Results (µg/m3)				
Sampling Date [17.02.2021 to 18.02.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
NEAR SECURITY GATE	22.9	27.8	88.9	42.7
NEAR METRO WATER STORAGE TANK	17.7	23.7	76.3	35.3
NEAR CPP RADIATOR	24.3	30.2	64.7	29.8
SALT YARD SOUTH SIDE	18.6	25.2	52.87	31.7
NEAR FABRICATION YARD	20.5	26.6	50.3	38.2
WARD PLANT – WEST SIDE	15.5	23.8	81.1	40.8

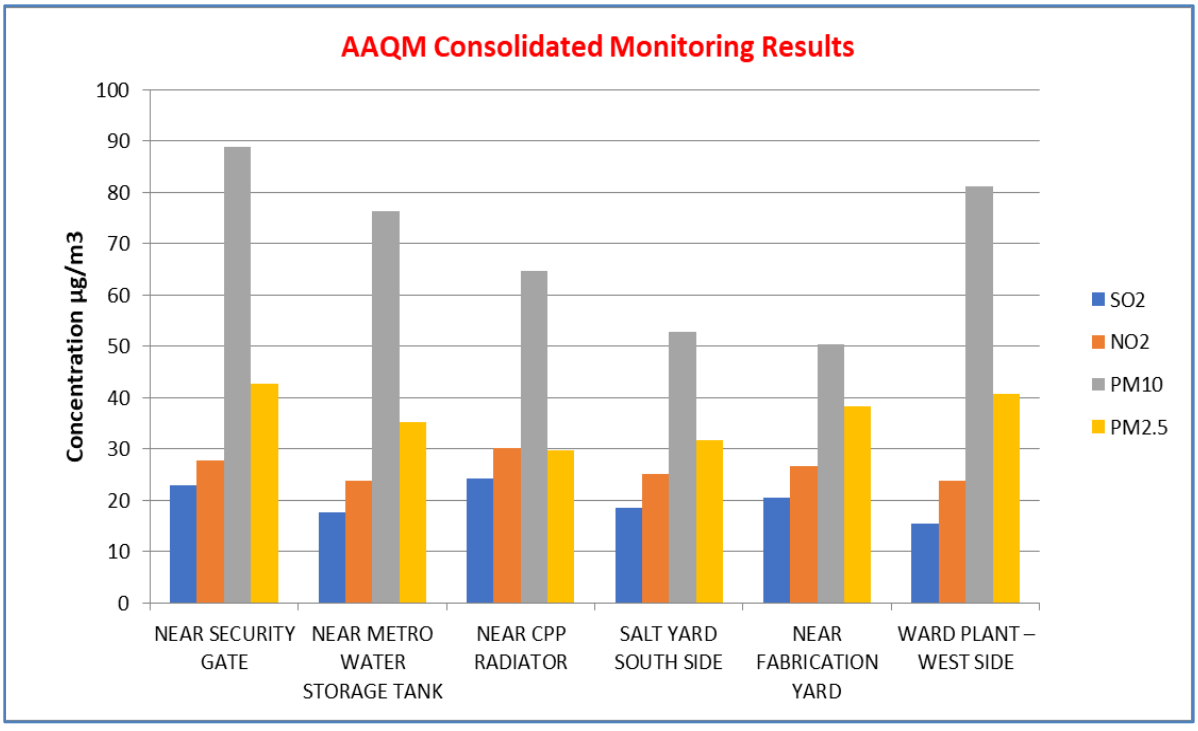

TPL Manali - Ambient Air Quality - PM2.5
17.02.2021 to 18.02.2021
Concentration µg/m3
80
70
60
50
40
30
20
10
0
42.7
35.3
29.8
31.7
38.2
40.8
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE

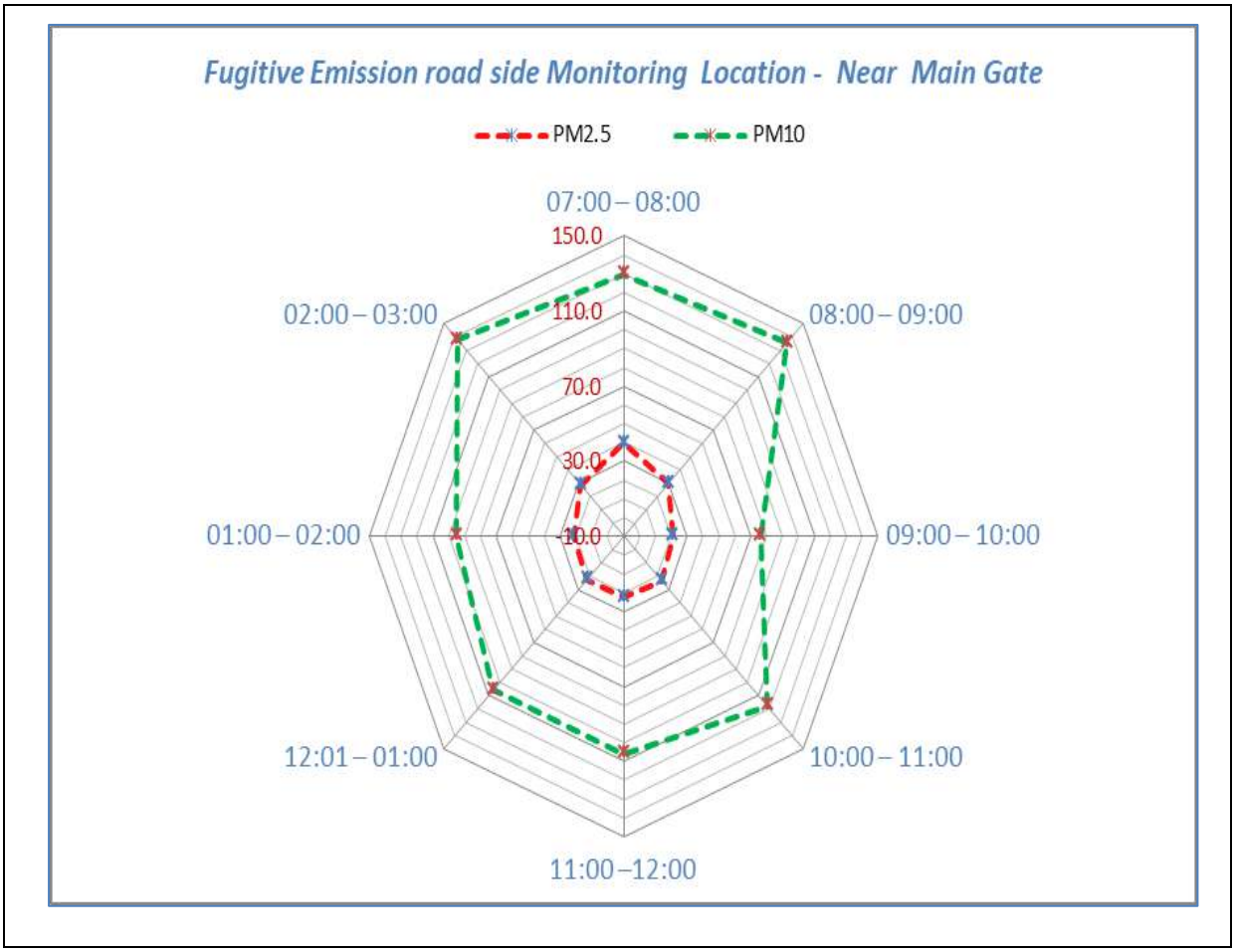

TPL Manali - Ambient Air Quality - PM10
17.02.2021 to 18.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
88.9
76.3
64.7
52.87
50.3
81.1
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE


TPL Manali - Ambient Air Quality - Sulphur dioxide
17.02.2021 to 18.02.2021
Concentration µg/m3
30
25
20
15
10
5
0
22.9
17.7
24.3
18.6
20.5
15.5
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE


TPL Manali - Ambient Air Quality - Nitrogen dioxide
17.02.2021 to 18.02.2021
Concentration µg/m3
35
30
25
20
15
10
5
0
27.8
23.7
30.2
25.2
26.6
23.8
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE
100
90
80
70
60
50
40
30
20
10
0


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NEAR SECURITY GATE
NEAR METRO WATER STORAGE TANK
NEAR CPP RADIATOR
SALT YARD SOUTH SIDE
NEAR FABRICATION YARD
WARD PLANT – WEST SIDE
SO2
NO2
PM10
PM2.5



CONCLUSION:

In Ambient Air Quality monitoring six sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Metro Water Storage Tank, Near CPP Radiator, Salt Yard South Side, Near Fabrication Yard, Ward Plant – West Side, Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.5 to 24.3µg/m^3. Highest value of 24.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 23.7 to 30.2µg/m^3. Highest value of 30.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.3 to 88.9µg/m^3. Highest value of 88.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.8 to 42.7µg/m^3. Highest value of 42.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 6.35 to 1247.3µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.

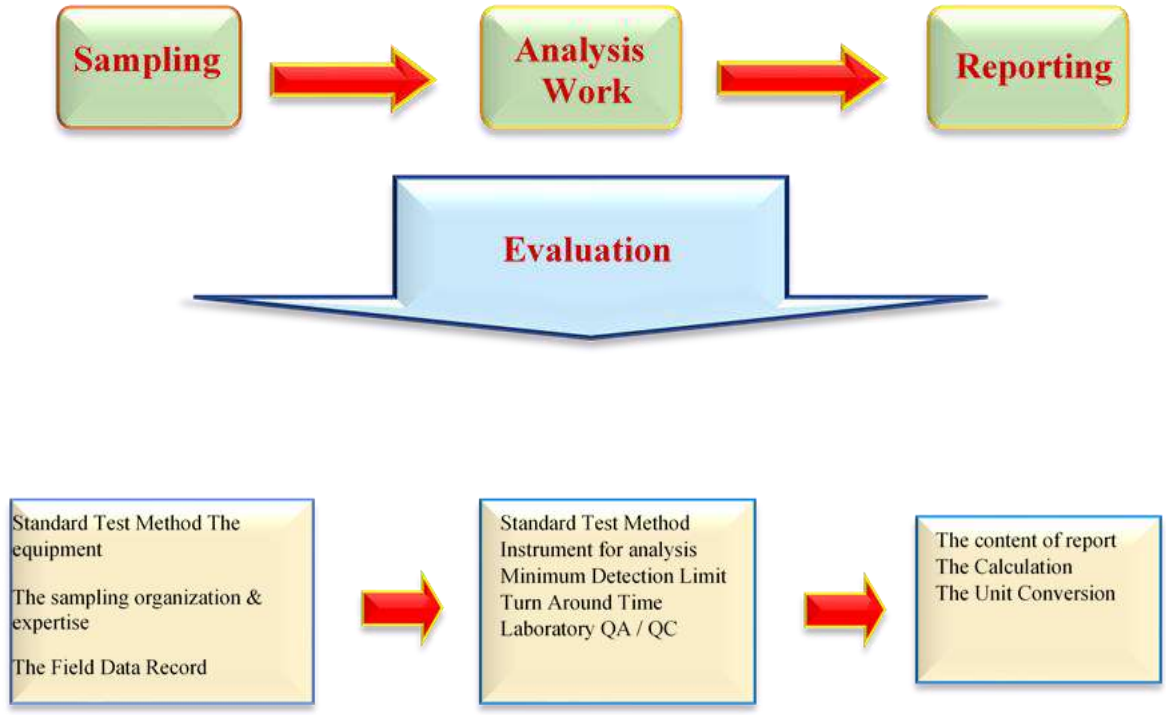
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.35 to 10253.9µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

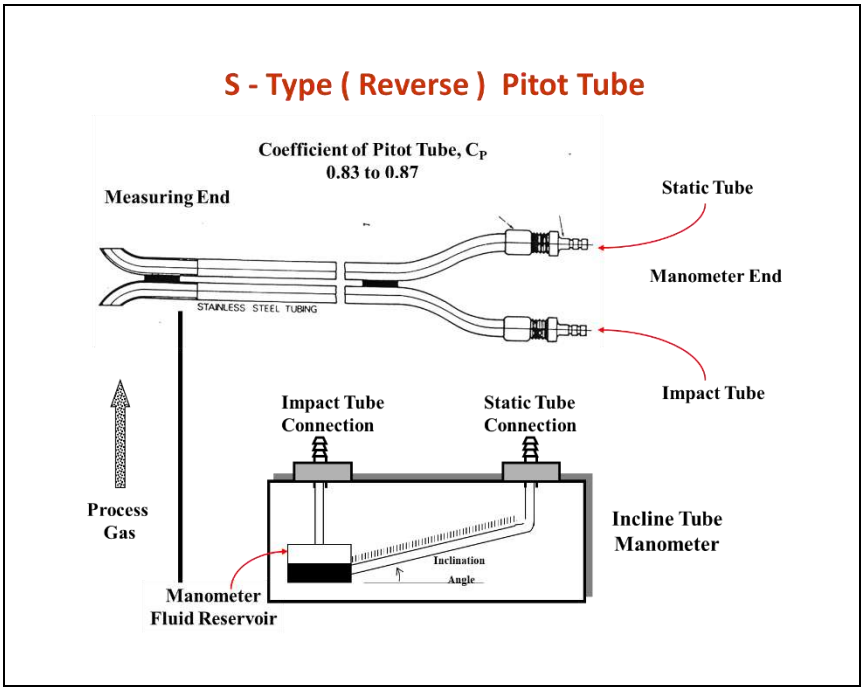


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

- ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points:

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

2. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

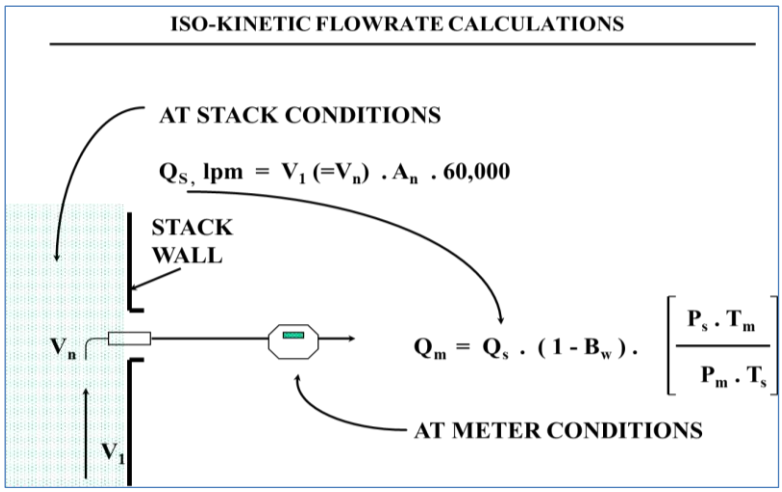
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

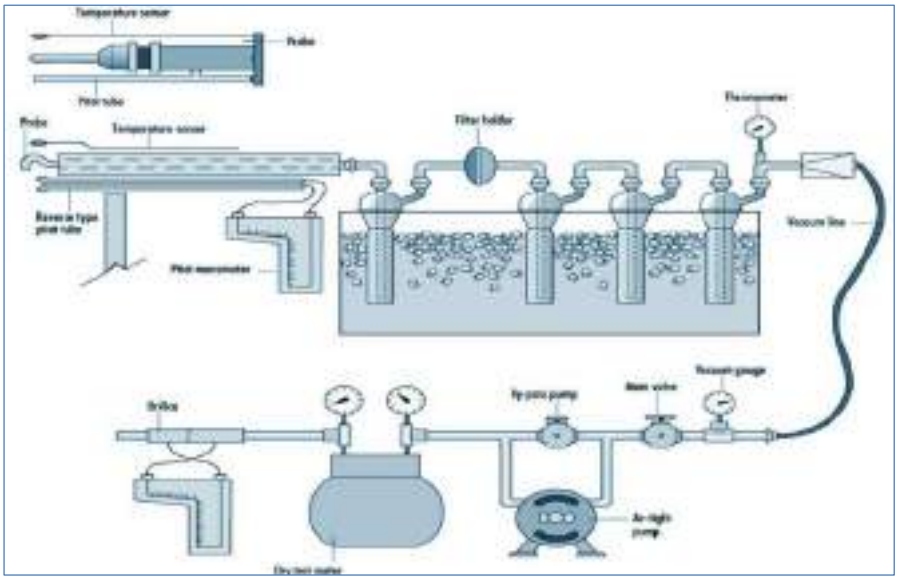
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

• ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the isopropyl

alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading; meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

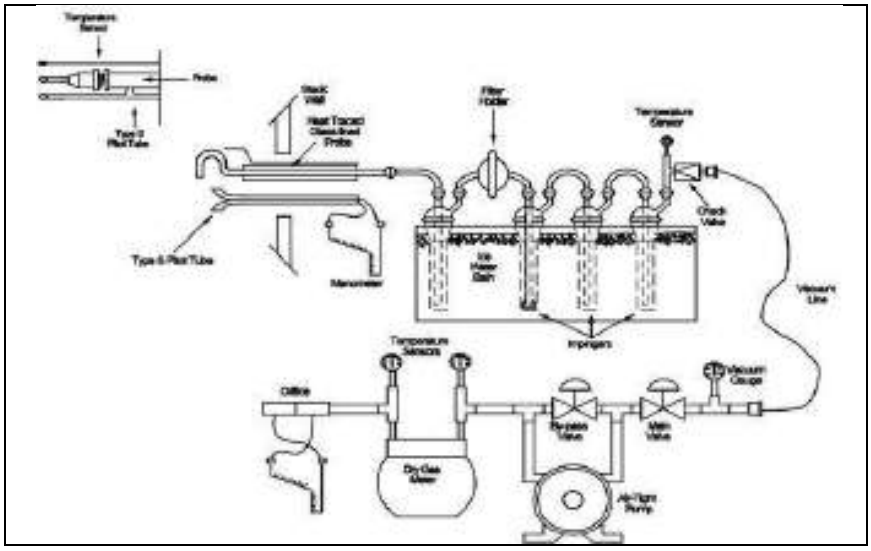
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

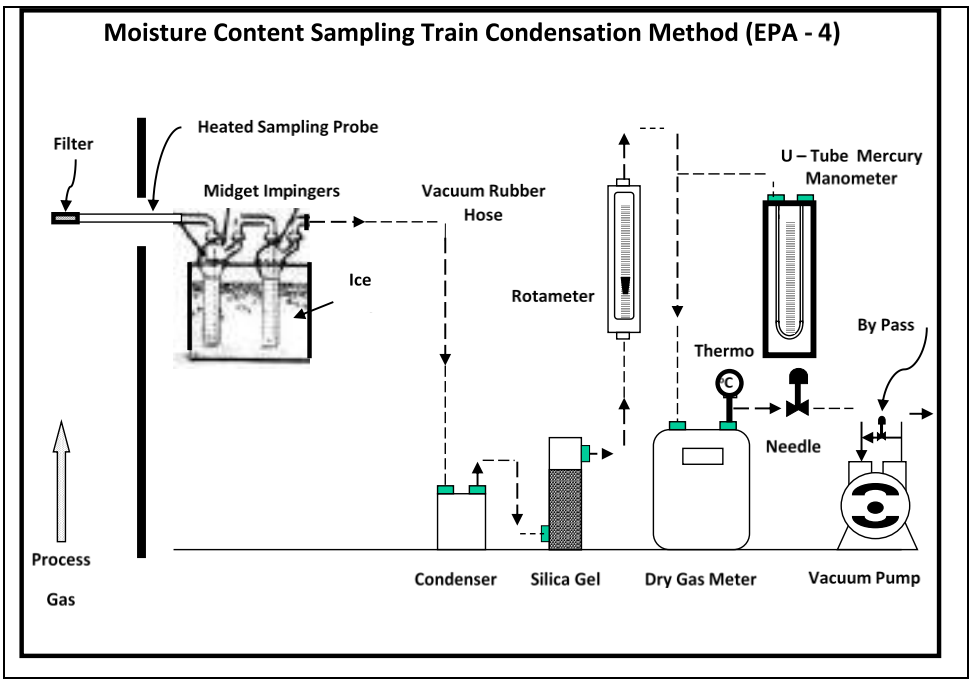
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS: MANALI, TAMILNADU

STACK- 1: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, BOILER 4 TON - 5 TON (HOUR), STACK

LOCATION - BOILER – 4 TON & 5 TON PER HOUR CONNECTED TO COMMON STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	441	NA
2	Velocity	m/sec	15.3	NA
3	Volume of Gas Discharge	Nm^3/hr	41955	NA
4	Oxygen as O_2	%	6.2	NA
5	Carbon Monoxide as CO	mg/Nm^3	BDL(DL:1.14)	150
6	Carbon Dioxide as CO_2	%	8.62	NA
7	Particulate Matter	mg/Nm^3	7.2	10
8	Sulphur Dioxide as SO_2	mg/Nm^3	4.8	50
9	Oxides of Nitrogen as NO_2	mg/Nm^3	212	350

In Stack Emission monitoring at **4** ton boiler the stack complies as per CPCB limit

STACK- 2: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, HCL-UNIT SCRUBBER STACK,

LOCATION - HCL-UNIT SCRUBBER STACK,MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	HCL	mg/m^3	2.8
2	Stack Temperature	K	304
3	Velocity	m/sec	1.26
4	Volume of Gas Discharge	Nm^3/hr	80

STACK- 3: M/s. TAMILNADU PETROPRODUCTS LTD, HCD DIVISION, WAD SCRUBBER CHLORINE STACK

LOCATION - WAD SCRUBBER CHLORINE STACK,MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	HCL	mg/m^3	2.9
2	Stack Temperature	K	305
3	Velocity	m/sec	4.32
4	Volume of Gas Discharge	Nm^3/hr	1100

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential preprocessed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modeling system consists of two preprocessors and a core dispersion model. AERMET is the meteorological preprocessor for the AERMOD while AERMAP is the terrain preprocessor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

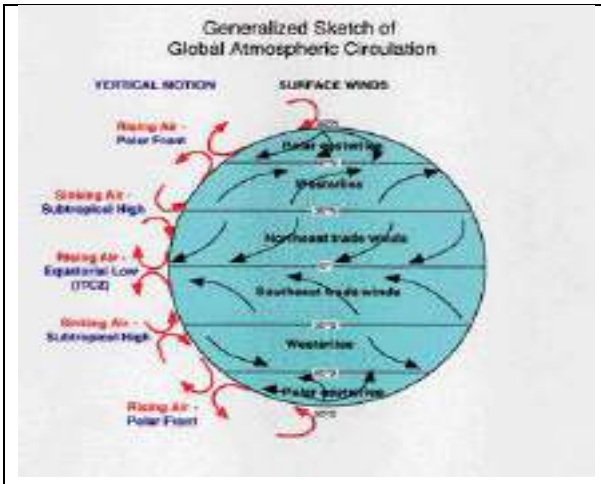
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from TPL Monitoring, Manali. For our simulations, the required source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

The AERMOD model was applied to study the diffusion of pollutants from TPL Monitoring, Manali and other sources in two days from 17.02.2021 to 18.02.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant

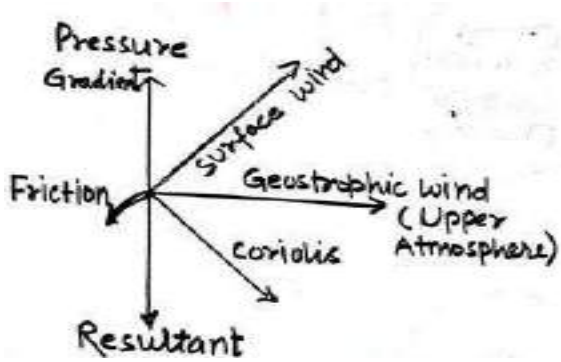
area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

TAMILNADU PETROPRODUCTS LTD - HCD_DIVISION

1 Boiler:

Particulate matter:

Stack Height, m	-	18
Exit Velocity, m/Sec	-	15.3
PM Concentration, mg/m3	-	7.2
Emission load, gm/Sec	-	0.0839
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	18
Exit Velocity, m/Sec	-	15.3
SO_2 Concentration, mg/m3	-	4.8
Emission load, gm/Sec	-	0.05594
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	18
Exit Velocity, m/Sec	-	15.3
NOx Concentration, mg/m3	-	212
Emission load, gm/Sec	-	2.4706
Plume rise, m	-	3

HCL Scrubber

Chlorine:

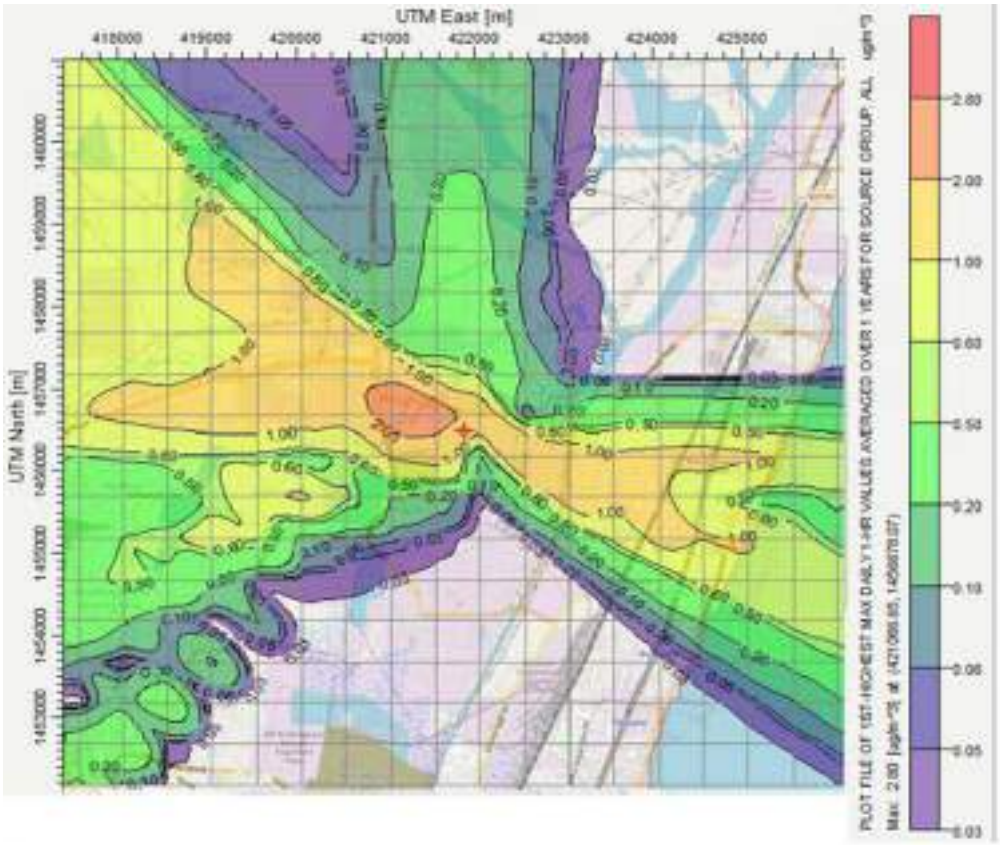
Stack Height, m	-	30
Exit Velocity, m/Sec	-	1.26
Cl2 Concentration, mg/m3	-	2.8
Emission load, gm/Sec	-	0.00006
Plume rise, m	-	2

WAD Scrubber

Chlorine:

Stack Height, m	-	16
Exit Velocity, m/Sec	-	3.32
Cl2 Concentration, mg/m3	-	2.9
Emission load, gm/Sec	-	0.00089
Plume rise, m	-	2

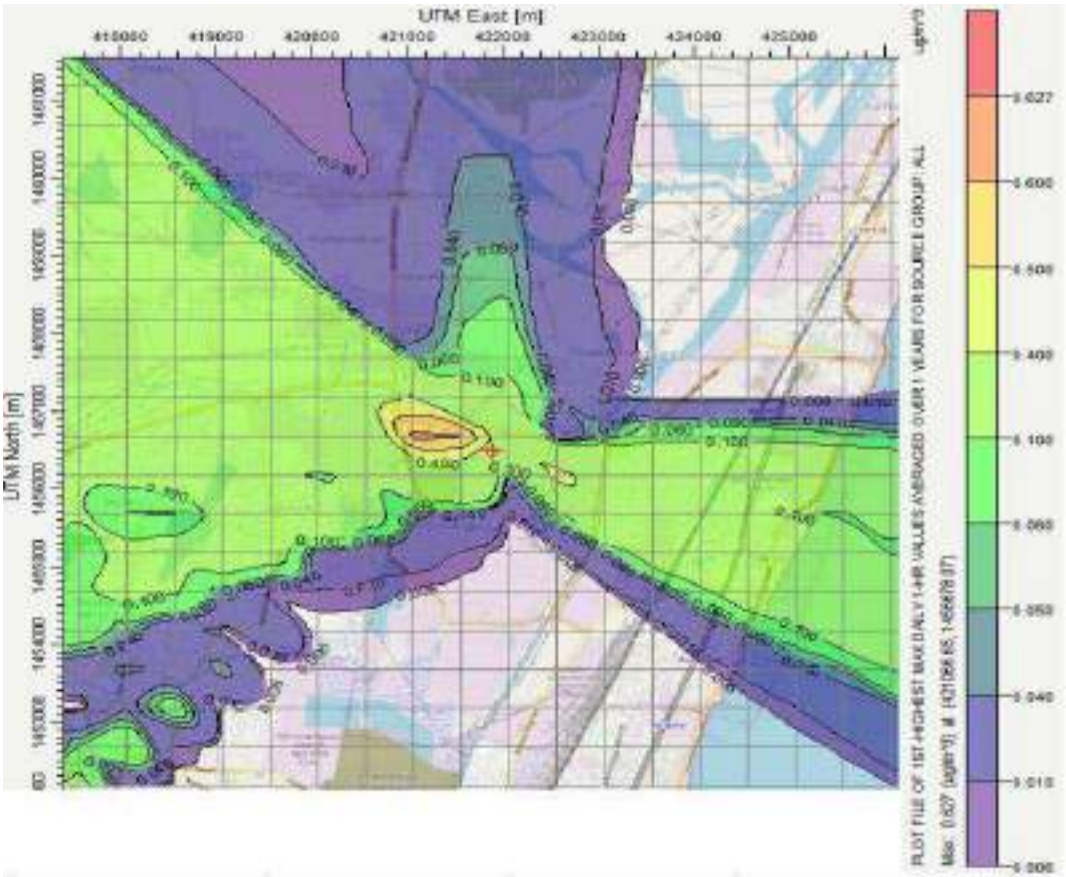
STACK EMISSION DISPERSION MODELLING –HCD Division Boiler @2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7.2	0.85	0.78	0.034	0.00081

HCD Division Boiler of Particulate matter concentration is 7.2 mg/m^3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.78µg/m^3 at 2km dispersion Particulate matter is 0.034µg/m^3 and at 5km dispersion Particulate matter is 0.00081µg/m^3 and the predominant wind direction is SSE.

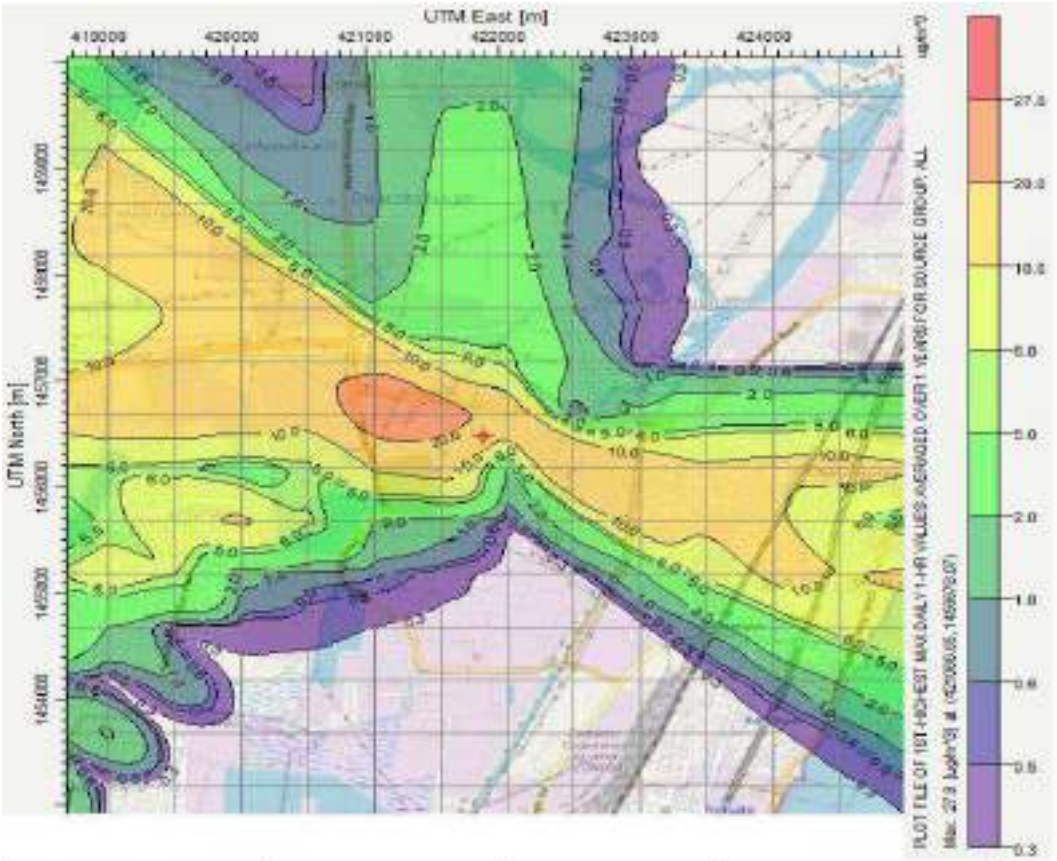
STACK EMISSION DISPERSION MODELLING –HCD Division Boiler @2 & 5 KM- Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
4.8	0.77	0.627	0.11	0.0267

HCD Division Boiler of Sulphur dioxide concentration is 4.8 mg/m^3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.627µg/m^3 at 2km dispersion Sulphur dioxide is 0.11µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0267µg/m^3 and the predominant wind direction is SSE.

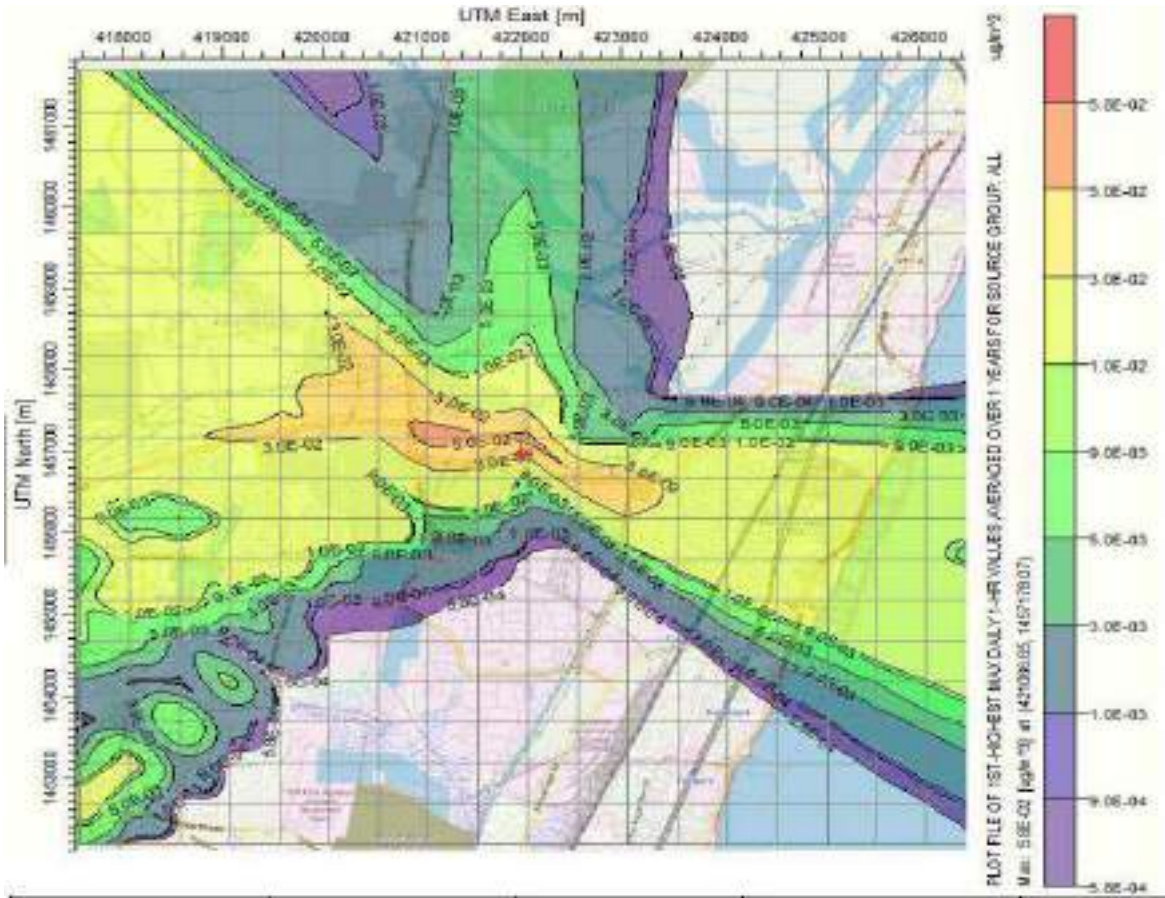
STACK EMISSION DISPERSION MODELLING –HCD Division Boiler @2 & 5 KM- Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
212	0.78	27.8	0.876	0.00777

HCD Division Boiler of Oxides of Nitrogen concentration is 212 mg/m^3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 27.8µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.876µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.00777µg/m^3 and the predominant wind direction is SSE.

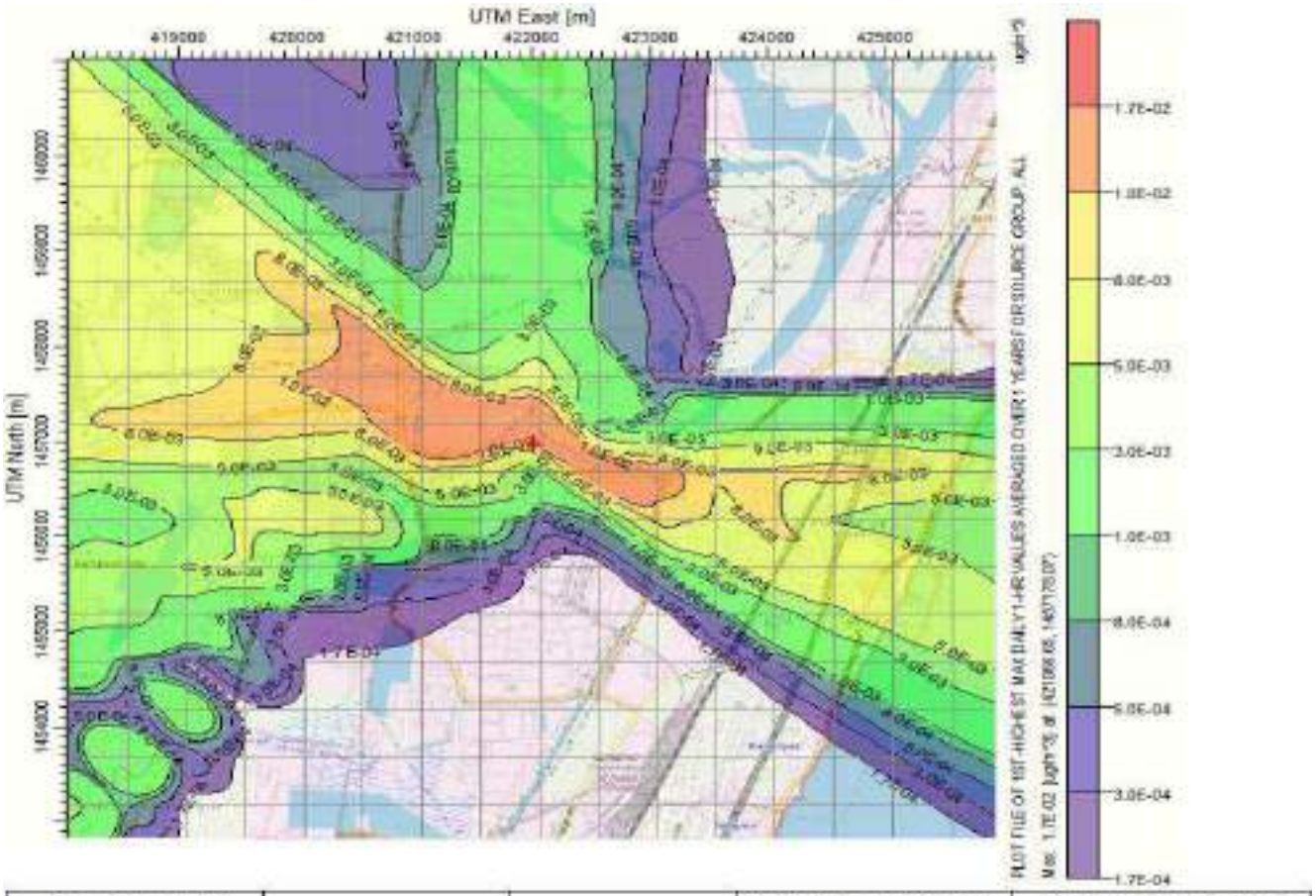
STACK EMISSION DISPERSION MODELLING –HCD Division HCL Scrubber @2 & 5 KM- Chlorine



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
2.8	0.89	0.58	0.0873	0.00221

HCD Division HCL Scrubber of Chlorine concentration is 2.8 mg/m^3 and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 1.26 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 0.58µg/m^3 at 2km dispersion Chlorine is 0.0873µg/m^3 and at 5km dispersion Chlorine is 0.00221µg/m^3 and the predominant wind direction is SSE.

STACK EMISSION DISPERSION MODELLING –HCD Division WAD Scrubber @2 & 5 KM- Chlorine

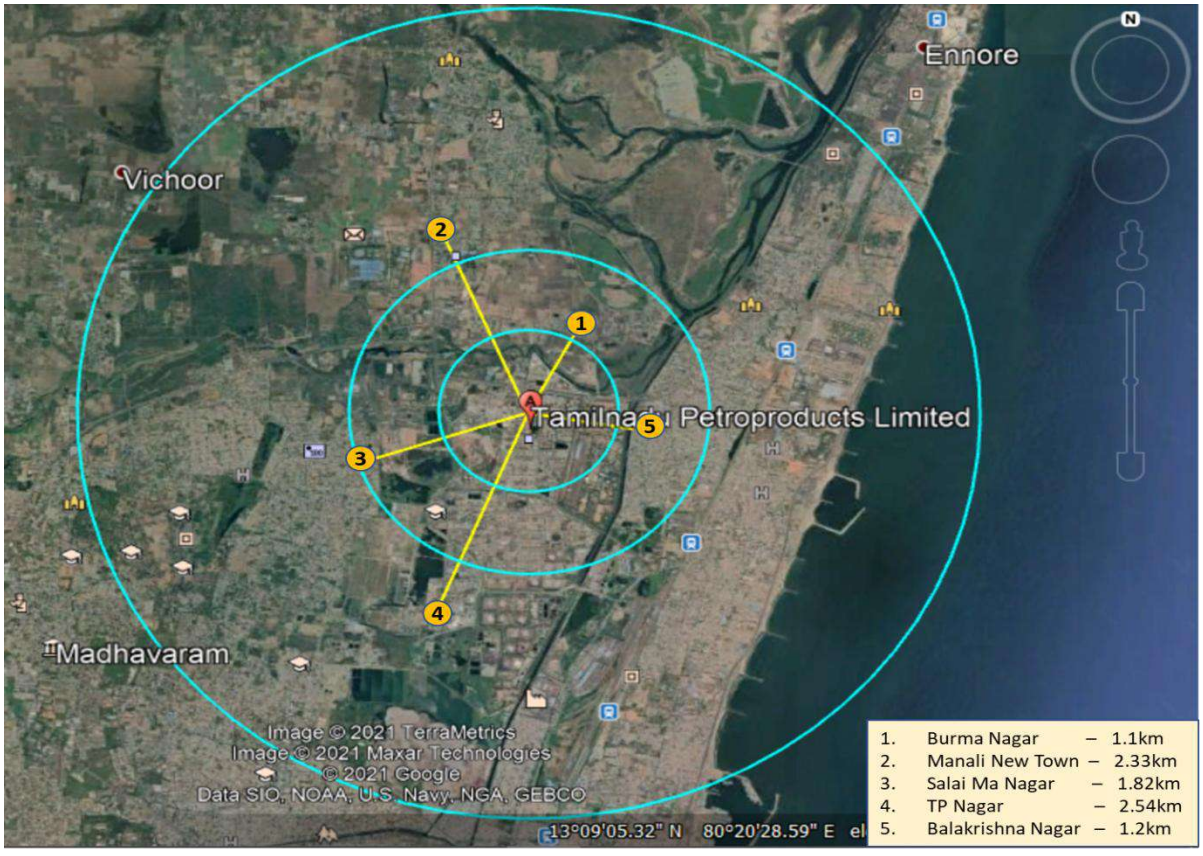


Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
2.9	0.92	0.17	0.0232	0.00985

HCD Division WAD Scrubber of Chlorine concentration is 2.9 mg/m^3 and dispersed at the effective stack height of 16 m (Stack height 16m + Plume Height 2m) with exit velocity of 3.32 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 0.17µg/m^3 at 2km dispersion Chlorine is 0.0232µg/m^3 and at 5km dispersion Chlorine is 0.00985µg/m^3 and the predominant wind direction is SSE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m^3)	Average concentration at 5 km (µg/m^3)
TPL - HCD DIVISION						
Boiler	PM	7.2	0.85	0.78	0.034	0.00081
Boiler	SO2	4.8	0.77	0.627	0.11	0.0267
Boiler	NOX	212	0.78	27.8	0.876	0.00777
HCL	Cl2	2.8	0.89	0.58	0.0873	0.00221
WAD	Cl2	2.9	0.92	0.17	0.0232	0.00985



10.0 FINDINGS ON MEASUREMENT RESULTS

10.1 Ambient Air Quality Monitoring Results

In Ambient Air Quality monitoring six sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Metro Water Storage Tank, Near CPP Radiator, Salt Yard South Side, Near Fabrication Yard, Ward Plant – West Side, Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.5 to 24.3µg/m^3. Highest value of 24.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 23.7 to 30.2µg/m^3. Highest value of 30.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.3 to 88.9µg/m^3. Highest value of 88.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.8 to 42.7µg/m^3. Highest value of 42.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 6.35 to 1247.3µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.35 to 10253.9µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

10.2 Stack Emission Monitoring Results

10.2.1 Boiler Stack:

HCD Division Boiler of Particulate matter concentration is 7.2 mg/m3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.78µg/m^{3} at 2km dispersion Particulate matter is 0.034µg/m^{3} and at 5km dispersion Particulate matter is 0.00081µg/m^{3} and the predominant wind direction is SSE.

HCD Division Boiler of Sulphur dioxide concentration is 4.8 mg/m^{3} and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.627µg/m^{3} at 2km dispersion Sulphur dioxide is 0.11µg/m^{3} and at 5km dispersion Sulphur dioxide is 0.0267µg/m^{3} and the predominant wind direction is SSE.

HCD Division Boiler of Oxides of Nitrogen concentration is 212 mg/m^{3} and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 27.8µg/m^{3} at 2km dispersion Oxides of Nitrogen is 0.876µg/m^{3} and at 5km dispersion Oxides of Nitrogen is 0.00777µg/m^{3} and the predominant wind direction is SSE.

10.2.2 HCL Scrubber Stack: HCD Division HCL Scrubber of Chlorine concentration is 2.8 mg/m^{3} and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 1.26 m/sec and the

flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 0.58µg/m^3 at 2km dispersion Chlorine is 0.0873µg/m^3 and at 5km dispersion Chlorine is 0.00221µg/m^3 and the predominant wind direction is SSE.

10.2.3 WAD Scrubber Stack

HCD Division WAD Scrubber of Chlorine concentration is 2.9 mg/m^3 and dispersed at the effective stack height of 16 m (Stack height 16m + Plume Height 2m) with exit velocity of 3.32 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 0.17µg/m^3 at 2km dispersion Chlorine is 0.0232µg/m^3 and at 5km dispersion Chlorine is 0.00985µg/m^3 and the predominant wind direction is SSE.

2.4 Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from TPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – HCD division through stacks is 17.2 mg/m3. The average ground level concentration achieves at an average distance of 0.85km and the sum of PM concentration at GLC is 2.8 µg/m^3 which includes all the stacks at TPL – HCD division. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from TPL – HCD division through stacks is 4.8 mg/m^3. The average ground level concentration achieves at an average distance of 0.85km and the sum of Sulphur Dioxide concentration at GLC is 6.27 µg/m^3 which includes all the stacks at TPL – HCD division. It clearly indicates the SO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from TPL – HCD division through stacks is 212 mg/m^3. The average ground level concentration achieves at an average distance of 0.78km and the sum of Nitrogen Oxides concentration at GLC is 27.8 µg/m^3 which includes all the stacks at TPL – HCD division. It clearly indicates the NOx contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative chlorine emissions from TPL – HCD division through stacks is 5.7 mg/m^3. The average ground level concentration achieves at an average distance of 0.905km and the sum of chlorine concentration at GLC is 0.375 µg/m^3 which includes all the stacks at TPL – HCD division. It clearly indicates the Cl2 contribution to the nearby residential areas are minimum and there is no limit for the National Ambient Air Quality Standards.

Predicted concentrations were not exceeding the National ambient air quality standard for PM, SO_2 and NO_2. Results from AERMOD simulation indicated that PM, SO_2 and NO_2 emissions from the TPL HCD division had no significant impact on nearby communities and Manali Industrial complex. For Chlorine there is no ambient air quality standard and the predicted concentrations also in trace level so that the impact on nearby communities and Manali Industrial complex is negligible.

The overall combined source mass emission load of PM, SO_2 and NO_2 with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industries source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are very much less.

***

Annexure-VIII

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Tamilnadu Petroproducts Ltd, Lab Division, Manali

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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ABOUT INDUSTRY

TPL is a joint venture between Tamil Nadu Industrial Development Corporation Limited(TIDCO), wholly owned by the Government of Tamilnadu and Southern Petrochemical Industries Corporation Ltd. (SPIC) with more than 80,000 shareholders. TPL is a listed company on Bombay Stock Exchange and National Stock Exchange. M/s. SPIC Limited, has diverse interest in fertilizers and other services. TIDCO is a public financial institution engaged in promoting industries in the State of Tamil Nadu.

Tamilnadu Petroproducts Limited (TPL) was established in 1984 at Manali, Thiruvallur district in Tamilnadu State to manufacture industrial intermediary Chemicals. TPL went into stream in the year 1989 with manufacturing facility for Linear Alkyl Benzene (LAB), finding application in manufacture of detergents and cleaning agents.

Heavy Chemicals Division was established by M/s. Kothari Chemicals ltd in 1978 and subsequently it was taken over by M.s SPIC during 1988. TPL acquired the Heavy Chemicals Division (HCD) from SPIC in the Year 2000 which manufactures Chloro Alkali comprising Caustic Soda & Chlorine which are most commonly used industrial chemicals in Textile, Paper and Pulp, Soaps & Detergents and Aluminium industries in India.

TPL established a facility to make Epichlorohydrin (ECH) in the year 1995 which is a key raw material in the manufacture of epoxy resins, pesticides and certain pharmaceutical formulations. However, the unit is not in operation since 1st April 2013 owing to unviable business opportunities for the product and huge losses incurred during the past 10 years.

Environmental Clearance obtained during 2015 to manufacture propylene Oxide and Chlorinated Organics in the exiting Epichlorohydrin (ECH) Plant. ECH – PO plant was installed during 2019 and commissioned for operation from Jan 2019.

Products

Linear Alkyl Benzene

Heavy Alkylate

Heavy Normal paraffin

Raw Material

Kerosene

Benzene

Process Description

Prefractionation section:

Kerosene obtained from the adjoining CPCL has a boiling range of 140 °C to 270°C. The kerosene is fractionated in two columns to obtain the heart-cut (C_{10} to C_{13}) between 170 – 250°C. The balance kerosene is returned to the refinery. The heart-cut also contains unwanted non-normal paraffin, which is removed in the subsequent sections.

Hydrobon section:

The product from the prefractionation section contains small quantities of Nitrogen and Sulphur compounds, which are injurious to the molecular sieves of the Molex section. Hence these contaminants are removed by reacting with hydrogen in the presence of metallic oxide catalyst at elevated temperature and pressure to form H_2S and NH_3, which are separated in the downstream of the section. The sulphur contained in the kerosene in thus reduced from 200 – 250 ppm by weight in the feed to this section to 1 ppm by weight in the product.

MOLEX section:

The Molex section essentially consists of molecular sieve beds packed in adsorption chambers. The molecular sieves selectively adsorb normal paraffins. The adsorbed paraffins are desorbed using liquid desorbent (N-Pentane and Iso-Octane). The extracted normal-paraffins and non-normal paraffins (Raffinate) are separated in the respective extract and Raffinate columns. Raffinate is returned to the refinery, while the extract is stored in storage tanks for further processing.

PACOL section

In this section, the extracted normal paraffin is converted to olefins by dehydrogenating the paraffin in the presence of platinum based catalyst at high temperature.

Detergent Alkylate section

Here the olefins along with the unconverted paraffins are reacted with Benzene in the presence of anhydrous Hydrofluoric acid (catalyst) to form Linear Alkyl Benzene (LAB), which is separated in subsequent columns.

Heavy Alkylate is a by-product generated in the process on account of reaction of di-olefins generated in the PACOL section with Benzene. The un-reacted normal-paraffins are recycled to the PACOL section.

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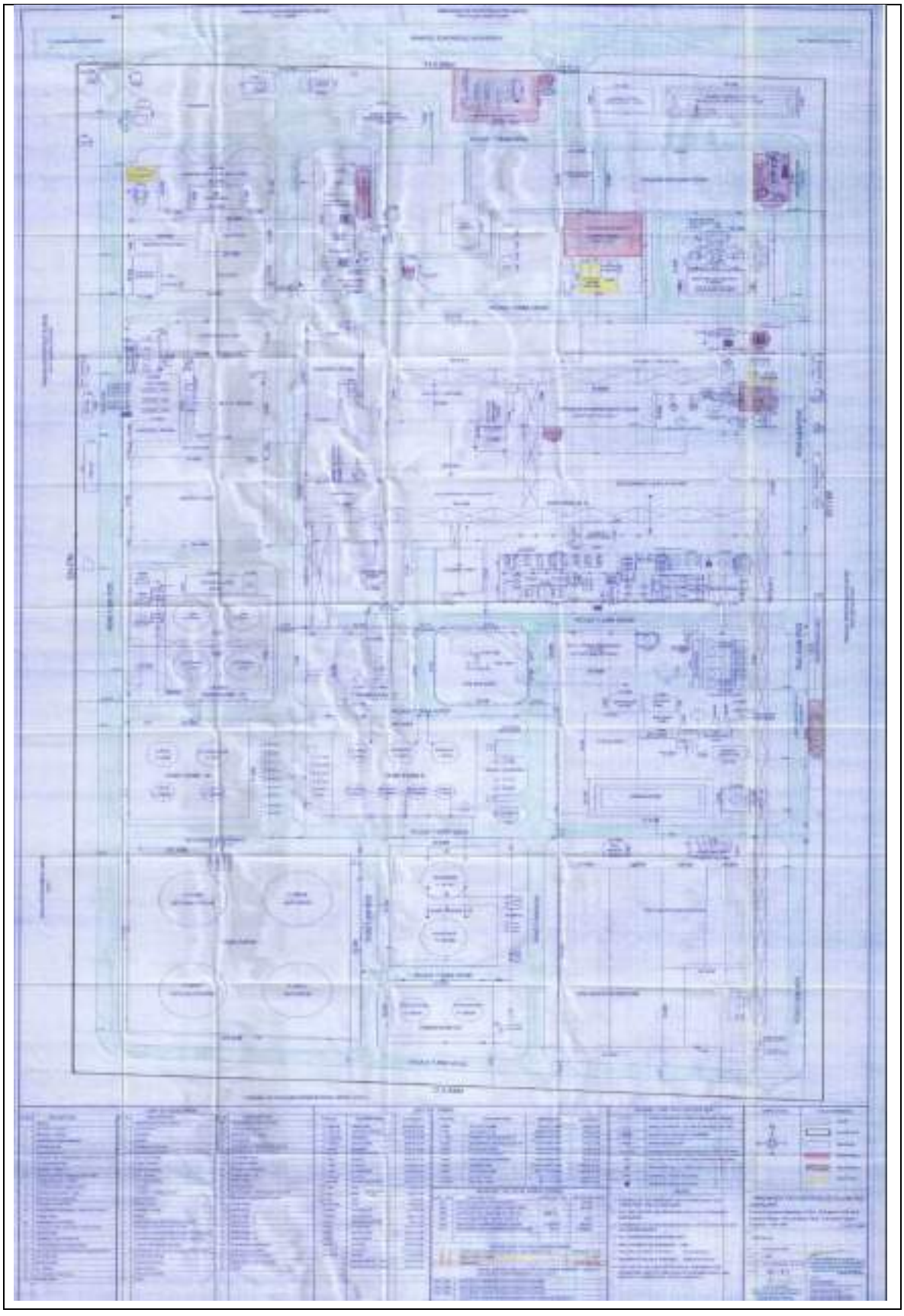
Imagery Date: 5/3/2021

PLANT LAYOUT



2.0 METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, $\mu g/m^3$	Annual * 24 Hours **	60 100	60 100
*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

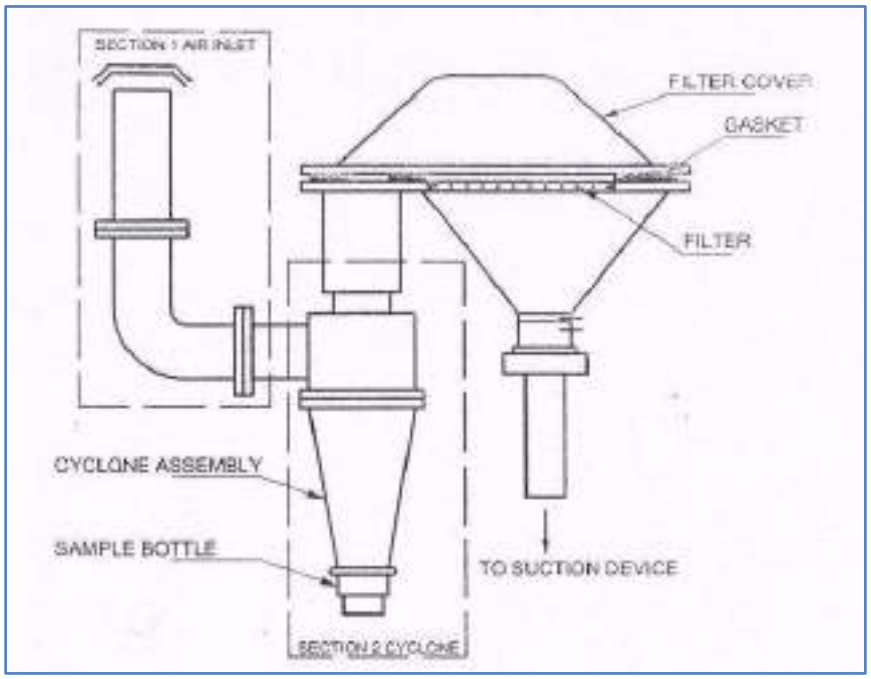
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30□ C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10} = Concentration of Particulate Matter, µg/m^3

Wf = Final weight of filter in g

Wi = Initial weight of filter in g

10^6 = Conversion of g to µg

V = Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flowrate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of PM2.5 in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, μg/m^3	Annual *	40	40
	24 Hours **	60	60
*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in μg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post-weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6”x 9”.
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).
- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine PM2.5 mass concentration:

PM2.5 = M2.5 / V

Where,

PM2.5 = mass concentration of PM2.5 particulates (µg/m^3)

PM2.5 = total mass of fine particulate collected during sampling period (µg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80

*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than

0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) **-** Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.

Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

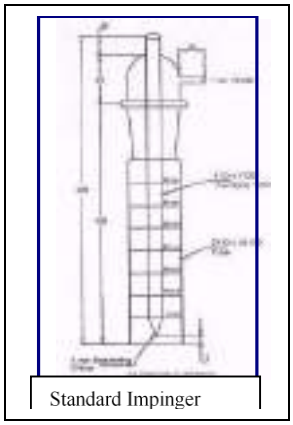
Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days

by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

$C\ SO_2$ = Concentration of Nitrogen dioxide, $\mu g/m^3$
A_s = Absorbance of sample
A_b = Absorbance of reagent blank
CF = Calibration factor
V_a = Volume of air sampled, m^3
V_s = Volume of sample, ml
V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)-ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water, Sodium hydroxide and Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and

protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of

unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled, m^3
V_s	=	Volume of sample, ml
V_t	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O_3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.			
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow

rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I_2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^{O}C.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 1 lpm for 60 minutes
⇩
Do not expose the absorbing reagent to direct sunlight
⇩
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
⇩
Prepare calibration graph as recommended in method
⇩
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Ozone in $\mu g/m^3$
⇩

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer

using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ ) = (As - Ab) \times CF / Va$$

Where,

$C\ NH_3$	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve

Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is $C_{20}H_{12}$ having molecular weight 252 and structural formula is given in following figure:

Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM- 2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard.

The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air

sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper ⇩
Ultrasonic extraction with Toluene (50 ml × 3 times) ⇩
Filter & dry with Anhydrous Sodium Sulphate ⇩
Concentration with Rotary Evaporator ⇩
Clean up with Silica Gel Column Chromatography ⇩
Elution with Cyclo-Hexane (5 ml × 3 times) ⇩
Evaporate to nearly dryness under Nitrogen ⇩

Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

- PM10 sampler (high volume design based)
- Hot plate
- Microwave Digestive System
- Analytical balance
- Digestion chamber
- Polyethylene or polypropylene bottle
- Glassware
- Top loading orifice kit
- ICPMS

Reagents / Chemicals

- Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)
- Hydrochloric Acid (HCl) Concentrated (AR grade)
- Nitric Acid (HNO3) Concentrated (AR grade)
- Sulphuric Acid (H2SO4) Concentrated (AR grade)
- Metal Standard Solutions (Certified standard)
- Sodium borohydride (GR/AR grade).
- Potassium iodide (GR/AR grade)
- Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge.

Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water.

Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A

standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration})}{\text{Spiked concentration}} \times 100$$

Sequence of Analysis:

- Standard blank
- Calibration standards
- QC check
- Samples
- Spike sample
- QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V = Volume of air, m^3

Q = Average sampling rate, m^3/min.

T = Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

- Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler
- Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.
- IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique
- EPA compendium method IO 3
- EPA compendium method IO 3.1
- EPA compendium method IO 3.2
- Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	Methods of Measurement
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m³	20 µg/ m³	-Improved West and Geek method -Ultraviolet Fluorescence
		24 hours	80 µg/ m³	80 µg/ m³	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m³	30 µg/ m³	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m³	80 µg/ m³	
3	Suspended Particulate Matter	Annual Average	60 µg/ m³	60 µg/ m³	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m³	100 µg/ m³	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m³	40 µg/ m³	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m³	60 µg/ m³	
5	Ozone (O_3)	8 hours	100 µg/ m³	100 µg/ m³	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m³	180 µg/ m³	
6	Lead	Annual Average	0.5 µg/ m³	0.5 µg/ m³	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m³	1.0 µg/ m³	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m³	2 mg/ m³	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m³	4 mg/ m³	
8	Ammonia	Annual Average	100 µg/ m³	100 µg/ m³	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m³	400 µg/ m³	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m³	5 µg/ m³	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m³	1 ng/ m³	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m³	6 ng/ m³	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m³	20 ng/ m³	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

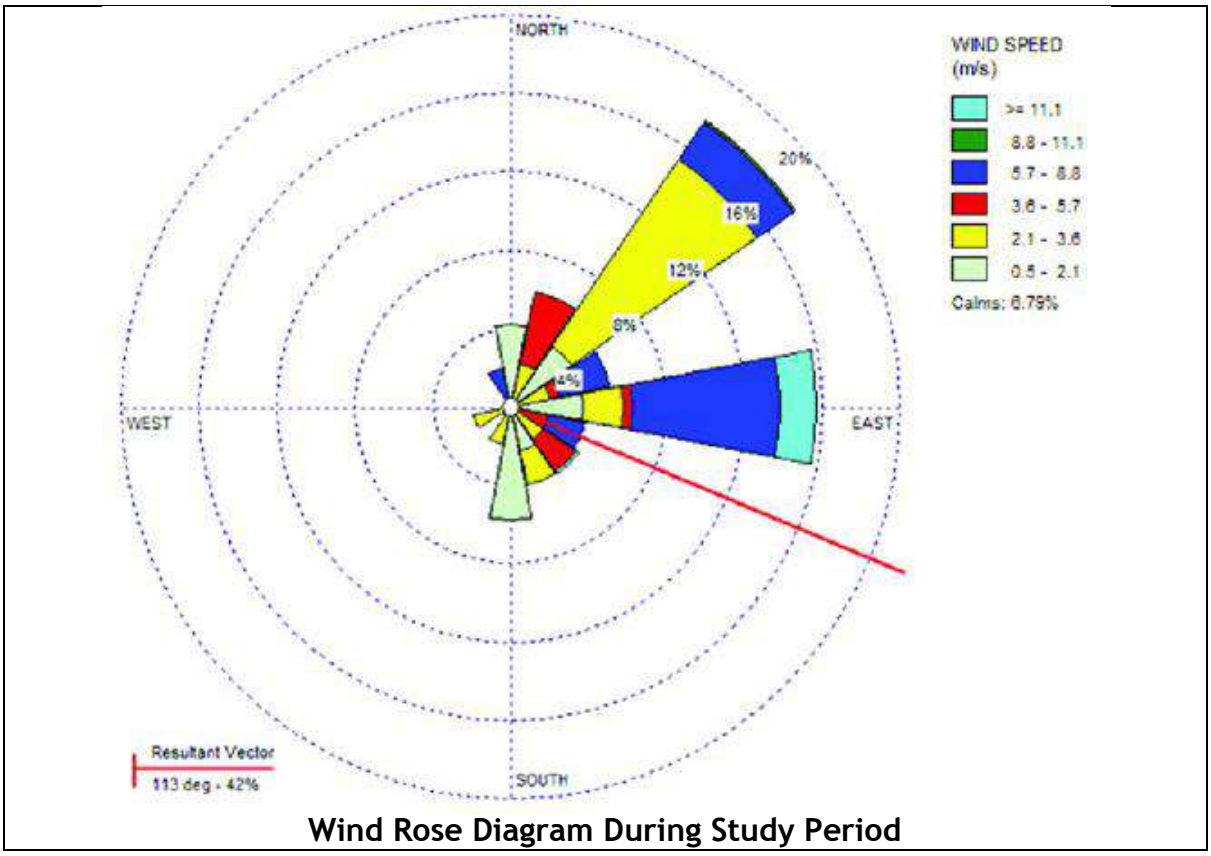
**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT TPL - 16.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
16.02.2021	1:00 AM	20.0	94	0	CALM
16.02.2021	2:00 AM	20.0	9	0	CALM
16.02.2021	3:00 AM	22.8	4	3	NNW
16.02.2021	4:00 AM	25.0	74	5	NW
16.02.2021	5:00 AM	27.8	62	2	VAR
16.02.2021	6:00 AM	30.0	51	2	VAR
16.02.2021	7:00 AM	31.1	43	8	ESE
16.02.2021	7:00 AM	31.1	43	9	SE
16.02.2021	8:00 AM	31.1	46	10	SE
16.02.2021	9:00 AM	30.0	51	10	E
16.02.2021	10:00 AM	28.9	58	9	SE
16.02.2021	11:00 AM	27.8	58	12	E
16.02.2021	12:00 PM	26.1	65	10	ESE
16.02.2021	1:00 PM	25.0	69	8	E
16.02.2021	2:00 PM	25.0	69	7	E
16.02.2021	3:00 PM	25.0	69	6	ESE
16.02.2021	4:00 PM	25.0	69	6	E
16.02.2021	5:00 PM	23.9	73	3	E
16.02.2021	6:00 PM	22.8	78	0	CALM
16.02.2021	7:00 PM	22.2	83	0	CALM
16.02.2021	8:00 PM	22.2	83	0	CALM
16.02.2021	9:00 PM	21.1	88	0	CALM
16.02.2021	10:00 PM	22.2	88	0	CALM
16.02.2021	11:00 PM	21.1	88	0	CALM
16.02.2021	12:00 AM	72.0	83	0	CALM
MIN		20.0	4.0	0.0	ENE
MAX		72.0	94.0	12.0	
AVG		27.2	63.9	4.4	

WEATHER MONITORING DATA AT TPL - 17.02.2021					
Date	**Time**	**Temp (˚C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
17.02.2021	1:00 AM	22.2	94	2	N
17.02.2021	2:00 AM	22.2	88	0	CALM
17.02.2021	3:00 AM	22.8	88	0	CALM
17.02.2021	4:00 AM	25.0	74	2	VAR
17.02.2021	5:00 AM	27.2	61	3	NE
17.02.2021	6:00 AM	28.9	51	6	SE
17.02.2021	6:00 AM	28.9	55	10	E
17.02.2021	7:00 AM	28.9	55	8	ESE
17.02.2021	8:00 AM	28.9	55	9	E
17.02.2021	9:00 AM	28.9	51	9	E
17.02.2021	10:00 AM	27.8	54	9	E
17.02.2021	11:00 AM	27.8	58	9	ESE
17.02.2021	12:00 PM	26.1	61	9	ESE
17.02.2021	1:00 PM	26.1	65	8	E
17.02.2021	2:00 PM	26.1	65	7	E
17.02.2021	3:00 PM	25.0	69	6	E
17.02.2021	4:00 PM	25.0	69	3	E
17.02.2021	5:00 PM	23.9	73	3	E
17.02.2021	6:00 PM	23.9	73	5	E
17.02.2021	7:00 PM	22.8	78	0	CALM
17.02.2021	8:00 PM	22.8	78	0	CALM
17.02.2021	9:00 PM	22.2	88	0	CALM
17.02.2021	10:00 PM	22.2	88	2	VAR
17.02.2021	11:00 PM	22.2	88	0	CALM
17.02.2021	12:00 AM	22.2	88	2	VAR
MIN		22.2	51.0	0.0	ENE
MAX		28.9	94.0	10.0	
AVG		25.2	70.7	4.5	



Wind Rose Diagram During Study Period

4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Stack Emission Monitoring Locations

Ambient Air Quality Monitoring Sampling Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, NEAR GATE 2

LOCATION - NEAR GATE 2,MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:30 Hrs] - 17.02.2021 [14:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	16.8
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	22.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	88.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	43.1
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, NEAR GUARD POND

LOCATION - NEAR GUARD POND,MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:35 Hrs] - 17.02.2021 [14:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	14.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	21.8
3	Particulate Matter (PM_{10})	$\mu g/m^3$	55.17
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)

10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, NEAR PACOL HEATER

LOCATION - NEAR PACOL HEATER,MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:40 Hrs] - 17.02.2021 [14:40 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	19.4
2	Nitrogen Dioxide as NO_2	µg/m^3	30.1
3	Particulate Matter (PM_{10})	µg/m^3	62.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	30.03
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, TANK NO 1920 A SOUTH SIDE

LOCATION - TANK NO 1920 A SOUTH SIDE,MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:45 Hrs] - 17.02.2021 [14:45 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	23
2	Nitrogen Dioxide as NO_2	µg/m^3	28.8
3	Particulate Matter (PM_{10})	µg/m^3	45.5
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	29.6
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)

6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, 1901 A WEST SIDE

LOCATION - 1901 A WEST SIDE, MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:50 Hrs] - 17.02.2021 [14:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	25.5
2	Nitrogen Dioxide as NO_2	µg/m^3	33.1
3	Particulate Matter (PM_{10})	µg/m^3	50.68
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	24.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, 1906 A WEST SIDE

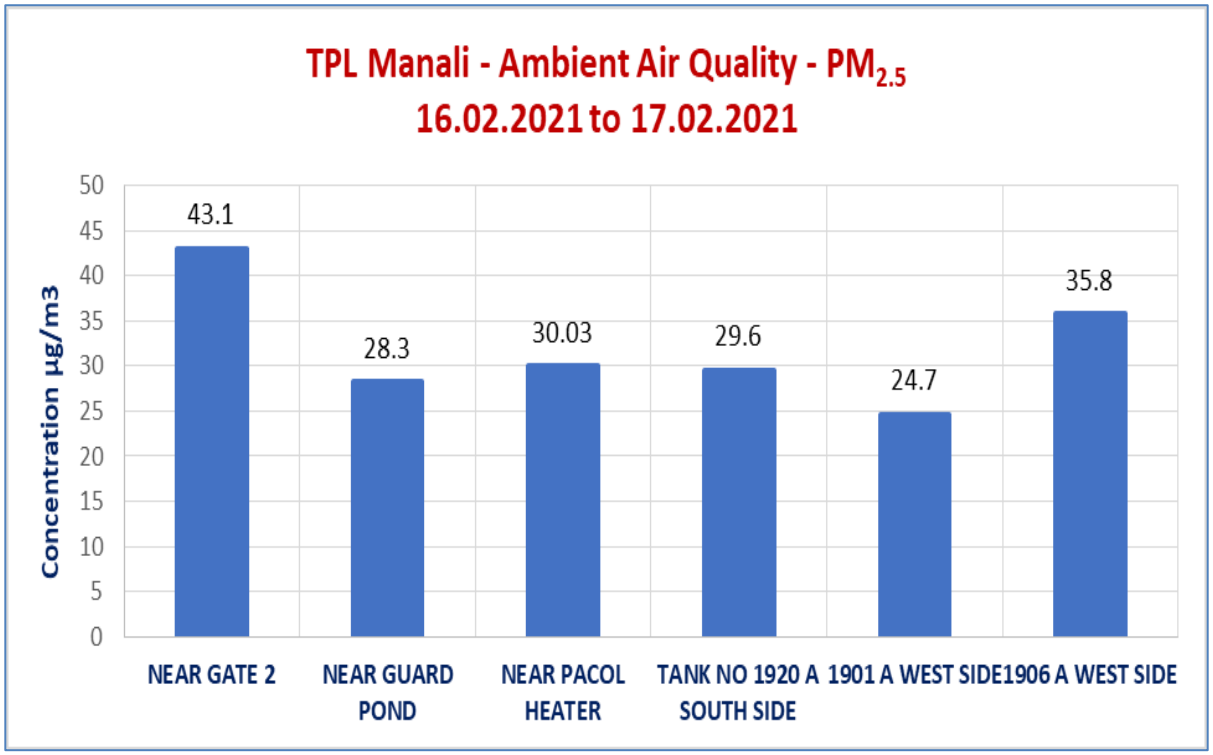
LOCATION - 1906 A WEST SIDE, MANALI			
SAMPLING DATE & TIME 16.02.2021 [14:55 Hrs] - 17.02.2021 [14:55 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	17
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.8
3	Particulate Matter (PM_{10})	$\mu g/m^3$	73.8
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	55.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

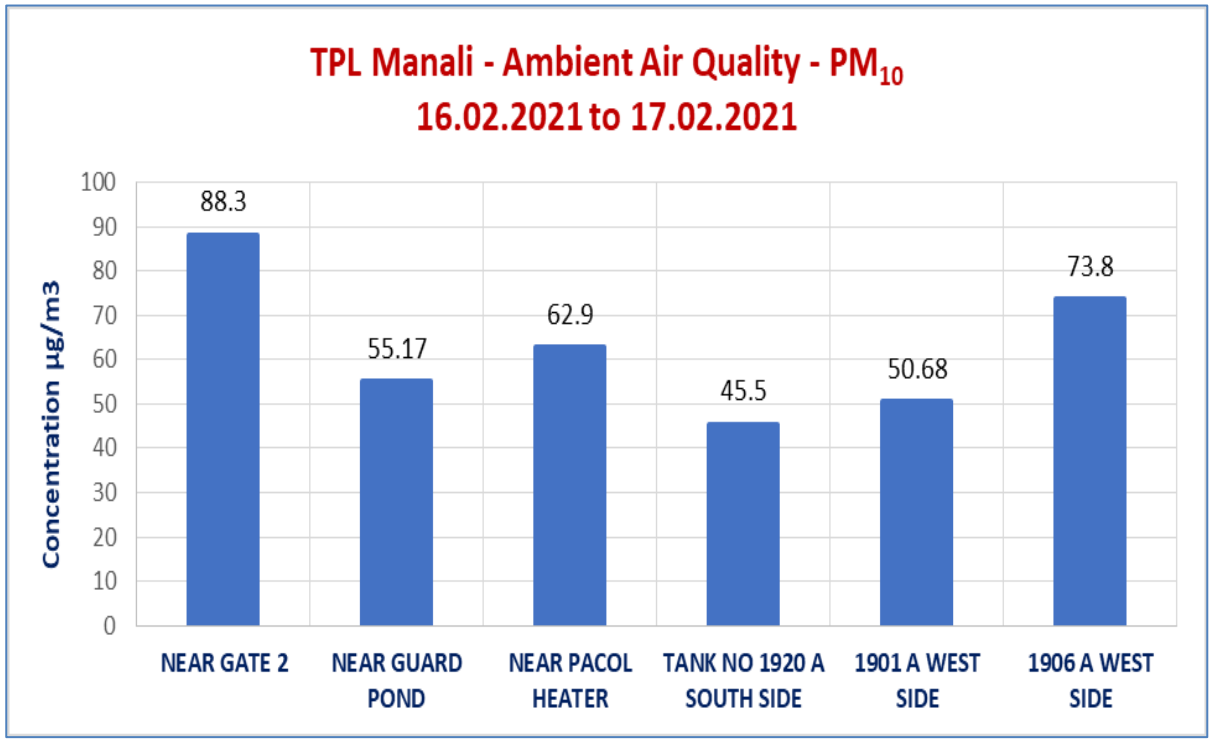
AAQ- 7: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, VISITOR GATE

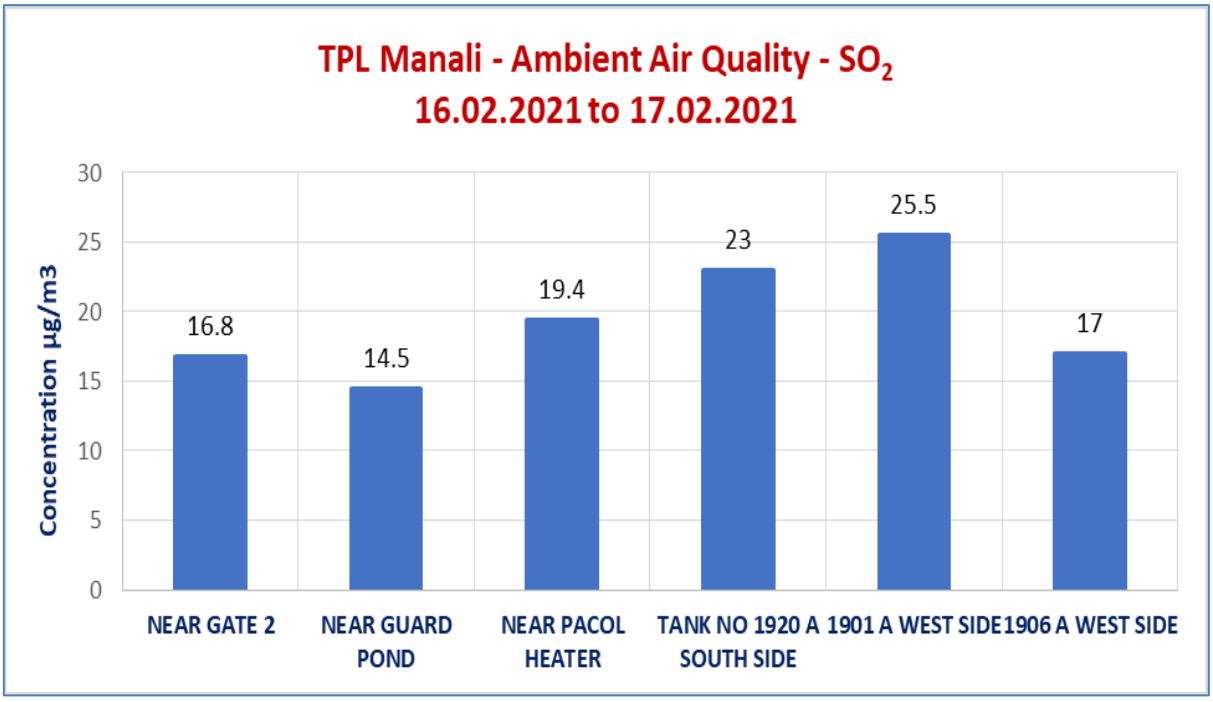
LOCATION - PLANT OUTSIDE – VISITOR GATE, MANALI				
SAMPLING DATE & TIME 17.02.2021 [07:00 Hrs] – 17.02.2021 [15:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	07:00 – 08:00	$\mu g/m^3$	432.8	730.6
2	08:00 – 09:00	$\mu g/m^3$	94.5	223.7
3	09:00 – 10:00	$\mu g/m^3$	29.8	81.6
4	10:00 – 11:00	$\mu g/m^3$	18.6	56.2
5	11:00 –12:00	$\mu g/m^3$	17.3	57.6
6	12:00 – 13:00	$\mu g/m^3$	19.8	71.7
7	13:00 –14:00	$\mu g/m^3$	18.9	83.5
8	14:00 – 15:00	$\mu g/m^3$	18.7	46.7
8 HOURS AVERAGE			81.3	168.9

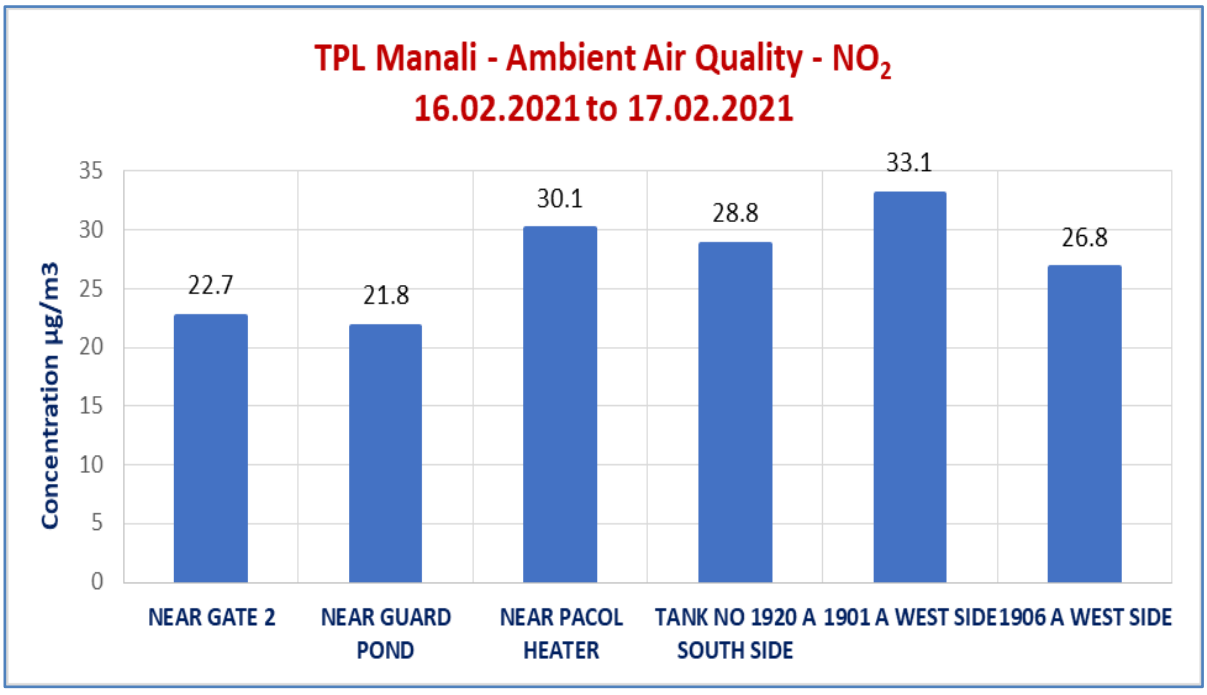
Consolidated AAQ Monitoring Results

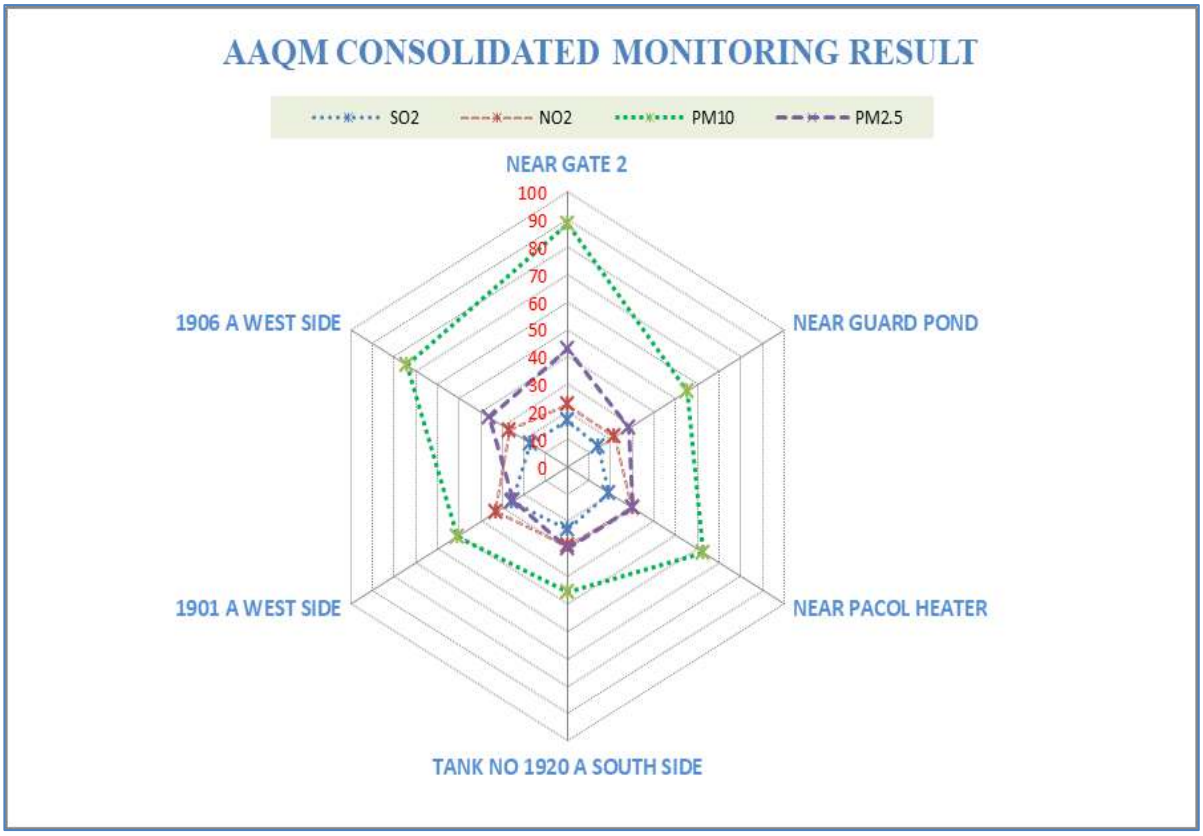
AAQM Consolidated Monitoring Results (µg/m3)				
Sampling Date [16.02.2021 to 17.02.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
NEAR GATE 2	16.8	22.7	88.3	43.1
NEAR GUARD POND	14.5	21.8	55.17	28.3
NEAR PACOL HEATER	19.4	30.1	62.9	30.03
TANK NO 1920 A SOUTH SIDE	23	28.8	45.5	29.6
1901 A WEST SIDE	25.5	33.1	50.68	24.7
1906 A WEST SIDE	17	26.8	73.8	35.8

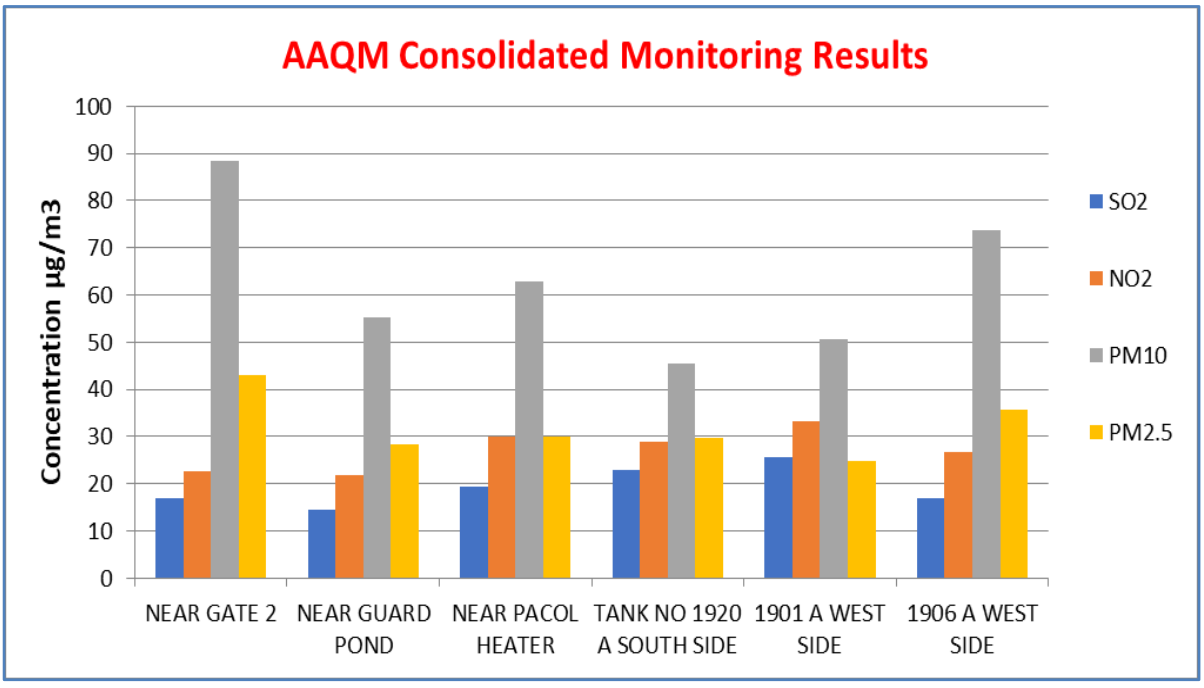

TPL Manali - Ambient Air Quality - PM2.5
16.02.2021 to 17.02.2021
Concentration µg/m3
50
45
40
35
30
25
20
15
10
5
0
43.1
28.3
30.03
29.6
24.7
35.8
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE

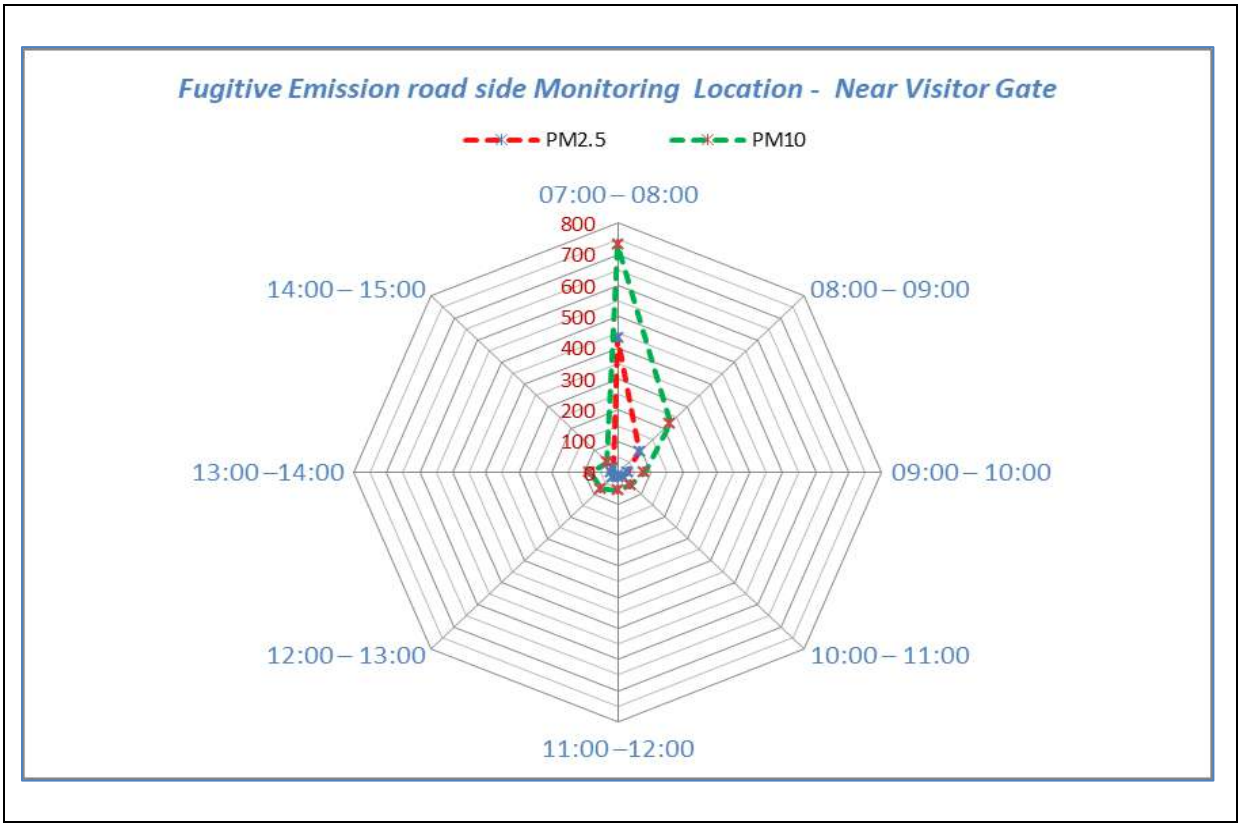

TPL Manali - Ambient Air Quality - PM10
16.02.2021 to 17.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
88.3
55.17
62.9
45.5
50.68
73.8
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE


TPL Manali - Ambient Air Quality - SO_2
16.02.2021 to 17.02.2021
Concentration µg/m3
30
25
20
15
10
5
0
16.8
14.5
19.4
23
25.5
17
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE


TPL Manali - Ambient Air Quality - NO_2
16.02.2021 to 17.02.2021
Concentration µg/m3
35
30
25
20
15
10
5
0
22.7
21.8
30.1
28.8
33.1
26.8
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE
100
90
80
70
60
50
40
30
20
10
0


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NEAR GATE 2
NEAR GUARD POND
NEAR PACOL HEATER
TANK NO 1920 A SOUTH SIDE
1901 A WEST SIDE
1906 A WEST SIDE
SO2
NO2
PM10
PM2.5


Fugitive Emission road side Monitoring Location - Near Visitor Gate
PM2.5
PM10
07:00 – 08:00
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 –12:00
12:00 – 13:00
13:00 –14:00
14:00 – 15:00
800
700
600
500
400
300
200
100
0

CONCLUSION:

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Gate 2, Near Guard Pond, Near PACOL Heater, Tank No 1920 A South Side, 1901 A West Side, 1906 A West Side, Visitor Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 14.5 to 25.5µg/m^3. Highest value of 25.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 21.8 to 33.1µg/m^3. Highest value of 33.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 45.5 to 88.3µg/m^3. Highest value of 88.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 24.7 to 43.1µg/m^3. Highest value of 43.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):* The measured $PM_{2.5}$ values are ranging from 5.93 to 801.82µg/m^3 which is very high when compared to NAAQM standards of 60 µg/m^3.

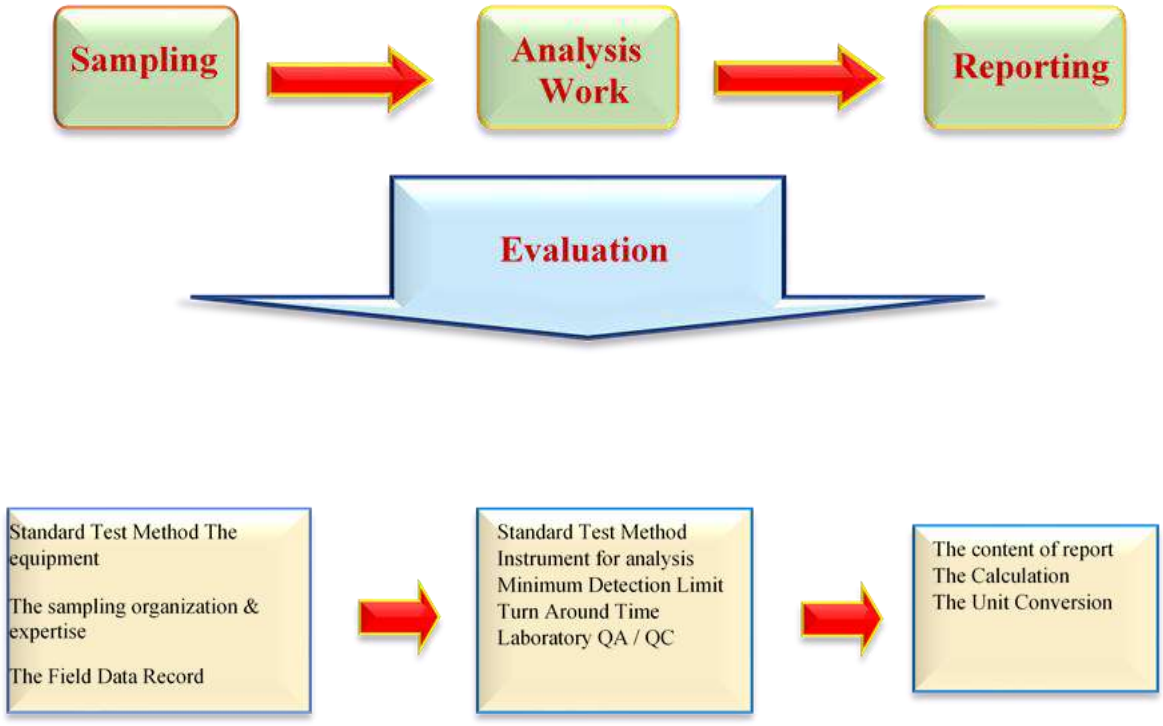
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.47 to 2469.4µg/m^3. which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

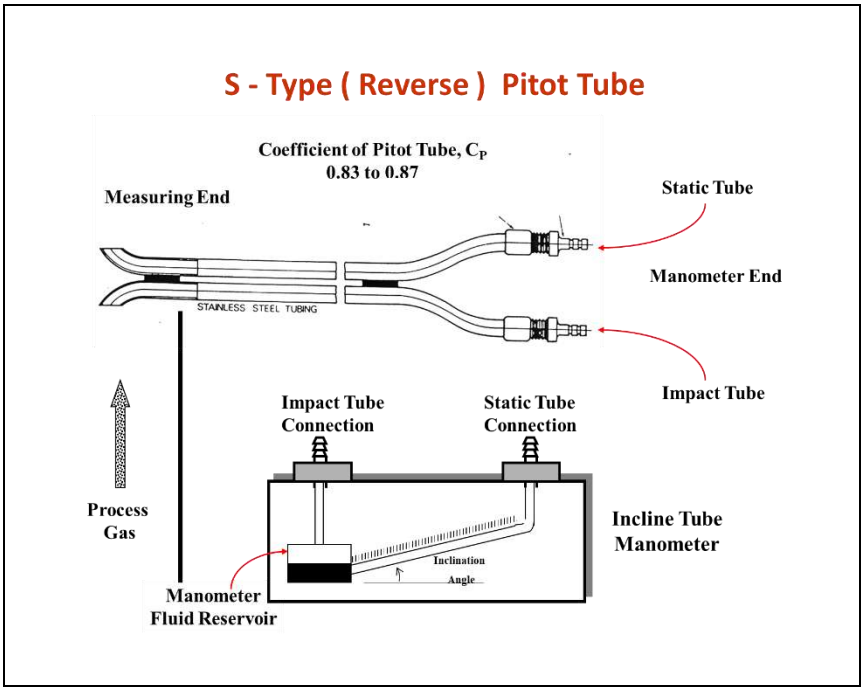


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points:

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

2. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}/Hr$

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

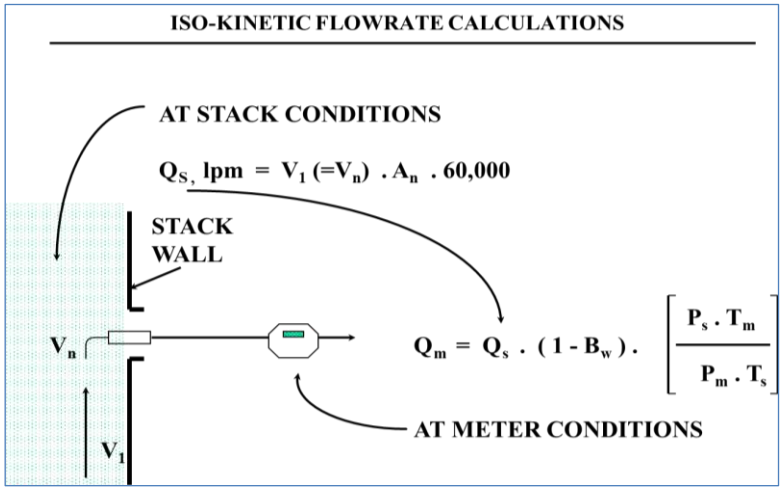
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

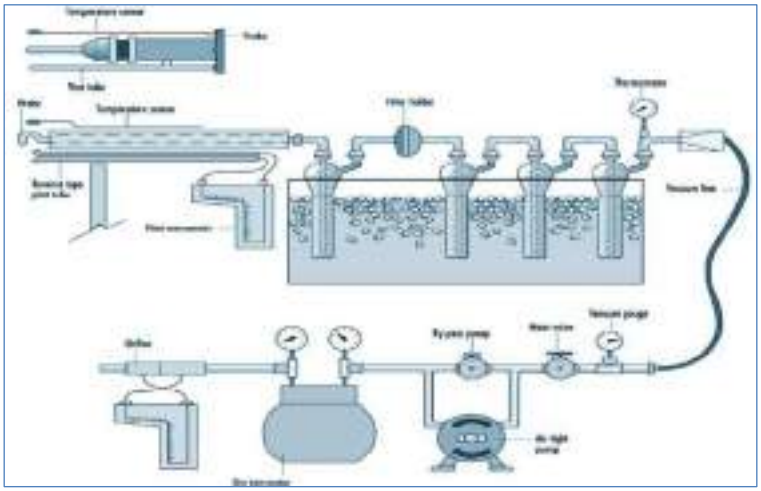
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The SO_2 is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. SO_2 is absorbed in the impingers and converted to form H_2SO_4.

PRINCIPLE AND APPLICABILITY:
The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water
2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_2O_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.
3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.
4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100

ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading; meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers. Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298^oK

Tm The absolute dry gas meter temperature, ^oK

Pn The absolute pressure at normal conditions, 760 mmHg

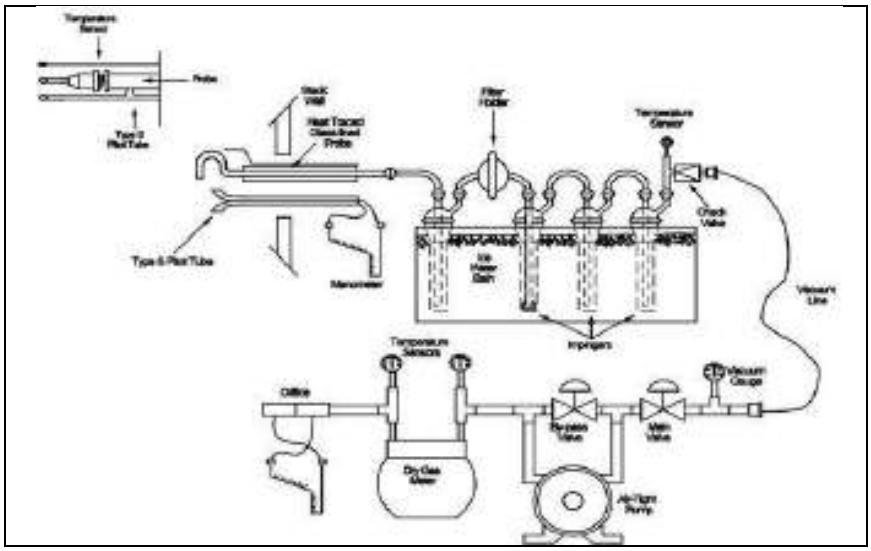
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$

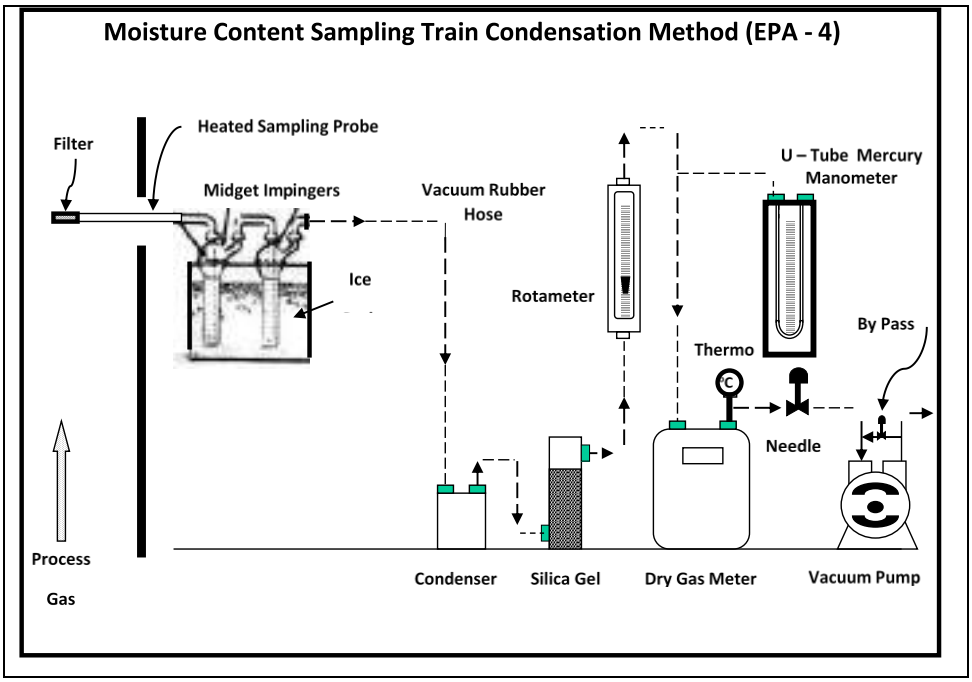


MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated.

The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS: MANALI, TAMILNADU

STACK- 1: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, HOT OIL HEATER-F-1601 R STACK

LOCATION - HOT OIL HEATER-F-1601 R STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	445	NA
2	Velocity	m/sec	9.3	NA
3	Volume of Gas Discharge	Nm^3/hr	204487	NA
4	Oxygen as O_2	%	6.9	NA
5	Carbon Monoxide as CO	mg/Nm^3	36	NA
6	Carbon Dioxide as CO_2	%	7.47	NA
7	Particulate Matter	mg/Nm^3	7.5	10
8	Sulphur Dioxide as SO_2	mg/Nm^3	4.9	50
9	Oxides of Nitrogen as NO_2	mg/Nm^3	3.0	350

In Stack Emission monitoring at Hot Oil Heater-F-1601 R Stack complies as per CPCB limit.

STACK- 2: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, PACOL CHARGER HEATER 1401 R STACK

LOCATION - PACOL CHARGER HEATER 1401 R STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	508	NA
2	Velocity	m/sec	11	NA
3	Volume of Gas Discharge	Nm^3/hr	22016	NA
4	Oxygen as O_2	%	3.9	NA
5	Carbon Monoxide as CO	mg/m^3	BDL(DL:1.14)	150
6	Carbon Dioxide as CO_2	%	9.66	NA
7	Particulate Matter	mg/Nm^3	7.8	10
8	Sulphur Dioxide as SO_2	mg/m^3	BDL(DL:3.0)	50
9	Oxides of Nitrogen as NO_2	mg/m^3	BDL(DL:2.0)	350

In Stack Emission monitoring at Pacol Charger Heater 1401 R the stack complies as CPCB Limit.

STACK- 3: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, HYDROBON WATER F1201 R STACK

LOCATION - HYDROBON WATER F1201 R STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	423	NA
2	Velocity	m/sec	5.01	NA
3	Volume of Gas Discharge	Nm^3/hr	4742	NA
4	Oxygen as O_2	%	12.9	NA
5	Carbon Monoxide as CO	mg/m^3	BDL(DL:1.14)	150
6	Carbon Dioxide as CO_2	%	4.61	NA
7	Particulate Matter	mg/Nm^3	7.9	10
8	Sulphur Dioxide as SO_2	mg/m^3	BDL(DL:3.0)	50
9	Oxides of Nitrogen as NO_2	mg/m^3	BDL(DL:2.0)	350

In Stack Emission monitoring at Pacol Charger Heater 1401 R the stack complies as CPCB Limit.

STACK- 4: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, BOILER 8 TON STACK

LOCATION - BOILER 8 TON STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	383	NA
2	Velocity	m/sec	9.93	NA
3	Volume of Gas Discharge	Nm^3/hr	42710	NA
4	Oxygen as O_2	%	12.3	NA
5	Carbon Monoxide as CO	mg/m^3	BDL(DL:1.14)	150
6	Carbon Dioxide as CO_2	%	4.96	NA
7	Particulate Matter	mg/Nm^3	8.3	10
8	Sulphur Dioxide as SO_2	mg/m^3	BDL(DL:3.0)	50
9	Oxides of Nitrogen as NO_2	mg/m^3	BDL(DL:2.0)	350

In Stack Emission monitoring at Pacol Charger Heater 1401 R the stack complies as CPCB Limit.

TACK- 5: M/s. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION, CPP-2 DG SET (3.2 MW) STACK

LOCATION - CPP-2 DG SET (3.2 MW) STACK, MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Stack Temperature	K	588
2	Velocity	m/sec	12.08
3	Volume of Gas Discharge	Nm^3/hr	24889
4	Oxygen as O_2	%	13.8
5	Carbon Monoxide as CO	mg/m^3	35
6	Carbon Dioxide as CO_2	%	4.01
7	Particulate Matter	mg/Nm^3	35.5
8	Sulphur Dioxide as SO_2	mg/m^3	68.5
9	Oxides of Nitrogen as NO_2	mg/m^3	458

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential preprocessed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modeling system consists of two preprocessors and a core dispersion model. AERMET is the meteorological preprocessor for the AERMOD while AERMAP is the terrain preprocessor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper

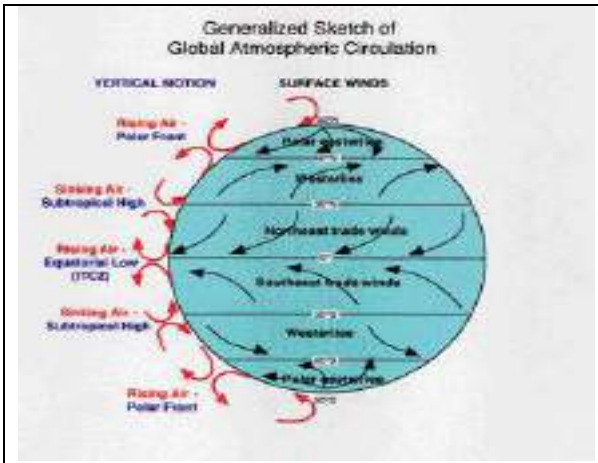
air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from TPL Monitoring, Manali. For our simulations, the required source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

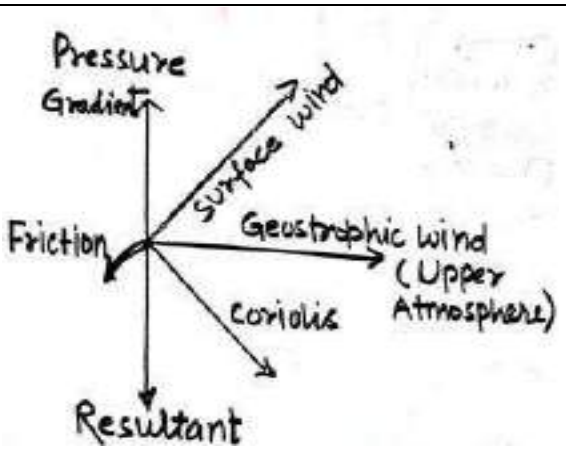
The AERMOD model was applied to study the diffusion of pollutants from TPL Monitoring, Manali and other sources in two days from 08.02.2021 to 31.03.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

TAMILNADU PETROPRODUCTS LTD - LAB_DIVISION

1 Boiler:

Particulate matter:

Stack Height, m	-	33
Exit Velocity, m/Sec	-	9.93
PM Concentration, mg/m3	-	8.3
Emission load, gm/Sec	-	0.09847
Plume rise, m	-	2

CPP-2

Particulate matter:

Stack Height, m	-	31.5
Exit Velocity, m/Sec	-	12.08
PM Concentration, mg/m3	-	35.5
Emission load, gm/Sec	-	0.2454
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	31.5
Exit Velocity, m/Sec	-	12.08
SO_2 Concentration, mg/m3	-	68.5
Emission load, gm/Sec	-	0.4735
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	31.5
Exit Velocity, m/Sec	-	12.08
NOx Concentration, mg/m3	-	458
Emission load, gm/Sec	-	3.1664
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	31.5
Exit Velocity, m/Sec	-	12.08
CO Concentration, mg/m3	-	35
Emission load, gm/Sec	-	0.2419
Plume rise, m	-	3

Hot Oil Heater - F-1601 R:

Particulate matter:

Stack Height, m	-	76
Exit Velocity, m/Sec	-	9.3
PM Concentration, mg/m3	-	7.5
Emission load, gm/Sec	-	0.4260
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	76
Exit Velocity, m/Sec	-	9.3
SO_2 Concentration, mg/m3	-	4.9
Emission load, gm/Sec	-	0.2783
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	76
Exit Velocity, m/Sec	-	9.3
NOx Concentration, mg/m3	-	3
Emission load, gm/Sec	-	0.1704
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	76
Exit Velocity, m/Sec	-	9.3
CO Concentration, mg/m3	-	36
Emission load, gm/Sec	-	2.0449
Plume rise, m	-	3

Pacol Charge Heater 1401 R

Particulate matter:

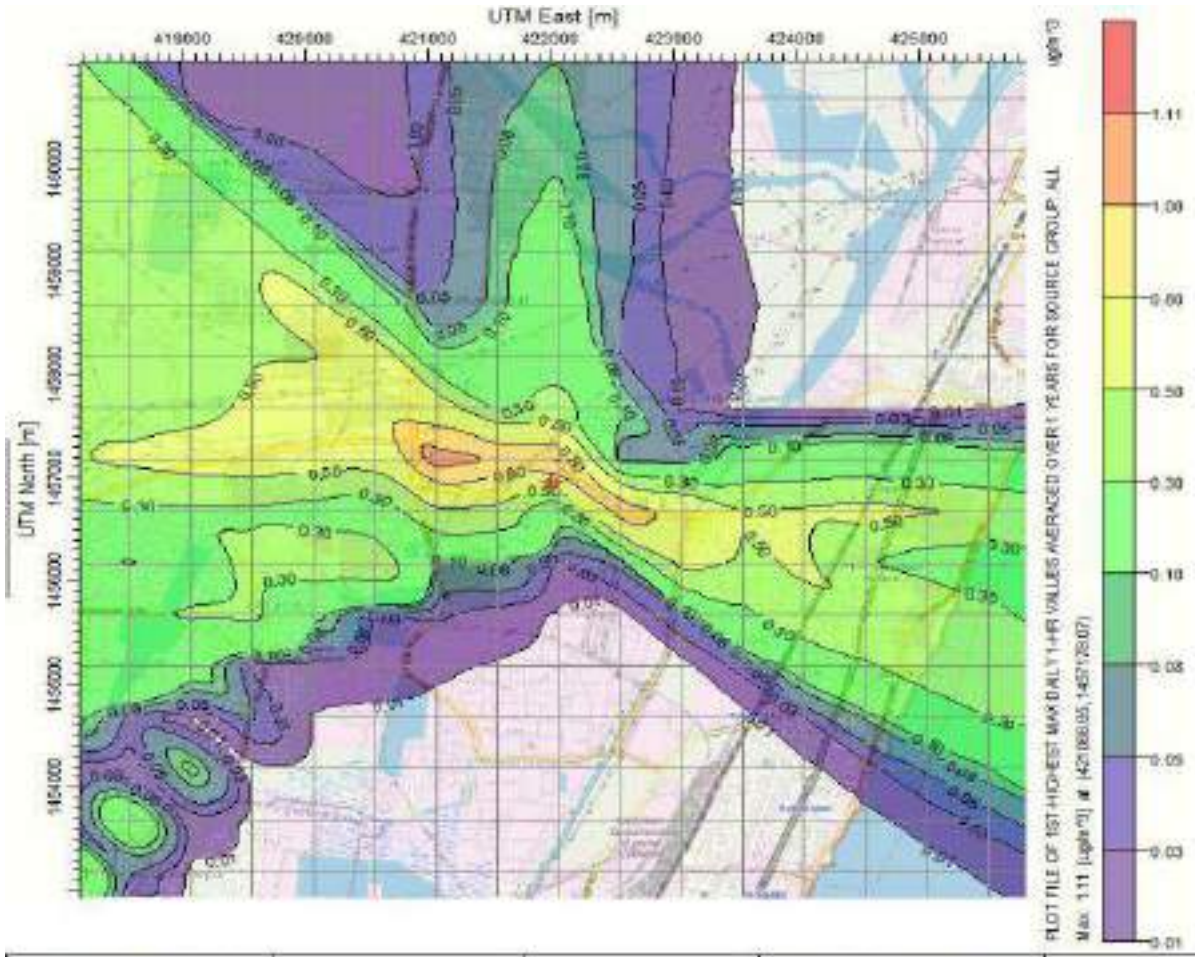
Stack Height, m	-	56
Exit Velocity, m/Sec	-	11
PM Concentration, mg/m3	-	7.8
Emission load, gm/Sec	-	0.0477
Plume rise, m	-	3

Hydrobon Water F1201 R

Particulate matter:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	5.01
PM Concentration, mg/m3	-	7.9
Emission load, gm/Sec	-	0.0104
Plume rise, m	-	3

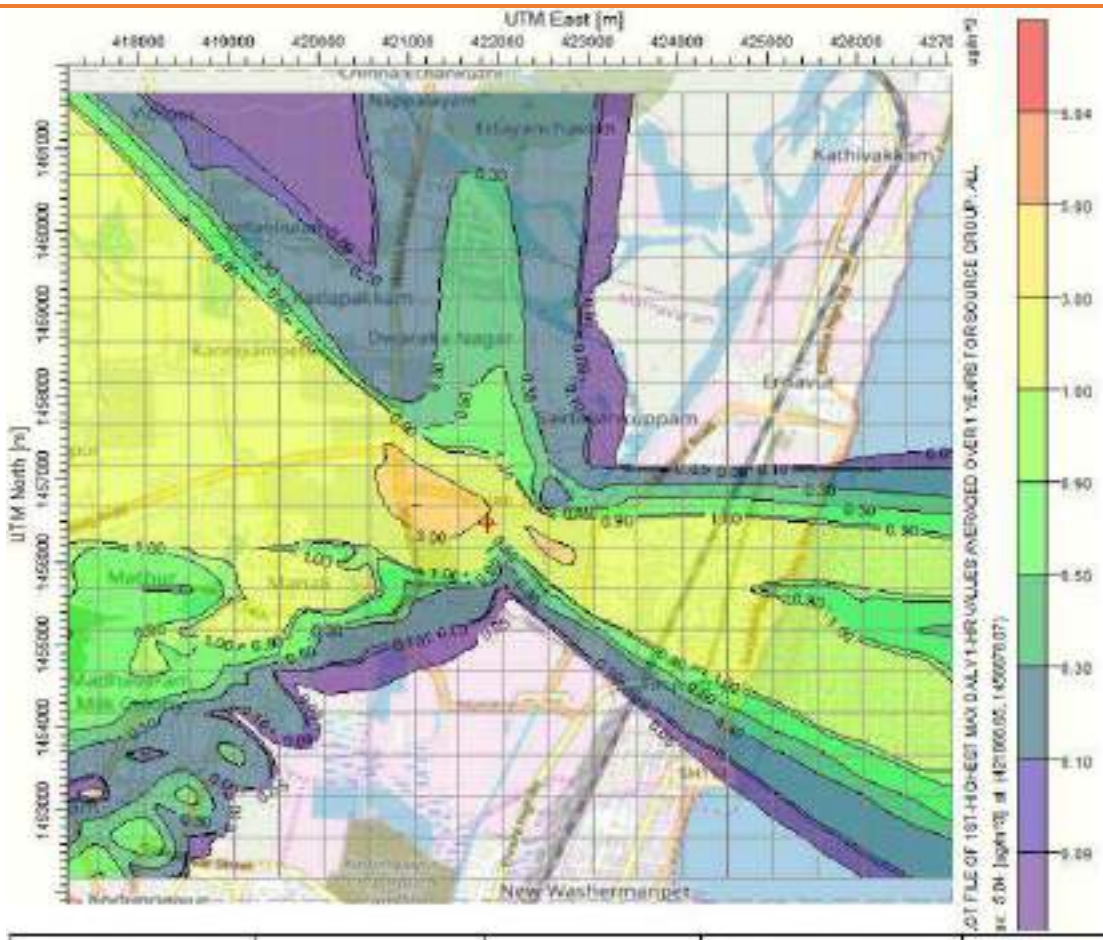
STACK EMISSION DISPERSION MODELLING – TPL – LAB Boiler @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
9.3	0.88	1.11	0.196	0.079

TPL – LAB BOILER emission of Particulate matter concentration is 8.3mg/m^3 and dispersed at the effective stack height of 33m (Stack height 33m + Plume Height 2.0m) with exit velocity of 9.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 1.11µg/m^3 at 2km dispersion Particulate matter is 0.196µg/m^3 and at 5km dispersion Particulate matter is 0.079µg/m^3 and the predominant wind direction is SSE.

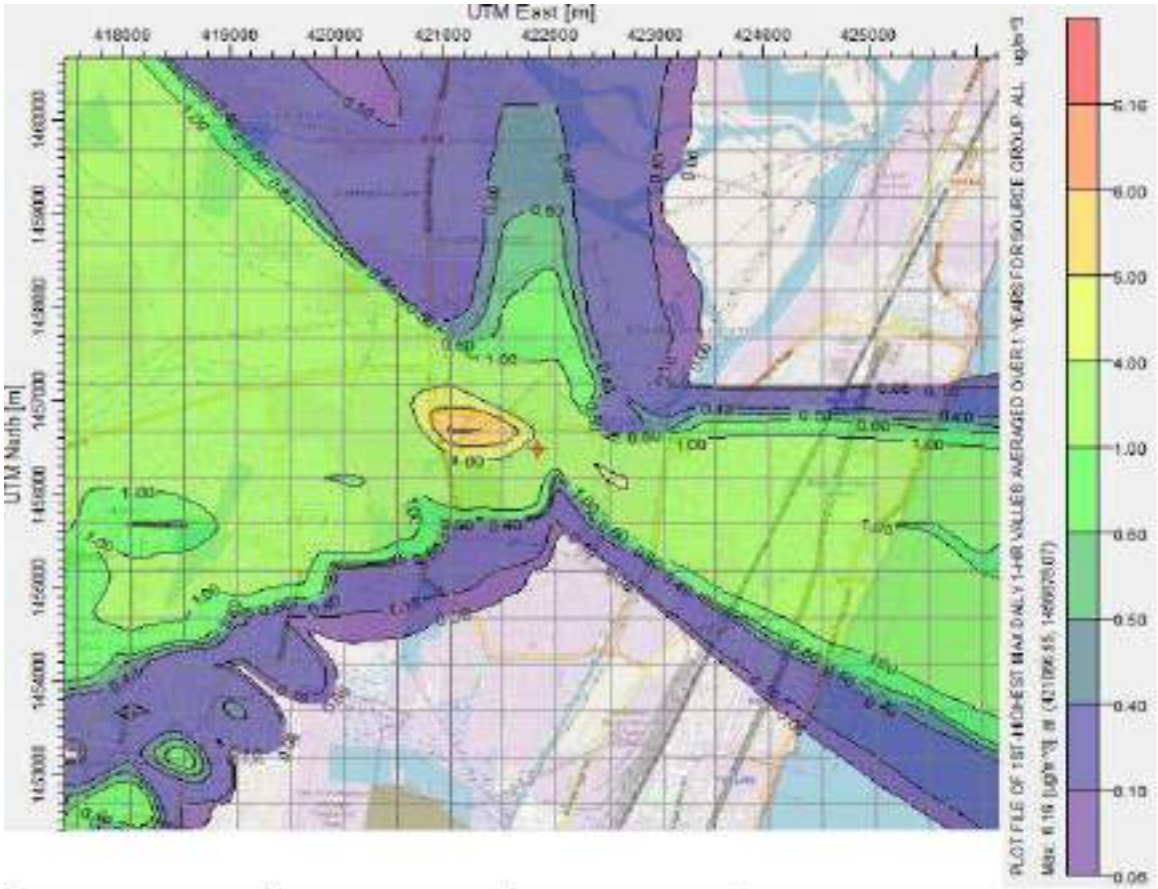
STACK EMISSION DISPERSION MODELLING – TPL – LAB CPP2 @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
35.5	0.83	5.04	0.11	0.0076

TPL – LAB CPP emission of Particulate matter concentration is 35.5 mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08 m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 5.04µg/m^3 at 2km dispersion Particulate matter is 0.11µg/m^3 and at 5km dispersion Particulate matter is 0.0076µg/m^3 and the predominant wind direction is SSE.

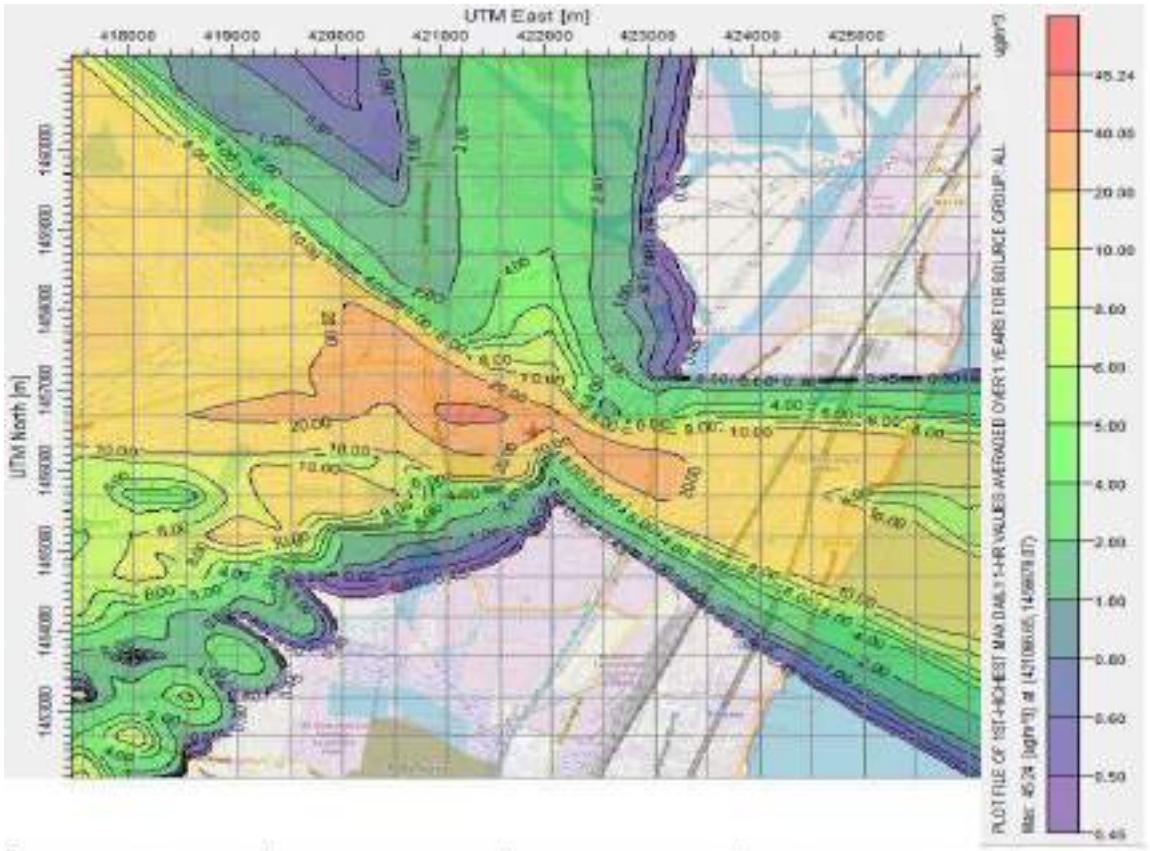
STACK EMISSION DISPERSION MODELLING –TPL-LAB CPP Boiler1 @ 2 & 5KM –Sulphur dioxide as SO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
68.5	0.85	6.16	0.168	0.0998

TPL – LAB CPP emission of Sulphur dioxide concentration is 68.5mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 6.16µg/m^3 at 2km dispersion Sulphur dioxide is 0.168µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0998µg/m^3 and the predominant wind direction is SSE.

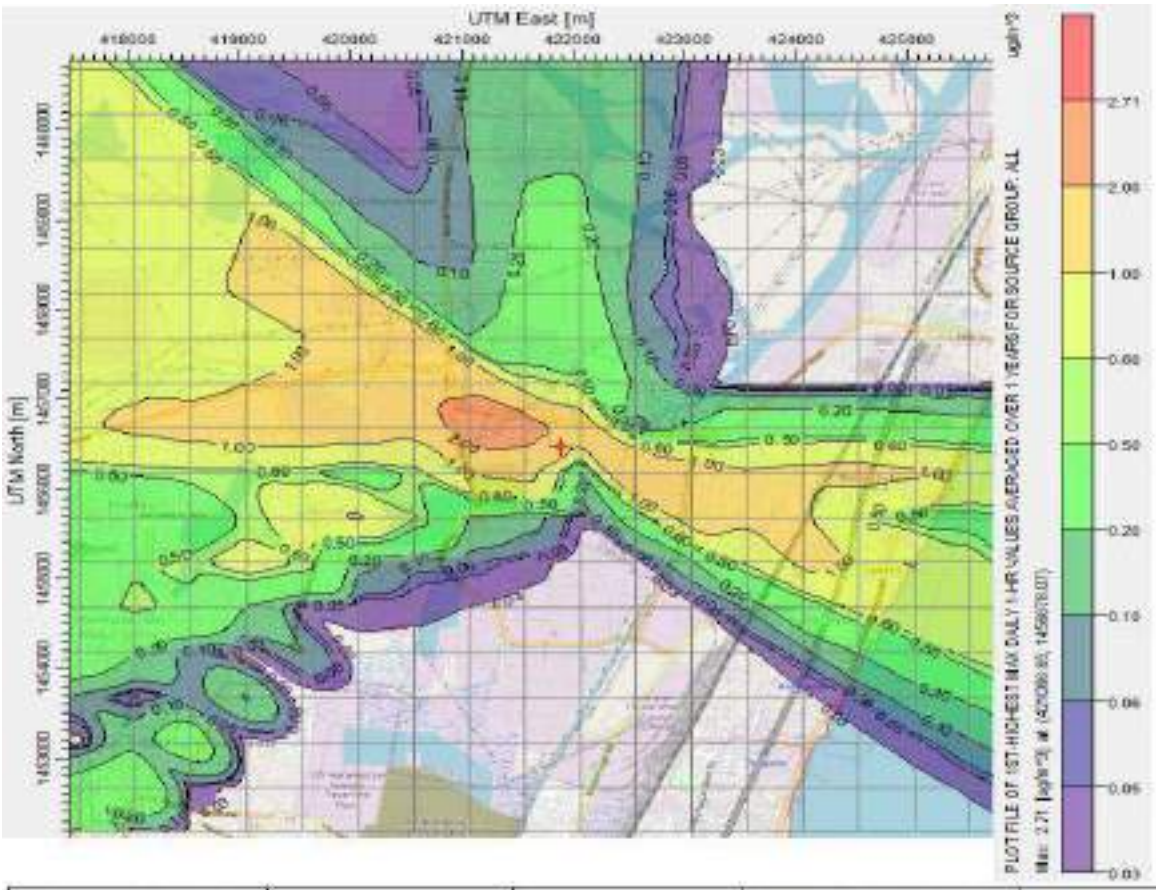
STACK EMISSION DISPERSION MODELLING –TPL – LAB CPP @2 & 5 KM- Oxides of Nitrogen as NO2



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
458	1.07	45.24	1.11	0.545

TPL – LAB CPP emission of Oxides of Nitrogen concentration is 458mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25^oC. All the modeling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.07km at the concentration of 45.24µg/m^3 at 2km dispersion Oxides of Nitrogen is 1.11µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0545µg/m^3 and the predominant wind direction is SSE.

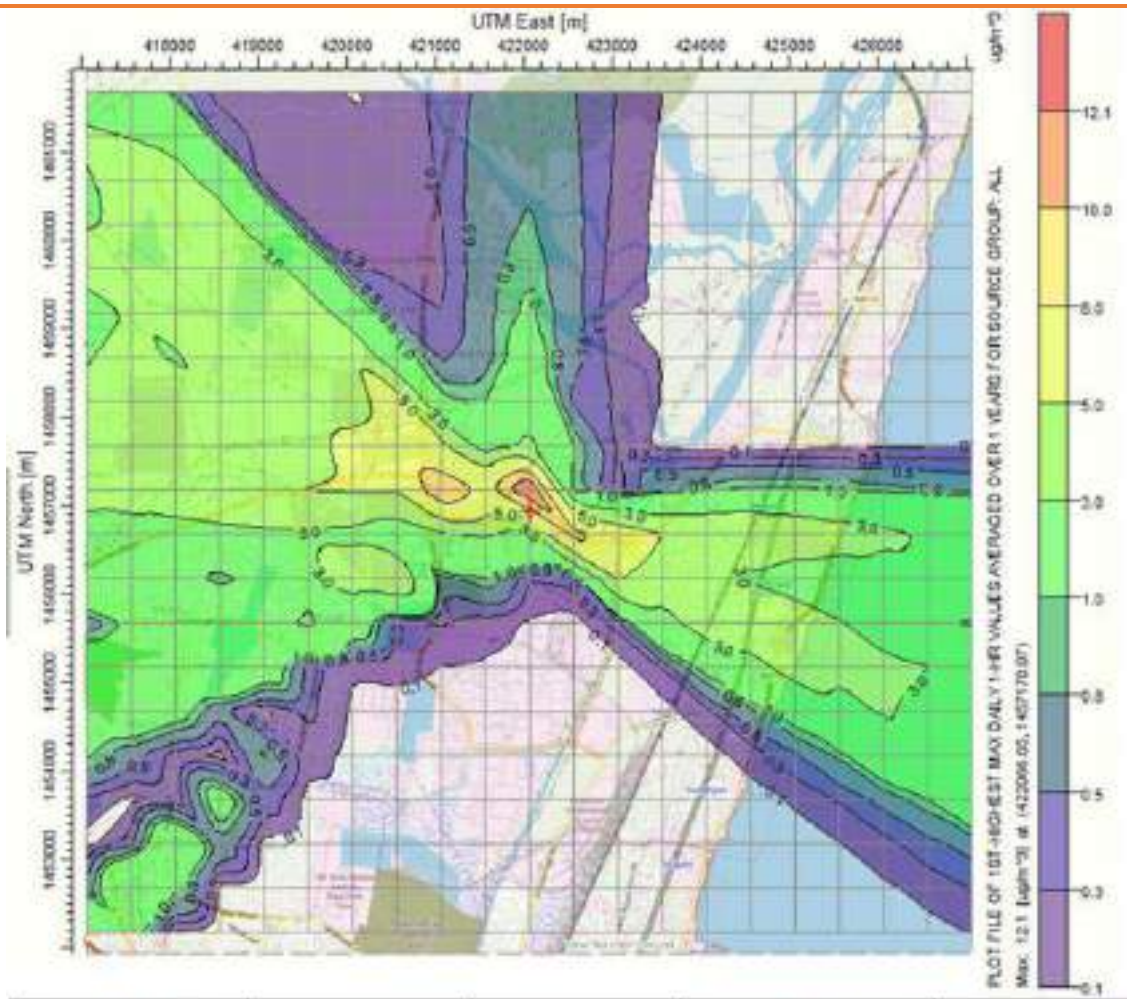
STACK EMISSION DISPERSION MODELLING –TPL – LAB CPP Stack @2 & 5 KM- Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
35	0.92	2.71	0.54	0.087

TPL – LAB CPP emission of Carbon Monoxide concentration is 35 mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 2.71µg/m^3 at 2km dispersion Carbon Monoxide is 0.54µg/m^3 and at 5km dispersion Carbon Monoxide is 0.087µg/m^3 and the predominant wind direction is SSE.

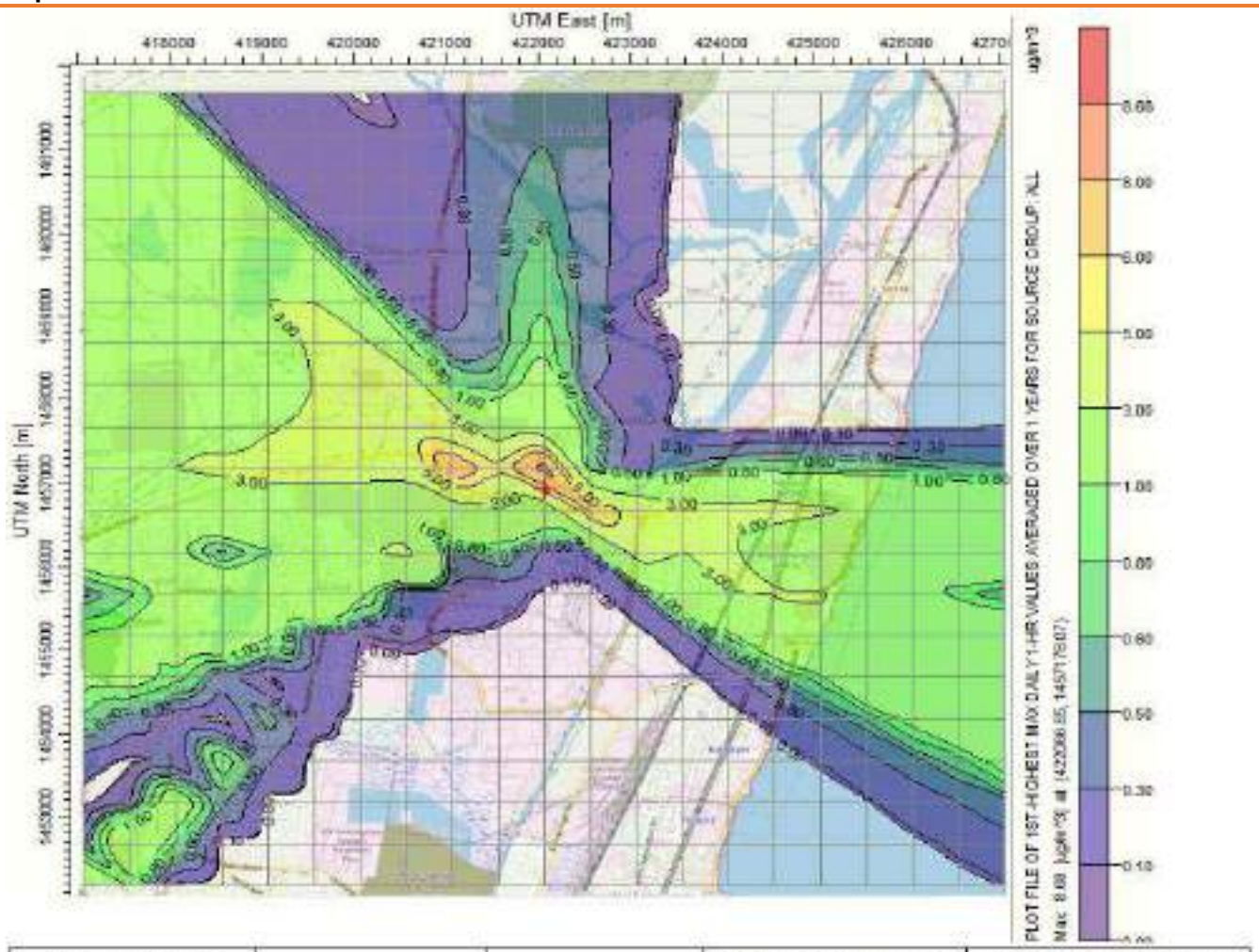
STACK EMISSION DISPERSION MODELLING –TPL-LAB Hot Oil Heater-F-1601 R @2 & 5 KM-Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
6.2	1.01	0.38	0.054	0.00232

TPL – LAB Hot Oil Heater of Particulate matter concentration is 6.2 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 0.38µg/m^3 at 2km dispersion Particulate matter is 0.054µg/m^3 and at 5km dispersion Particulate matter is 0.00232µg/m^3 and the predominant wind direction is SSE.

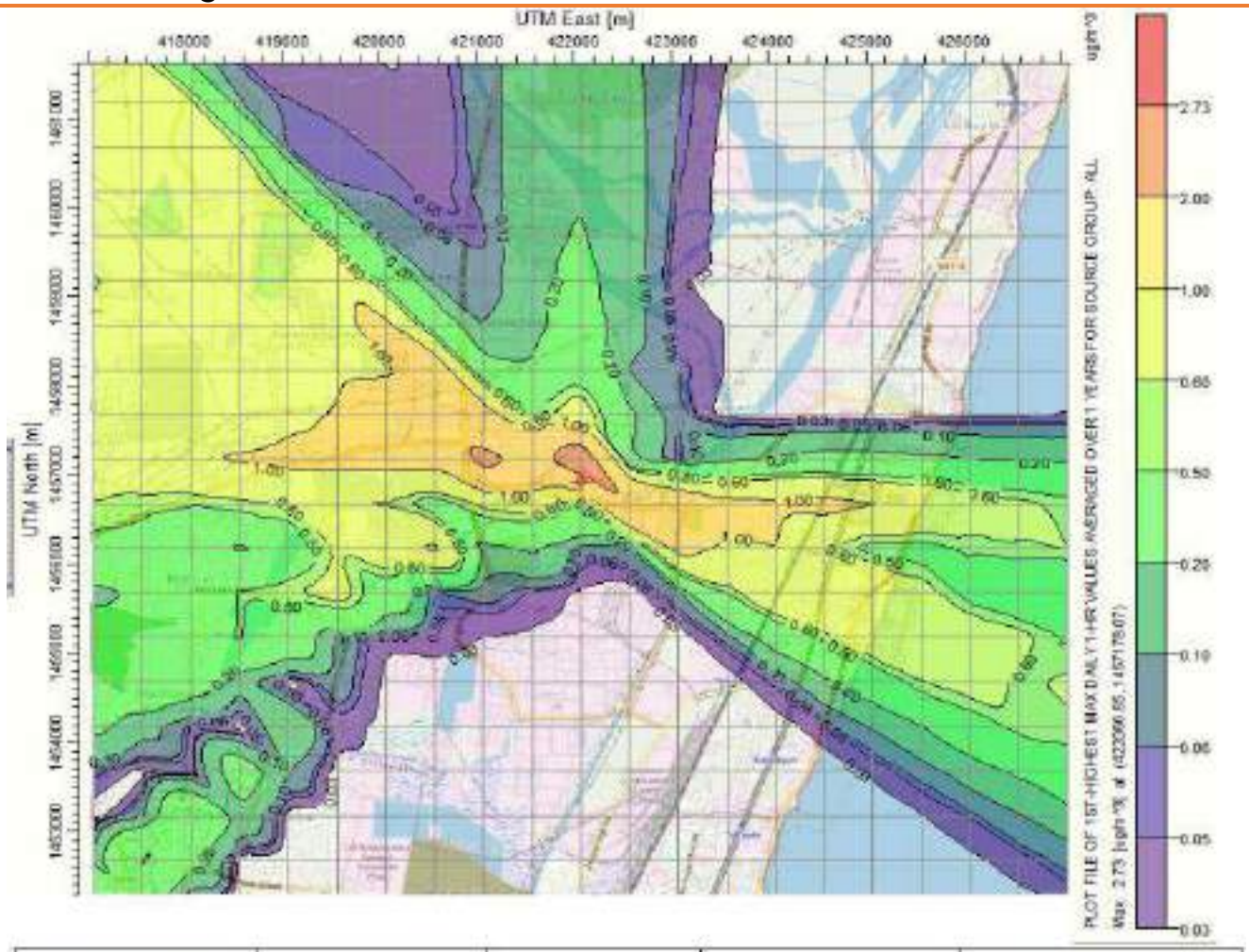
STACK EMISSION DISPERSION MODELLING – TPL – LAB Hot Oil Heater - F-1601 R @2 & 5 KM- Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
4.9	0.88	8.68	1.56	0.0651

TPL – LAB Hot Oil Heater of Sulphur dioxide concentration is 4.9 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 8.68µg/m^3 at 2km dispersion Sulphur dioxide is 1.56µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0651µg/m^3 and the predominant wind direction is SSE.

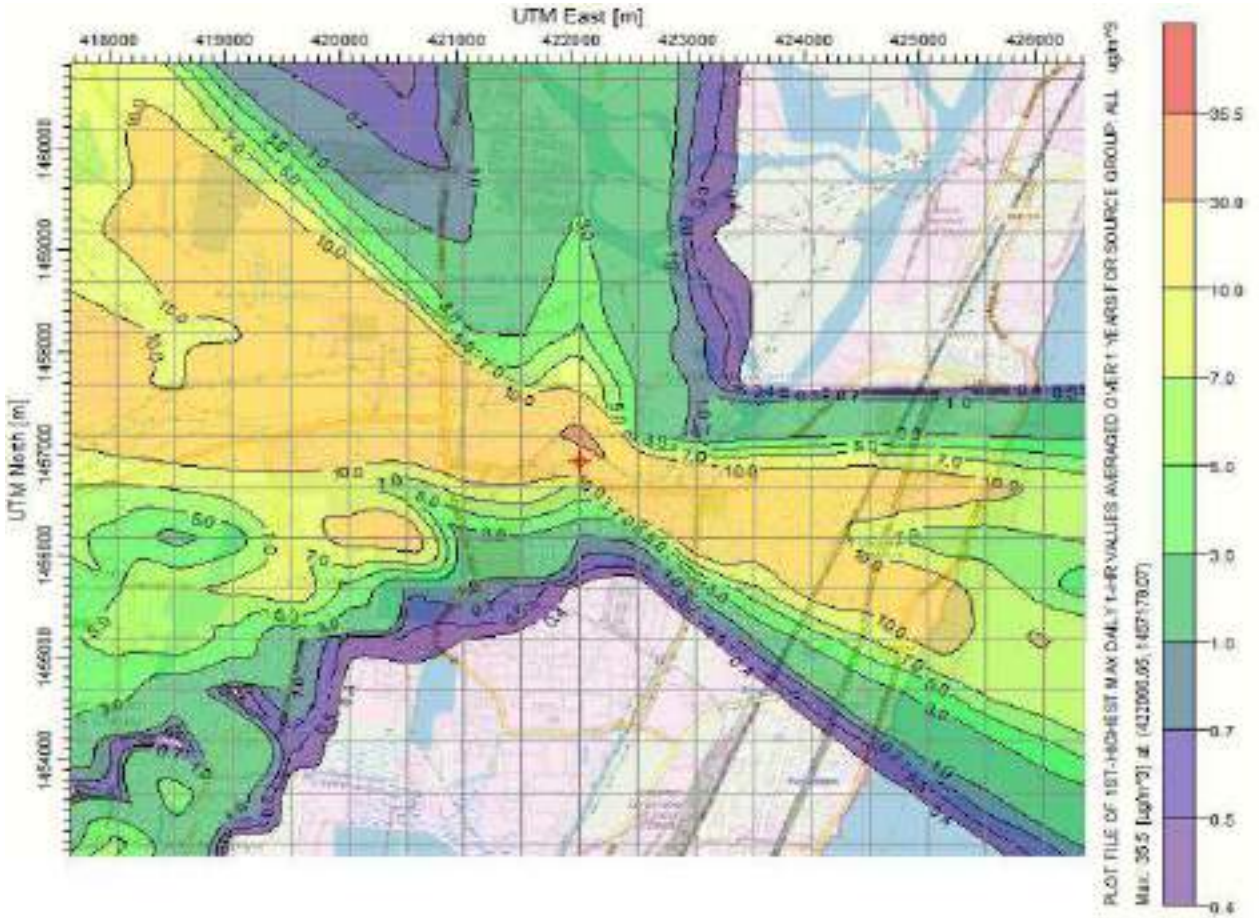
STACK EMISSION DISPERSION MODELLING –TPL – LAB Hot Oil Heater - F-1601 R @2 & 5 KM- Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
3	0.79	2.73	0.167	0.0341

TPL – LAB Hot Oil Heater of Oxides of Nitrogen concentration is 3 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 2.73µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.167µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0341µg/m^3 and the predominant wind direction is SSE.

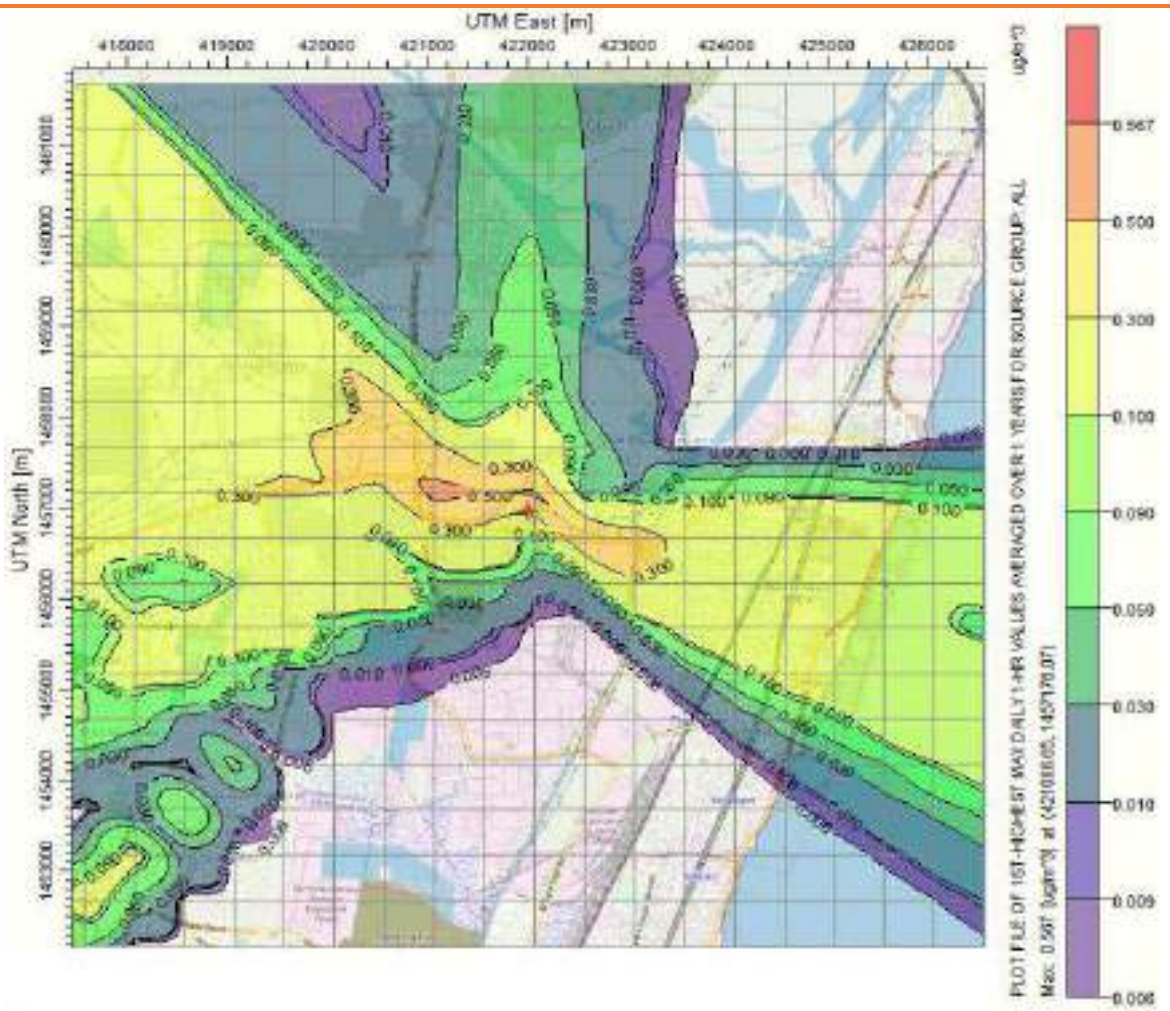
STACK EMISSION DISPERSION MODELLING –TPL – LAB Hot Oil Heater - F-1601 R @2 & 5 KM- Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
36	0.84	35.5	0.987	0.0322

TPL – LAB Hot Oil Heater of Carbon Monoxide concentration is 36 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 35.5µg/m^3 at 2km dispersion Carbon Monoxide is 0.987µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m^3 and the predominant wind direction is SSE.

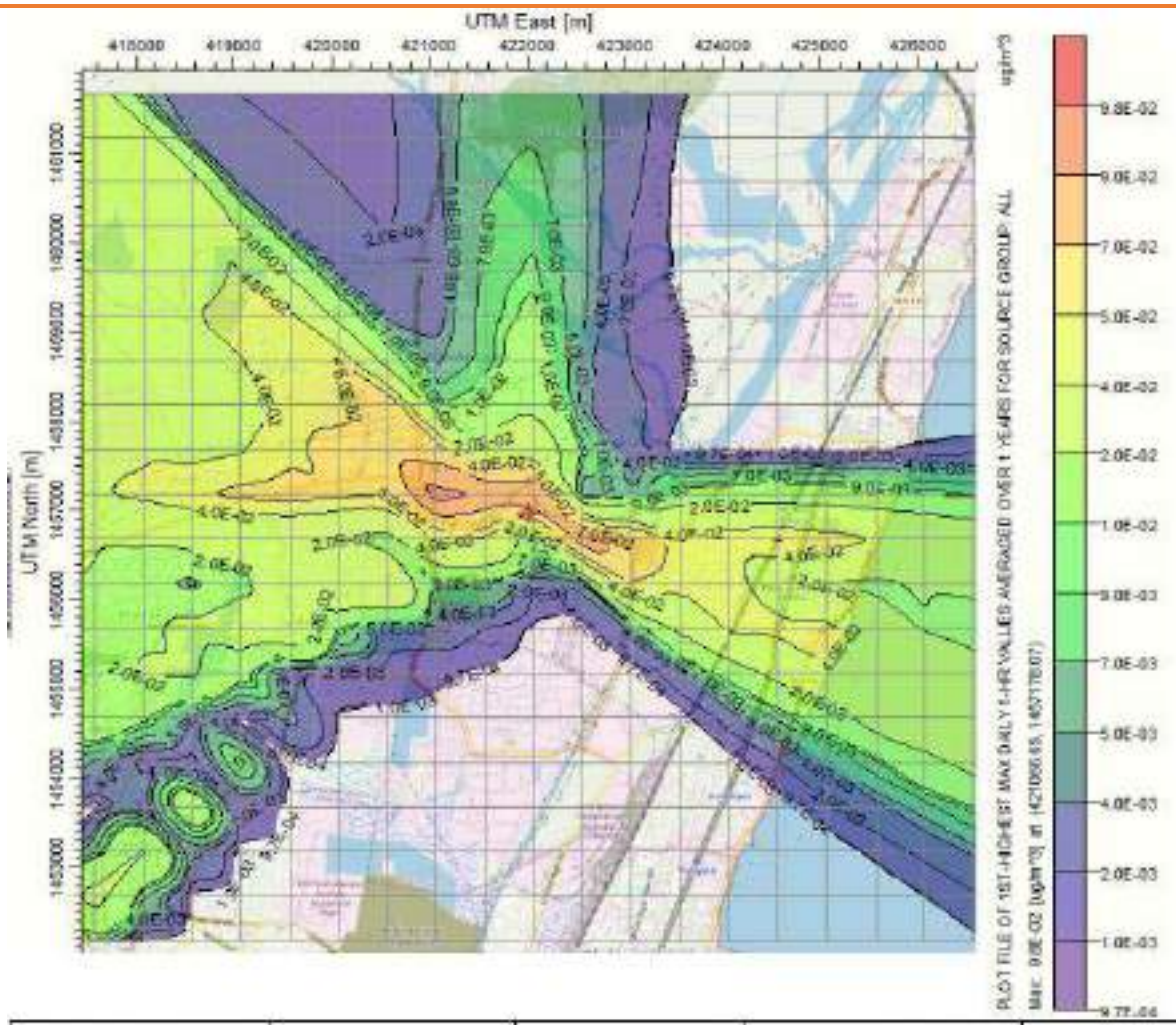
STACK EMISSION DISPERSION MODELLING –TPL – LAB PACOL Charge Heater R @2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
9.8	0.82	0.567	0.334	0.0904

TPL – LAB PACOL Charge Heater of Particulate matter concentration is 7.8 mg/m^3 and dispersed at the effective stack height of 56m (Stack height 56m + Plume Height 3m) with exit velocity of 11m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 0.567µg/m^3 at 2km dispersion Particulate matter is 0.334µg/m^3 and at 5km dispersion Particulate matter is 0.0904µg/m^3 and the predominant wind direction is SSE.

STACK EMISSION DISPERSION MODELLING –TPL – LAB Hydrobon Water @2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7.9	0.77	0.98	0.0557	0.00316

TPL – LAB Hydrobon Water of Particulate matter concentration is 7.9 mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.01m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.98µg/m^3 at 2km dispersion Particulate matter is 0.0557µg/m^3 and at 5km dispersion Particulate matter is 0.00316µg/m^3 and the predominant wind direction is SSE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m^3)	Average concentration at 5 km (µg/m^3)
TPL - LAB DIVISION						
Boiler	PM	8.3	0.88	1.11	0.196	0.079
CPP	PM	35.5	0.83	5.04	0.11	0.0076
CPP	SO2	68.5	0.85	6.16	0.168	0.0998
CPP	NOx	458	1.07	45.24	1.11	0.545
CPP	CO	35	0.92	2.71	0.54	0.087
Hot Oil Heater	PM	6.2	1.01	0.38	0.054	0.00232
Hot Oil Heater	SO2	4.9	0.88	8.68	1.56	0.0651
Hot Oil Heater	NOx	3	0.79	2.73	0.167	0.0341
Hot Oil Heater	CO	36	0.84	35.5	0.987	0.0322
PACOL Charge	PM	9.8	0.82	0.567	0.334	0.0904
Hydrobon Water	PM	7.9	0.77	0.98	0.0557	0.00316

Ennore
Vichoor
Tamilnadu Petroproducts Limited
Madhavaram
1. Burma Nagar – 1.1km
2. Manali New Town – 2.33km
3. Salai Ma Nagar – 1.82km
4. TP Nagar – 2.54km
5. Balakrishna Nagar – 1.2km

10.0 FINDINGS OF AIR POLLUTION MONITORING RESULTS

10.1 Ambient Air Quality Monitoring:

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Gate 2, Near Guard Pond, Near PACOL Heater, Tank No 1920 A South Side, 1901 A West Side, 1906 A West Side, Visitor Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 14.5 to 25.5µg/m^3. Highest value of 25.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 21.8 to 33.1µg/m^3. Highest value of 33.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 45.5 to 88.3µg/m^3. Highest value of 88.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 24.7 to 43.1µg/m^3. Highest value of 43.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):* The measured $PM_{2.5}$ values are ranging from 5.93 to 801.82µg/m^3 which is very high when compared to NAAQM standards of 60 µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.47 to 2469.4µg/m^3. which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind

direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

10.2 Stack Emission Monitoring

10.2.1 Boiler Stack:

BOILER emission of Particulate matter concentration is 8.3mg/m3 and dispersed at the effective stack height of 33m (Stack height 33m + Plume Height 2.0m) with exit velocity of 9.93m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 1.11µg/m^3 at 2km dispersion Particulate matter is 0.196µg/m^3 and at 5km dispersion Particulate matter is 0.079µg/m^3 and the predominant wind direction is SSE

10.2.2 Captive Power Plant:

CPP emission of Particulate matter concentration is 35.5 mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08 m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 5.04µg/m^3 at 2km dispersion Particulate matter is 0.11µg/m^3 and at 5km dispersion Particulate matter is 0.0076µg/m^3 and the predominant wind direction is SSE.

CPP emission of Sulphur dioxide concentration is 68.5mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 6.16µg/m^3 at 2km dispersion Sulphur dioxide is 0.168µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0998µg/m^3 and the predominant wind direction is SSE.

CPP emission of Oxides of Nitrogen concentration is 458mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the

dispersion parameters the GLC reached at 1.07km at the concentration of 45.24µg/m3 at 2km dispersion Oxides of Nitrogen is 1.11µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0545µg/m^3 and the predominant wind direction is SSE.

CPP emission of Carbon Monoxide concentration is 35 mg/m^3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 2.71µg/m^3 at 2km dispersion Carbon Monoxide is 0.54µg/m^3 and at 5km dispersion Carbon Monoxide is 0.087µg/m^3 and the predominant wind direction is SSE.

10.2.3 Hot Oil Heater:

Hot Oil Heater of Particulate matter concentration is 6.2mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 0.38µg/m^3 at 2km dispersion Particulate matter is 0.054µg/m^3 and at 5km dispersion Particulate matter is 0.00232µg/m^3 and the predominant wind direction is SSE.

Hot Oil Heater of Sulphur dioxide concentration is 4.9 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 8.68µg/m^3 at 2km dispersion Sulphur dioxide is 1.56µg/m^3 and at 5km dispersion Sulphur dioxide is 0.0651µg/m^3 and the predominant wind direction is SSE.

Hot Oil Heater of Oxides of Nitrogen concentration is 3 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 2.73µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.167µg/m^3 and at 5km

dispersion Oxides of Nitrogenis 0.0341µg/m^3 and the predominant wind direction is SSE.

Hot Oil Heater of Carbon Monoxide concentration is 36 mg/m^3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 35.5µg/m^3 at 2km dispersion Carbon Monoxide is 0.987µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m^3 and the predominant wind direction is SSE.

10.2.4 PACOL Charge Heater:

PACOL Charge Heater of Particulate matter concentration is 9.6 mg/m^3 and dispersed at the effective stack height of 56m (Stack height 56m + Plume Height 3m) with exit velocity of 11m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 0.481µg/m^3 at 2km dispersion Particulate matter is 0.354µg/m^3 and at 5km dispersion Particulate matter is 0.00878µg/m^3 and the predominant wind direction is SSE.

10.2.5 Hydrobon Water F1201 R:

Hydrobon Water F1201 R of Particulate matter concentration is 7.9 mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.01m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.98µg/m^3 at 2km dispersion Particulate matter is 0.0557µg/m^3 and at 5km dispersion Particulate matter is 0.00316µg/m^3 and the predominant wind direction is SSE.

2.7 Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from TPL – Lab Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is

surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – Lab division through stacks is 74.6mg/m^3. The average ground level concentration achieves at an average distance of 0.85km and the sum of PM concentration at GLC is 19.8 µg/m^3 which includes all the stacks at TPL – Lab division. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from TPL – Lab division through stacks is 73.4 mg/m^3. The average ground level concentration achieves at an average distance of 0.865km and the sum of Sulphur Dioxide concentration at GLC is 7.72 µg/m^3 which includes all the stacks at TPL – Lab division. It clearly indicates the SO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from TPL – Lab division through stacks is 461 mg/m^3. The average gound level concentration achieves at a average distance of 0.93km and the sum of Nitrogen Oxides concentration at GLC is 48 µg/m^3 which includes all the stacks at TPL – Lab division. It clearly indicates the NO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2 and NO2. Results from AERMOD simulation indicated that PM, SO2 and NO2 emissions from the TPL PO division had no significant impact on nearby communities and Manali Industrial complex. For Chlorine there is no ambient air quality standard and the predicted concentrations also in trace level so that the impact on nearby communities and Manali Industrial complex is negligible.

The overall combined source mass emission load of PM, SO2 and NO2 with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are very much less.

***

Annexure-IX

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Manali Petrochemicals Ltd, Unit-I, Manali

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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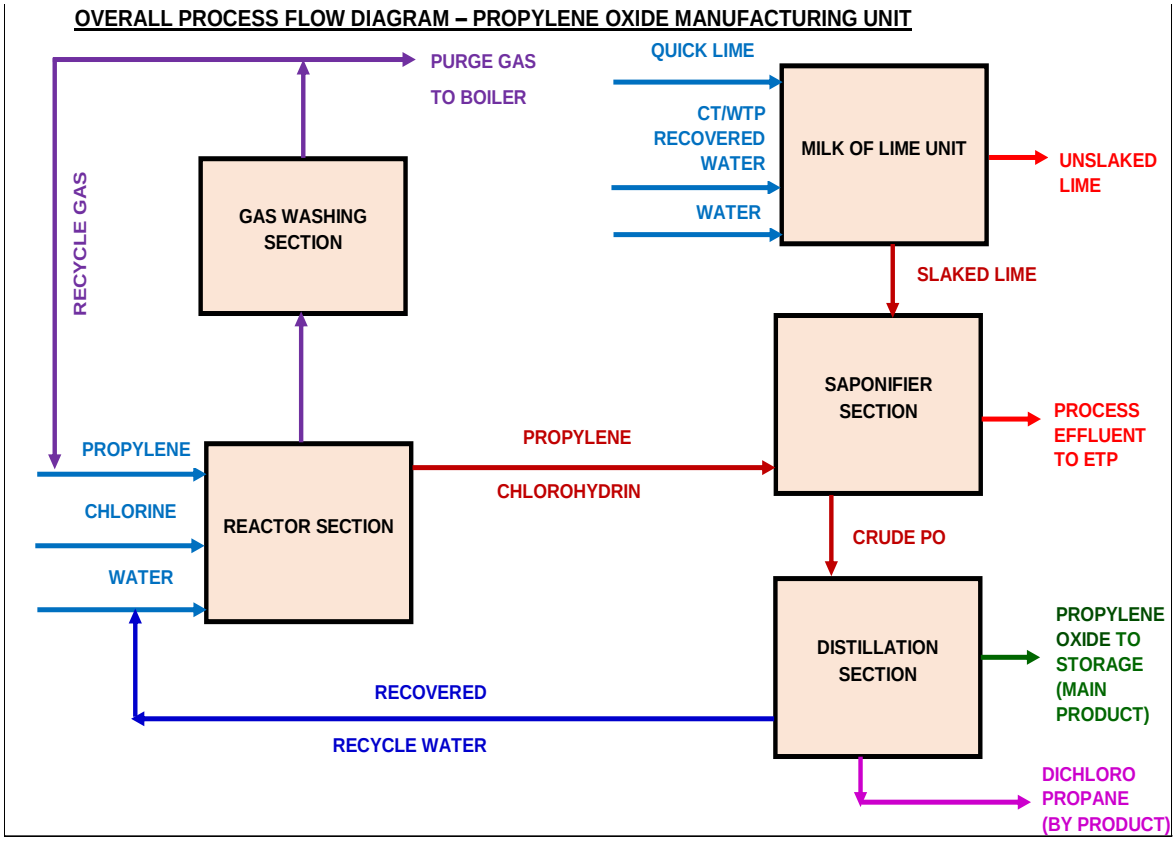
1. ABOUT INDUSTRY

Manali Petrochemicals Limited (MPL) is a leader in the production and marketing of Propylene Oxide (PO), Propylene Glycol (PG) and various grades of Polyols in India. It operates two production facilities (Plant-I and Plant-II) at Manali, near Chennai.\

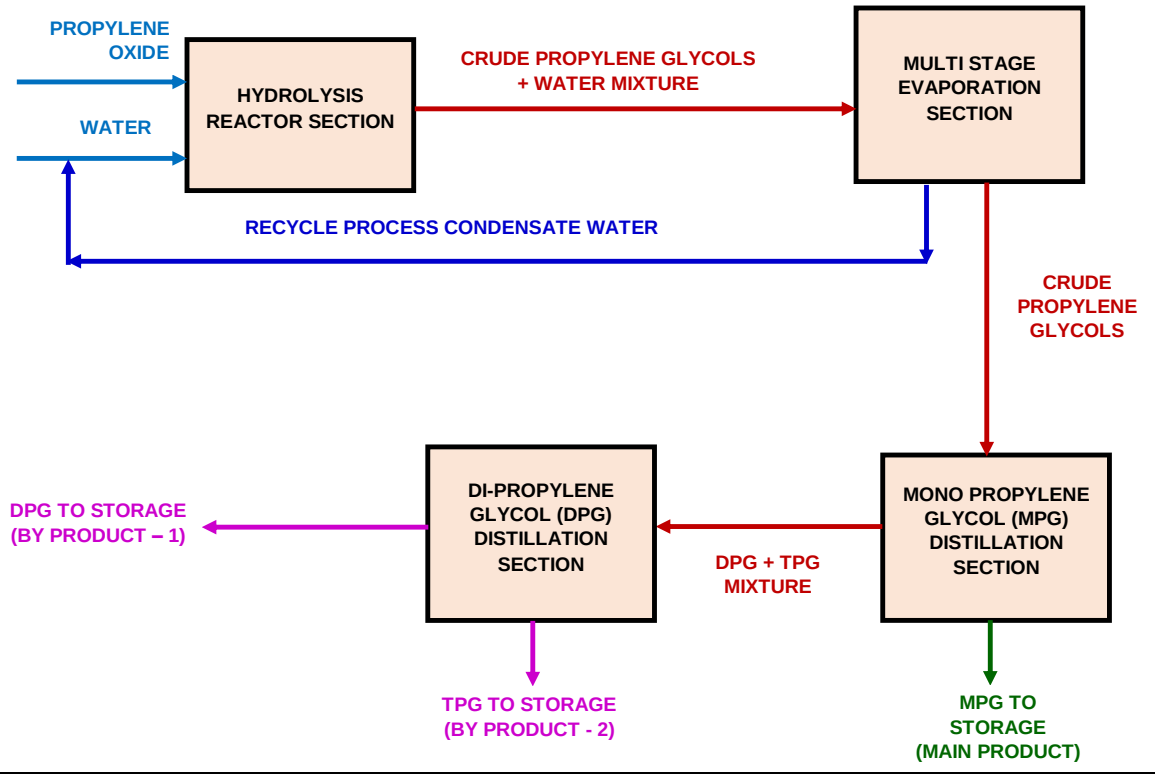
Plant-I is situated at the Ponneri High Road, Manali, Chennai, opposite to Madras Fertilizers Limited, having an installed capacity of 18000 MTPA of PO, 10000 MTPA of PG and 22560 MTPA of Polyol. This Plant has been in operation for more than 3 decades.
Its commercial production commenced in the year 1990 and remains to be a part of the AMIH Group at present.

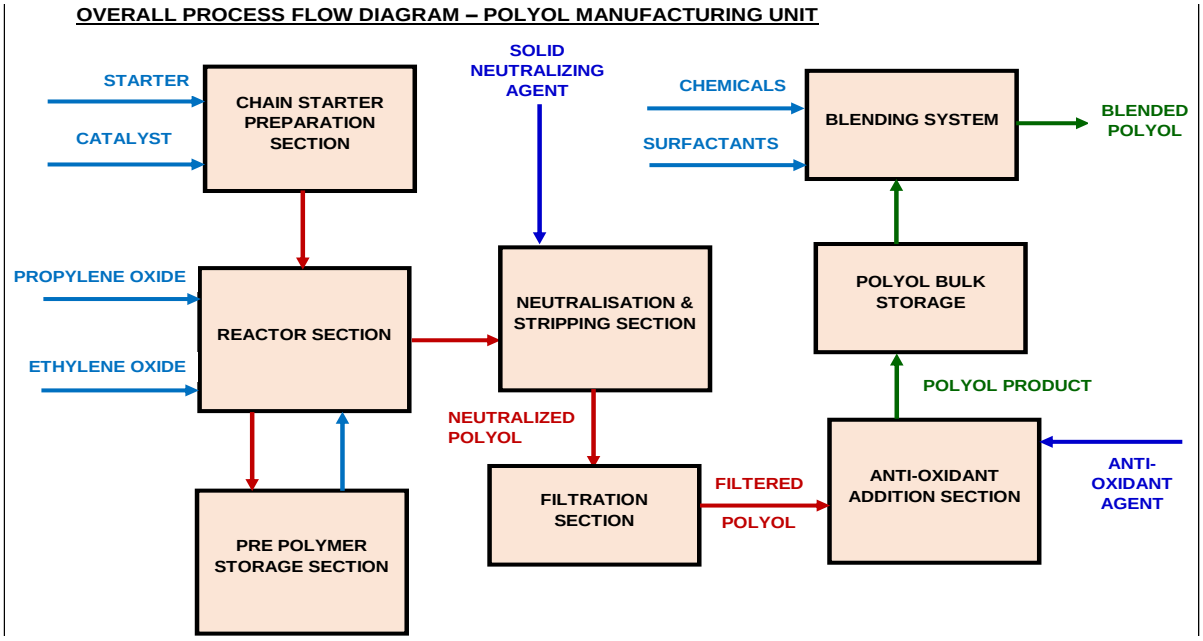
In 2008, the company was granted EC vide J-11011/155/2008-IA(II) dated 7th May 2008 towards Augmentation of Propylene Oxide, Propylene Glycol and Polyol Units at Plant – I. The expansion activities got completed and CTO for expansion granted in 2016 and the units are operating at expanded capacity.

OVERALL PROCESS FLOW DIAGRAM – PROPYLENE OXIDE MANUFACTURING UNIT



OVERALL PROCESS FLOW DIAGRAM – PROPYLENE GLYCOL MANUFACTURING UNIT




OVERALL PROCESS FLOW DIAGRAM – POLYOL MANUFACTURING UNIT
STARTER
CATALYST
CHAIN STARTER PREPARATION SECTION
SOLID NEUTRALIZING AGENT
CHEMICALS
SURFACTANTS
BLENDING SYSTEM
BLENDED POLYOL
PROPYLENE OXIDE
ETHYLENE OXIDE
REACTOR SECTION
NEUTRALISATION & STRIPPING SECTION
POLYOL BULK STORAGE
POLYOL PRODUCT
NEUTRALIZED POLYOL
FILTRATION SECTION
FILTERED POLYOL
ANTI-OXIDANT ADDITION SECTION
ANTI-OXIDANT AGENT
PRE POLYMER STORAGE SECTION

Kanali Petrochemical Ltd Plant

2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

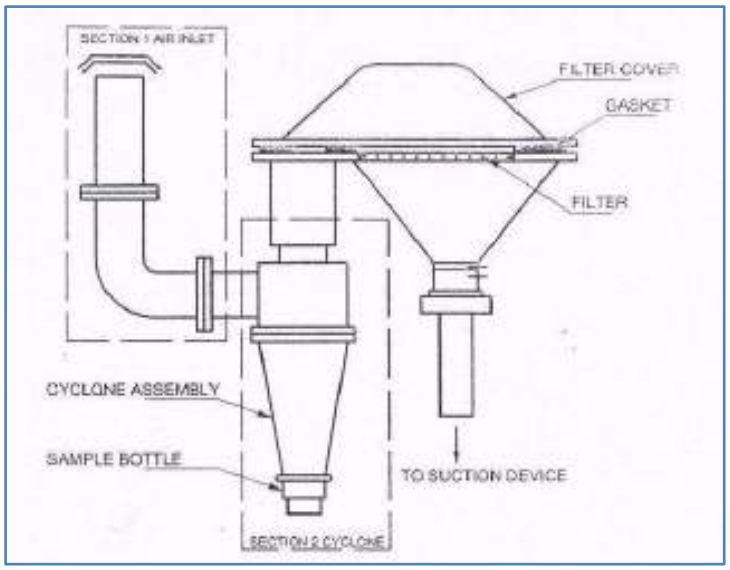
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in an envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, µg/m^3	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter

Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine PM2.5 mass concentration:

$PM_{2.5} = M2.5 / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

PM2.5 = total mass of fine particulate collected during sampling period (µg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80

*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting

50 ml of stock solution to 500 ml with distilled water.

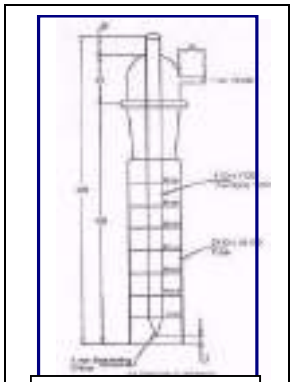
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and

transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO2 = Concentration of Nitrogen dioxide, µg/m^3

As = Absorbance of sample

Ab = Absorbance of reagent blank

CF = Calibration factor

Va = Volume of air sampled, m^3

Vs = Volume of sample, ml

Vt = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
Draw air at a sampling rate of 0.5 lpm for 8 hours
Check the volume of sample at the end of sampling and record it
Transfer the exposed samples in storage bottle and preserve
Prepare calibration graph as recommended in method
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
Add 1ml hydrogen peroxide,
Add 10ml Sulphanilamide
Add 1.4 ml NEDA
Make up to mark (50 ml.) with distilled water.
Keep it 10 minutes for reaction
Set Zero of spectrophotometer with Distilled water
Measure absorbance at 540 nm
Calculate concentration using calibration graph
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as

in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ )\ =\ (As\ -\ Ab)\ x\ CF\ /\ Va$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

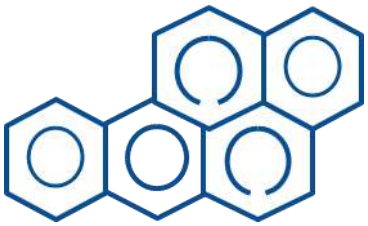
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various

PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
Ultrasonic extraction with Toluene (50 ml × 3 times)
Filter & dry with Anhydrous Sodium Sulphate
Concentration with Rotary Evaporator
Clean up with Silica Gel Column Chromatography
Elution with Cyclo-Hexane (5 ml × 3 times)
Evaporate to nearly dryness under Nitrogen
Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H_2SO_4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.

Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V = Volume of air, m^3

Q = Average sampling rate, m^3/min.

T = Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C = Concentration, µg Metal/M^3.
Ms = Metal Concentration µg/ml
Mb = Blank Concentration µg/ml
Vs = Total Volume of Extraction in ml

Fa = Total Area of Exposed Filter in Cm^2
V = Volume of Air Sampled in M^3
Ft = Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	Methods of Measurement
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greek method -Ultraviolet Fluorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)- particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT MPL - 08.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
08.02.2021	15:00	30	35	19	ENE
08.02.2021	16:00	29	43	26	E
08.02.2021	17:00	28	48	24	E
08.02.2021	18:00	27	58	15	ENE
08.02.2021	19:00	26	61	9	ENE
08.02.2021	20:00	25	65	7	ENE
08.02.2021	21:00	25	69	4	NE
08.02.2021	22:00	23	78	0	CALM
08.02.2021	23:00	24	78	4	N
09.02.2021	00:00	24	78	4	N
09.02.2021	01:00	24	83	0	CALM
09.02.2021	02:00	23	83	4	N
09.02.2021	03:00	23	83	0	CALM
09.02.2021	04:00	23	83	0	CALM
09.02.2021	05:00	23	83	0	CALM
09.02.2021	06:00	24	74	7	E
09.02.2021	07:00	25	61	9	E
09.02.2021	08:00	26	54	19	E
09.02.2021	09:00	27	51	17	E
09.02.2021	10:00	28	51	19	E
09.02.2021	11:00	28	48	15	E
09.02.2021	12:00	29	48	17	E
09.02.2021	13:00	30	40	19	E
09.02.2021	14:00	30	35	17	E
MIN		**23.0**	**35**	**-**	**E**
MAX		**30.0**	**83**	**26.0**	
AVG		**26.0**	**62**	**10.6**	

WEATHER MONITORING DATA AT MPL - 09.02.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
09.02.2021	15:00	30	40	15	E
09.02.2021	16:00	29	43	17	E
09.02.2021	17:00	28	45	17	ENE
09.02.2021	18:00	27	48	13	E
09.02.2021	19:00	26	54	9	E
09.02.2021	20:00	25	57	13	ENE
09.02.2021	21:00	25	57	11	ENE
09.02.2021	22:00	24	61	9	ENE
09.02.2021	23:00	24	69	0	CALM
10.02.2021	00:00	23	69	4	N
10.02.2021	01:00	23	74	0	N
10.02.2021	02:00	23	74	7	N
10.02.2021	03:00	22	78	6	NNW
10.02.2021	04:00	22	78	4	N
10.02.2021	05:00	21	83	4	N
10.02.2021	06:00	22	79	0	CALM
10.02.2021	07:00	23	76	0	CALM
10.02.2021	08:00	24	74	4	WNW
10.02.2021	09:00	26	64	4	N
10.02.2021	10:00	27	58	4	WNW
10.02.2021	11:00	29	45	11	E
10.02.2021	12:00	30	43	13	E
10.02.2021	13:00	30	43	13	ESE
10.02.2021	14:00	29	48	15	ESE
MIN		**21.0**	**40**	**-**	**E**
MAX		**30.0**	**83**	**17.0**	
AVG		**25.5**	**61**	**8.0**	

4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Ambient Air Quality Monitoring Sampling Location

Stack Emission Monitoring Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR CAR PARKING

LOCATION - NEAR CAR PARKING ,MANALI			
SAMPLING DATE & TIME 08.02.2021 [12:05 Hrs] – 09.02.2021 [12:05 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	13.2
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	15.07
3	Particulate Matter (PM_{10})	$\mu g/m^3$	63.8
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	35.4
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR RO PLANT OPPOSITE

LOCATION - NEAR RO PLANT OPPOSITE,MANALI			
SAMPLING DATE & TIME 08.02.2021 [13:00 Hrs] – 09.02.2021 [13:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	11.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	16.46
3	Particulate Matter (PM_{10})	$\mu g/m^3$	82.6
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR WEIGH BRIDGE

LOCATION - NEAR WEIGH BRIDGE, MANALI			
SAMPLING DATE & TIME 08.02.2021 [13:45Hrs] – 09.02.2021 [13:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	10.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	17.46
3	Particulate Matter (PM_{10})	$\mu g/m^3$	87.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	40.9
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR ETP- RAW WATER UNLOADING AREA

LOCATION - NEAR ETP- RAW WATER UNLOADING AREA, MANALI			
SAMPLING DATE & TIME 09.02.2021 [15:25 Hrs] – 10.02.2021 [15:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	16.8
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	18.5
3	Particulate Matter (PM_{10})	$\mu g/m^3$	59.1
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	29.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR RVDF OPPOSITE

LOCATION - NEAR RVDF OPPOSITE, MANALI			
SAMPLING DATE & TIME 09.02.2021 [15:35 Hrs] - 10.02.2021 [15:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	14.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	18.96
3	Particulate Matter (PM_{10})	$\mu g/m^3$	73.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	33.9
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. MANALI PETROCHEMICAL LTD PLANT-I, NEAR DRUMING PLANT

LOCATION - NEAR DRUMING PLANT, MANALI			
SAMPLING DATE & TIME 09.02.2021 [15:50 Hrs] - 10.02.2021 [15:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	19.7
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	20.51
3	Particulate Matter (PM_{10})	$\mu g/m^3$	91.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	44.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 7: M/s. MANALI PETROCHEMICAL LTD PLANT-I, VISITOR GATE

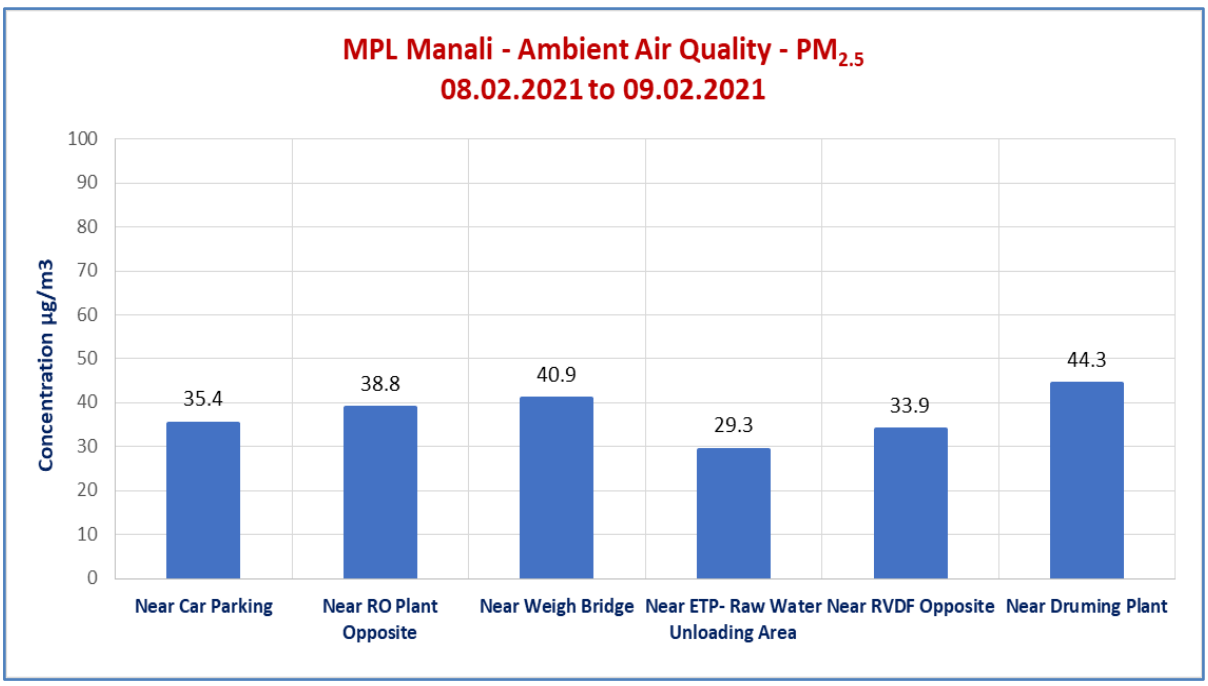
LOCATION - VISITOR GATE, MANALI				
SAMPLING DATE & TIME 09.02.2021 [19:00 Hrs] - 10.02.2021 [15:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	19:00 – 20:00	$\mu g/m^3$	33.11	82.83
2	20:00 – 21:00	$\mu g/m^3$	66.43	161.99
3	21:00 – 22:00	$\mu g/m^3$	90.24	183.72
4	22:00 – 23:00	$\mu g/m^3$	148.66	237.04
5	23:00 – 00:01	$\mu g/m^3$	238.67	359.51
6	00:01 – 01:00	$\mu g/m^3$	240.91	359.12
7	01:00 – 02:00	$\mu g/m^3$	209.01	290.35
8	02:00 – 03:00	$\mu g/m^3$	72.52	121.25
8 HOURS AVERAGE			**137.44**	**224.48**

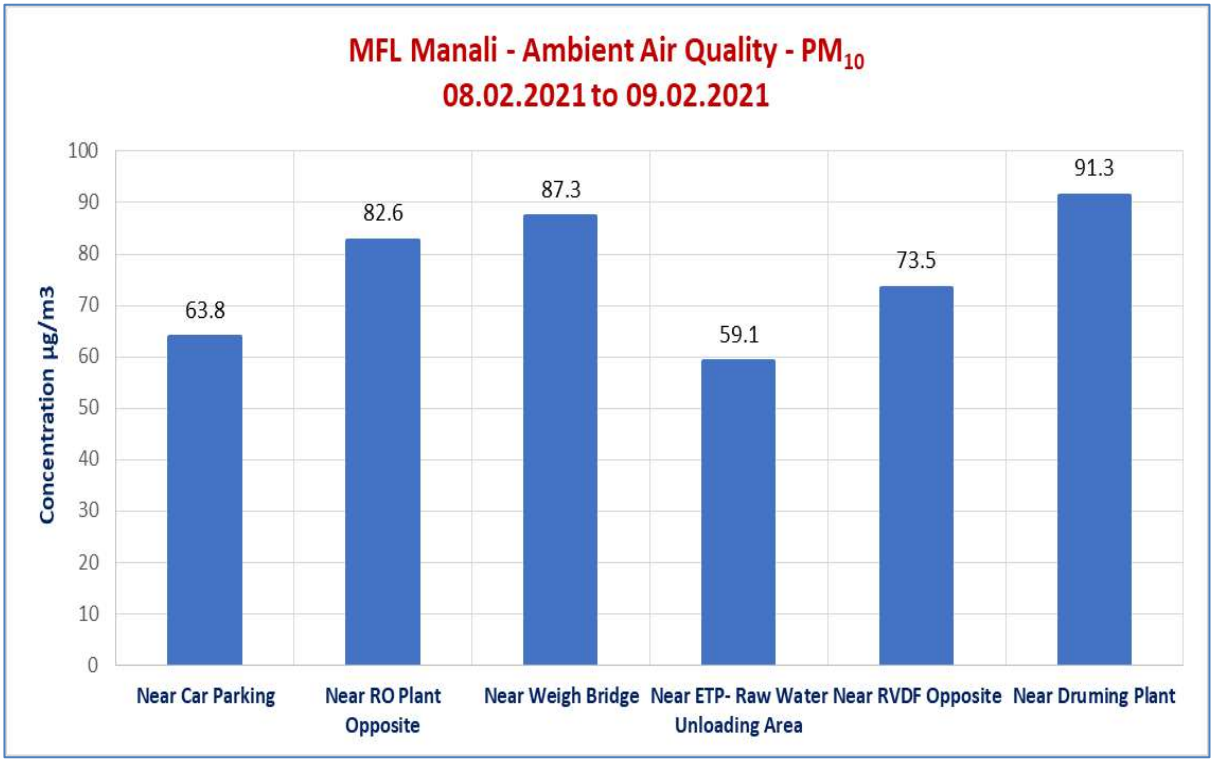
AAQ- 8: M/s. MANALI PETROCHEMICAL LTD PLANT-I, MATERIAL GATE

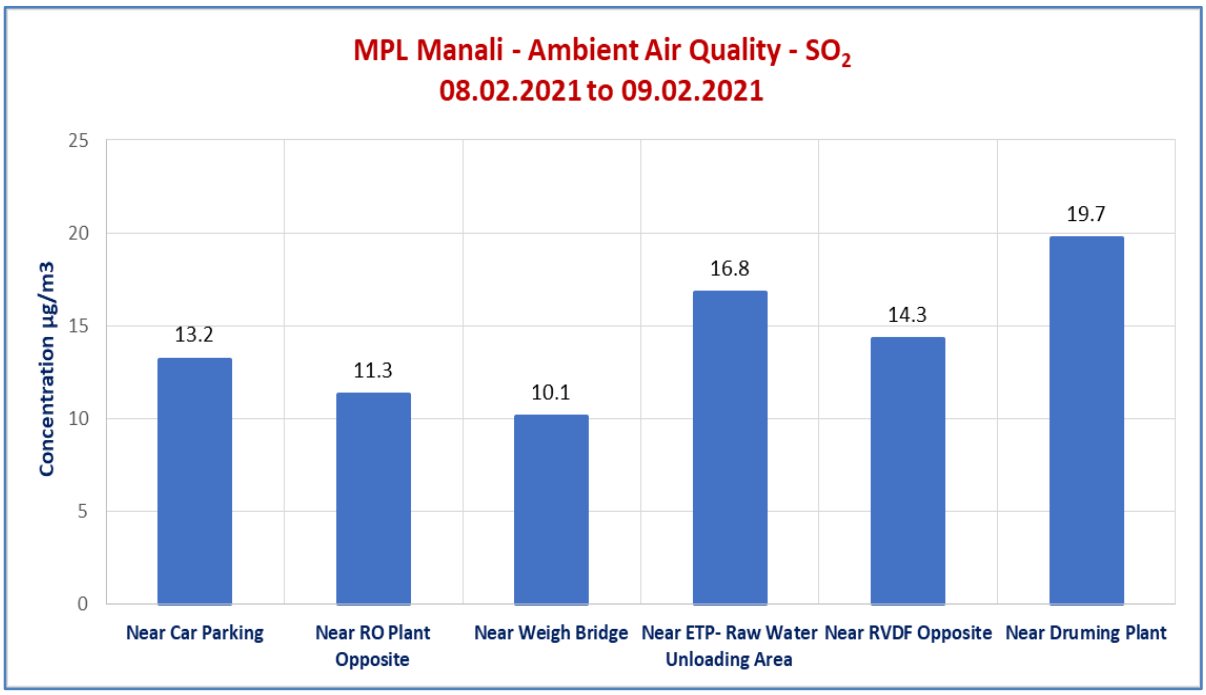
LOCATION - MATERIAL GATE, MANALI				
SAMPLING DATE & TIME 09.02.2021 [18:00 Hrs] – 10.02.2021 [02:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	18:00 -19:00	µg/m^3	31.44	76.64
2	19:00 -20:00	µg/m^3	28.35	73.18
3	20:00 -21:00	µg/m^3	32.99	75.19
4	21:00 -22:00	µg/m^3	30.04	68.82
5	22:00 -23:00	µg/m^3	32.1	74.11
6	23:00 -00:00	µg/m^3	36.98	97.28
7	00:00 -01:00	µg/m^3	38.53	92.75
8	01:00 -02:00	µg/m^3	50.65	157.77
8 HOURS AVERAGE			**35.13**	**89.47**

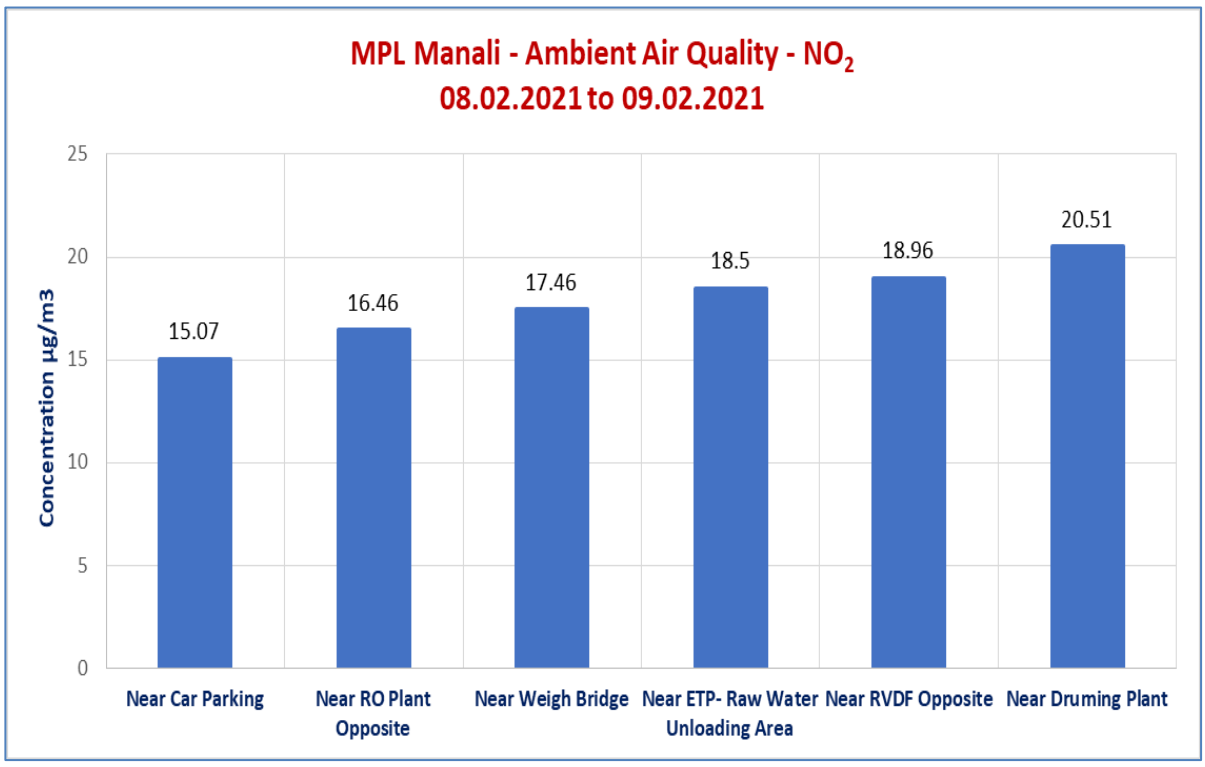
AAQM Consolidated Monitoring Results:

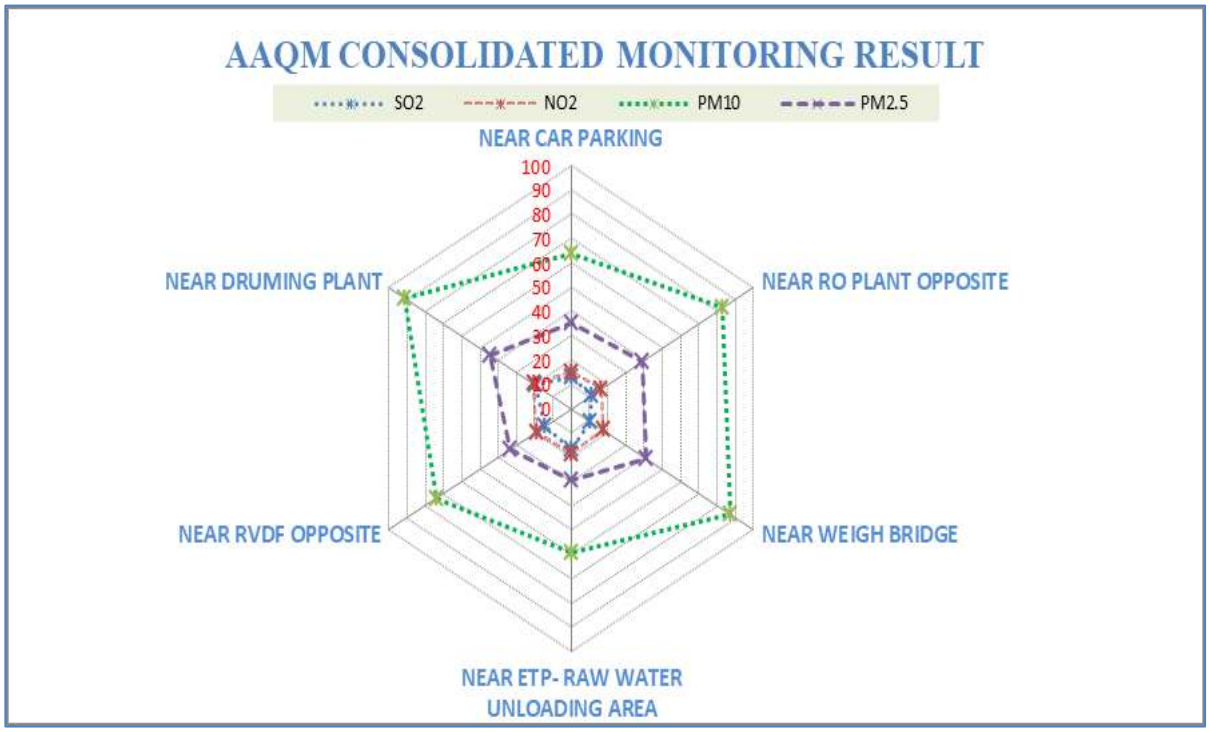
AAQM Consolidated Monitoring Results (µg/m3)				
[08.02.2021 to 09.02.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
Near Car Parking	13.2	15.07	63.8	35.4
Near RO Plant Opposite	11.3	16.46	82.6	38.8
Near Weigh Bridge	10.1	17.46	87.3	40.9
Near ETP- Raw Water Unloading Area	16.8	18.5	59.1	29.3
Near RVDF Opposite	14.3	18.96	73.5	33.9
Near Druming Plant	19.7	20.51	91.3	44.3

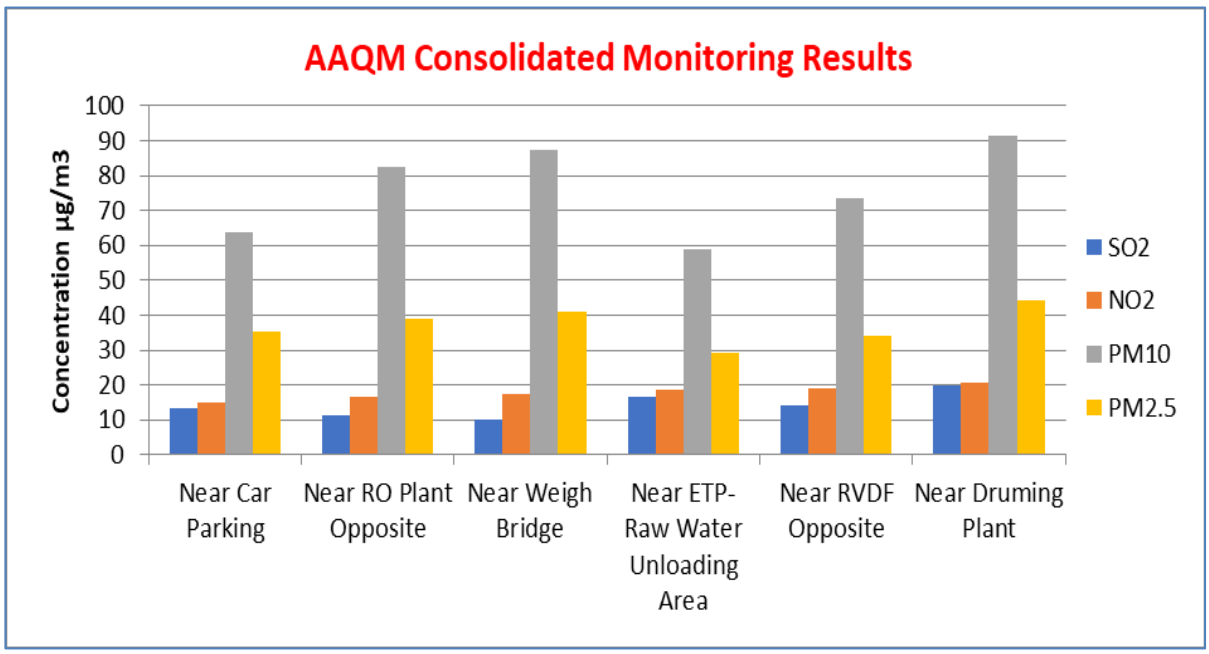

MPL Manali - Ambient Air Quality - PM2.5
08.02.2021 to 09.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
35.4
38.8
40.9
29.3
33.9
44.3
Near Car Parking
Near RO Plant Opposite
Near Weigh Bridge
Near ETP- Raw Water Unloading Area
Near RVDF Opposite
Near Druming Plant

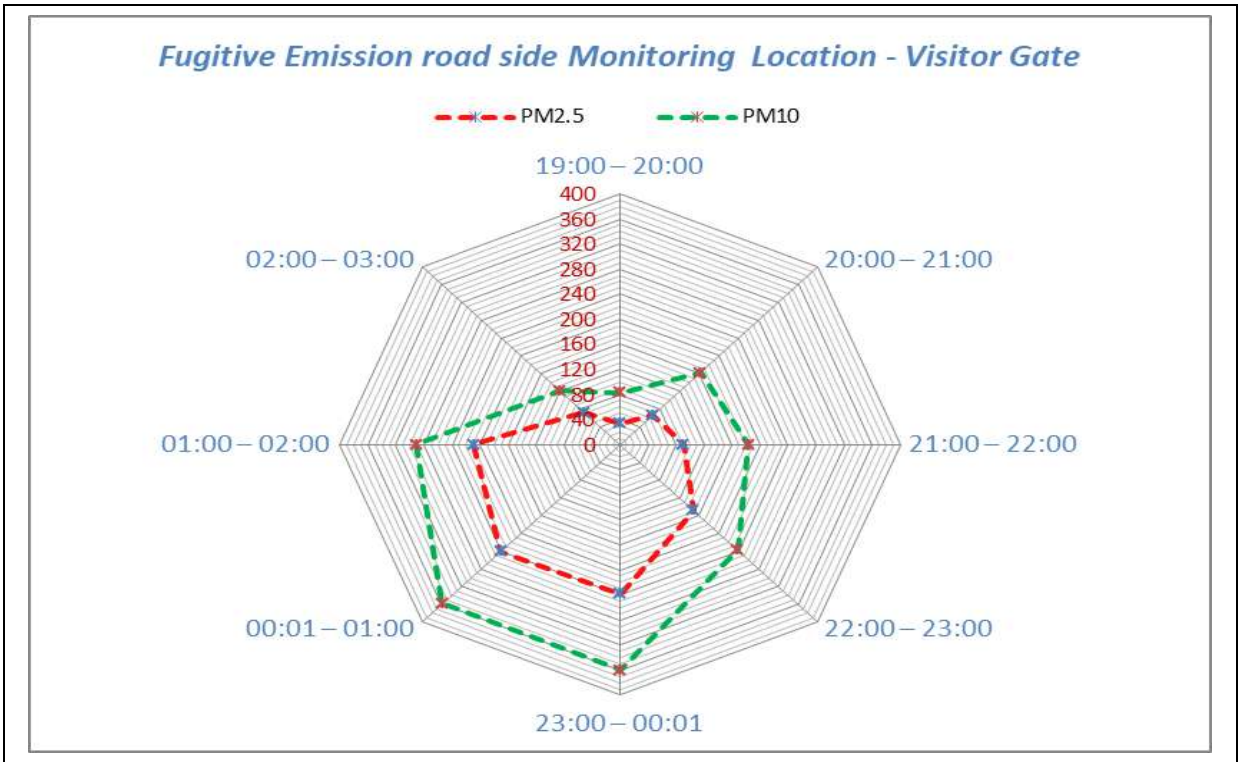

MFL Manali - Ambient Air Quality - PM10
08.02.2021 to 09.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
63.8
82.6
87.3
59.1
73.5
91.3
Near Car Parking
Near RO Plant Opposite
Near Weigh Bridge
Near ETP- Raw Water Unloading Area
Near RVDF Opposite
Near Druming Plant

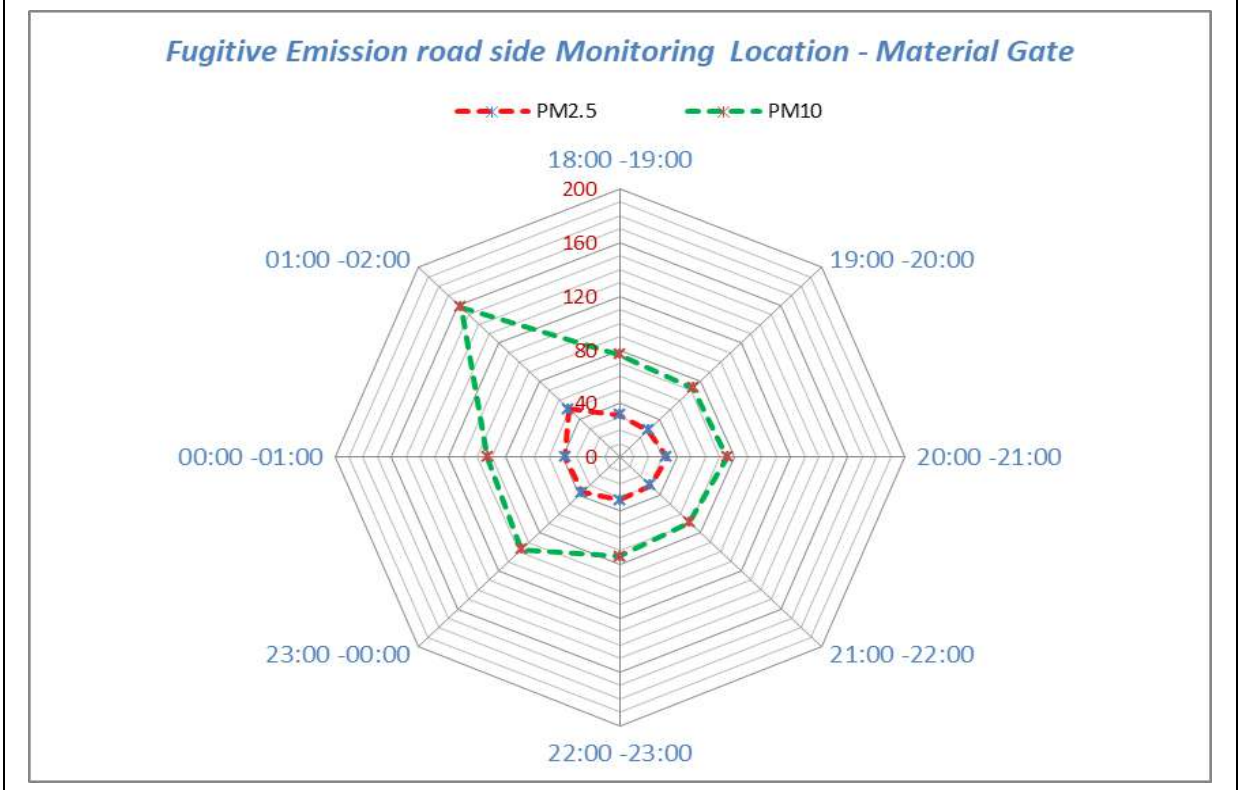

MPL Manali - Ambient Air Quality - SO2
08.02.2021 to 09.02.2021
Concentration µg/m3
25
20
15
10
5
0
13.2
11.3
10.1
16.8
14.3
19.7
Near Car Parking
Near RO Plant Opposite
Near Weigh Bridge
Near ETP- Raw Water Unloading Area
Near RVDF Opposite
Near Druming Plant


MPL Manali - Ambient Air Quality - NO2
08.02.2021 to 09.02.2021
Concentration µg/m3
25
20
15
10
5
0
15.07
16.46
17.46
18.5
18.96
20.51
Near Car Parking
Near RO Plant Opposite
Near Weigh Bridge
Near ETP- Raw Water Unloading Area
Near RVDF Opposite
Near Druming Plant


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NEAR CAR PARKING
NEAR RO PLANT OPPOSITE
NEAR WEIGH BRIDGE
NEAR ETP- RAW WATER UNLOADING AREA
NEAR RVDF OPPOSITE
NEAR DRUMING PLANT
100
90
80
70
60
50
40
30
20
10
0


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
Near Car Parking
Near RO Plant Opposite
Near Weigh Bridge
Near ETP-Raw Water Unloading Area
Near RVDF Opposite
Near Druming Plant
SO2
NO2
PM10
PM2.5


Fugitive Emission road side Monitoring Location - Visitor Gate
PM2.5
PM10
19:00 – 20:00
20:00 – 21:00
21:00 – 22:00
22:00 – 23:00
23:00 – 00:01
00:01 – 01:00
01:00 – 02:00
02:00 – 03:00
400
360
320
280
240
200
160
120
80
40
0


Fugitive Emission road side Monitoring Location - Material Gate
PM2.5
PM10
18:00 -19:00
19:00 -20:00
20:00 -21:00
21:00 -22:00
22:00 -23:00
23:00 -00:00
00:00 -01:00
01:00 -02:00
200
160
120
80
40
0

CONCLUSION:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Car Parking, Near RO Plant Opposite, Near Weigh Bridge, Near ETP- Raw Water Unloading Area, Near RVDF Opposite, Near Drumming Plant, Visitor Gate and Material Gate.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 10.1 to 19.7µg/m^3. Highest value of 19.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 15.07 to 20.51µg/m^3. Highest value of 20.51µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 59.1to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.3 to 44.3µg/m^3. Highest value of 41µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 28.35 to 240.91µg/m^3.

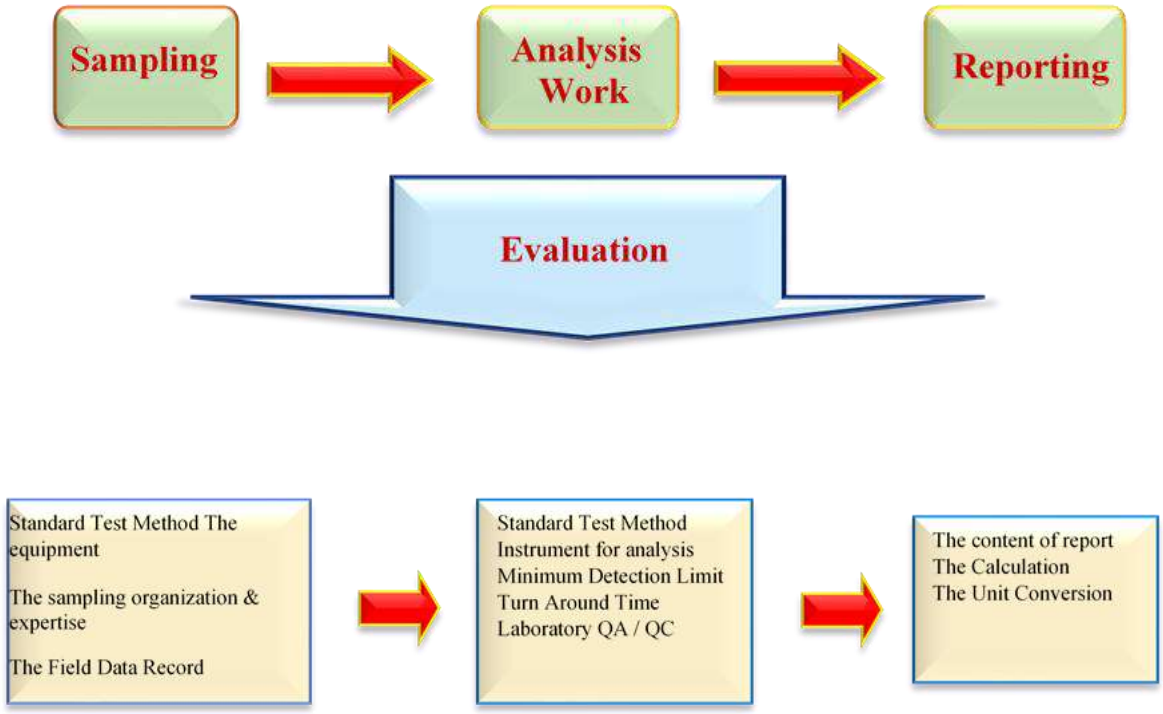
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 68.82 to 359.51µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

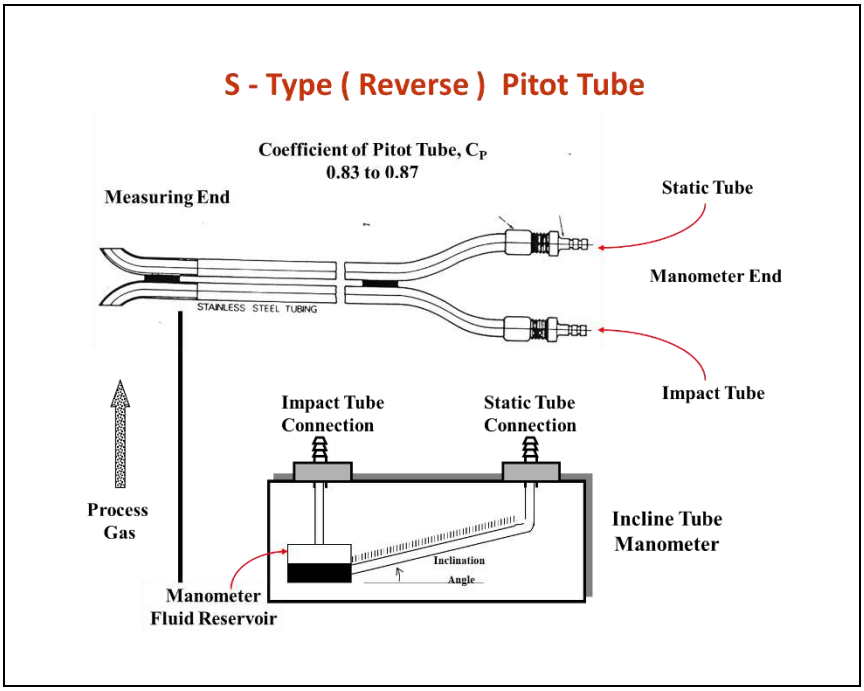


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points:

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

5. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

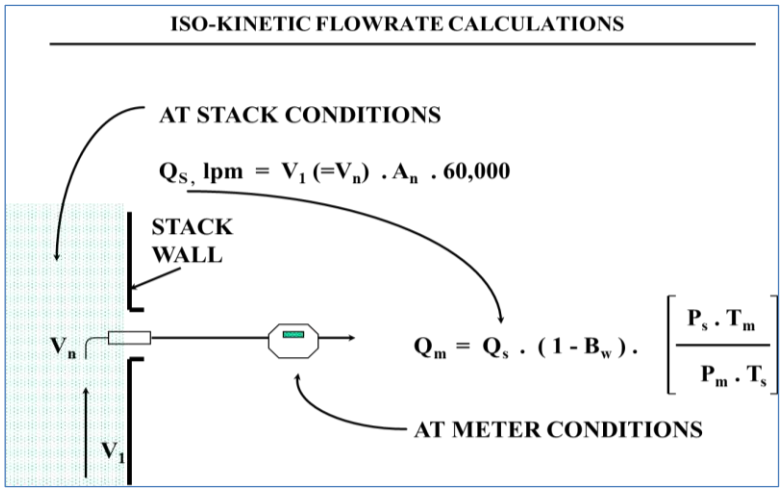
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

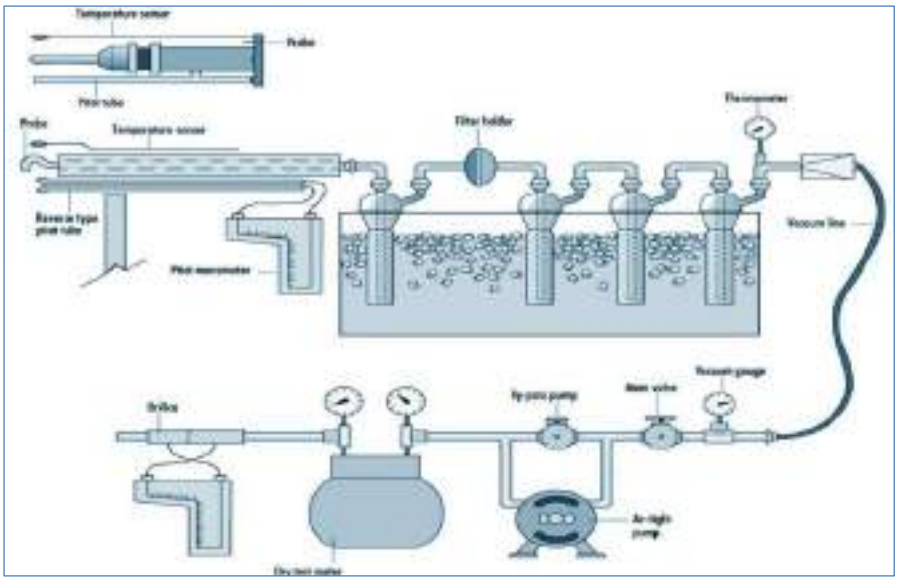
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the

isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading, meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

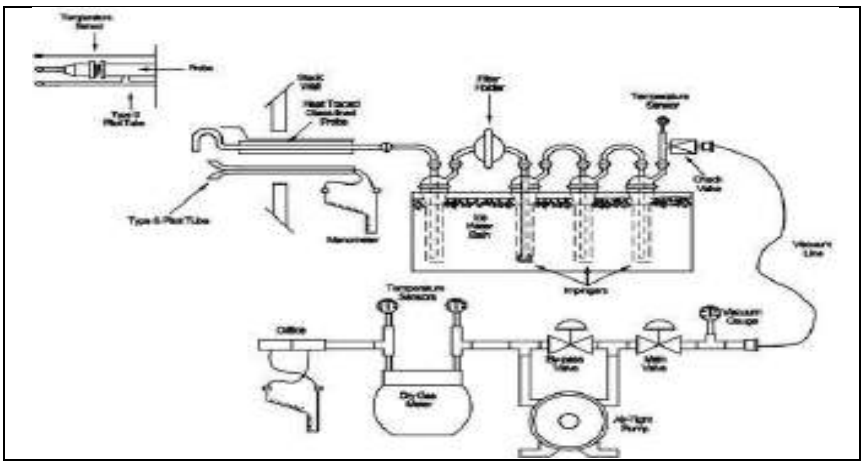
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

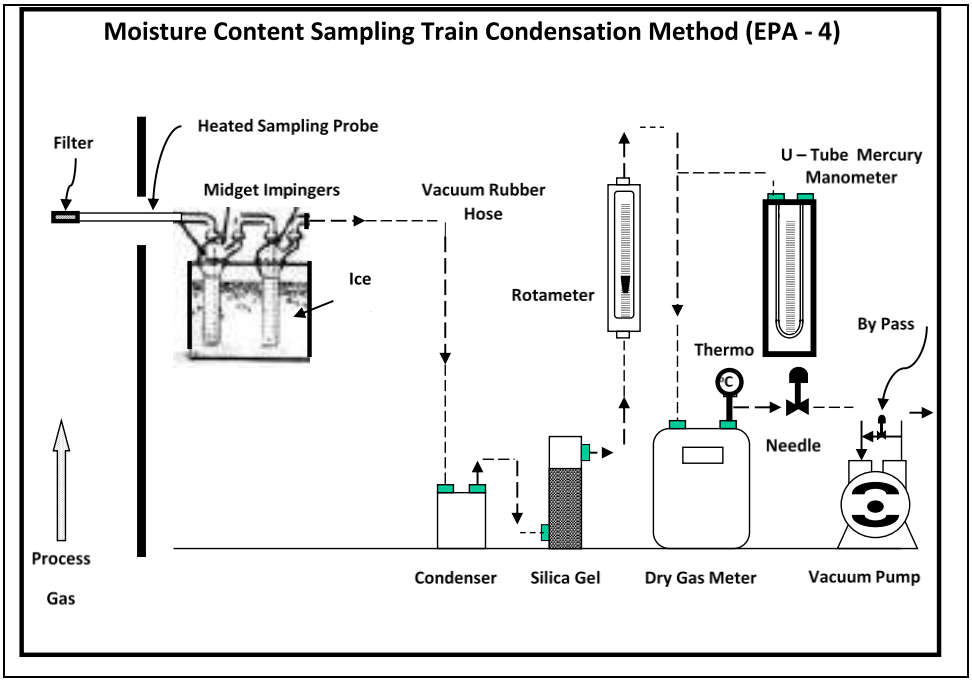
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS: MANALI, TAMILNADU

STACK- 1: M/s. MANALI PETROCHEMICAL LTD PLANT-I, 18 TON BOILER STACK

LOCATION - 18 TON BOILER , MANALI				
S.NO	**POLLUTANT**	**UNIT**	**18 TON BOILER STACK**	**CPCB LIMIT**
1	Stack Temperature	K	398	NA
2	Velocity	m/sec	3.16	NA
3	Volume of Gas Discharge	Nm^3/hr	11713	NA
4	Oxygen as O_2	%	7.90	NA
5	Carbon Monoxide as CO	mg/Nm^3	11.14	150
6	Carbon Dioxide as CO_2	%	9.60	NA
7	Particulate Matter	mg/Nm^3	7.8	10
8	Sulphur Dioxide as SO_2	mg/m^3	BDL(DL:3.0)	50
9	Oxides of Nitrogen as NO_2	mg/Nm^3	47.9	350

The above 18 ton boiler stack complies as per CPCB limit.

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

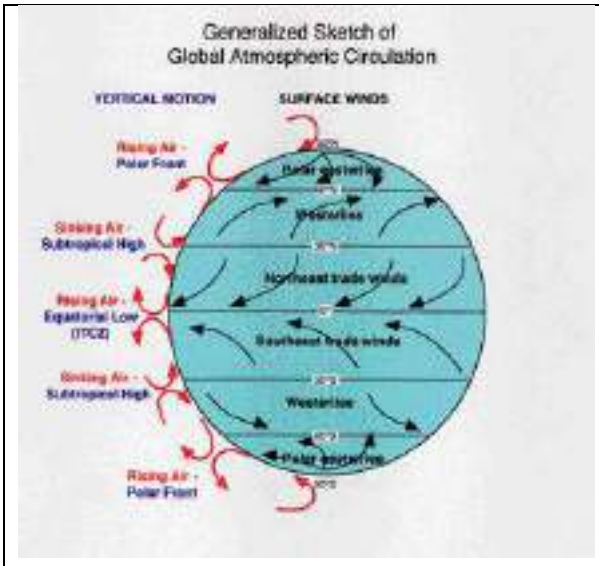
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from Manali Petrochemical Ltd, Manali. For our simulations, the required

source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

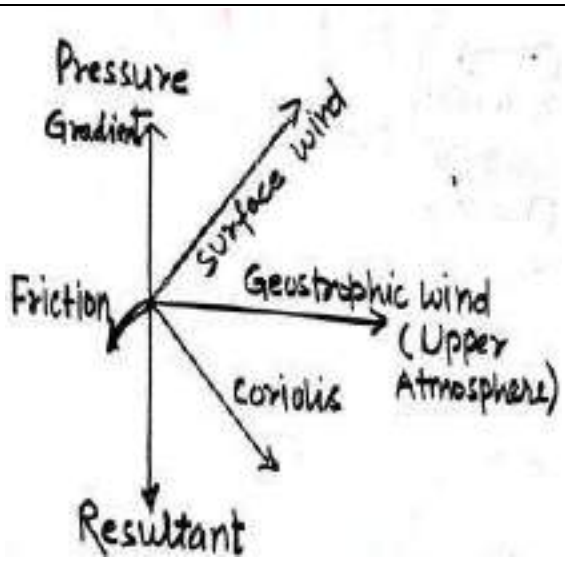
The AERMOD model was applied to study the diffusion of pollutants from Manali Petrochemical Ltd**,** Manali and other sources in three days from 08.02.2021 to 10.02.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

18 TON BOILER

Particulate matter:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	3.16
PM Concentration, mg/m3	-	7.8
Emission load, gm/Sec	-	0.025
Plume rise, m	-	3

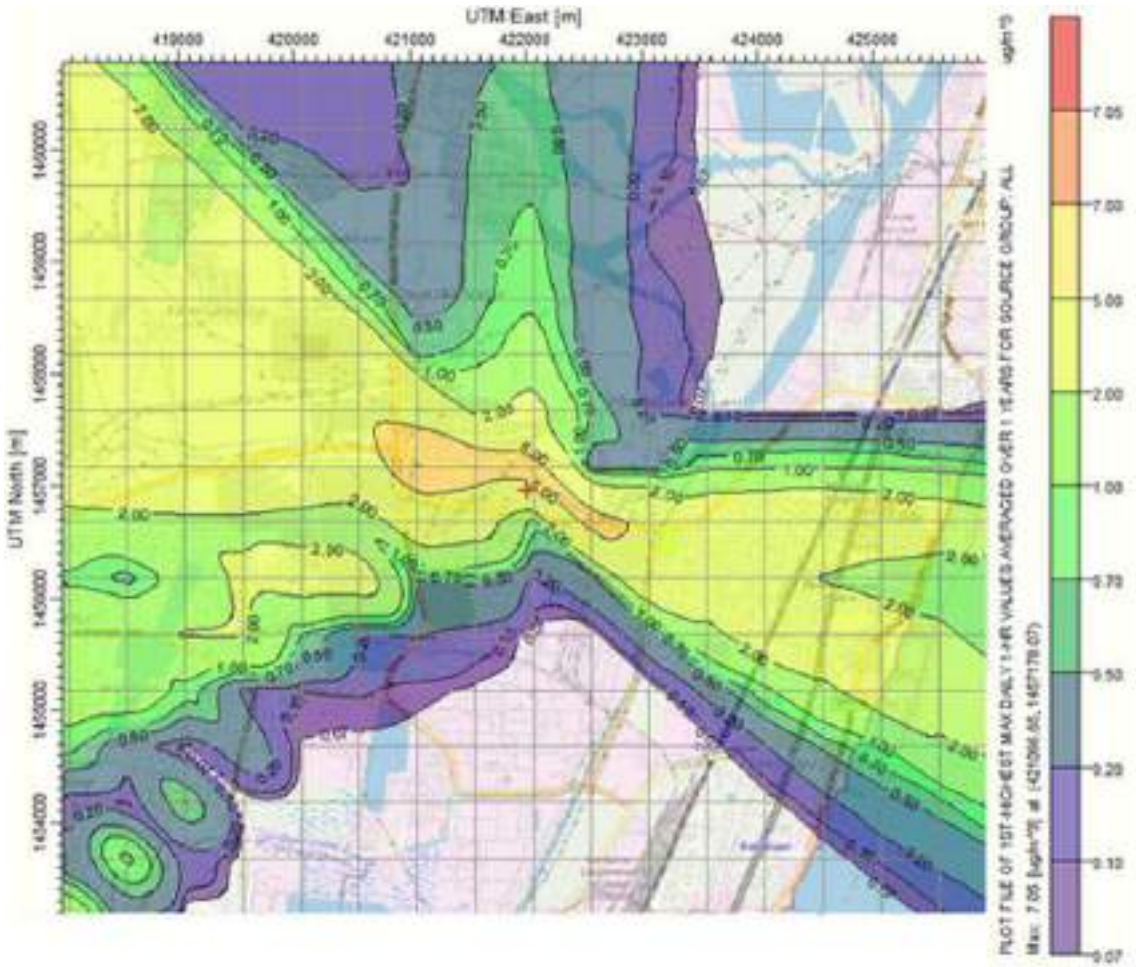
Oxides of Nitrogen as NO2:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	3.16
NOx Concentration, mg/m3	-	47.9
Emission load, gm/Sec	-	0.156
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	30
Exit Velocity, m/Sec	-	3.16
NOx Concentration, mg/m3	-	11.14
Emission load, gm/Sec	-	0.036
Plume rise, m	-	3

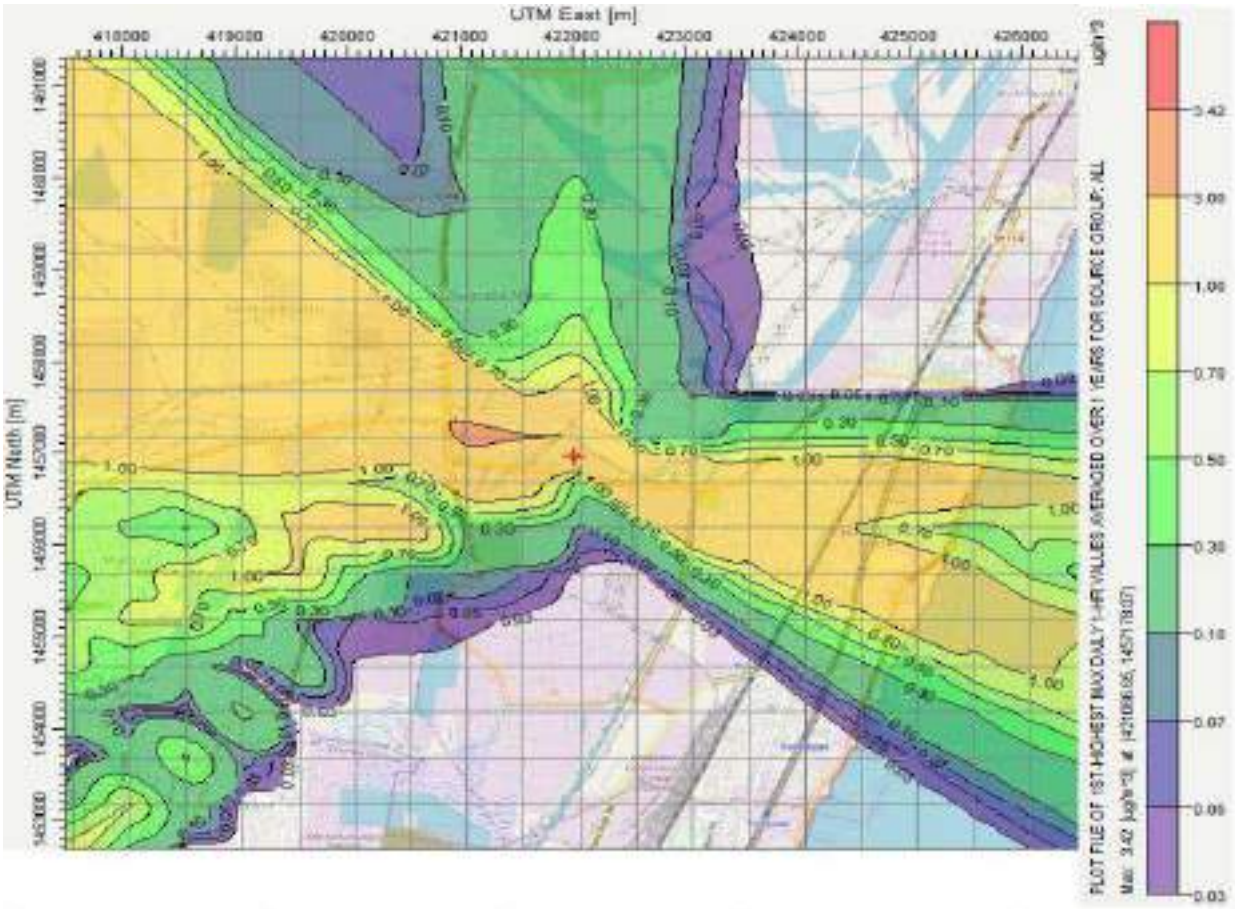
STACK EMISSION DISPERSION MODELLING – MPL-1 18 TON BOILER @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7.8	0.87	0.86	0.077	0.0017

MPL-1 18 TON BOILER emission of Particulate matter concentration is 7.8 mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 0.86µg/m^3 at 2km dispersion Particulate matter is 0.077µg/m^3 and at 5km dispersion Particulate matter is 0.0017µg/m^3 and the predominant wind direction is ENE.

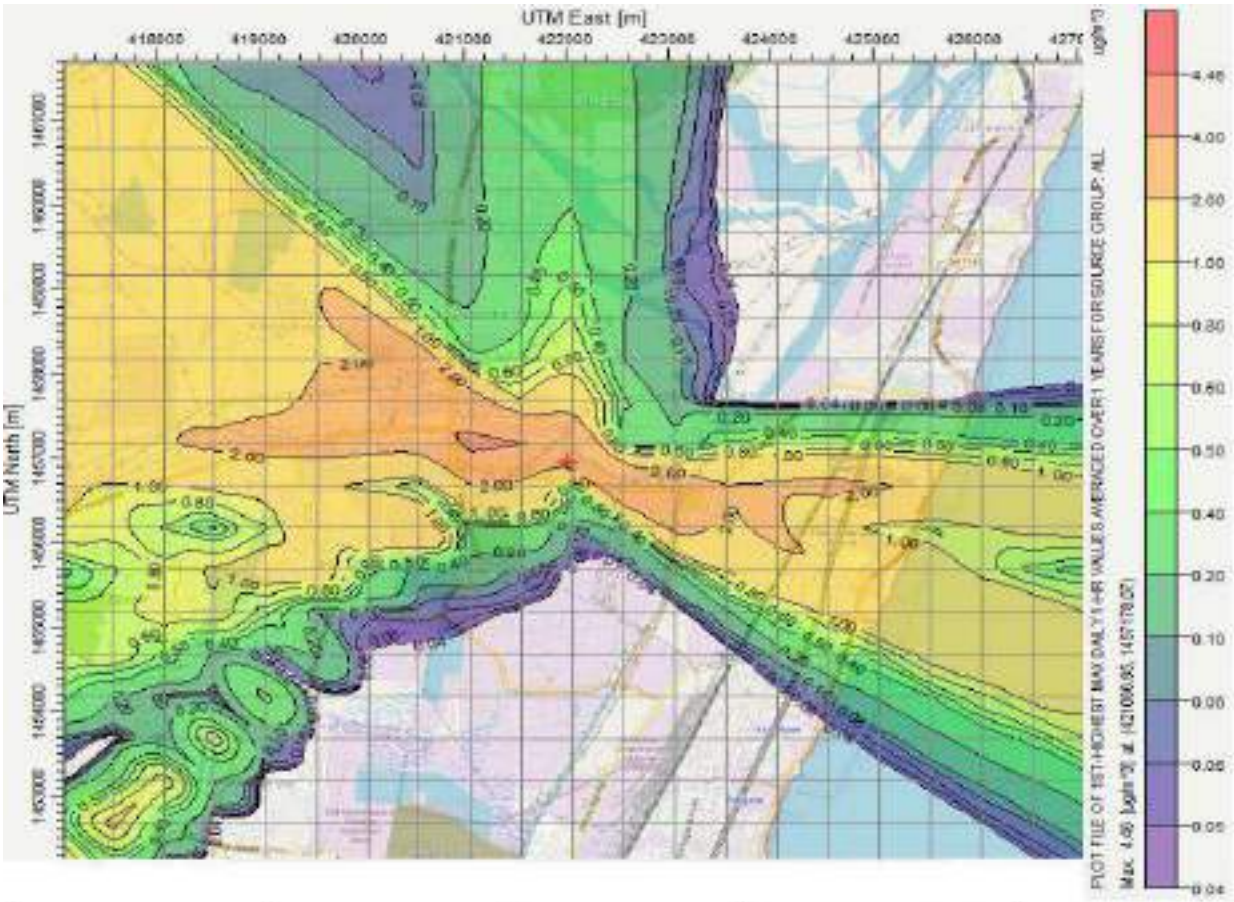
STACK EMISSION DISPERSION MODELLING – MPL-1 18 TON BOILER @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
11.14	0.8	3.42	0.118	0.0322

MPL-1 18 TON BOILER emission of Carbon Monoxide concentration is 11.14mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 3.42µg/m^3 at 2km dispersion Carbon Monoxide is 0.118µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m^3 and the predominant wind direction is ENE.

STACK EMISSION DISPERSION MODELLING – MPL -1 18 TON BOILER @ 2 & 5KM – Oxides of Nitrogen

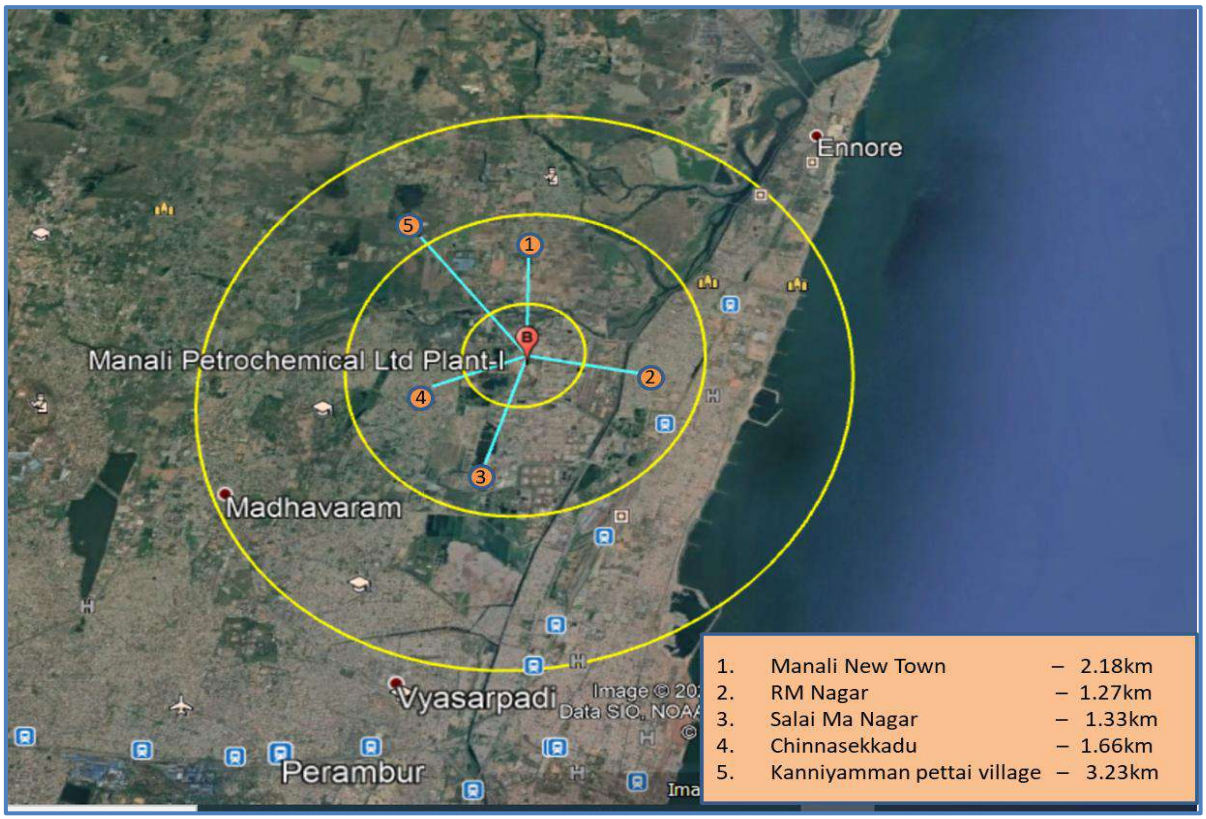


Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
47.9	0.77	4.46	0.273	0.0908

MPL-1 18 TON BOILER emission of Oxides of Nitrogen concentration is 47.9mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 4.46µg/m^3 at 2km dispersion Oxides of Nitrogen is 0.273µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.0908µg/m^3 and the predominant wind direction is ENE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)
18 ton Boiler	PM	7.8	0.87	7.05	0.776	0.0898
18 ton Boiler	CO	11.14	0.8	3.42	0.118	0.0322
18 ton Boiler	NOx	47.9	0.77	4.46	0.273	0.0908



10.0 FINDINGS ON AIR POLLUTION MEASUREMENT RESULTS

10.1 Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Car Parking, Near RO Plant Opposite, Near Weigh Bridge, Near ETP- Raw Water Unloading Area, Near RVDF Opposite, Near Drumming Plant, Visitor Gate and Material Gate.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 10.1 to 19.7µg/m^3. Highest value of 19.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 15.07 to 20.51µg/m^3. Highest value of 20.51µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 59.1to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.3 to 44.3µg/m^3. Highest value of 41µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 28.35 to 240.91µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 68.82 to 359.51µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

10.2 Stack Emission Monitoring

MPL-1 18 TON BOILER emission of Particulate matter concentration is 7.8mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 0.86µg/m^3 at 2km dispersion Particulate matter is 0.0776µg/m^3 and at 5km dispersion Particulate matter is 0.0017µg/m^3 and the predominant wind direction is ENE.

MPL-1 18 TON BOILER emission of Carbon Monoxide concentration is 11.14mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 3.42µg/m3 at 2km dispersion Carbon Monoxide is 0.118µg/m3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m3 and the predominant wind direction is ENE.

MPL-1 18 TON BOILER emission of Oxides of Nitrogen concentration is 47.9mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 4.46µg/m3 at 2km dispersion Oxides of Nitrogen is 0.273µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0908µg/m3 and the predominant wind direction is ENE.

10.3 Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The MPL plant is surrounded by residential areas like 1.Manali New Town, 2.RM Nagar, 3.Salai Ma Nagar, 4.Chinnasekkadu

and 5.Kanniyammanpettai village. From MPL to Manali New Town aerial distance is 2.18km, to RM Nagar is 1.27km, to Salai Ma Nagar is 1.33km, to Chinnasekkadu is 1.66km and to Kanniyammanpettai village is 3.23km.

The cumulative particulate matter emissions from MPL through stacks is 22.1 mg/m^3. The average ground level concentration achieves at an average distance of 0.87km and the sum of PM concentration at GLC is 7.05 $\mu g/m^3$ which includes all the stacks at MPL. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from MPL through stacks is 11.14 mg/m^3. The average ground level concentration achieves at an average distance of 0.8km and the sum of Sulphur Dioxide concentration at GLC is 3.42 $\mu g/m^3$ which includes all the stacks at MPL. It clearly indicates the CO contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MPL through stacks is 47.9 mg/m^3. The average ground level concentration achieves at an average distance of 0.77km and the sum of Nitrogen Oxides concentration at GLC is 4.46 $\mu g/m^3$ which includes all the stacks at MPL. It clearly indicates the NOx contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceeding the National ambient air quality standard for PM, NO_2 and CO. Results from AERMOD simulation indicated that PM, NO_2 and CO emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM, NO_2 and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel in most of the emissions sources so that the emissions from the combustion sources are very much less.

***

Annexure-X

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Manali Petrochemicals Ltd, Unit-II, Manali

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. ABOUT INDUSTRY

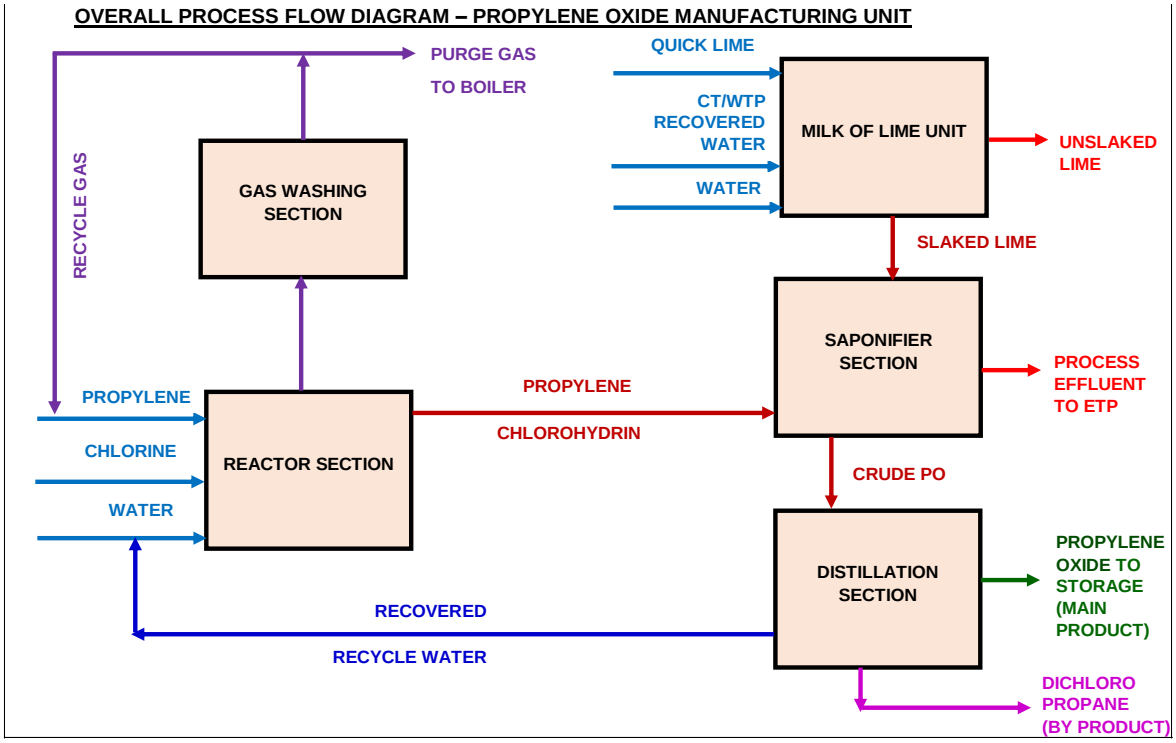
Manali Petrochemicals Limited (MPL) is a leader in the production and marketing of Propylene Oxide (PO), Propylene Glycol (PG) and various grades of Polyols in India. It operates two production facilities (Plant-I and Plant-II) at Manali, near Chennai.

Plant-II is situated at the Sathangadu village, Chennai, adjacent to Balmer Lawrie Ltd., having an installed capacity of 18000 MTPA of PO, 12000 MTPA of PG and 22705 MTPA of Polyol. This Plant has been in operation for more than 3 decades.

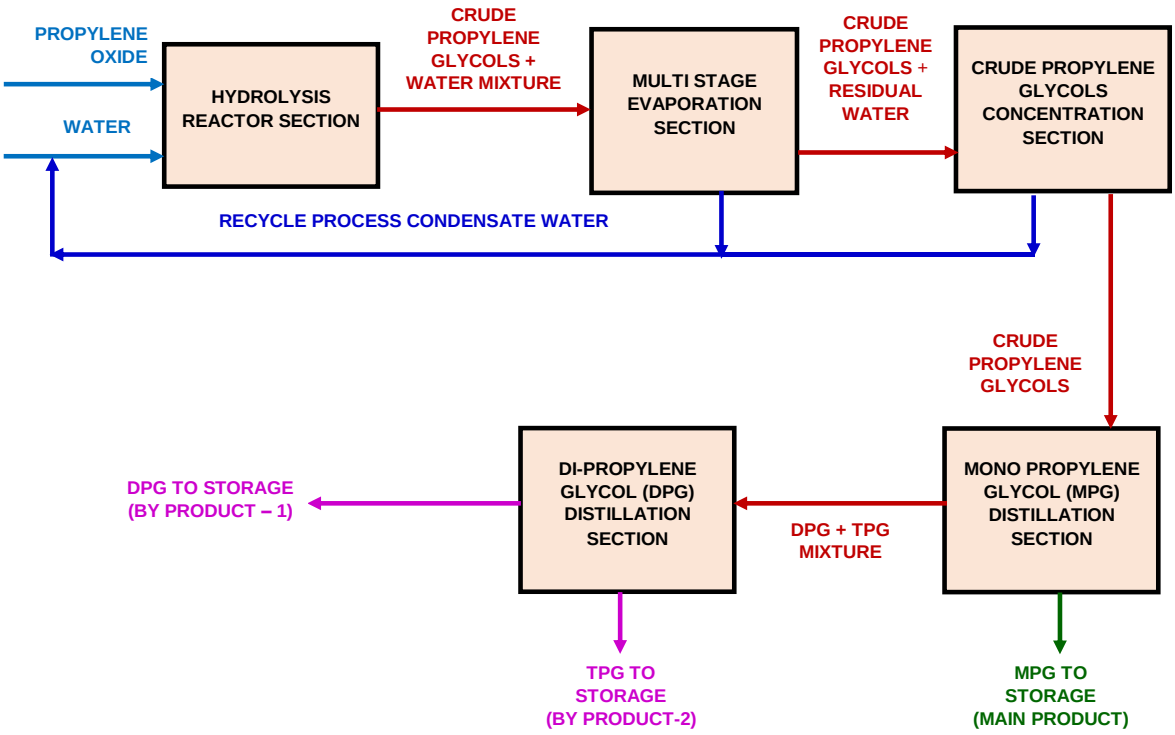
Plant-II was originally established by UB Petro Products Limited. Its commercial production commenced in the year 1990, post which the Plant was taken over by SPIC in 1995. This was further merged with MPL in the year 2000, and remains to be a part of the AMIH Group at present.

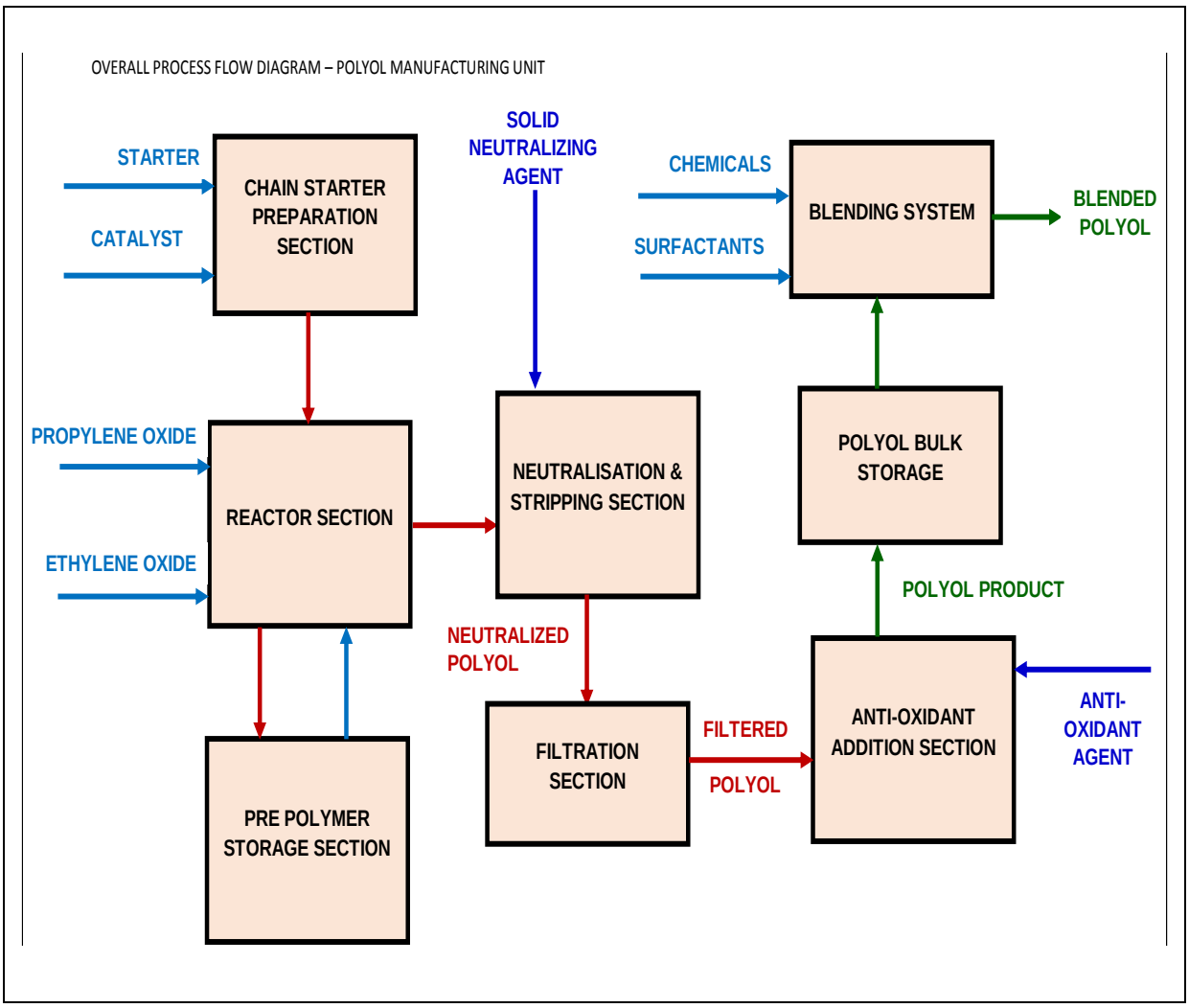
In 2008, the company was granted EC vide J-11011/156/2008-IA(II) dated 7th May 2008 towards Augmentation of Propylene Oxide, Propylene Glycol and Polyol Units at Plant – II. The expansion activities got completed and CTO for expansion granted in 2016 and the units are operating at expanded capacity.

OVERALL PROCESS FLOW DIAGRAM – PROPYLENE OXIDE MANUFACTURING UNIT



OVERALL PROCESS FLOW DIAGRAM – PROPYLENE GLYCOL MANUFACTURING UNIT




OVERALL PROCESS FLOW DIAGRAM – POLYOL MANUFACTURING UNIT
STARTER
CATALYST
CHAIN STARTER PREPARATION SECTION
SOLID NEUTRALIZING AGENT
CHEMICALS
SURFACTANTS
BLENDING SYSTEM
BLENDED POLYOL
PROPYLENE OXIDE
ETHYLENE OXIDE
REACTOR SECTION
NEUTRALISATION & STRIPPING SECTION
POLYOL BULK STORAGE
POLYOL PRODUCT
NEUTRALIZED POLYOL
FILTRATION SECTION
FILTERED POLYOL
ANTI-OXIDANT ADDITION SECTION
ANTI-OXIDANT AGENT
PRE POLYMER STORAGE SECTION

2.0 METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, µg/m^3	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

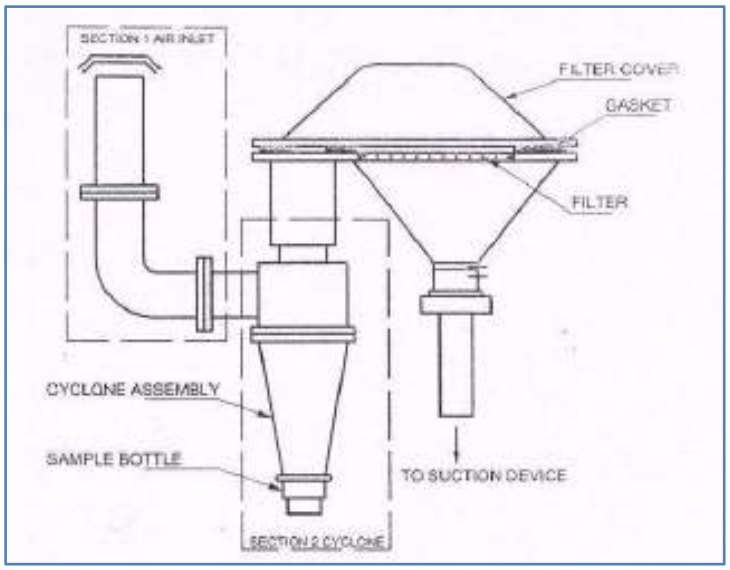
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = (Wf – Wi) x 10^6 / V

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, $\mu g/m^3$	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)

Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter

Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

M2.5 = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80

*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting

50 ml of stock solution to 500 ml with distilled water.

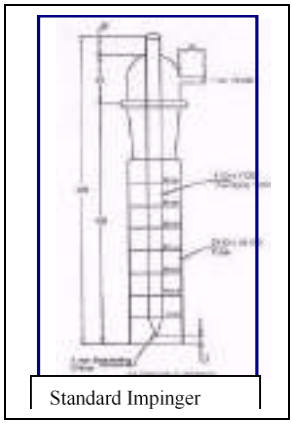
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{o}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml

V1 = Volume of thiosulfate for blank, ml

V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

$C\ SO_2$ = Concentration of Nitrogen dioxide, $\mu g/m^3$
A_s = Absorbance of sample
A_b = Absorbance of reagent blank
CF = Calibration factor
V_a = Volume of air sampled, m^3
V_s = Volume of sample, ml
V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution

is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I_2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^oC.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as

in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ ) = (As - Ab) \times CF / Va$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled in m^3

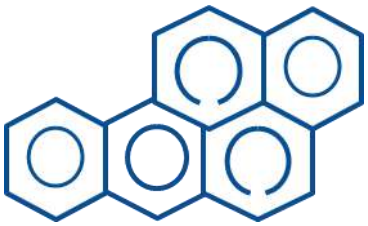
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank.
Plot the calibration curve
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is C20H12 having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH

in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4˚C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various

PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

10 Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
Ultrasonic extraction with Toluene (50 ml × 3 times)
Filter & dry with Anhydrous Sodium Sulphate
Concentration with Rotary Evaporator
Clean up with Silica Gel Column Chromatography
Elution with Cyclo-Hexane (5 ml × 3 times)
Evaporate to nearly dryness under Nitrogen
Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H_2SO_4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.

Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V = Volume of air, m^3

Q = Average sampling rate, m^3/min.

T = Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C = Concentration, µg Metal/M^3.
Ms = Metal Concentration µg/ml
Mb = Blank Concentration µg/ml
Vs = Total Volume of Extraction in ml

Fa = Total Area of Exposed Filter in Cm^2
V = Volume of Air Sampled in M^3
Ft = Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greek method -Ultraviolet Fluorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2%**

of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 Weather Monitoring Data

WEATHER MONITORING DATA AT MPL - 10.02.2021					
Date	Time	Temp (°C)	% RH	Wind Speed [m/sec]	Wind Dir.
10.02.2021	17:00	27	58	13	ESE
10.02.2021	18:00	26	61	15	E
10.02.2021	19:00	25	65	9	E
10.02.2021	20:00	25	65	9	E
10.02.2021	21:00	24	69	9	E
10.02.2021	22:00	24	69	7	E
10.02.2021	23:00	23	74	4	E
11.02.2021	00:00	22	78	4	N
11.02.2021	01:00	22	83	0	N
11.02.2021	02:00	21	83	0	N
11.02.2021	03:00	21	86	0	N
11.02.2021	04:00	20	88	0	N
11.02.2021	05:00	21	88	0	N
11.02.2021	06:00	21	83	0	N
11.02.2021	07:00	22	83	0	N
11.02.2021	08:00	23	80	4	N
11.02.2021	09:00	24	74	4	E
11.02.2021	10:00	27	54	6	E
11.02.2021	11:00	28	51	4	E
11.02.2021	12:00	28	48	7	ESE
11.02.2021	13:00	29	45	7	ESE
11.02.2021	14:00	29	45	17	E
11.02.2021	15:00	28	45	13	ESE
11.02.2021	16:00	28	42	17	ESE
MIN		**20.0**	**42**	**-**	**E**
MAX		**29.0**	**88**	**17.0**	

AVG	24.5	67	6.2	

4.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Ambient Air Quality Monitoring Sampling Location

Stack Emission Monitoring Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR SECURITY GATE

LOCATION - NEAR SECURITY GATE,MANALI			
SAMPLING DATE & TIME 10.02.2021 [15:25 Hrs] – 11.02.2021 [15:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	20.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	26.6
3	Particulate Matter (PM_{10})	$\mu g/m^3$	67.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31.5

5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR CONTROL ROOM

LOCATION - NEAR CONTROL ROOM,MANALI			
SAMPLING DATE & TIME 10.02.2021 [15:35 Hrs] – 11.02.2021 [15:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	21.5
2	Nitrogen Dioxide as NO_2	µg/m^3	27.5
3	Particulate Matter (PM_{10})	µg/m^3	89
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	40.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)

6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR MMS TRANSFORMER

LOCATION - NEAR MMS TRANSFORMER,MANALI			
SAMPLING DATE & TIME 10.02.2021 [15:50 Hrs] – 11.02.2021 [15:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	16.9
2	Nitrogen Dioxide as NO_2	µg/m^3	23.9
3	Particulate Matter (PM_{10})	µg/m^3	82.5
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	39.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)

6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR FURNACE OIL STORAGE TANK

LOCATION - NEAR FURNACE OIL STORAGE TANK,MANALI			
SAMPLING DATE & TIME 10.02.2021 [16:15 Hrs] - 11.02.2021 [16:15 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	19.4
2	Nitrogen Dioxide as NO_2	µg/m^3	25.4
3	Particulate Matter (PM_{10})	µg/m^3	91.4
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	44.3

5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR ETP AREA

LOCATION - NEAR ETP AREA,MANALI			
SAMPLING DATE & TIME 10.02.2021 [16:30 Hrs] – 11.02.2021 [16:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	17.9
2	Nitrogen Dioxide as NO_2	µg/m^3	28.5
3	Particulate Matter (PM_{10})	µg/m^3	79
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	36.6

5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. MANALI PETROCHEMICAL LTD PLANT-II, NEAR RAW MATERIAL GODOWN

LOCATION - NEAR RAW MATERIAL GODOWN,MANALI			
SAMPLING DATE & TIME 10.02.2021 [16:45 Hrs] – 11.02.2021 [16:45 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	15.7
2	Nitrogen Dioxide as NO_2	µg/m^3	22.9
3	Particulate Matter (PM_{10})	µg/m^3	58.4

4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28.9
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 7: M/s. MANALI PETROCHEMICAL LTD PLANT-II, VEL MUTHUMARI AMMAN TEMPLE-NEAR MAIN GATE

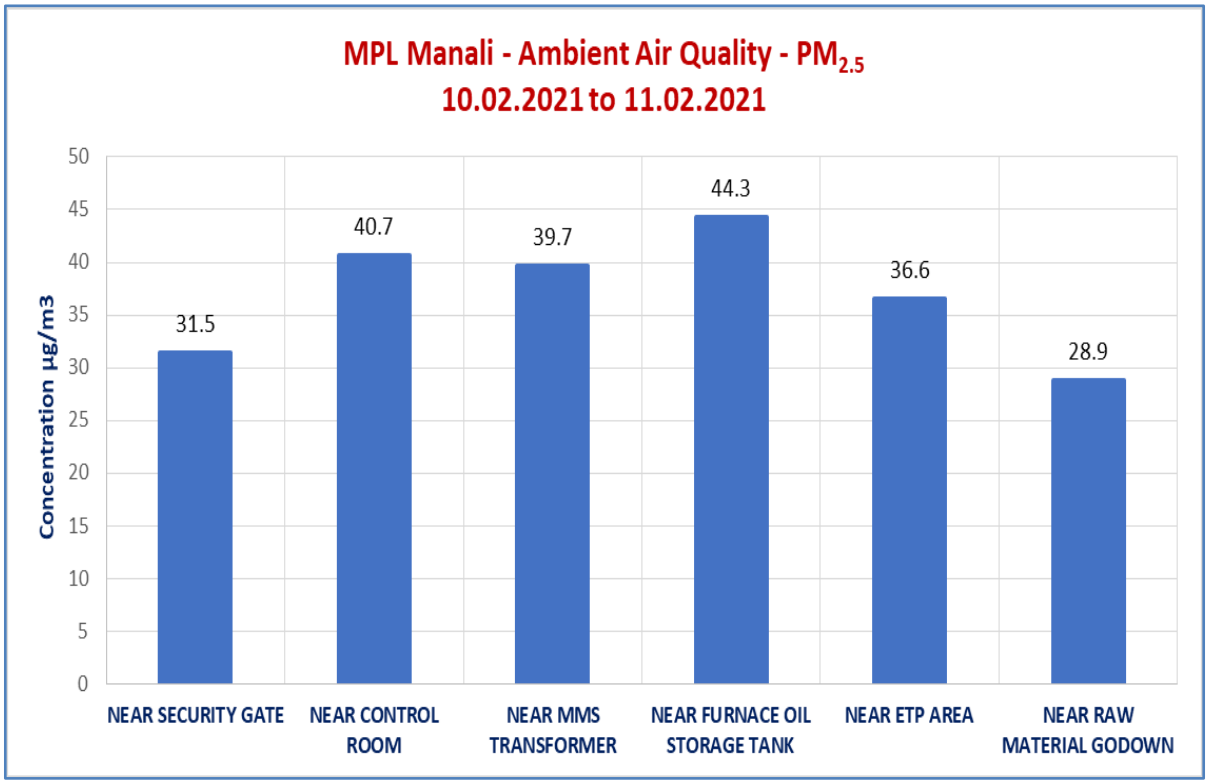
LOCATION - VEL MUTHUMARI AMMAN TEMPLE-NEAR MAIN GATE, MANALI				
SAMPLING DATE & TIME 11.02.2021 [09:00 Hrs] – 11.02.2021 [17:00 Hrs]				
S.NO	**TIME**	**UNIT**	**PARTICULATE MATTER (PM 2.5)**	**PARTICULATE MATTER (PM 10)**
1	09:00-10:00	$\mu g/m^3$	77.55	119.4
2	10:00-11:00	$\mu g/m^3$	49.45	157.23

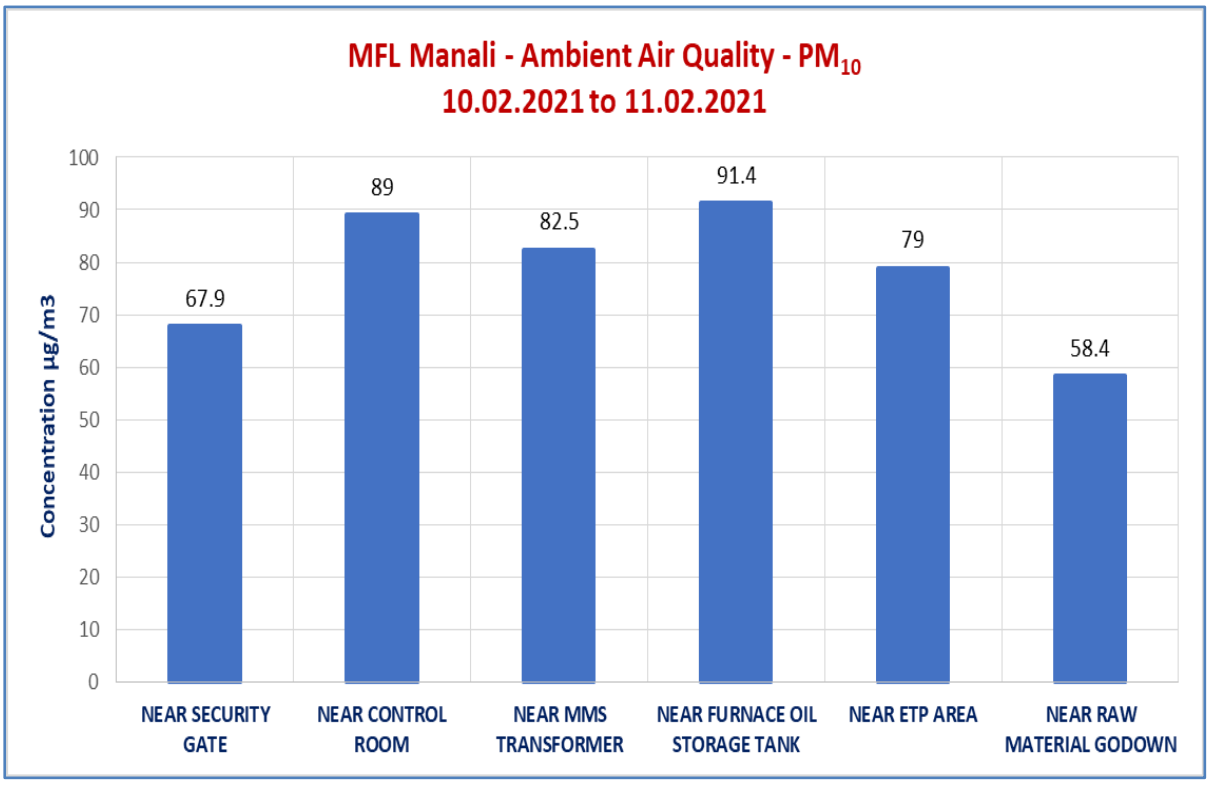
3	11:00-12:00	µg/m^3	33.27	241.97
4	12:00-13:00	µg/m^3	33.05	204.09
5	13:00 – 14:00	µg/m^3	31.5	241
6	14:00 – 15:00	µg/m^3	29.02	206.91
7	15:00 – 16:00	µg/m^3	23.14	144.05
8	16:00 – 17:00	µg/m^3	14.13	57.94
8 HOURS AVERAGE			**36.39**	**171.57**

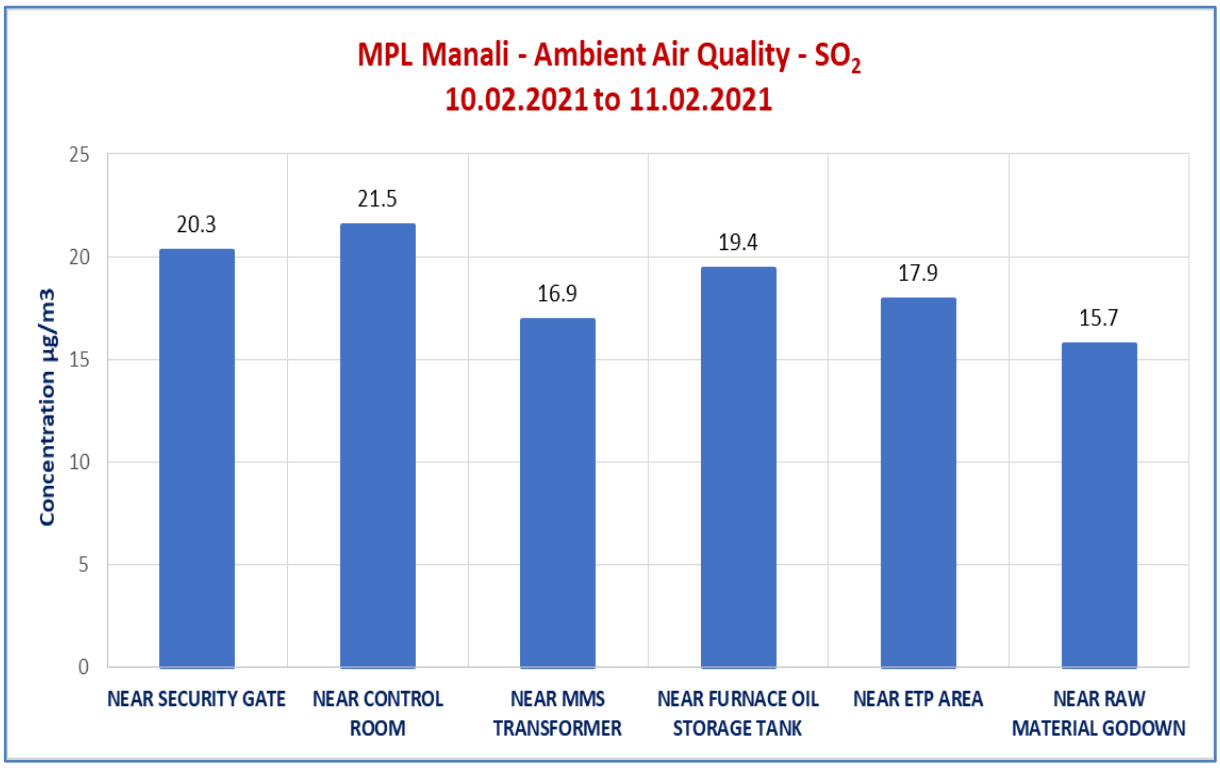
AAQM Consolidated Monitoring Results:

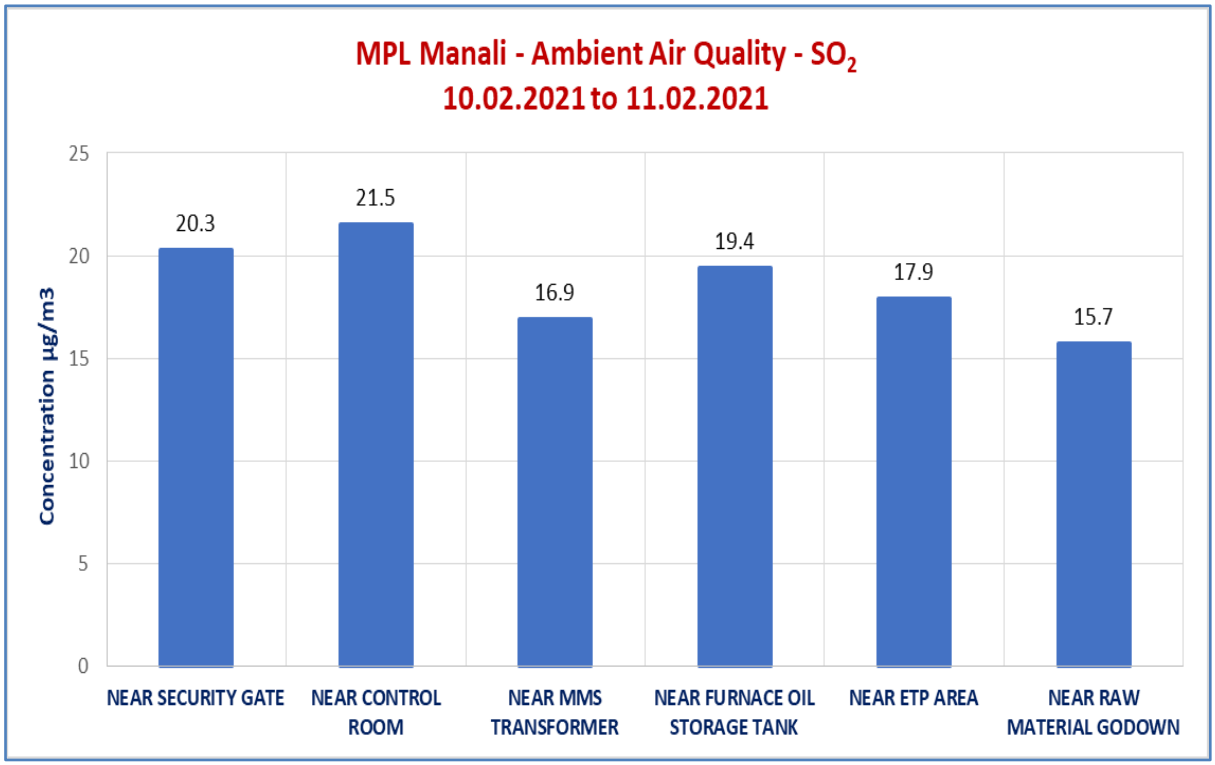
AAQM Consolidated Monitoring Results (µg/m3)				
[10.02.2021 to 11.02.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
NEAR SECURITY GATE	20.3	26.6	67.9	31.5

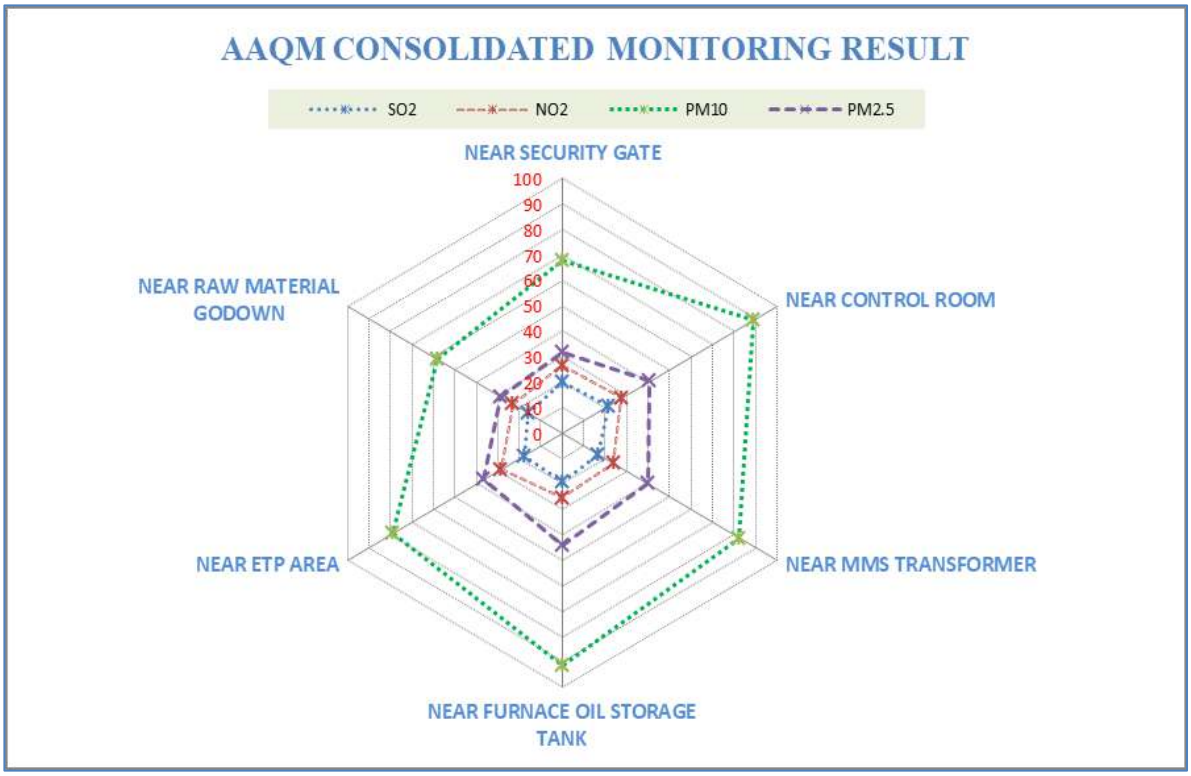
NEAR CONTROL ROOM	21.5	27.5	89	40.7
NEAR MMS TRANSFORMER	16.9	23.9	82.5	39.7
NEAR FURNACE OIL STORAGE TANK	19.4	25.4	91.4	44.3
NEAR ETP AREA	17.9	28.5	79	36.6
NEAR RAW MATERIAL GODOWN	15.7	22.9	58.4	28.9

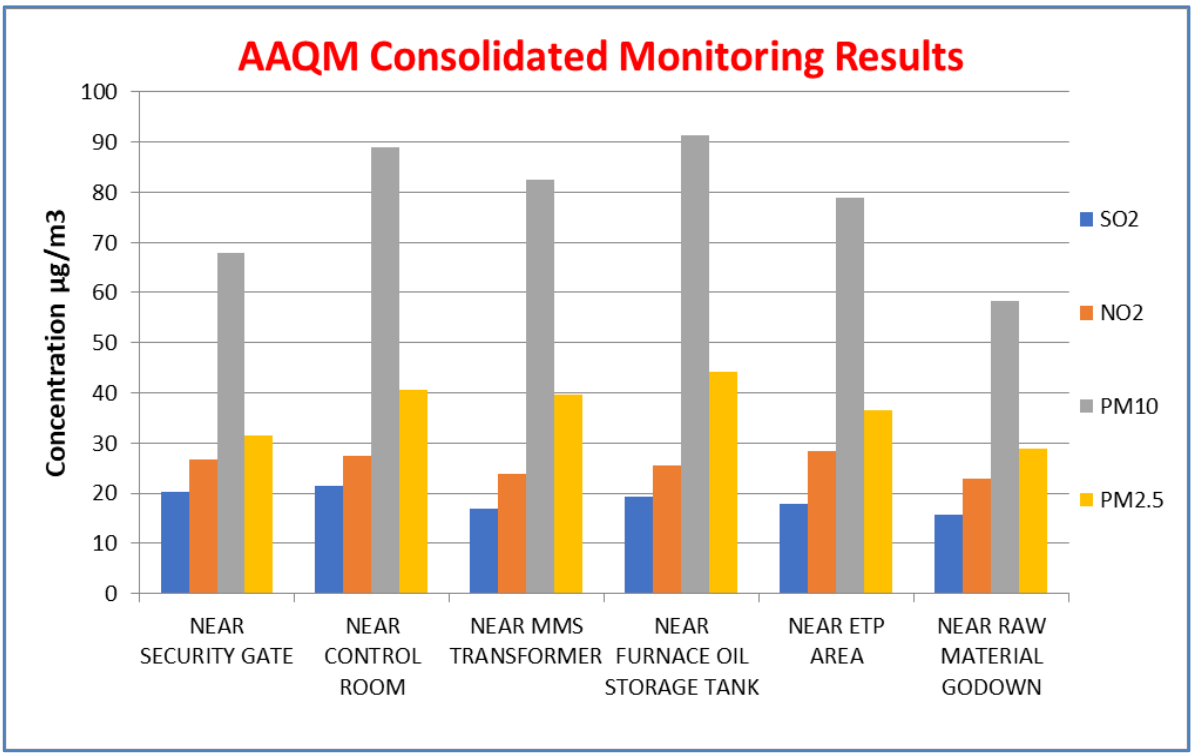

MPL Manali - Ambient Air Quality - PM2.5
10.02.2021 to 11.02.2021
Concentration µg/m3
50
45
40
35
30
25
20
15
10
5
0
31.5
40.7
39.7
44.3
36.6
28.9
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN

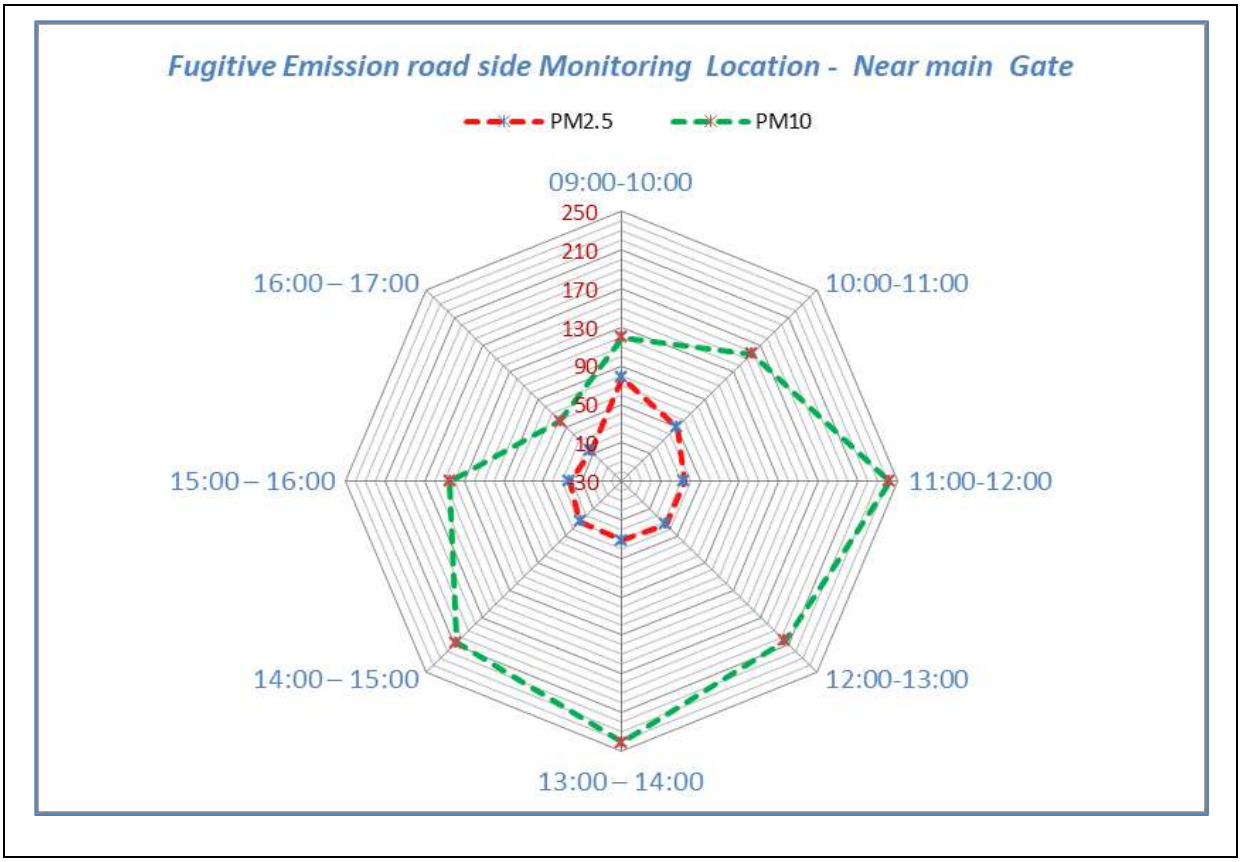

MFL Manali - Ambient Air Quality - PM10
10.02.2021 to 11.02.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
67.9
89
82.5
91.4
79
58.4
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN


MPL Manali - Ambient Air Quality - SO2
10.02.2021 to 11.02.2021
Concentration µg/m3
25
20
15
10
5
0
20.3
21.5
16.9
19.4
17.9
15.7
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN


MPL Manali - Ambient Air Quality - SO2
10.02.2021 to 11.02.2021
Concentration µg/m3
25
20
15
10
5
0
20.3
21.5
16.9
19.4
17.9
15.7
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN
100
90
80
70
60
50
40
30
20
10
0


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NEAR SECURITY GATE
NEAR CONTROL ROOM
NEAR MMS TRANSFORMER
NEAR FURNACE OIL STORAGE TANK
NEAR ETP AREA
NEAR RAW MATERIAL GODOWN
SO2
NO2
PM10
PM2.5


Fugitive Emission road side Monitoring Location - Near main Gate
PM2.5
PM10
09:00-10:00
10:00-11:00
11:00-12:00
12:00-13:00
13:00 – 14:00
14:00 – 15:00
15:00 – 16:00
16:00 – 17:00
250
210
170
130
90
50
10
30

CONCLUSION:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Control Room, Near MMS Transformer, Near Furnace Oil Storage Tank, Near ETP Area, Near Raw Material Godown, Near Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.7 to 21.5µg/m^3. Highest value of 21.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 22.9 to 28.5µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 58.4 to 91.4µg/m^3. Highest value of 91.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.9 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 14.13 to 77.55µg/m^3.

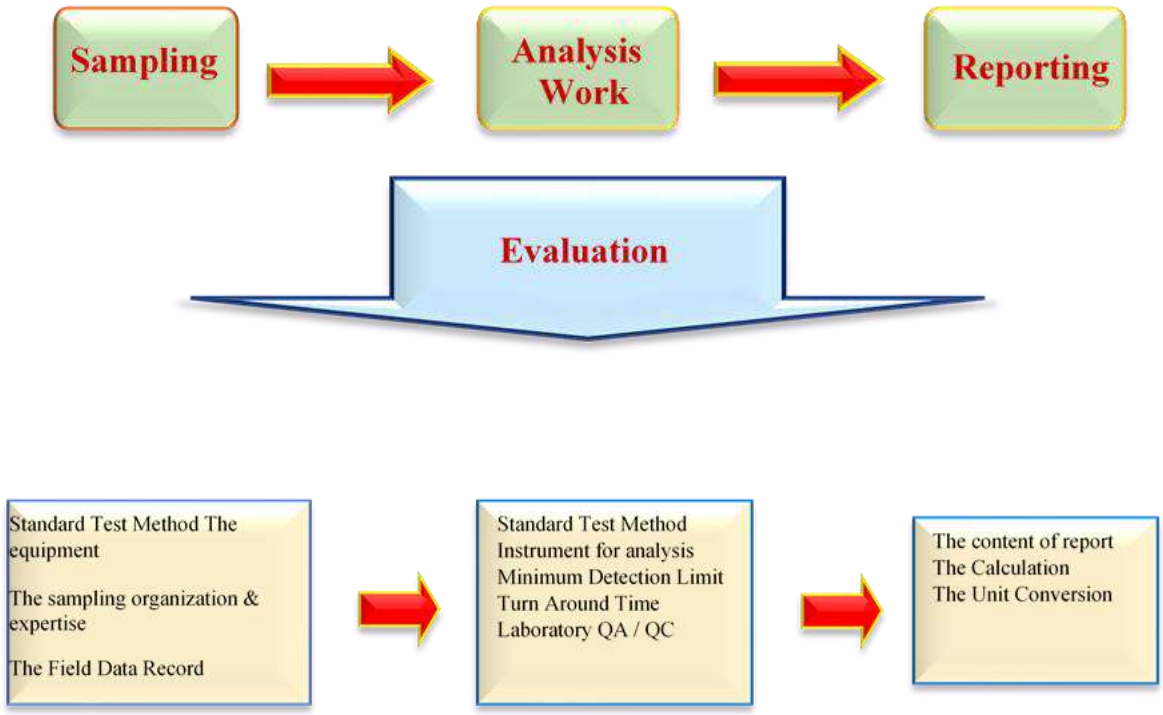
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 57.94 to 241.97µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

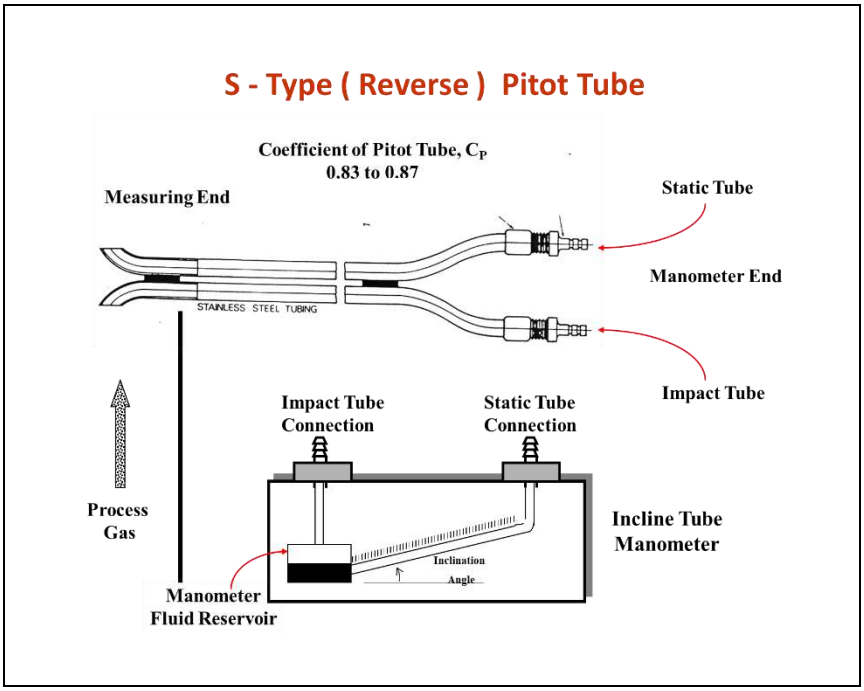


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

Exhaust Gas Volume Stream

Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: *Field Sampling Procedure:*

Duct Cross section and Number of Traverse Points :

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

5. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

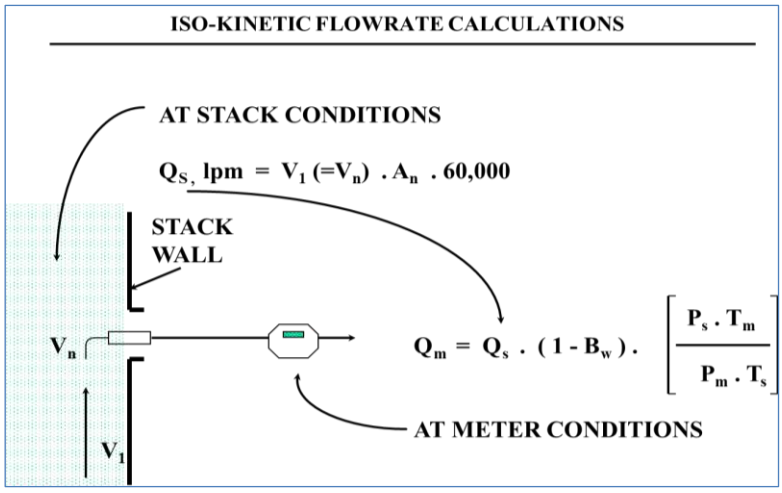
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

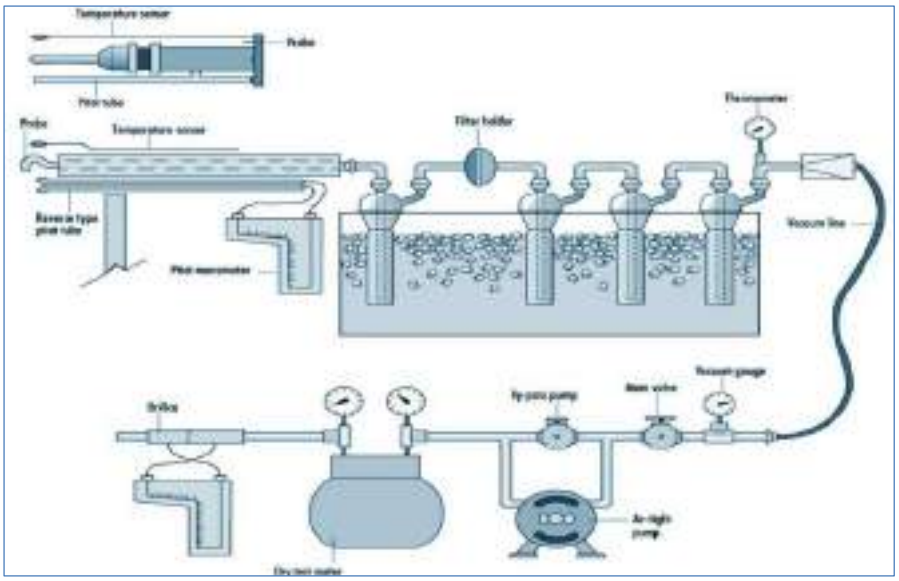
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

- ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride, $BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the

isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading, meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of $S0_2$ along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

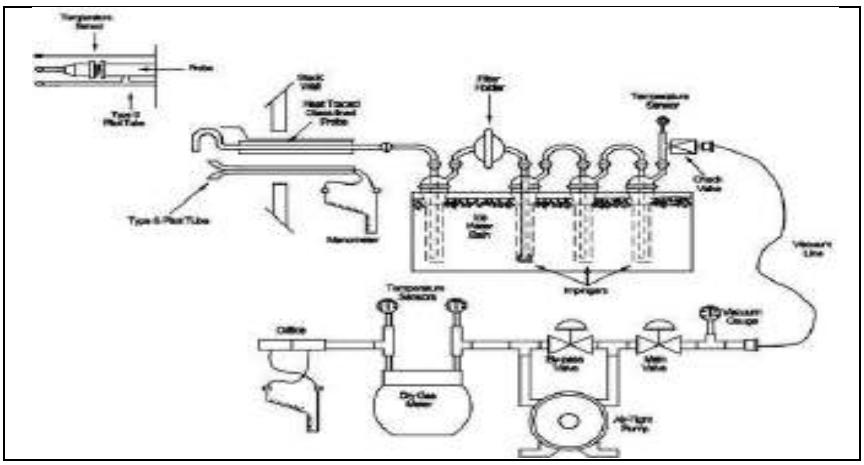
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of $S0_2$ in the gases is determined using the same expression for $S0_3$ by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

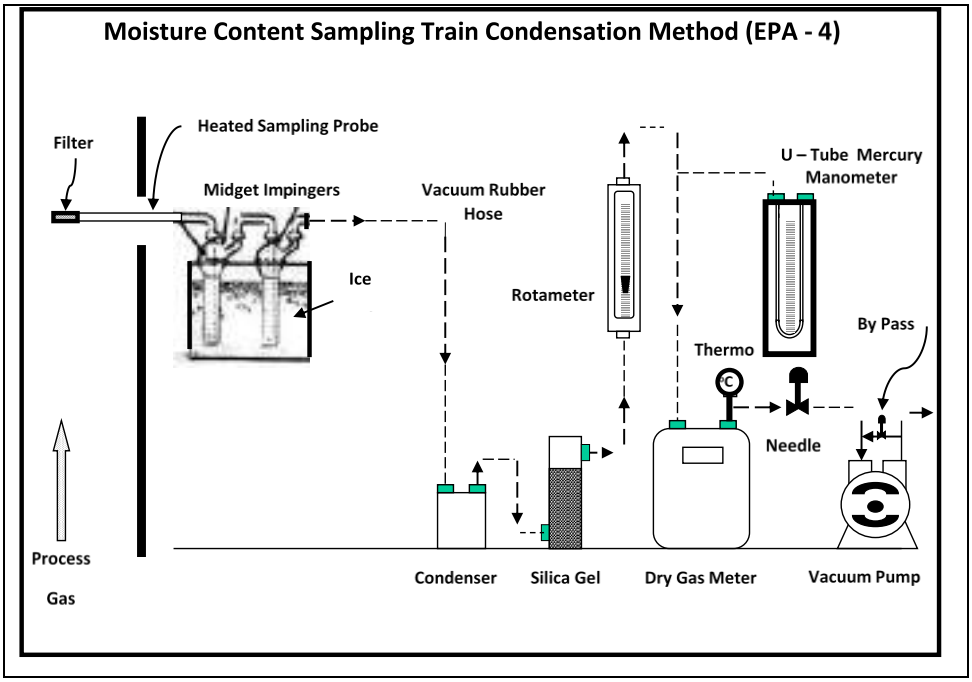
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS

STACK- 8: M/s. MANALI PETROCHEMICAL LTD PLANT-II, 18 TON BOILER STACK

LOCATION - 18 TON BOILER , MANALI				
S.NO	**POLLUTANT**	**UNIT**	**18 TON BOILER STACK**	**CPCB LIMIT**
1	Stack Temperature	K	447	NA
2	Velocity	m/sec	4.41	NA
3	Volume of Gas Discharge	Nm^3/hr	18687	NA
4	Oxygen as O_2	%	5.9	NA
5	Carbon Monoxide as CO	mg/Nm^3	5	NA
6	Carbon Dioxide as CO_2	%	11.1	NA
7	Particulate Matter	mg/Nm^3	26	150
8	Sulphur Dioxide as SO_2	mg/Nm^3	308	NA
9	Oxides of Nitrogen as NO_2	mg/Nm^3	363	NA

The above 18 ton boiler stack complies as per CPCB limit.

8.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

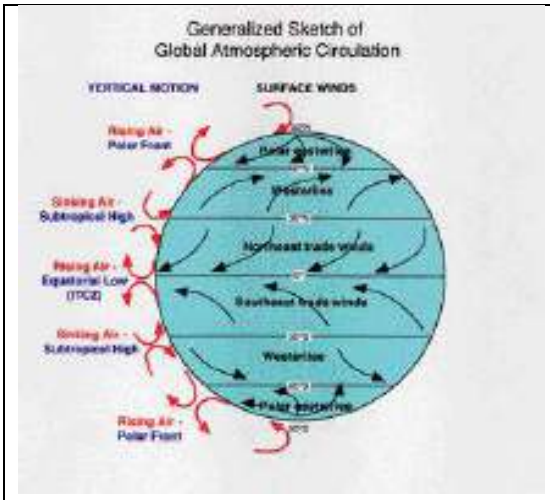
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from Manali Petrochemical Ltd Plant-II, Manali. For our simulations, the

required source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

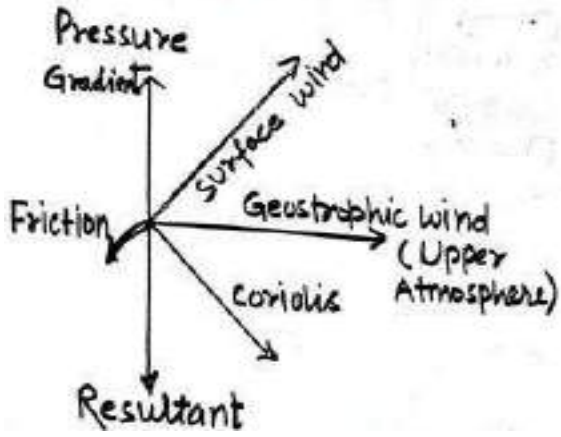
The AERMOD model was applied to study the diffusion of pollutants from Manali Petrochemical Ltd Plant-II, Manali and other sources in two days from 10.02.2021 to 11.02.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

18 TPH BOILER

Particulate matter:

Stack Height, m	-	30.5
Exit Velocity, m/Sec	-	4.41
PM Concentration, mg/m3	-	26
Emission load, gm/Sec	-	0.1349
Plume rise, m	-	3

Sulphur dioxide as SO_2:

Stack Height, m	-	30.5
Exit Velocity, m/Sec	-	4.41
SO_2 Concentration, mg/m3	-	308
Emission load, gm/Sec	-	1.60
Plume rise, m	-	3

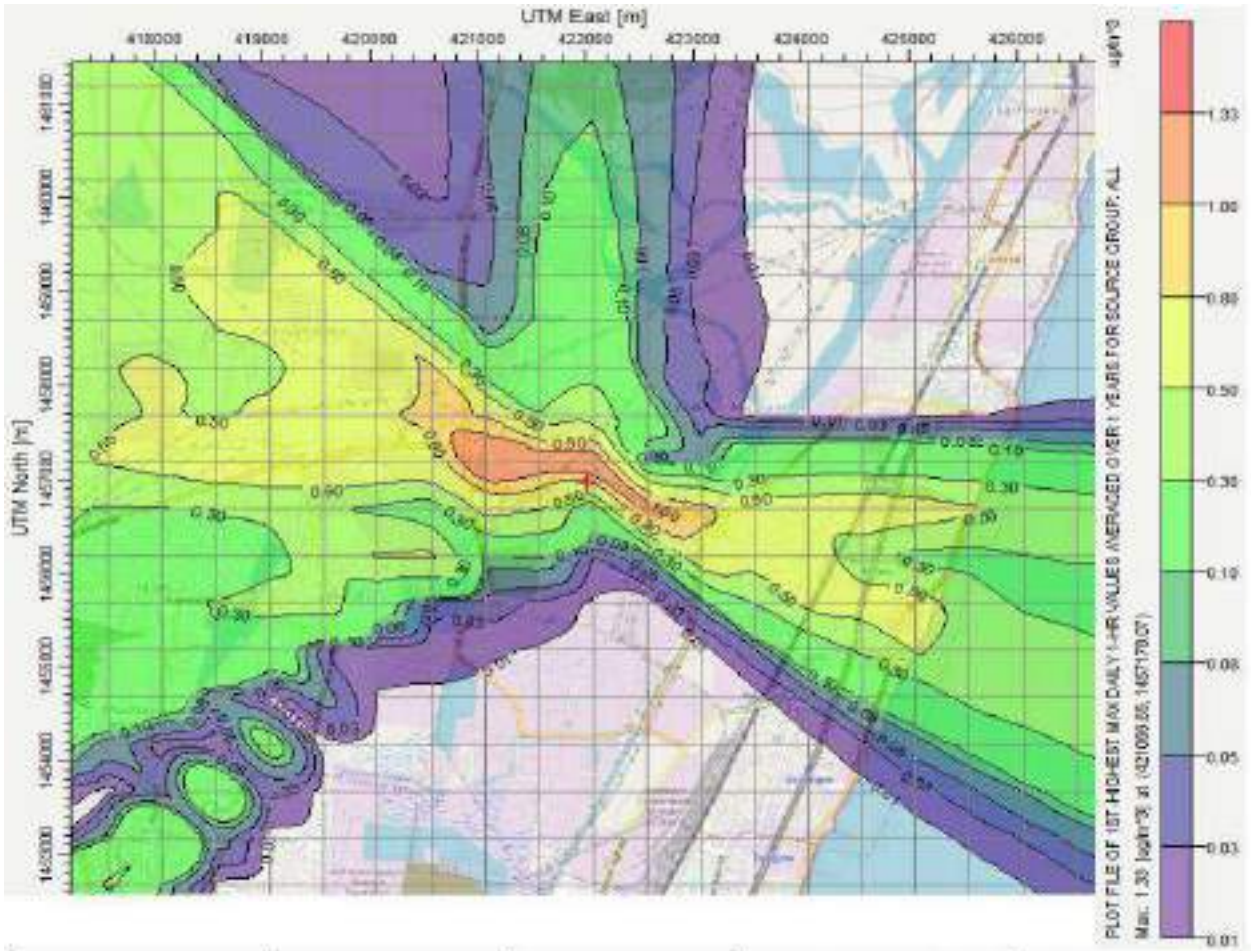
Oxides of Nitrogen as NO_2:

Stack Height, m	-	30.5
Exit Velocity, m/Sec	-	4.41
NOx Concentration, mg/m3	-	363
Emission load, gm/Sec	-	1.88
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	30.5
Exit Velocity, m/Sec	-	4.41
CO Concentration, mg/m3	-	5
Emission load, gm/Sec	-	0.0259
Plume rise, m	-	3

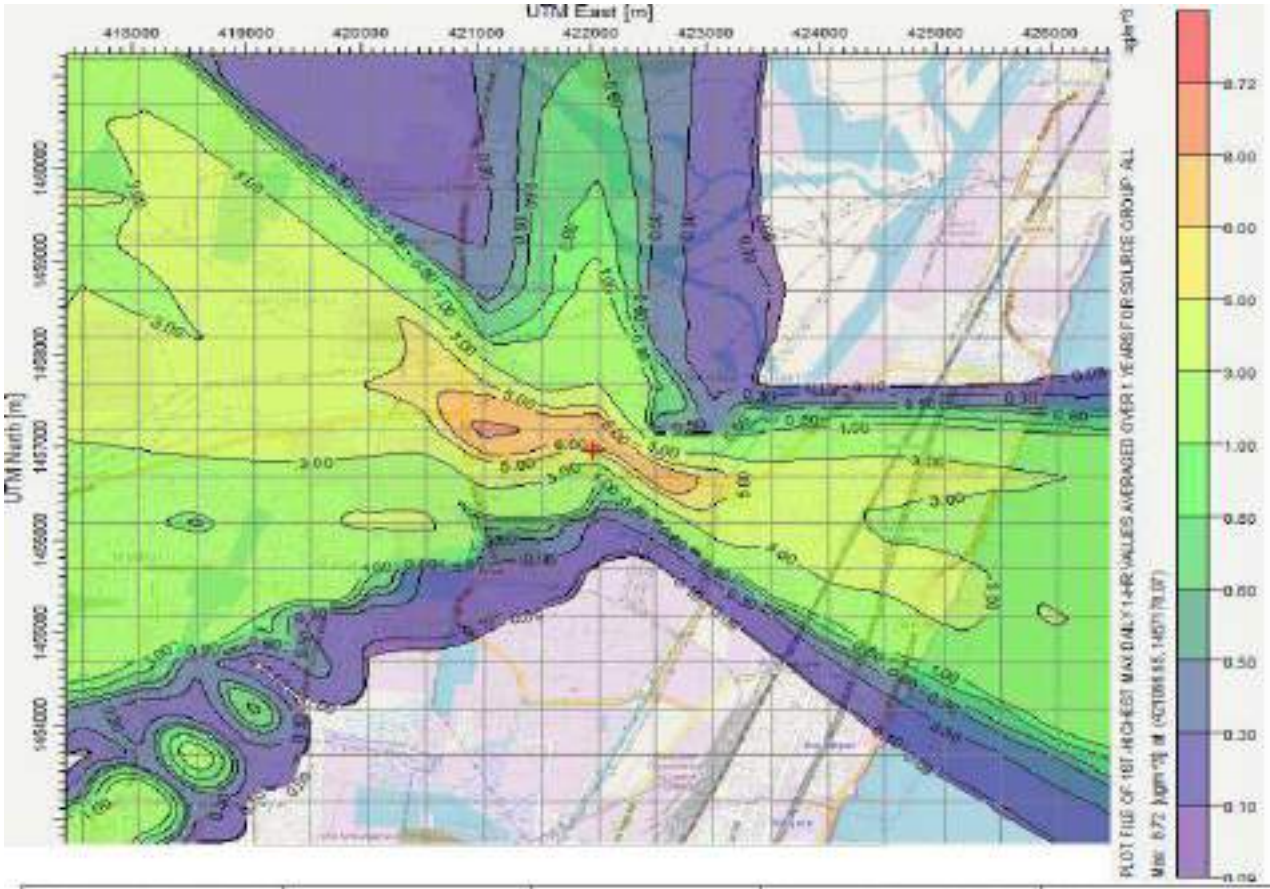
STACK EMISSION DISPERSION MODELLING – MPL-2 18 TON BOILER @ 2 & 5KM – Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
26	0.78	1.33	0.245	0.0432

MPL-2 18 TON BOILER emission of Particulate matter concentration is 26 mg/m^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.33µg/m^3 at 2km dispersion Particulate matter is 0.245µg/m^3 and at 5km dispersion Particulate matter is 0.0432µg/m^3 and the predominant wind direction is ESE.

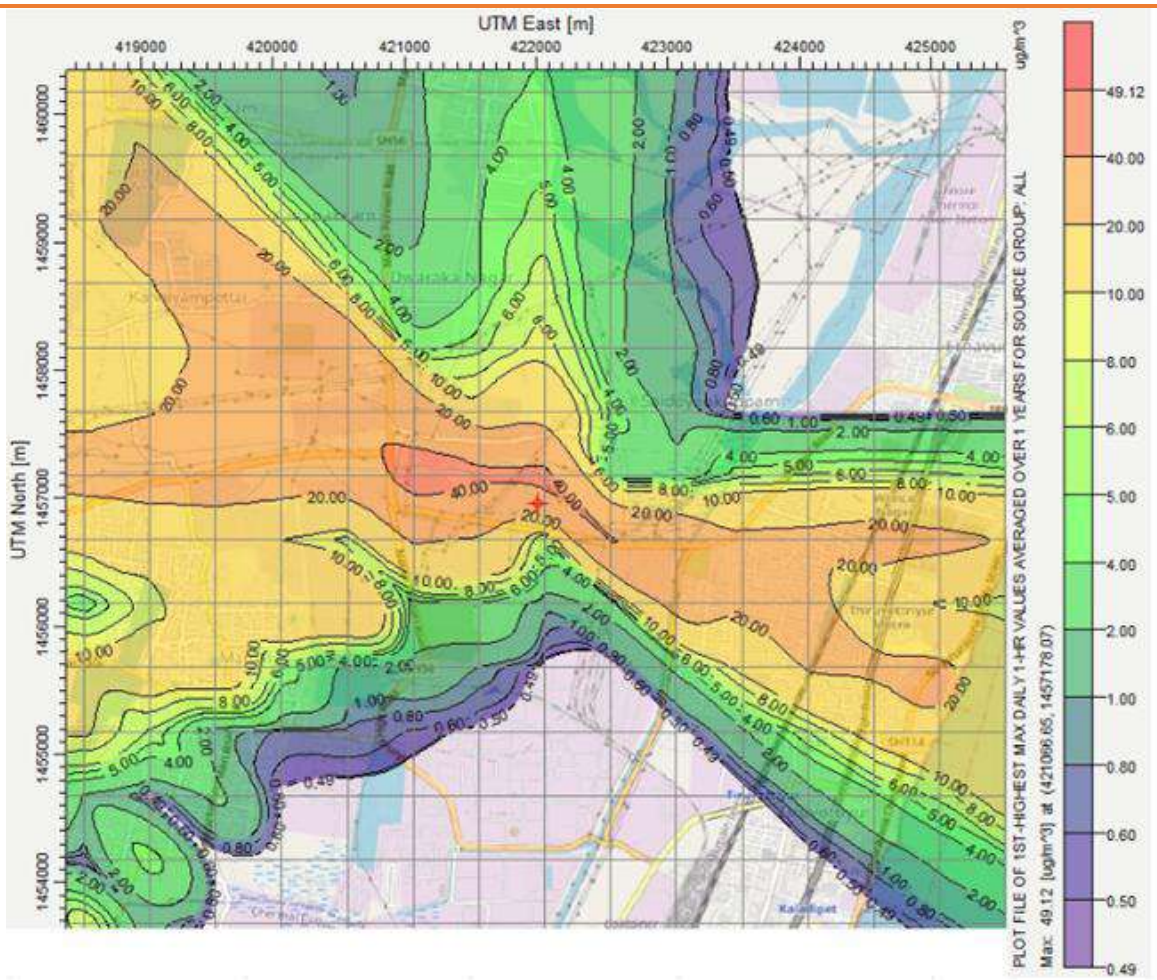
STACK EMISSION DISPERSION MODELLING – MPL-2 18 TON BOILER @ 2 & 5KM – Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
5	0.76	8.72	0.28	0.0842

MPL-2 18 TON BOILER emission of Carbon Monoxide concentration is 5.0mg/m^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.72µg/m^3 at 2km dispersion Carbon Monoxide is 0.28µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0842µg/m^3 and the predominant wind direction is ESE.

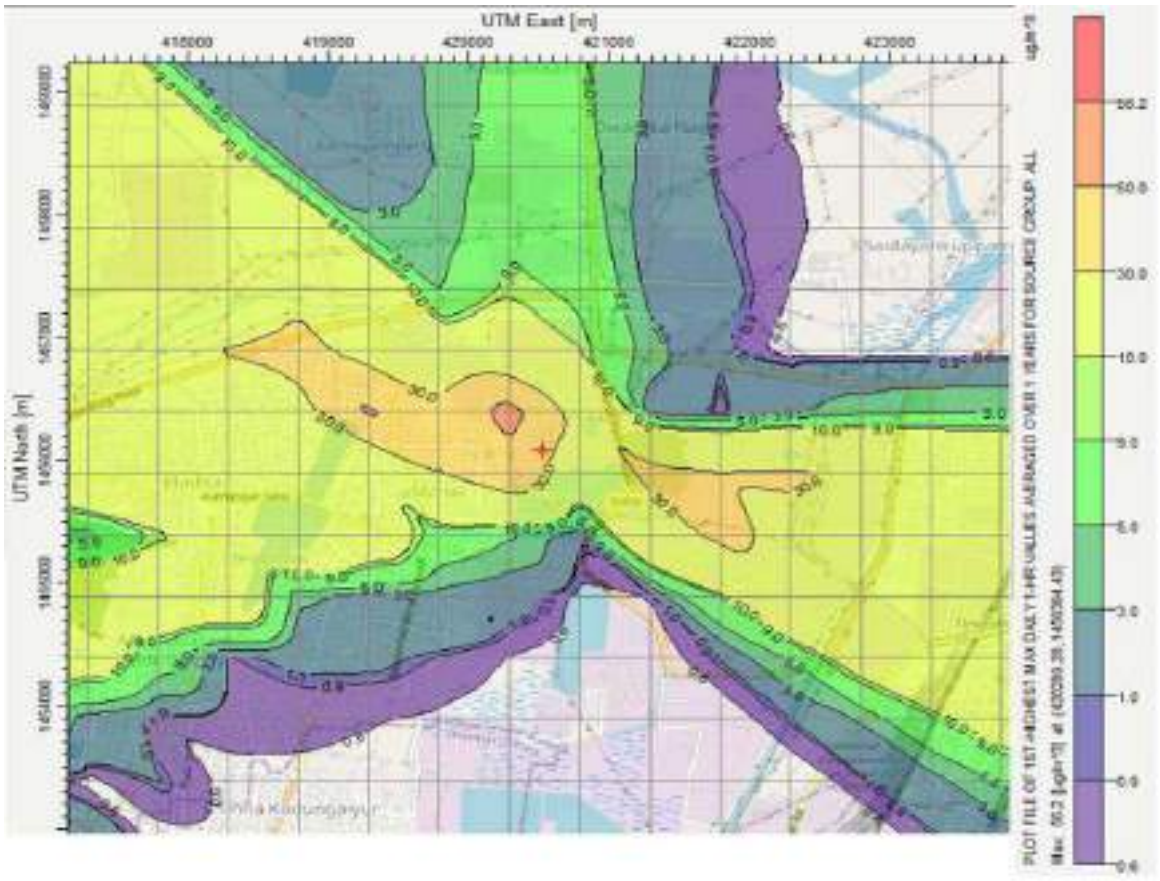
STACK EMISSION DISPERSION MODELLING – MPL -2 18 TON BOILER @ 2 & 5KM – Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
308	0.91	39.12	6.76	0.97

MPL-2 18 TON BOILER emission of Sulphur dioxide concentration is 308mg/Nm^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 39.12µg/m^3 at 2km dispersion Sulphur dioxide is 6.76µg/m^3 and at 5km dispersion Sulphur dioxide is 0.97µg/m^3 and the predominant wind direction is ESE.

STACK EMISSION DISPERSION MODELLING – MPL -2 18 TON BOILER @ 2 & 5KM – Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
363	0.83	56.2	10.11	1.47

MPL-2 18 TON BOILER emission of Oxides of Nitrogen concentration is 363mg/m^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 56.2µg/m^3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m^3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m^3 and the predominant wind direction is ESE.

9.0 FINDINGS ON AIR POLLUTION MONITORING:

9.1 Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Control Room, Near MMS Transformer, Near Furnace Oil Storage Tank, Near ETP Area, Near Raw Material Godown, Near Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.7 to 21.5µg/m^3. Highest value of 21.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 22.9 to 28.5µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 58.4

to 91.4µg/m^3. Highest value of 91.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.9 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 14.13 to 77.55µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 57.94 to 241.97µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

9.2 Stack Emission Monitoring:

MPL-2 18 TON BOILER emission of Particulate matter concentration is 26 mg/Nm^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.33µg/m^3 at 2km dispersion Particulate matter is 0.245µg/m^3 and at 5km dispersion Particulate matter is 0.0432µg/m^3 and the predominant wind direction is SSE.

MPL-2 18 TON BOILER emission of Carbon Monoxide concentration is 5.0mg/Nm^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These

stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.72µg/m^3 at 2km dispersion Carbon Monoxide is 0.28µg/m^3 and at 5km dispersion Carbon Monoxide is 0.0842µg/m^3 and the predominant wind direction is SSE.

MPL-2 18 TON BOILER emission of Sulphur dioxide concentration is 308mg/Nm^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 39.12µg/m^3 at 2km dispersion Sulphur dioxide is 6.76µg/m^3 and at 5km dispersion Sulphur dioxide is 0.97µg/m^3 and the predominant wind direction is ESE.

MPL-2 18 TON BOILER emission of Oxides of Nitrogen concentration is 363mg/Nm^3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 56.4µg/m^3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m^3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m^3 and the predominant wind direction is SSE.

9.3 Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The MPL plant is surrounded by residential areas like 1.Manali New Town, 2.Indira Gandhi Nagar, 3.Shastri Nagar, 4.Tendral Nagar and 5.Bhaktavatsala Nagar. From MPL to Manali New Town aerial distance is 4.47km, to Indira Gandhi Nagar is 2.11km, to Shastri Nagar is 1.69km, to Tendral Nagar is 2.01km and to Bhaktavatsala Nagar is 1.85km.

The cumulative particulate matter emissions from MPL through stacks is 26 mg/m^3. The average ground level concentration achieves at an average distance of 0.78km and the sum of PM concentration at GLC is 13.3 µg/m^3 which includes all the stacks at MPL. The residential areas are more than 1.5km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the PM

contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from MPL through stacks is 5 mg/m^3. The average ground level concentration achieves at an average distance of 0.76km and the sum of Carbon monoxide concentration at GLC is 8.72 µg/m3 which includes all the stacks at MPL. The residential areas are more than 1.5km radius and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the CO contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MPL through stacks is 744 mg/m^3. The average ground level concentration achieves at an average distance of 0.82km and the sum of Nitrogen Oxides concentration at GLC is 58.9 µg/m^3 which includes all the stacks at MPL. The residential areas are more than 1.5km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the NO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur dioxide emissions from MPL through stacks is 618 mg/m^3. The average ground level concentration achieves at an average distance of 0.76km and the sum of Sulphur dioxide concentration at GLC is 49.12 µg/m^3 which includes all the stacks at MPL. The residential areas are more than 1.5km radius and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the SO2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceeding the National ambient air quality standard for PM, SO2, NO_2 and CO. Results from AERMOD simulation indicated that PM, SO2, NO_2 and CO emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM, SO2, NO_2 and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load.

***

Annexure-XI

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING

At

M/s.Madras Fertilizers Ltd, Chennai

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. ABOUT INDUSTRY

MFL was incorporated on December 8, 1966 as a joint venture between GOI and AMOCO India incorporated of U.S.A (AMOCO) in accordance with the Fertilizer Formation Agreement executed on 14.5.1966 with equity contributions of 51% and 49% respectively. In accordance with the participation agreement between GOI, AMOCO and National Iranian Oil Company (NIOC), an undertaking of Government of Iran, NIOC acquired 50% of the shareholding of AMOCO in MFL on 22.11.1972. With this acquisition, shareholding of AMOCO and NIOC were at 24.5% each, with the balance 51% being held by GOI. Subsequently, on 22.7.1985, the shareholding of AMOCO was proportionately purchased by GOI and NIOC. As a result, GOI and NIOC shareholding was revised to 67.55% and 32.45% respectively. Subsequent to the issue of rights shares in 1994 for part-financing the project, the holding of GOI and NIOC stood at 69.78% and 30.22% respectively. MFL had an initial public offering of its shares in May 1997.

The Plant

MFL consists of production plants, Ammonia, Urea in single streams and NPK in three streams, viz. NPK A Train, B Train and C Train. Utilities Plant is the service plant supplying treated water, cooling water, off-site steam, instrument air, captive power and emergency power.

On November 1, 1971, MFL commenced commercial production of Ammonia, Urea and NPK complex. The feedstock for Ammonia is Naphtha and it is being supplied by the neighboring M/s Chennai Petroleum Corporation Limited (CPCL).

The original Ammonia / Urea Plants were of Chemico design with the daily rated capacity of 750 MT (247500 MTPA) and 885 MT (292000 MTPA) respectively. Initially there were only two trains to produce granulated complex fertilizers with a total installed capacity of 360000 MTPA and in September 1976 on more NPK stream, namely C Train, was added raising the installed capacity to 540000 MTPA, all by Hindustan Dorr Oliver.

In 1991, the old Chemico converter of Ammonia Plant was replaced with the latest S 200 Radial Converter.

The company, to extend the economic life of the plants by another 15 years and also envisaging improvement in energy consumption, undertook a major Revamp-cum-Modernization and Capacity Enhancement of its plants at a cost of Rs 600 Cr during 1993-1998. Production from the Revamped Plants commenced from March 3, 1998.

Process License and Basic Engineering from M/s Haldor Topsoe, Denmark for Ammonia Plant and from M/s Urea Technologies Inc., U.S.A for Urea Plant was adopted with modern Distributed Control System (DCS). The enhanced production capacities are 1050 MTPD for Ammonia (346500 MTPA) and 1475 MTPD for Urea (486750 MTPD). With respect to NPK, Pipe-reactor with Process License & Basic Engineering from M/s Grande Parroise, France was incorporated in NPK B Train. By this and along with higher on-stream efficiency, the installed capacity was raised to 2550 MTPD (840000 MTPD).

After overcoming initial teething troubles, the Ammonia & Urea Plants reached 87% and 83% capacity utilization levels in 1999-2000. To improve product quality and bring down product temperature before admitting into bagging streams, Prill Tower modification was carried out by Monsanto Enviro-Chem (MECSI), U.S.A. and a fluidized bed cooler (Prills Cooling System PCS) was put into service.

Urea Plant achieved a record production of 486750 MT in 2011-12 surpassing the previous best of 478834 MT in 2010-11. Specific consumption of feedstock has also come down over the years after process stabilization.

Product	**BEFORE REVAMP**	**AFTER REVAMP**
AMMONIA MT/DAY	750	1050
UREA	885	1475
NPK MT/MONTH	45,000	70000

AMMONIA PLANT

- Revamped in 1997 by Haldor Topsoe Technology
- Raw Materials – H_2 from RLNG and N_2 from Air
- RLNG feed to Pre-Reformer to convert higher hydrocarbons into CH4, CO2, CO and H2
- Reformation in Primary Reformer
- Air addition in Secondary. Reformer
- CO conversion to CO2 in two stage High temperature and Low temperature shift convertors
- CO_2 gas removal in MDEA solution Absorber

AMMONIA PLANT (Contd.)

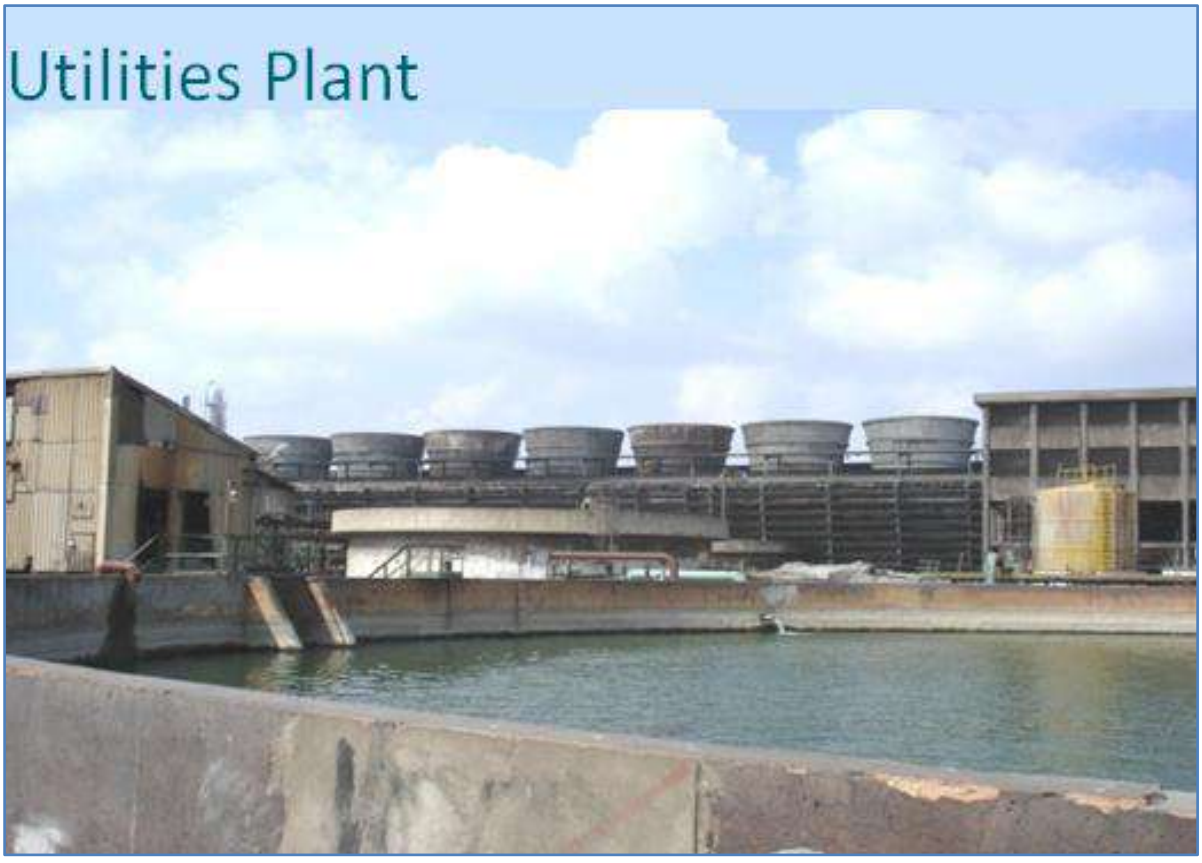
- Methanator – Residual CO and CO_2 conversion into methane
- Synthesis Gas (H2+N2) compression to 165-170 Kg/SC
- Ammonia Convertors – S200 and S50
- Ammonia Removal and storage in 2 X 5000 MT Atmospheric Storage Tanks with built in Safety System and a flare system

UREA PLANT

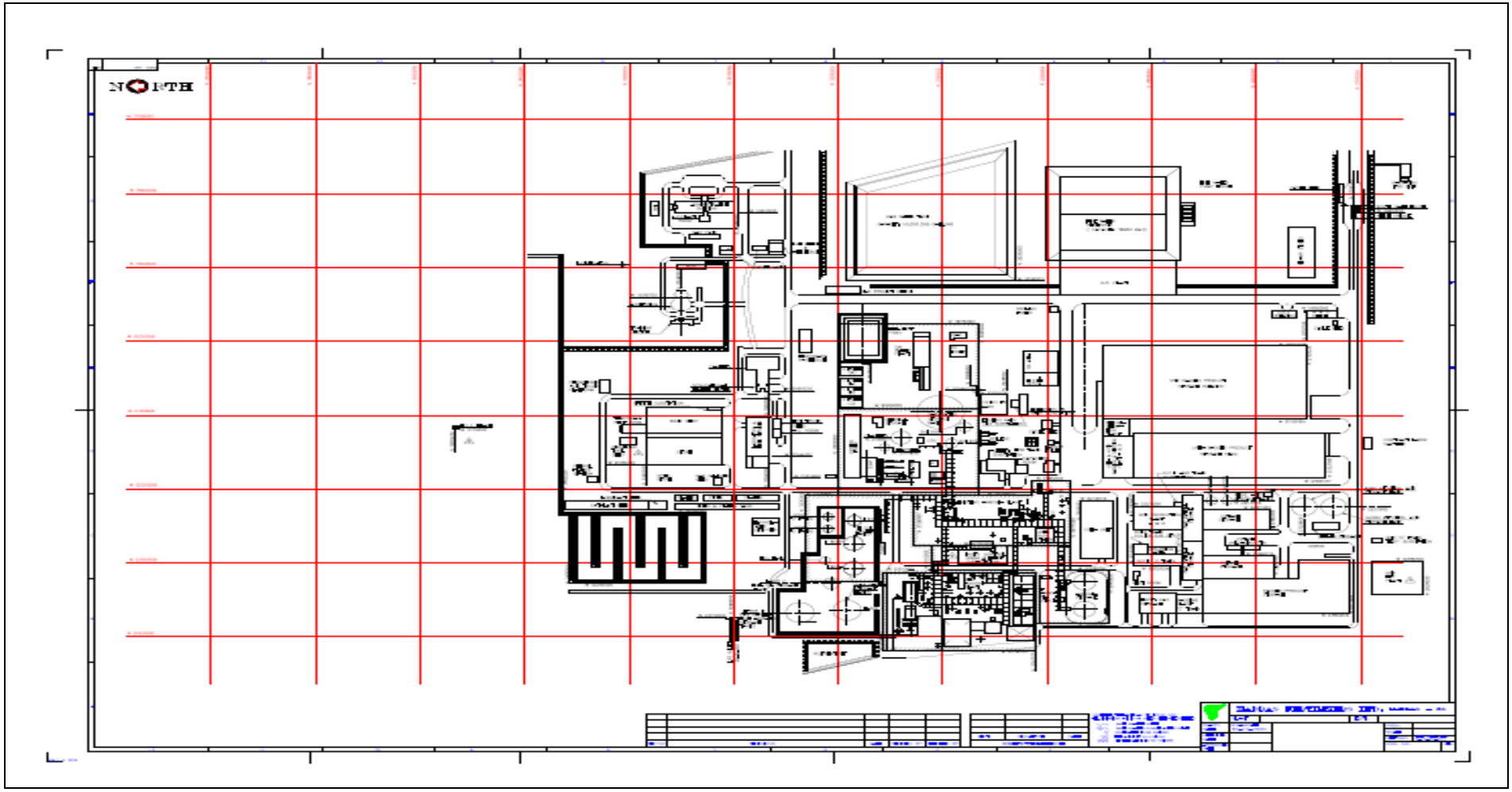
- Revamped in 1997 by Urea Technologies Incorporation, USA
- Raw materials – Ammonia and CO_2
- Feeding High Pressure Ammonia, CO_2 and recycle ammonium carbamate into Two reactors in parallel at 222 Kg/SC
- Separation of urea solution from Reactor outlet
- Decomposition and Absorption of the un reacted ammonia and carbon dioxide in 2 stages
- Concentration of Urea to 88% in a Concentrator
- Further Urea Concentration to 99.5 % in Evaporators
- Spraying of the molten Urea in a prill tower of 55m height
- Product Urea Cooling in a Prill Cooling System
- Quality Urea product to Bagging and Shipping Plant

Utilities Plant

- Providing following utilities to Production Units
- Cooling water
- Boiler feed water
- Steam from Utility Boilers
- Inert gas
- Instrument Air
- DM and Polished water Production
- Fuel Oil Storage
- LPG Storage
- Fire water control system



PLANT LAYOUT



2. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

2.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

2.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM10 is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, $\mu g/m^3$	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

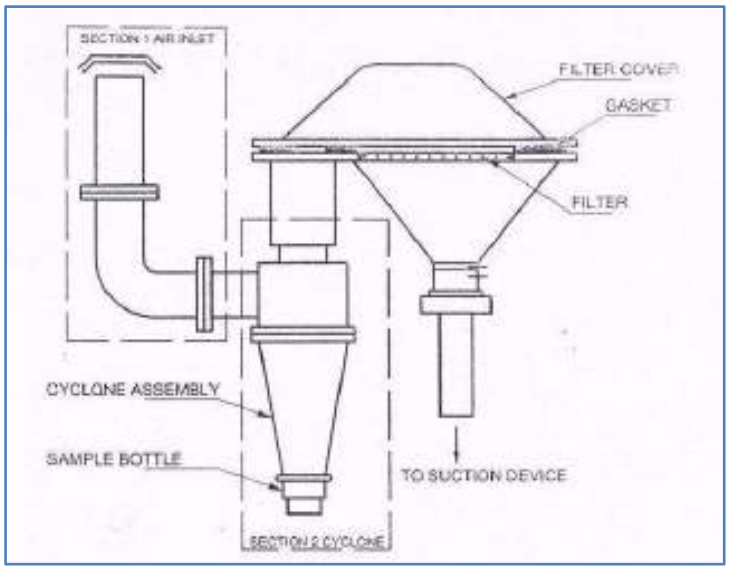
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30□ C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30□ C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = $(Wf - Wi) \times 10^6 / V$

Where,

C_{PM10}	=	Concentration of Particulate Matter, µg/m^3
Wf	=	Final weight of filter in g
Wi	=	Initial weight of filter in g
10^6	=	Conversion of g to µg
V	=	Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
Mark identification number on the filter
Condition the filter in conditioning room / desiccator for 24 hours
Record initial weight
Place the filter on the sampler
Run the sampler for eight hours
Record the flow rate on hourly basis
Remove the filter from the sampler
Keep the exposed filter in a proper container
Record the total time of sampling & average flowrate
Again condition the filter in conditioning room / desiccator for 24 hours
Record final weight
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

2.3 Methodology for determination of $PM_{2.5}$ in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, $\mu g/m^3$	Annual *	40	40
	24 Hours **	60	60

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± °C.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method) Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene support ring.
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2°C) temperature between 25°C. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).

- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M2.5 = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

$M2.5$ = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates ($\mu g/m^3$)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (μg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1.0 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2.0 PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

2.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural	Ecologically Sensitive Area (Notified by
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) **-** Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.

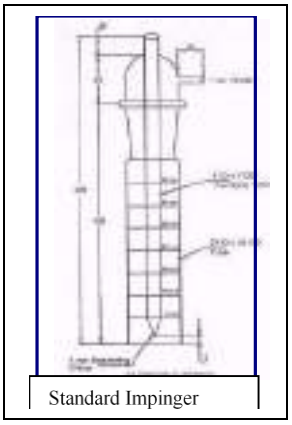
Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.

Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite-TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^{O}C.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO2 = Concentration of Nitrogen dioxide, µg/m^3

A_s = Absorbance of sample

A_b = Absorbance of reagent blank

CF = Calibration factor

V_a = Volume of air sampled, m^3

V_s = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide.

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

2.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), $\mu g/m^3$	Annual *	40	30
	24 Hours **	80	80
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.			
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml

per minute through the sampling solution

Calibrated flow easuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm path length cells.

Glass wares: low actinic glassware's are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{O}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, this solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution is kept in refrigerated and protected from light.

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as a part of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

C NO2	=	Concentration of Nitrogen dioxide, µg/m^3
As	=	Absorbance of sample
Ab	=	Absorbance of reagent blank
CF	=	Calibration factor
Va	=	Volume of air sampled, m^3
Vs	=	Volume of sample, ml
Vt	=	Volume of aliquot taken for analysis, ml
0.82	=	Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen.

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

2.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O_3), $\mu g/m^3$	8 Hours *	100	100
	1 Hour **	180	180
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.			
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^{o}C.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_s - A_b) \times CF \times 1.962 / V_a$$

Where,

C NH_3	=	Concentration of Ammonia in µg/m^3
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in $\mu g/m^3$

2.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25°C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ )\ =\ (A_s\ -\ A_b)\ x\ CF\ /\ V_a$$

Where,

C NH_3	=	Concentration of Ammonia in $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3

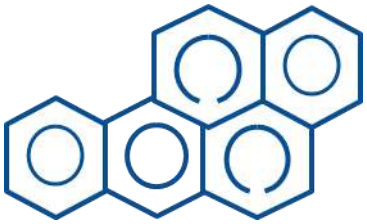
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water ⇩
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx ⇩
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration ⇩
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis ⇩
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution ⇩
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer ⇩
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank. ⇩
Plot the calibration curve ⇩
Calculate the concentration of NH_3 in $\mu g/m^3$

2.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is $C_{20}H_{12}$ having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume

(1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM10 high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM10 high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM10 sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25°C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4°C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added 50 ml of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes. Repeated the procedure twice (50ml x 2 times) for complete extraction. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected the elute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
Ultrasonic extraction with Toluene (50 ml × 3 times)
Filter & dry with Anhydrous Sodium Sulphate
Concentration with Rotary Evaporator
Clean up with Silica Gel Column Chromatography
Elution with Cyclo-Hexane (5 ml × 3 times)
Evaporate to nearly dryness under Nitrogen
Re-dissolved in 0.5 to 1.0 ml Toluene
Capillary GC-MS

2.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual * 24 Hours **	0.50 1.0	0.50 1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper: EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30°C until analysis.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1).

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensure acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples: ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.

Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{(\text{Spiked sample concentration} - \text{sample concentration}) \times 100}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank

Calibration standards

QC check

Samples

Spike sample

QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V	=	Volume of air, m^3
Q	=	Average sampling rate, m^3/min.
T	=	Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler.

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Gaeke method
		24 hours	80 µg/ m^3	80 µg/ m^3	-Ultraviolet Fluorescence
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM
		24 hours	100 µg/ m^3	100 µg/ m^3	-Beta attenuation
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

3.0 WEATHER MONITORING DATA

WEATHER MONITORING DATA AT MFL - 29.03.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
29.03.2021	1:00 AM	26.1	94	5	W
29.03.2021	2:00 AM	26.1	94	6	W
29.03.2021	3:00 AM	27.8	84	6	W
29.03.2021	4:00 AM	28.9	74	6	WSW
29.03.2021	5:00 AM	31.1	66	7	SSW
29.03.2021	6:00 AM	32.8	52	7	SW
29.03.2021	6:00 AM	33.9	49	9	SSW
29.03.2021	7:00 AM	35.0	47	6	SW
29.03.2021	8:00 AM	35.0	47	8	SSW
29.03.2021	9:00 AM	33.9	52	8	SSE
29.03.2021	10:00 AM	32.2	62	15	SSE
29.03.2021	11:00 AM	31.1	58	13	S
29.03.2021	12:00 PM	30.0	62	10	S
29.03.2021	1:00 PM	28.9	79	9	S
29.03.2021	2:00 PM	28.9	79	9	SSW
29.03.2021	3:00 PM	27.8	84	12	SSW
29.03.2021	4:00 PM	27.8	84	10	SSW
29.03.2021	5:00 PM	27.8	84	9	SSW
29.03.2021	6:00 PM	27.8	84	6	SSW
29.03.2021	7:00 PM	27.2	89	3	SSW
29.03.2021	8:00 PM	27.2	89	5	SW
29.03.2021	9:00 PM	27.2	89	3	WSW
29.03.2021	10:00 PM	27.2	89	3	SW
29.03.2021	11:00 PM	26.1	94	3	W
29.03.2021	12:00 AM	26.1	94	5	W
MIN		26.1	47.0	3.0	SSW
MAX		35.0	94.0	15.0	
AVG		29.4	75.2	7.3	

WEATHER MONITORING DATA AT MFL - 30.03.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
30.03.2021	1:00 AM	27.2	79	8	SW
30.03.2021	2:00 AM	27.2	79	7	SW
30.03.2021	3:00 AM	27.8	74	7	WSW
30.03.2021	4:00 AM	30.0	62	12	WSW
30.03.2021	5:00 AM	32.2	56	12	WSW
30.03.2021	6:00 AM	33.9	49	12	W
30.03.2021	6:00 AM	35.0	47	12	WNW
30.03.2021	7:00 AM	37.2	42	10	WNW
30.03.2021	8:00 AM	37.8	35	5	NW
30.03.2021	9:00 AM	38.9	31	6	NW
30.03.2021	10:00 AM	37.2	42	12	SSE
30.03.2021	11:00 AM	35.0	53	9	SSE
30.03.2021	12:00 PM	31.1	70	8	SE
30.03.2021	1:00 PM	30.0	74	6	S
30.03.2021	2:00 PM	28.9	79	7	S
30.03.2021	3:00 PM	28.9	79	6	SSE
30.03.2021	4:00 PM	28.9	79	5	SSW
30.03.2021	5:00 PM	27.8	89	3	SSW
30.03.2021	6:00 PM	27.8	84	7	SW
30.03.2021	7:00 PM	27.8	84	7	WSW
30.03.2021	8:00 PM	27.8	79	8	WSW
30.03.2021	9:00 PM	27.2	79	5	WSW
30.03.2021	10:00 PM	27.2	79	3	SW
30.03.2021	11:00 PM	27.2	79	8	WSW
30.03.2021	12:00 AM	27.2	79	7	SW
MIN		27.2	31.0	3.0	SW
MAX		38.9	89.0	12.0	
AVG		30.7	67.3	7.7	

WEATHER MONITORING DATA AT MFL - 31.03.2021					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir.**
31.03.2021	1:00 AM	27.2	79	3	WSW
31.03.2021	2:00 AM	27.2	84	7	SW
31.03.2021	3:00 AM	28.9	74	8	SSW
31.03.2021	4:00 AM	31.1	66	10	WSW
31.03.2021	5:00 AM	32.2	62	10	W
31.03.2021	6:00 AM	33.9	56	9	WSW
31.03.2021	6:00 AM	35.0	49	10	WSW
31.03.2021	7:00 AM	37.8	35	7	W
31.03.2021	8:00 AM	38.9	33	2	VAR
31.03.2021	9:00 AM	37.2	0	10	SE
31.03.2021	10:00 AM	35.0	59	12	S
31.03.2021	11:00 AM	32.8	66	8	S
31.03.2021	12:00 PM	31.1	70.0	7.0	SSW
31.03.2021	1:00 PM	30.0	74	7	S
31.03.2021	2:00 PM	30.0	74	7	S
31.03.2021	3:00 PM	28.9	84	9	SW
31.03.2021	4:00 PM	28.9	84	7	SSW
31.03.2021	5:00 PM	28.9	84	7	SSW
31.03.2021	6:00 PM	27.8	89	6	SW
31.03.2021	7:00 PM	27.2	94	6	W
31.03.2021	8:00 PM	27.2	89	6	W
31.03.2021	9:00 PM	27.2	89	6	WSW
31.03.2021	10:00 PM	27.2	84	3	WSW
31.03.2021	11:00 PM	27.2	84	6	WSW
31.03.2021	12:00 AM	27.8	89	4	WSW
MIN		27.2	0.0	2.0	SW
MAX		38.9	94.0	12.0	
AVG		30.7	70.0	7.1	

4.0 GOOGLE EARTH MAP – MADRAS FERTILIZERS LIMITED

Ambient Air Quality Monitoring Sampling Location

Stack Emission Monitoring Locations

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

AAQ- 1: M/s. MADRAS FERTILIZERS LIMITED, NNE SIDE OF THE PLANT

LOCATION - NNE SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 29.03.2021 [11:30 Hrs] - 30.03.2021 [11:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	9.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	11.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	87.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	44.4
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	23.2
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 2: M/s. MADRAS FERTILIZERS LIMITED, NW SIDE OF THE PLANT

LOCATION - NW SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 29.03.2021 [11:50 Hrs] - 30.03.2021 [11:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	8.7
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	16.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	58.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	32.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	33.5
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 3: M/s. MADRAS FERTILIZERS LIMITED, WSW SIDE OF THE PLANT

LOCATION - WSW SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 29.03.2021 [12:00 Hrs] – 30.03.2021 [12:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	9.7
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	17.3
3	Particulate Matter (PM_{10})	$\mu g/m^3$	66.6
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	36.8
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	29.4
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 4: M/s. MADRAS FERTILIZERS LIMITED, ENE SIDE OF THE PLANT

LOCATION - ENE SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 29.03.2021 [14:30 Hrs] – 30.03.2021 [14:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	11.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	14.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	56.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	28.5
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	25.5
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 5: M/s. MADRAS FERTILIZERS LIMITED, SE SIDE OF THE PLANT

LOCATION - SE SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 30.03.2021 [15:30 Hrs] - 31.03.2021 [15:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	12.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	16.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	71.2
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	40.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	22.3
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 6: M/s. MADRAS FERTILIZERS LIMITED, SSW SIDE OF THE PLANT

LOCATION - SSW SIDE OF THE PLANT, MANALI			
SAMPLING DATE & TIME 30.03.2021 [16:00 Hrs] - 31.03.2021 [16:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	9.9
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	17.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	62.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	30.9
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	21.4
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

AAQ- 7: M/s. MADRAS FERTILIZERS LIMITED, NEAR MAIN GATE

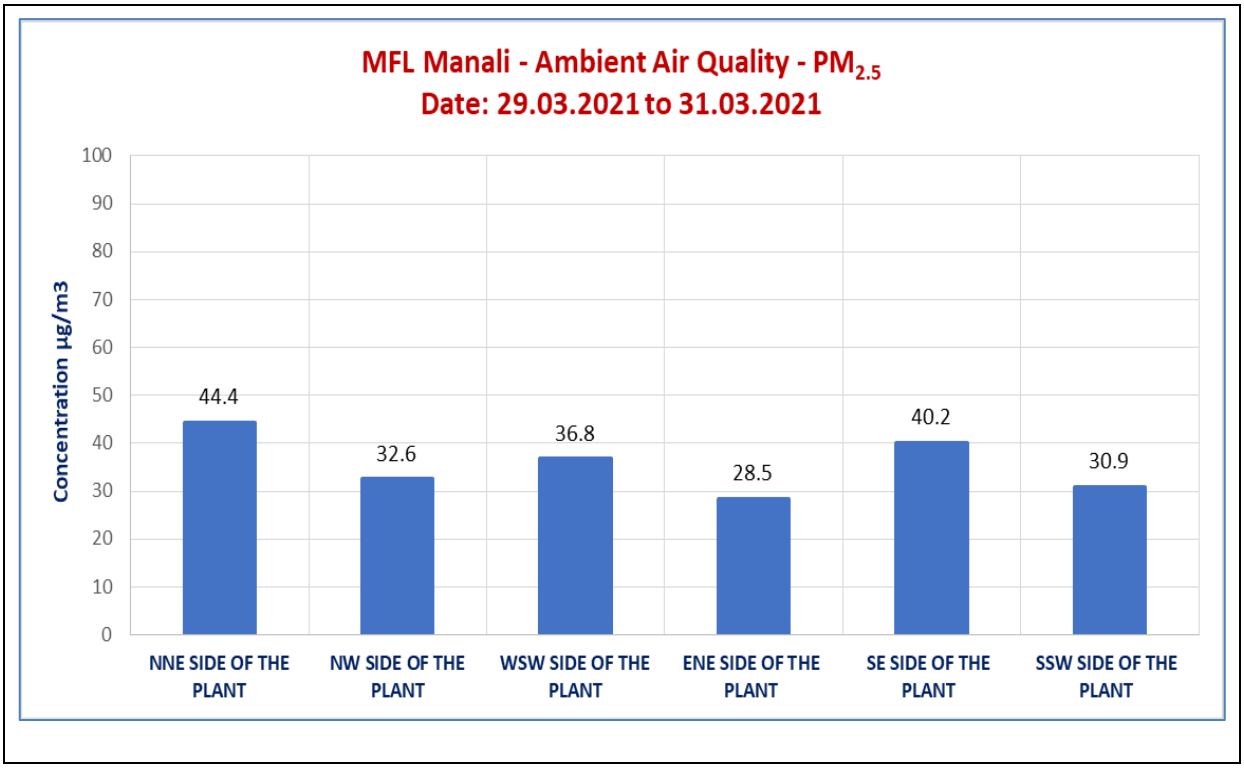
LOCATION - NEAR MAIN GATE, MANALI				
SAMPLING DATE & TIME 30.03.2021 [05:00 Hrs] - 30.03.2021 [13:00 Hrs]				
S.NO	TIME	UNIT	PARTICULATE MATTER (PM 2.5)	PARTICULATE MATTER (PM 10)
1	05:00 - 06:00	µg/m³	26.7	50.6
2	06:00 - 07:00	µg/m³	19.4	47.7
3	07:00 - 08:00	µg/m³	38.1	80.5
4	08:00 - 09:00	µg/m³	22.7	71.4
5	09:00 - 10:00	µg/m³	29.5	85.1
6	10:00 - 11:00	µg/m³	55.2	112.2
7	11:00 - 12:00	µg/m³	41.7	85.7
8	12:00 - 13:00	µg/m³	46.9	96.2
8 HOURS AVERAGE			35.03	78.68

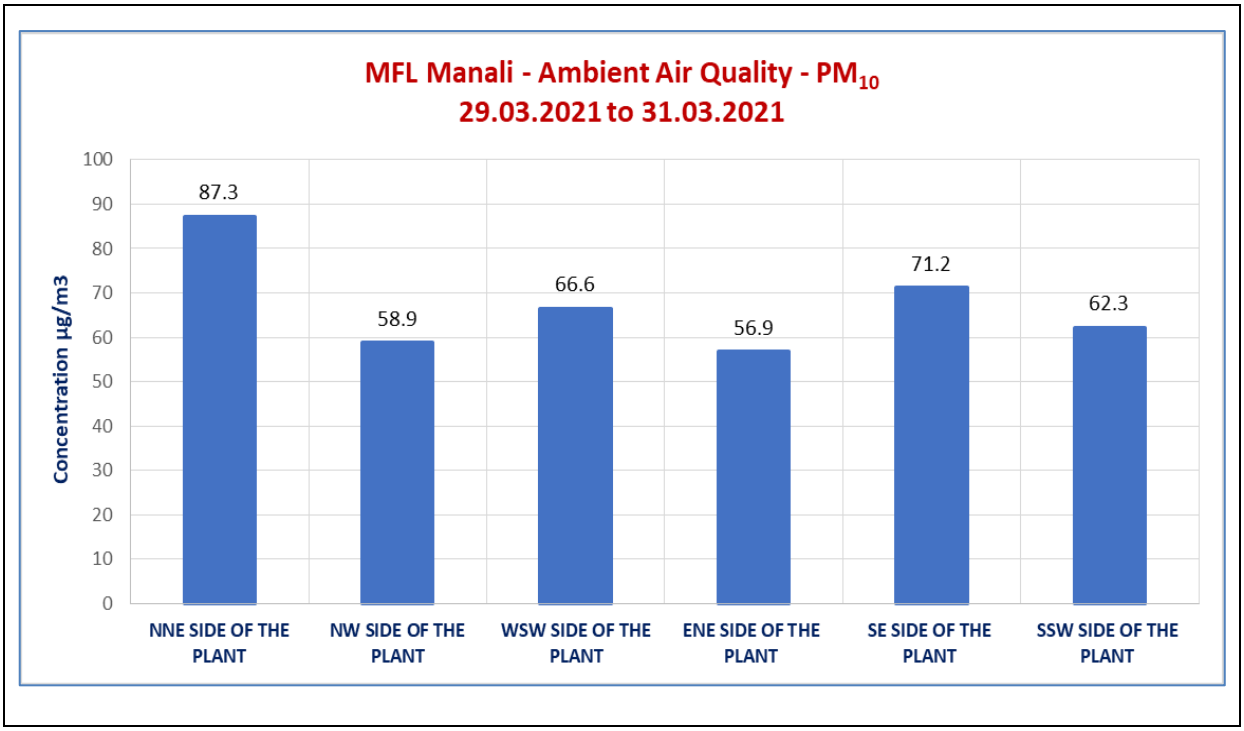
AAQ- 8: M/s. MADRAS FERTILIZERS LIMITED, BESIDE ROAD TOWARDS MOOLAKADAI

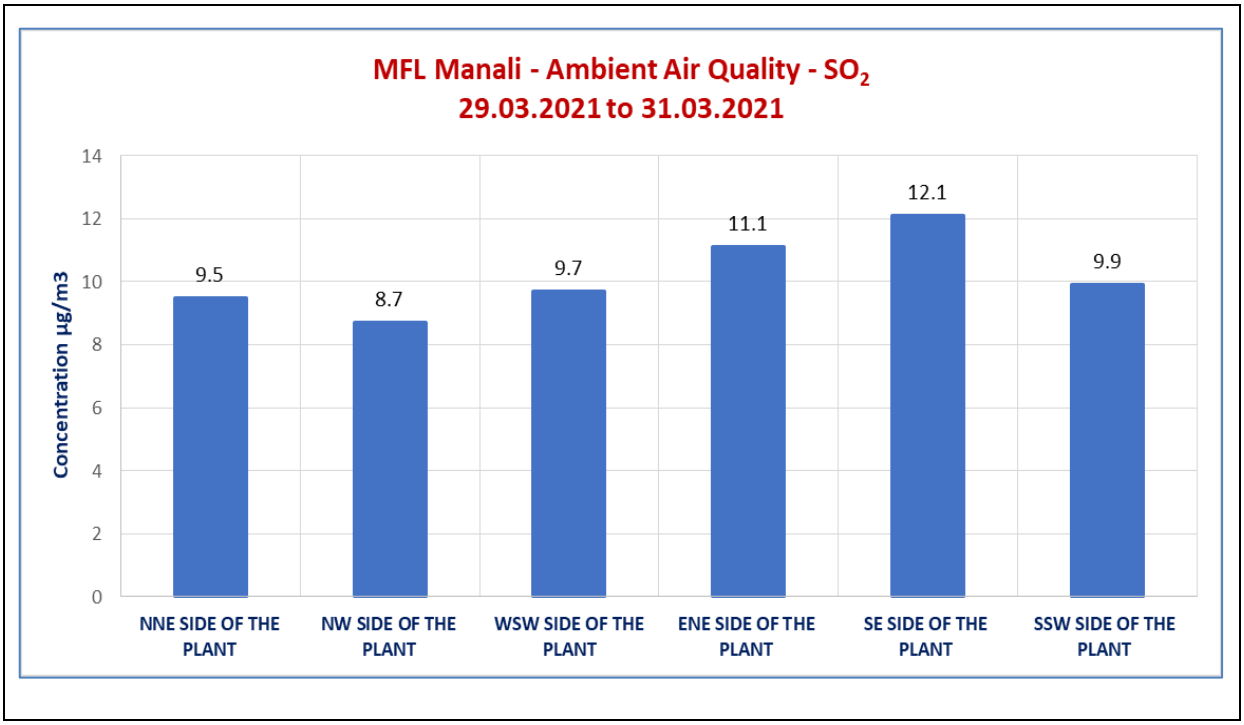
LOCATION - BESIDE ROAD TOWARDS MOOLAKADAI , MANALI				
SAMPLING DATE & TIME 31.03.2021 [10:00 Hrs] - 31.03.2021 [18:00 Hrs]				
S.NO	TIME	UNIT	PARTICULATE MATTER (PM 2.5)	PARTICULATE MATTER (PM 10)
1	10:00 - 11:00	µg/m³	13.4	54.7
2	11:00 - 12:00	µg/m³	28.9	99.2
3	12:00 - 13:00	µg/m³	27.6	97.3
4	13:00 -14:00	µg/m³	31.5	169.0
5	14:00 - 15:00	µg/m³	22.7	79.9
6	15:00 - 16:00	µg/m³	31.6	137.9
7	16:00 - 17:00	µg/m³	38.1	183.6
8	17:00 - 18:00	µg/m³	36.9	134.9
8 HOURS AVERAGE			28.8	119.6

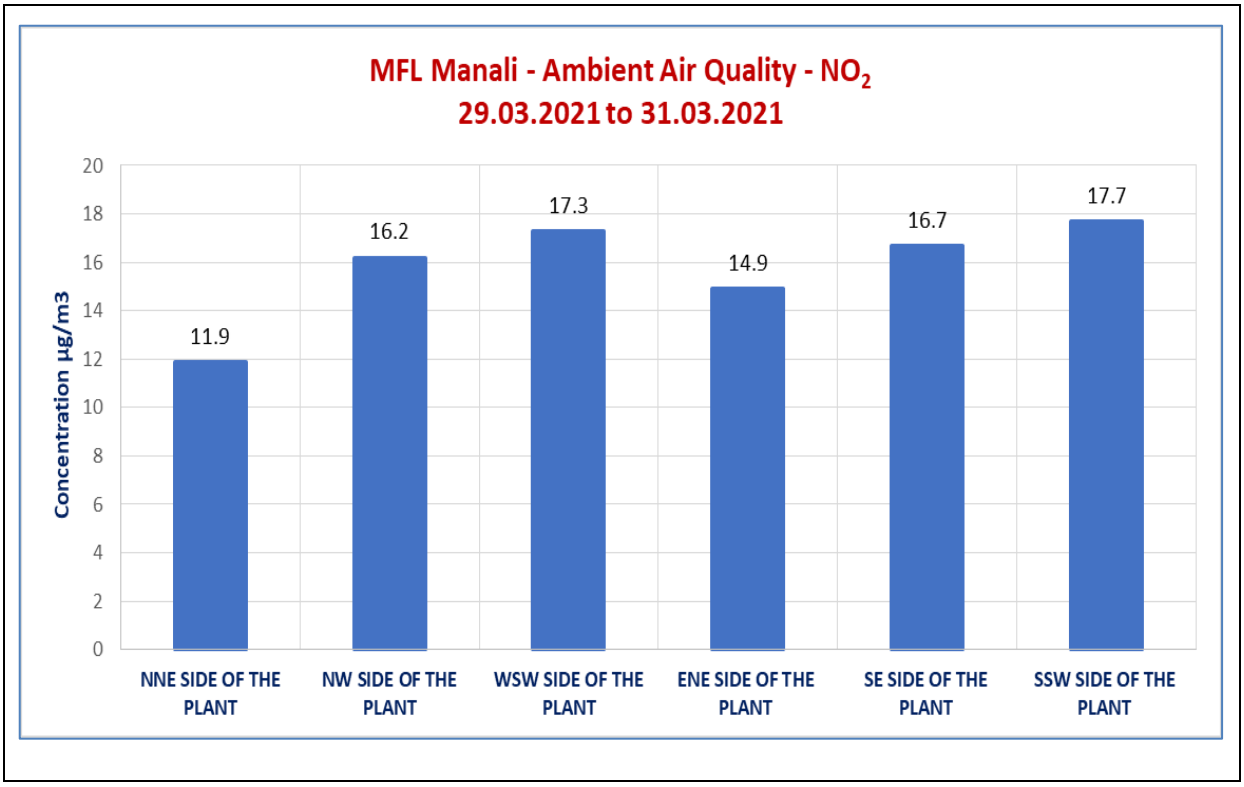
6.0 Consolidated Monitoring Results

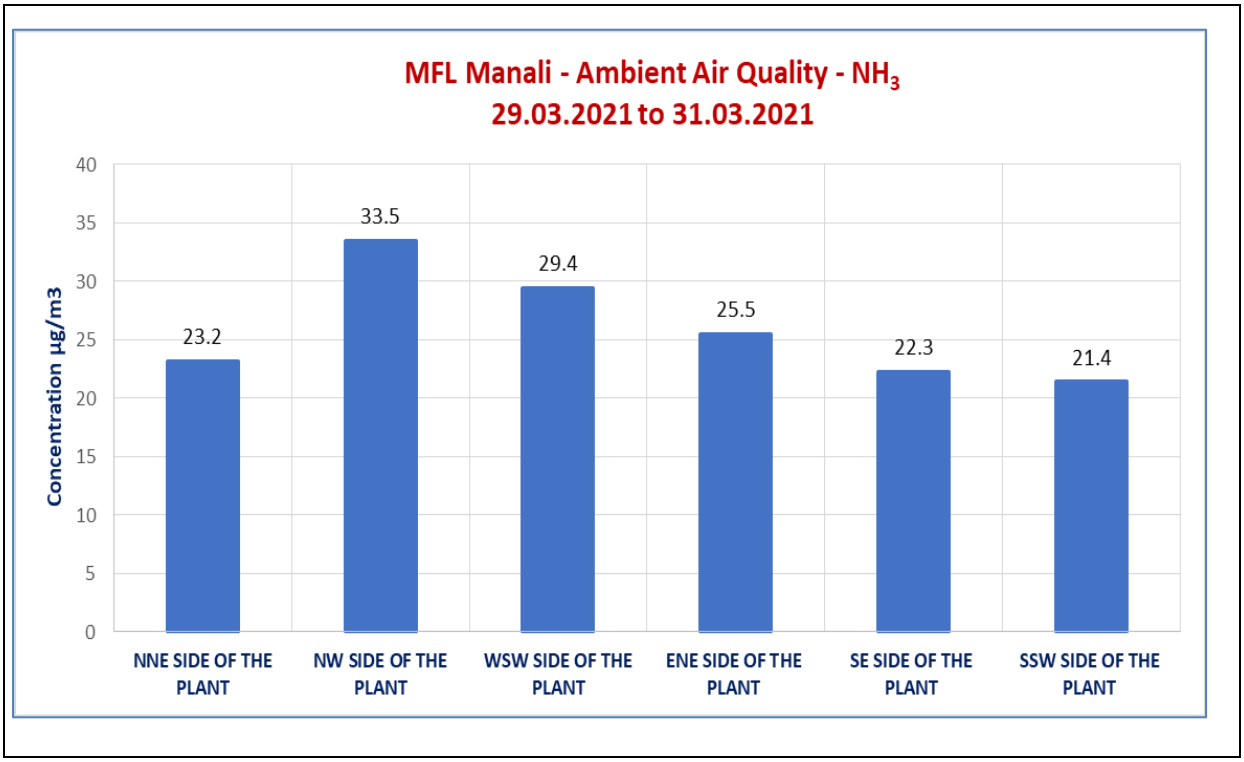
AAQM Consolidated Monitoring Results (µg/m3)					
Sampling Date [29.03.2021 to 31.03.2021]					
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**	**NH3**
NNE SIDE OF THE PLANT	9.5	11.9	87.3	44.4	23.2
NW SIDE OF THE PLANT	8.7	16.2	58.9	32.6	33.5
WSW SIDE OF THE PLANT	9.7	17.3	66.6	36.8	29.4
ENE SIDE OF THE PLANT	11.1	14.9	56.9	28.5	25.5
SE SIDE OF THE PLANT	12.1	16.7	71.2	40.2	22.3
SSW SIDE OF THE PLANT	9.9	17.7	62.3	30.9	21.4

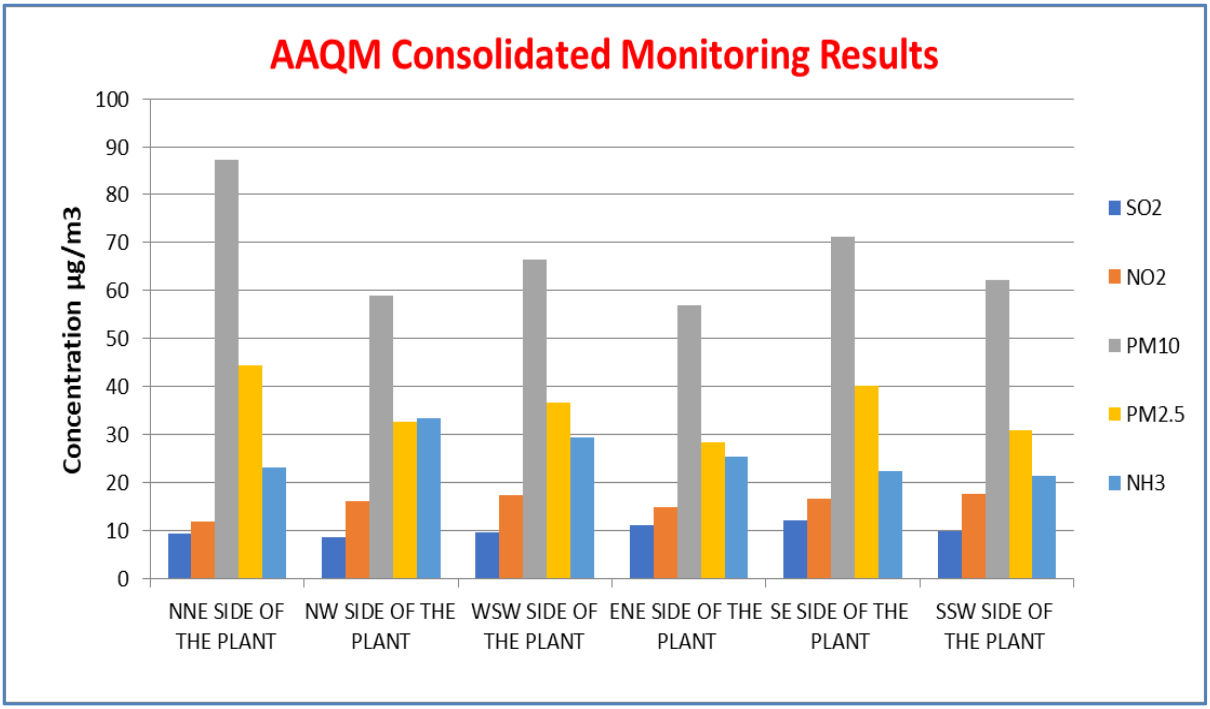


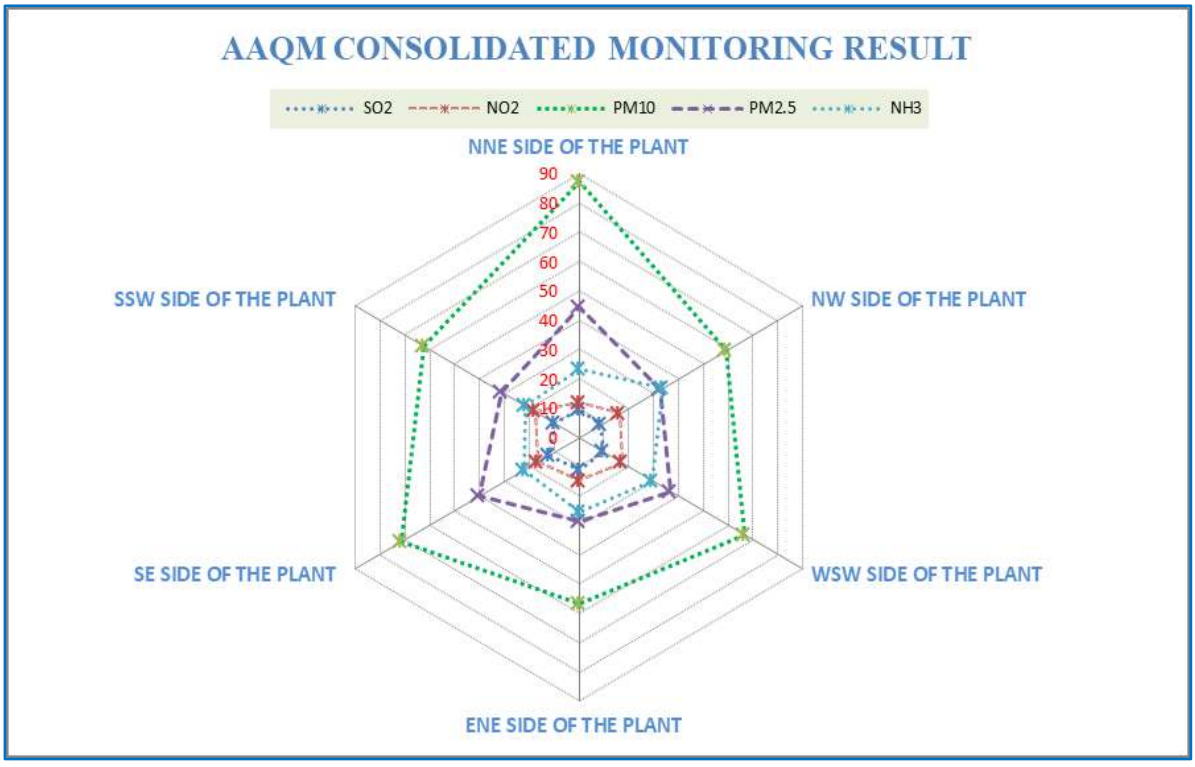

MFL Manali - Ambient Air Quality - PM10
29.03.2021 to 31.03.2021
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
87.3
58.9
66.6
56.9
71.2
62.3
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT

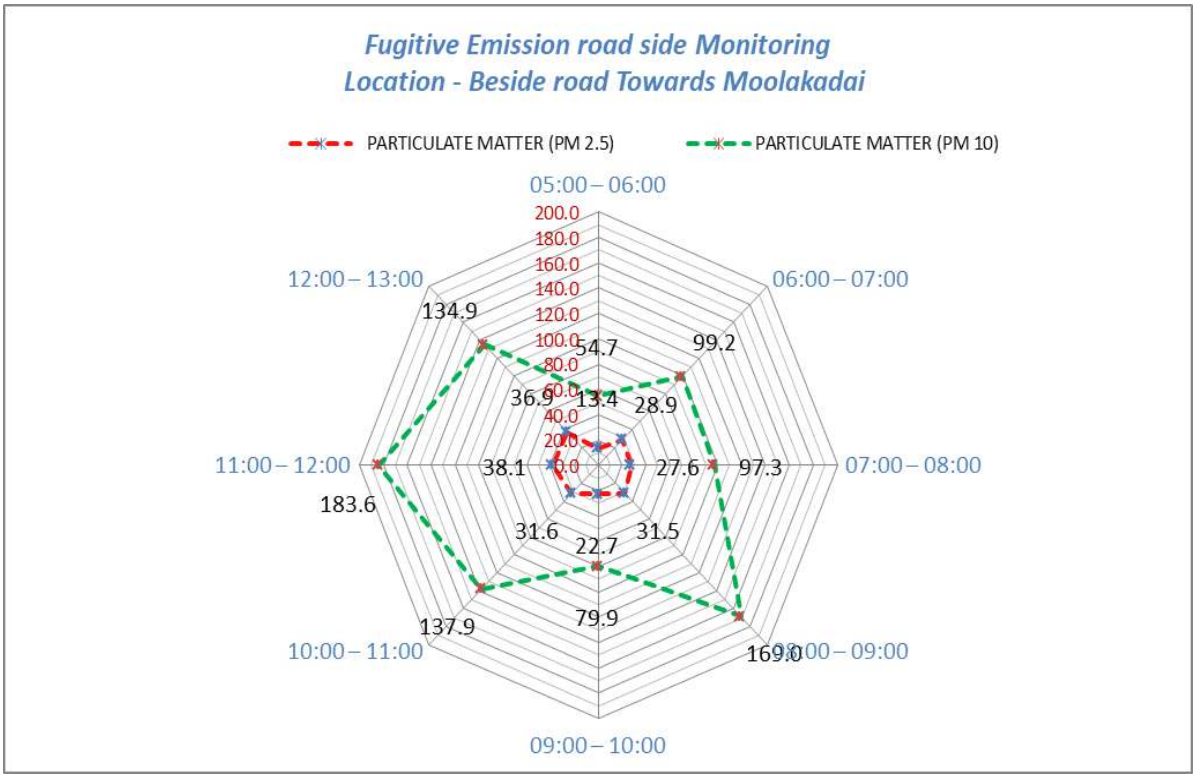

MFL Manali - Ambient Air Quality - SO2
29.03.2021 to 31.03.2021
Concentration µg/m3
14
12
10
8
6
4
2
0
9.5
8.7
9.7
11.1
12.1
9.9
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT

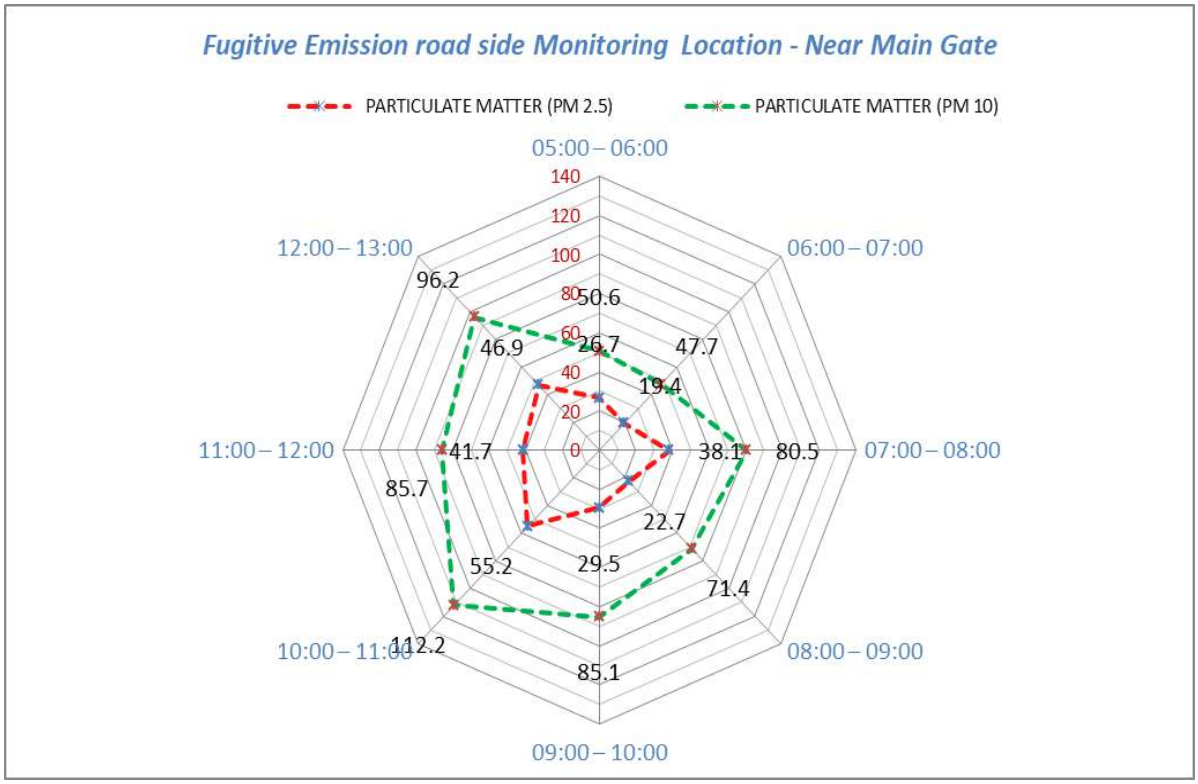

MFL Manali - Ambient Air Quality - NO2
29.03.2021 to 31.03.2021
Concentration µg/m3
20
18
16
14
12
10
8
6
4
2
0
11.9
16.2
17.3
14.9
16.7
17.7
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT


MFL Manali - Ambient Air Quality - NH3
29.03.2021 to 31.03.2021
Concentration µg/m3
40
35
30
25
20
15
10
5
0
23.2
33.5
29.4
25.5
22.3
21.4
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT


AAQM Consolidated Monitoring Results
Concentration µg/m3
100
90
80
70
60
50
40
30
20
10
0
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT
SO2
NO2
PM10
PM2.5
NH3


AAQM CONSOLIDATED MONITORING RESULT
SO2
NO2
PM10
PM2.5
NH3
NNE SIDE OF THE PLANT
NW SIDE OF THE PLANT
WSW SIDE OF THE PLANT
ENE SIDE OF THE PLANT
SE SIDE OF THE PLANT
SSW SIDE OF THE PLANT
90
80
70
60
50
40
30
20
10
0


Fugitive Emission road side Monitoring
Location - Beside road Towards Moolakadai
PARTICULATE MATTER (PM 2.5)
PARTICULATE MATTER (PM 10)
05:00 – 06:00
06:00 – 07:00
07:00 – 08:00
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 – 12:00
12:00 – 13:00
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
54.7
99.2
13.4
28.9
36.9
134.9
38.1
27.6
97.3
183.6
31.6
31.5
22.7
79.9
137.9
169.0


Fugitive Emission road side Monitoring Location - Near Main Gate
PARTICULATE MATTER (PM 2.5)
PARTICULATE MATTER (PM 10)
05:00 – 06:00
06:00 – 07:00
07:00 – 08:00
08:00 – 09:00
09:00 – 10:00
10:00 – 11:00
11:00 – 12:00
12:00 – 13:00
140
120
100
80
60
40
20
0
50.6
47.7
26.7
19.4
46.9
96.2
38.1
80.5
41.7
85.7
22.7
29.5
55.2
71.4
112.2
85.1

7.0 CONCLUSION ON AMBIENT AIR QUALITY MONITORING:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are NNE Side of the Plant, NW Side of the Plant, WSW Side of the Plant, ENE Side of the Plant, SE Side of the Plant, SSW Side of the Plant, Near Main Gate (Road Side) and Beside Road Towards Moolakadai (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 8.7 to 12.1µg/m^3. Highest value of 12.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 11.9 to 17.7µg/m^3. Highest value of 17.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 56.9 to 87.3µg/m^3. Highest value of 87.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.5 to 44.4µg/m^3. Highest value of 44.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ammonia (NH_3):* Ambient Air Quality values of NH_3 are ranging from 21.4 to 33.5µg/m^3. Highest value of 33.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 13.4 to 54.7µg/m^3.

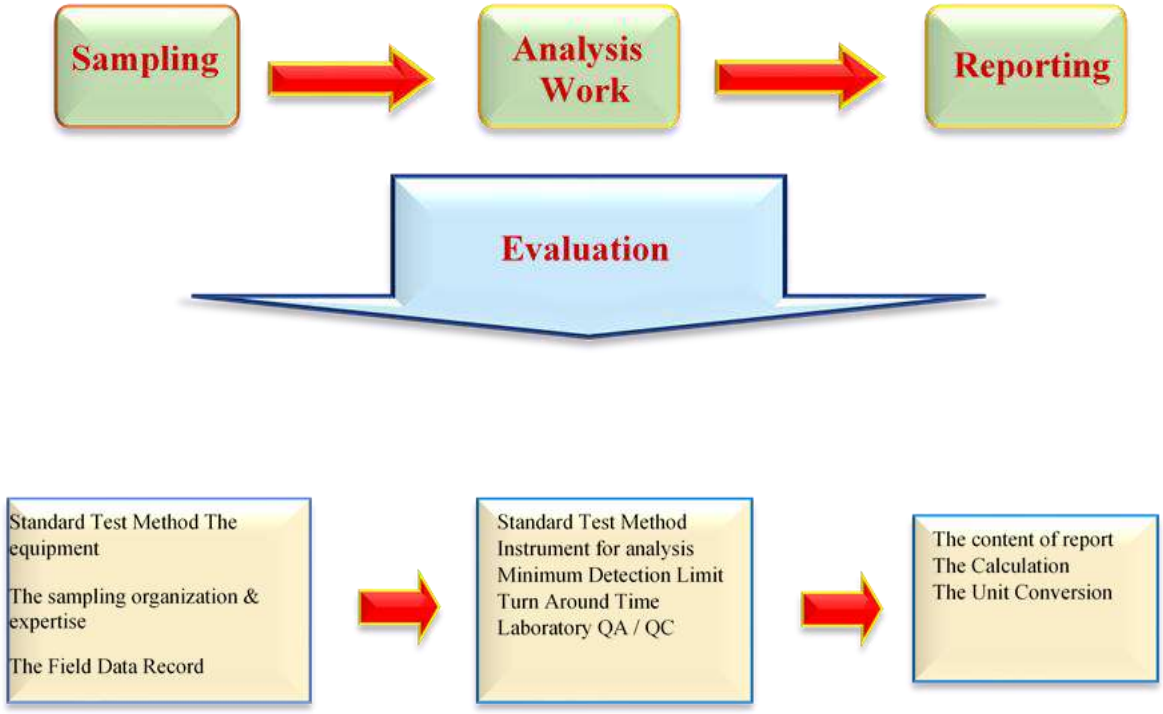
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 54.7 to 183.6µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

6.0 STACK EMISSION MONITORING AND ANALYSIS:

PROCEDURES FOR THE STACK EMISSION MONITORING AND ANALYSIS:

The assessment is exercised the technical and quality aspects to meet the requirements of standard test method. The diagram below illustrates the evaluation following the applied steps:

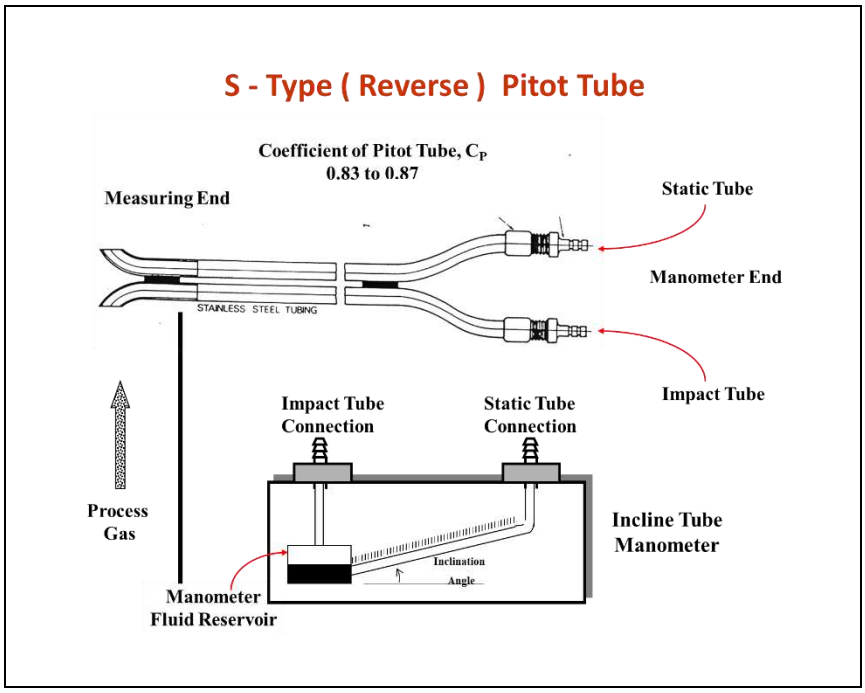


The evaluation is based on the activities of stack measurement. The activity is consisting of 3 steps of work: Sampling Work, Analysis Work and Reporting. Each step is contributing to the accuracy of the results.

1 Exhaust Gas Volume Stream

1.1.1 Velocity

The velocity profile was measured using the discontinuous network measurement according to EPA Method -1. The measurement was carried out with a Prandtl tube (Pitot Tube) in connection with micro manometers.



Pitot tube is used to measure the instantaneous velocity without disturbing the plant operations. Measure the point velocities at each traverse point and find out the average velocity. By the use of pitot tube measure difference in impact and the static pressured by means of manometer in terms of velocity head and actual velocity of the gas is calculated using the following equation.

$$V_{m/sec} = 34.96 \times Cp \left\{ \frac{\Delta P \times Ts}{Ps \times Mw} \right\}^{0.5}$$

Where,

Cp = Pitot Tube Coefficient

ΔP = Velocity Pressure, mmWc

Ts = Flue Gas Temperature, ^{o}K

Ps = Absolute Stack Pressure, mmHg

Mw = Molecular Weight of Flue Gas, Kg/Kg mole

• ***Prandl tube (Pitot tube)***

o EPA design

• ***Dynamic pressure & Static Pressure***

o Micro manometer

o Ranges: 0 -1000 [mmWc]

o Accuracy: ± 1 [%] of measuring range

- ***Exhaust gas temperature***

During the whole measuring period the temperature of the exhaust gas was measured in one point of the cross-section area of the stack with a calibrated Fe-Cu-Ni thermocouple in connection with a display unit.

• Temperature range: 0 - 1200 [°C]

• Accuracy: ± 2 [°C]

PARTICULATE MATTER: ***Field Sampling Procedure:***

Duct Cross section and Number of Traverse Points:

The sampling ports and the duct walls from the probable dust deposits are checked. The cross section of the duct is measured and decided the number of traverse points from which the measurements and samples is taken. The length of the sampling port from the inner side of the duct is measured and added the port length to the traverse points and marked the distances of traverse points on the pitot tube.

The following measurements are taken to calculate the velocity, flowrate and optimum Nozzle diameter.

1. Velocity Head Measurement

2. Absolute Static Pressure of the stack

3. Absolute Stack Temperature

4. Molecular weight of the gas

2. Moisture content of the gas

Velocity of the gas: Calculated the velocity of the gases at each traverse point using the velocity equation with the data collected from the velocity head measurement, absolute stack pressure, absolute stack temperature and molecular weight of the gas and estimated the arithmetic average velocity across the cross section.

Normal Flow Rate of the Gases: With the average gas velocity and the cross sectional area of the duct the total flow rate of the gases at the stack conditions is calculated as given in the flow rate of gases at normal conditions.

Flow Rate at Stack Condition$_{m3/Hr}$

Qs = Avg Velocity, M/Sec x Area of Flow Cross Section, M^2

Normalized Flow Rate, $Nm3_{Dry}$/Hr

$$Qn = Qs \times \frac{Ps \times Tn}{Pn \times Ts} \times (1 - Bw)$$

Selection of Optimum Nozzle dia: For the calculation of the optimum iso-kinetic flow rate range it is required to estimate the suitable nozzle diameter using the super iso-kinetic sampling method. The nearest diameter nozzle available in the kit is selected, as that of the calculated and fixes it to the thimble holder.

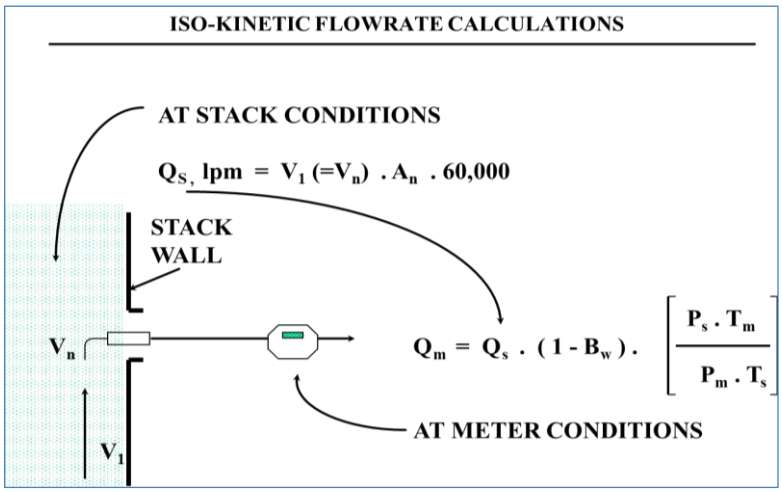
Diameter of the nozzle, dn (mm) providing average iso-kinetic flow rate of 25 lpm at meter conditions

$$D_n = \left\{ \frac{25 \times 1000 \times 4 \times Pm \times Ts}{(1 - Bw) \times 60 \times V \times \pi_{Avg} \times Tm \times Ps} \right\}^{0.5}$$

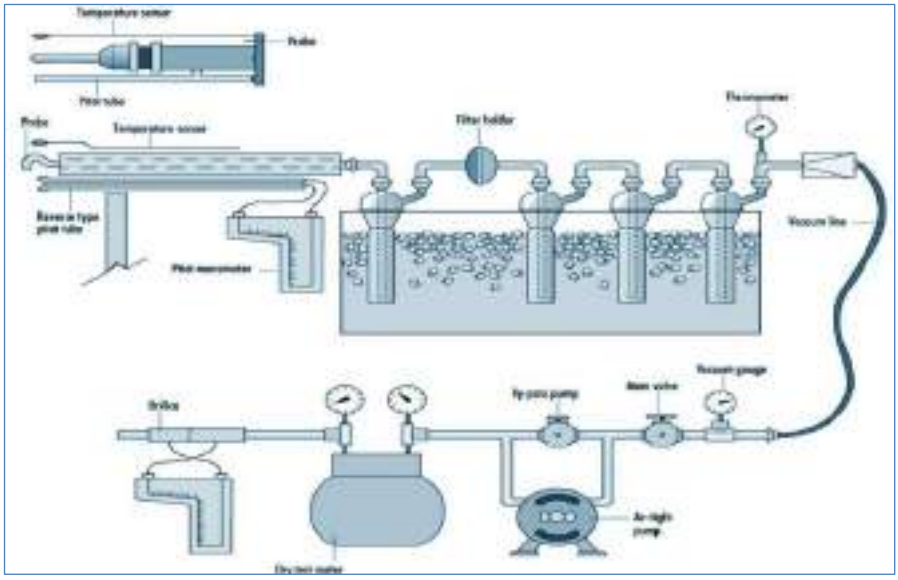
m & S … At Meter and Stack conditions respectively

V_{avg} … Average Stack/Duct velocity, M/Sec.

Calculation of Iso-kinetic flow rates: Used the selected diameter nozzle and the calculated velocities at each traverse point calculated the iso-kinetic flowrates.



Thimble Holder and Probe: Fixed the prepared thimble in the thimble holder with proper gasket fittings so that no leakage of air is possible. Marked the traverse points on the probe connected to thimble holder as marked on pitot tube in case of velocity measurement. Inserted the probe into the duct through the sampling port and located a the centre of the duct for about 15mts so that the nozzle in the direction of the flow to bring he temperature of thimble holder to the temperature of the gas avoided the dust deposit in the nozzle. The heating of the thimble holder is essential to avoid thermal precipitation on the holder walls. The indicator metal strip at the end of the sampling probe is arranged accordingly.



Dry Gas Meter Settings: Recorded the initial reading of the DGM in litres and arranged the pressure gauge reading at 0 mmHg.

Nitrogen monoxide (NO), Carbon dioxide (CO2), Carbon Monoxide (CO) and Oxygen (O2)

The measurement of the compounds NO, NO2, CO, CO2 and O2 was carried out using MRU Optima-7, Germany Portable Flue Gas Analyser.

Measurement of:	
O_2	0 ... 21,00 %
CO_2 calculated value	0 ... 20,00 %
CO low	0 ... 300 ppm
CO/H_2 compensated	0 ... 4.000 ppm
NO low	0 ... 300 ppm
NO	0 ... 1.000 ppm
NO_2	0 ... 200 ppm
NO_x	0 ... 2.000 ppm
SO_2	0 ... 2.000 ppm
CO high	0 ... 2,0 %
CO very high	0 ... 10,00 %
Combustion air temperature	up to 100° C
Stack gas temperature	up to 1.100° C *
Stack draft measurement	± 100 hPa
Differential pressure	± 100 hPa
Differential temperature	up to 1.100° C *

• ***Extraction and conditioning of the sample gas***

o Extraction probe: High-grade steel head with connected glass-filter-case, heated at 120 [°C]

o Dust filter: Stuffed quartz-wool

o Sample gas connection tubes: Teflon; 6 [m] length and heated at 120 [°C] between extraction probe and cooler; 2 [m] length and unheated between cooler and analyzer

Sulfur Dioxide (SO2)

Extractive Measurement

Additionally, to the used continuous method with dilution the sulfur dioxide concentration was measured with a discontinuous method. The used method is described in EPA Method - 6

SCOPE: The sample collector consists of two midget impingers. The $S0_2$ is removed in this two midget impingers, which contain 100 ml each of 3% Hydrogen peroxide solutions. $S0_2$ is absorbed in the impingers and converted to form H_2S0_4.

PRINCIPLE AND APPLICABILITY:

The Sulfur dioxide is then absorbed in a 3% Hydrogen peroxide solution and eventually is determined quantitatively by titration with 0.1N Barium Perchlorate solution. Thorin is used as a colour indicator for this titration.

REAGENTS:

1. Deionized distilled water

2. Hydrogen Peroxide, (3% solution): Prepare by diluting 100ml of 30% hydrogen peroxide to 1 litter with dolonized water. Caution: the 30% H_20_2 is a strong skin irritant which is not noticeable until a few minutes after the injury occurs. This solution must be prepared daily.

3. Isopropyl alcohol, (80% solution); Prepare by mixing 80 ml of isopropyl alcohol with 20 ml of deionized water. This solution is stable.

4. Thorin indicator: [1-(0-arsonophenylazo) -2-naphthol-3, 6-disulfonic acid, disodiuin salt (or equivalent)]. Prepare by dissolving 0.2 grams in 100 ml of deionized distilled water. It should be stored in a polyethylene container since it tends to, deteriorate if stored in glass.

5. Barium perchlorate (0.01N): Prepare by dissolving 1.95 grams of barium perchlorate, $Ba(Cl0_4)_2$ $3H_20$ in 200 ml of deionized water. Then dilute to 1 liter using isopropyl alcohol. Alternatively, dissolve l.22 grams of barium chloride,

$BaCl_2.2H_20$, in 200 ml deionized water and then dilute to 1 liter with the isopropyl alcohol. The normality of this solution should be standardized with standard sulfuric acid.

SAMPLING PROCEDURE:

This method determines only the concentration in the gas stream. The volumetric flow rate of the stack must be determined according to EPA methods 1 and 2. The same sampling port which in used for the velocity monitoring can be used for the gaseous sampling. Even though the gas composition in uniform across the cross section of the duct, It is advised to collect the sample at the centroid of the duct or not closer then 200mm to the duct wall.

The sampling train is assembled, and leak tested by plugging the probe inlet and pulling 300mmHg vacuum. Observing the dry gas meter, the leakage rate should not exceed 1% of the desired sampling rate. If the leakage is severe each joint of the train should be inspected, and the leak test performed again. A thin film of silicone grease often helps to make the joints leak tight.

The impingers are filled with the absorbing reagents. The initial reading of the DGM is recorded and a sampling flow rate of 2 lpm is maintained at the rotameter. In case of unsteady source conditions, “proportionate sampling" is implemented by introducing the Pitot tube in to the duct along with the sampling probe and the sampling flow rate varies with the variations in the velocity of the gas stream. Gas samples are collected for a minimum period of 20 to 30 minutes and the final DGM reading; meter temperature and pressure are recorded.

At the end of the sampling disconnect the sampling probe from impingers and flush the impingers with about 10 litres of atmospheric air by turning on the vacuum pump. It is necessary to transfer the entrapped $S0_2$ in the first impinger and absorbed in the following impingers. Transfer the contents of the impingers into the polythene bottles and continue sampling for next set of samples. A minimum of two samples have to be collected to get consistent and representative data.

ANALYTICAL PROCEDURES:

Sulfur Dioxide ($S0_2$): Transfer the samples from the two midget impingers in to two 100ml volumetric flasks separately and make upto the mark with distilled water. The $S0_2$ has been oxidized to $S0_3$ with H_20_2 and hydrolysed to form sulfuric acid in the impingers.

Follow the same analytical for the samples in both the impingers separately to cheek the absorption efficiency and to ensure that there is no escape of SO_2 along with the gas.

$$Qn = Qm \frac{Tn \times Pm}{Tm \times Pn}$$

Where

Qn Volume of gas sample under normal condition, Nm^3

Qm Volume of gas sample under meter conditions, m^3

Tn The absolute gas temperature at normal conditioned, 298°K

Tm The absolute dry gas meter temperature, °K

Pn The absolute pressure at normal conditions, 760 mmHg

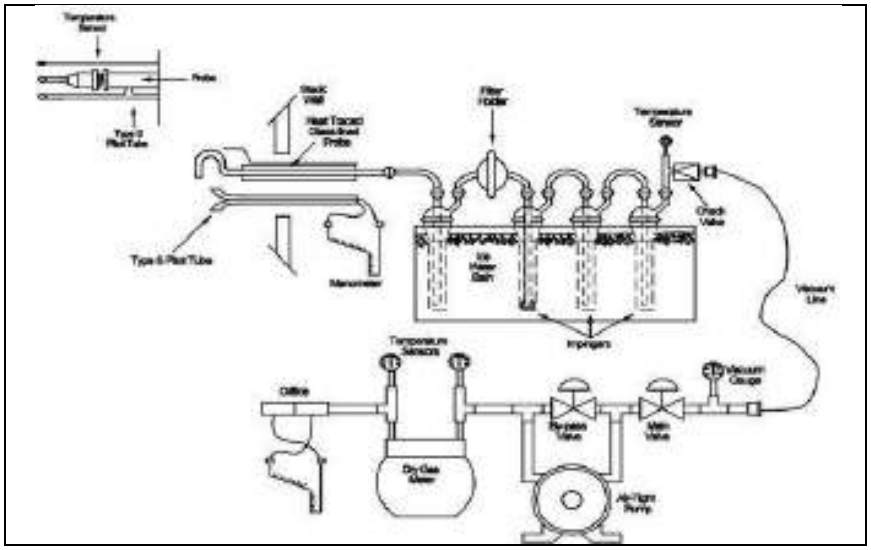
Pm The absolute pressure at the gas meter, mmHg

SO_2 CONCENTRATION:

The concentration of SO_2 in the gases is determined using the same expression for SO_3 by replacing the equivalent weight with 32 gm/gm mole. The average concentration of SO_2 is estimated by considering the arithmetic average of both the impinger reading.

Concentration of SO_2 in the sample gas, mg/Nm^3

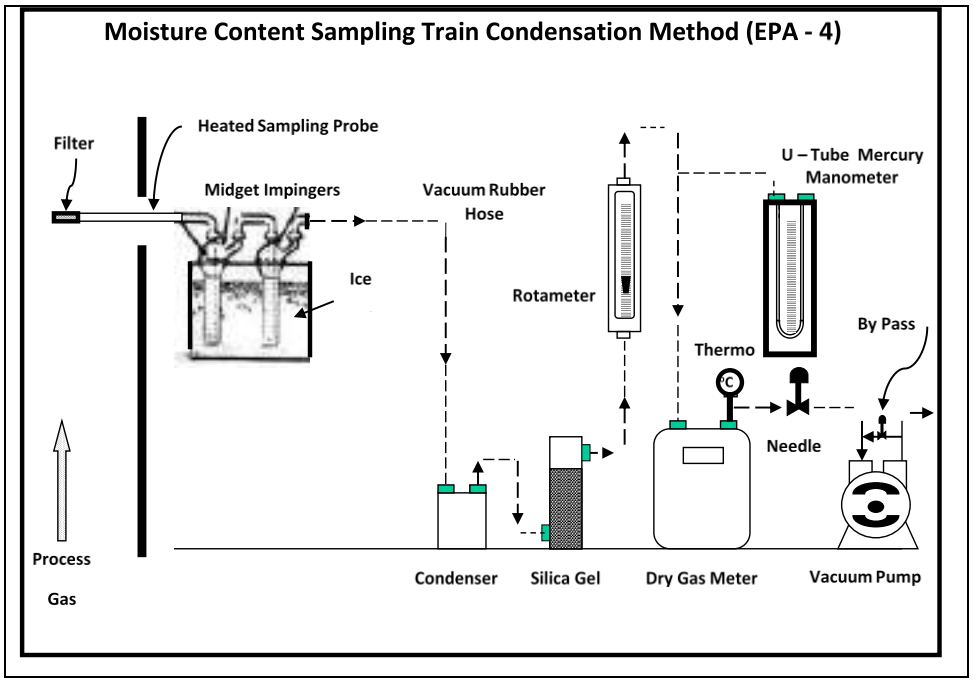
$$= \frac{(A-B) \times V_{sample} \times N \times 32 \times 1000 \times Pn \times Tm}{V_{ali} \times Q \times Pm \times Tn}$$



MOISTURE CONTENT

The moisture content was measured with a special psychrometer according to the recommendations in <Lit.2,3>. The extraction system contains a heated extraction probe with dust filter and a heated connection tube (temperature: 120 [°C]).

The flue gas is allowed to pass through a set of midget glass impingers, which are cooled in an ice bath. With the quantity of water condensed in the impingers for a particular amount of flue gas passed through the moisture content is calculated. The density of the gases get affected predominantly, when moisture content is more than 2.0 gms/Nm^3.



7.0 STACK EMISSION RESULTS:

STACK- 1: M/s. MADRAS FERTILIZERS LIMITED, NPK COMMON OUTLETSTACK

LOCATION - BOILER – NPK COMMON OUTLETSTACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Particulate Matter	mg/Nm3	13	150
2	Hydrogen Fluoride as HF	mg/Nm3	3.5	-
3	Ammonia as NH3	mg/Nm3	243	300

STACK- 2: M/s. MADRAS FERTILIZERS LIMITED, NPK FUME FANS SCRUBBER INLET STACK

LOCATION - BOILER – NPK FUME FANS SCRUBBER INLET STACK, MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Particulate Matter	mg/Nm3	15.2
2	Hydrogen Fluoride as HF	mg/Nm3	5.17
3	Ammonia as NH3	mg/Nm3	2046

STACK- 3: M/s. MADRAS FERTILIZERS LIMITED, NPK FUME FANS SCRUBBER OUTLET STACK

LOCATION - BOILER – NPK FUME FANS SCRUBBER OUTLET STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Particulate Matter	mg/Nm3	8.6	150
2	Hydrogen Fluoride as HF	mg/Nm3	2.3	-
3	Ammonia as NH3	mg/Nm3	242	300

STACK- 4: M/s. MADRAS FERTILIZERS LIMITED, NPK DRYER DISCHARGE WET SECRUBBER OUTLET

LOCATION - BOILER – NPK DRYER DISCHARGE WET SECRUBBER OUTLET, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Particulate Matter	mg/Nm3	9.3	150
2	Hydrogen Fluoride as HF	mg/Nm3	2	-
3	Ammonia as NH3	mg/Nm3	245	300

STACK- 5: M/s. MADRAS FERTILIZERS LIMITED, UREA DEMISTER- A INLET

LOCATION - BOILER – UREA DEMISTER- A INLET, MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Particulate Matter	mg/Nm3	8.8
2	Hydrogen Fluoride as HF	mg/Nm3	4
3	Ammonia as NH3	mg/Nm3	2242

STACK- 6: M/s. MADRAS FERTILIZERS LIMITED, UREA DEMISTER- A OUTLET

LOCATION - BOILER – UREA DEMISTER- A OUTLET, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Particulate Matter	mg/Nm3	7	150
2	Hydrogen Fluoride as HF	mg/Nm3	1.5	-
3	Ammonia as NH3	mg/Nm3	253	-

STACK- 7: M/s. MADRAS FERTILIZERS LIMITED, UREA DEMISTER- B INLET

LOCATION - BOILER – UREA DEMISTER- B INLET, MANALI			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Particulate Matter	mg/Nm3	12
2	Hydrogen Fluoride as HF	mg/Nm3	3.5
3	Ammonia as NH3	mg/Nm3	2106

STACK- 8: M/s. MADRAS FERTILIZERS LIMITED, UREA DEMISTER- B OUTLET

LOCATION - BOILER – UREA DEMISTER- B OUTLET, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Particulate Matter	mg/Nm3	5.8	150
2	Hydrogen Fluoride as HF	mg/Nm3	1.67	-
3	Ammonia as NH3	mg/Nm3	45	-

STACK- 9: M/s. MADRAS FERTILIZERS LIMITED, UTILLITY BOILER 1 & 2 COMMON STACK

LOCATION - BOILER – UTILLITY BOILER 1 & 2 COMMON STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	401	NA
2	Velocity	m/sec	6.39	NA
3	Volume of Gas Discharge	Nm^3/hr	264010	NA
4	Oxygen as O_2	%	15.4	NA
5	Carbon Monoxide as CO	mg/Nm^3	51	NA
6	Carbon Dioxide as CO_2	%	3.8	NA
7	Particulate Matter	mg/Nm^3	31.3	150
8	Sulphur Dioxide as SO_2	mg/Nm^3	386	NA
9	Oxides of Nitrogen as NO_2	mg/Nm^3	54	NA

STACK- 10: M/s. MADRAS FERTILIZERS LIMITED, 110ATA/ PCB BOILER STACK

LOCATION - BOILER – 110ATA/ PCB BOILER STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	395	NA
2	Velocity	m/sec	9.79	NA
3	Volume of Gas Discharge	Nm^3/hr	811362	NA
4	Oxygen as O_2	%	11.8	NA
5	Carbon Monoxide as CO	mg/Nm^3	22	NA
6	Carbon Dioxide as CO_2	%	5.8	NA
7	Particulate Matter	mg/Nm^3	36.4	150
8	Sulphur Dioxide as SO_2	mg/Nm^3	14	NA
9	Oxides of Nitrogen as NO_2	mg/Nm^3	293	NA

STACK- 11: M/s. MADRAS FERTILIZERS LIMITED, DG UNIT – 5 1000KVA STACK

LOCATION – DG UNIT – 5 1000KVA STACK, MANALI				
S.NO	**POLLUTANT**	**UNIT**	**RESULT**	**CPCB LIMIT**
1	Stack Temperature	K	522	NA
2	Velocity	m/sec	15.04	NA
3	Volume of Gas Discharge	Nm^3/hr	2525	NA
4	Oxygen as O_2	%	12.8	NA
5	Carbon Monoxide as CO	g/kW-hr	0.16	≤ 3.5
6	Carbon Dioxide as CO_2	%	5.4	NA
7	Particulate Matter	g/kW-hr	0.07	≤ 0.2
8	Sulphur Dioxide as SO_2	mg/Nm^3	36	NA
9	Oxides of Nitrogen as NO_2	g/kW-hr	0.46	≤4.0

CONCLUSION:

In Stack Emission monitoring at all stack complying all the parameters against the emission limit values.

8.0 WET SCRUBBER PERFORMANCE EFFICIENCY

8.1 NPK FUME FANS SCRUBBER INLET AND OUTLET STACK EFFICIENCY

LOCATION - BOILER – NPK FUME FANS SCRUBBER INLET AND OUTLET STACK, MANALI					
S.NO	**POLLUTANT**	**UNIT**	**INLET**	**OUTLET**	**EFFICIENCY**
1	Particulate Matter	mg/Nm3	15.2	8.6	43.42
2	Hydrogen Fluoride as HF	mg/Nm3	5.17	2.3	55.51
3	Ammonia as NH3	mg/Nm3	2046	243	89.64

8.2 UREA DEMISTER- A INLET AND OUTLET STACK EFFICIENCY

LOCATION - BOILER – UREA DEMISTER- A INLET INLET AND OUTLET STACK, MANALI					
S.NO	**POLLUTANT**	**UNIT**	**INLET**	**OUTLET**	**EFFICIENCY**
1	Particulate Matter	mg/Nm3	8.8	7	20.45
2	Hydrogen Fluoride as HF	mg/Nm3	4	1.5	62.50
3	Ammonia as NH3	mg/Nm3	2242	253	90.95

8.3 BOILER – UREA DEMISTER- B INLET AND OUTLET STACK EFFICIENCY

LOCATION - BOILER – UREA DEMISTER- B INLET AND OUTLET STACK, MANALI					
S.NO	**POLLUTANT**	**UNIT**	**INLET**	**OUTLET**	**EFFICIENCY**
1	Particulate Matter	mg/Nm3	12	5.8	51.67
2	Hydrogen Fluoride as HF	mg/Nm3	3.5	1.67	52.29
3	Ammonia as NH3	mg/Nm3	2106	45	97.86

9.0 DISPERSION MODELLING OF STACKS EMISSIONS:

Dispersion models are deterministic models, based upon physical theories, that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, orographic and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy.

The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected back into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

Sources may be located in rural or urban areas, and receptors may be located in simple or complex terrain. Complex terrain is defined as terrain in which ground elevations are above the stack tip or release height and the complex terrain capabilities of AERMOD are of particular interest. It employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

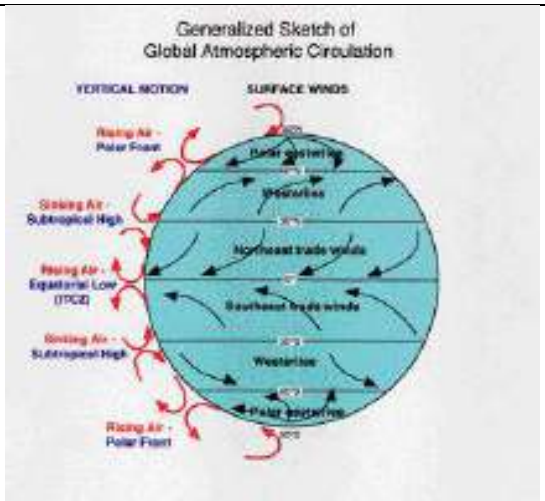
The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from Madras Fertilizers Limited, Manali. For our simulations, the required

source data input includes source type, emission rate, location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

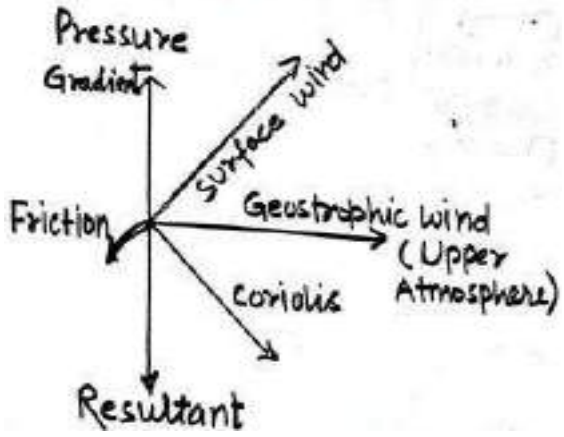
The AERMOD model was applied to study the diffusion of pollutants from Madras Fertilizers Limited, Manali and other sources in three days from 29.03.2021 to 31.03.2021. Among the discrete receptors, we included the locations of air quality monitoring stations around the plant area to compare model output and measured values. This enables to compare the maximum values provided by the model with the maximum measurements of monitoring stations. These simulations could allow understanding cause-effect ratio related to plant sources of their pollutants.

Dispersion of pollutants is not only terrain morphology but also its dynamic and thermal effects on the atmospheric flow. The vertical structure of the atmospheric boundary layer (ABL), and therefore the vertical profiles of meteorological variables, are mainly determined by the surface turbulent fluxes of momentum, heat and moisture.

Wind: The speed and direction of the wind is governed by three forces; the **pressure** gradient force (PGF), the Coriolis Force and **friction**. In general, **wind** speed increases with height as you go up in the atmosphere. This is because friction from the ground slows down the air at the surface. The **wind** often **changes** in **direction** as height increases as well.



Coriolis Force



Balance of Forces During Wind Movement

Pressure Gradient Force

Pressure Gradient Force is created due to the difference in the atmospheric pressure, and it is directed from the high pressure to the low pressure. PGF is the primary cause behind the wind.

STACK EMISSIONS AND DISPERSION MODELLING USING AERMOD 5.2

NPK Common Stack Outlet

Particulate matter:

Stack Height, m	-	45
Exit Velocity, m/Sec	-	12.8
PM Concentration, mg/m3	-	13
Emission load, gm/Sec	-	0.7608
Plume rise, m	-	2

Hydrogen Fluoride:

Stack Height, m	-	45
Exit Velocity, m/Sec	-	12.8
HF Concentration, mg/m3	-	3.5
Emission load, gm/Sec	-	0.2048
Plume rise, m	-	2

Ammonia:

Stack Height, m	-	45
Exit Velocity, m/Sec	-	12.8
NH3 Concentration, mg/m3	-	213
Emission load, gm/Sec	-	12.466
Plume rise, m	-	2

Urea Demister-A/Outlet

Particulate matter:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.31
PM Concentration, mg/m3	-	7
Emission load, gm/Sec	-	1.9467
Plume rise, m	-	2

Hydrogen Fluoride:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.31
HF Concentration, mg/m3	-	1.5
Emission load, gm/Sec	-	0.417
Plume rise, m	-	2

Ammonia:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.31
NH3 Concentration, mg/m3	-	203
Emission load, gm/Sec	-	56.456
Plume rise, m	-	2

Urea Demister-B Outlet

Particulate matter:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.4
PM Concentration, mg/m3	-	5.8
Emission load, gm/Sec	-	1.6463
Plume rise, m	-	2

Hydrogen Fluoride:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.4
HF Concentration, mg/m3	-	1.5
Emission load, gm/Sec	-	0.474
Plume rise, m	-	2

Ammonia:

Stack Height, m	-	73
Exit Velocity, m/Sec	-	3.4
NH3 Concentration, mg/m3	-	45
Emission load, gm/Sec	-	12.773
Plume rise, m	-	2

Utility Boiler-1&2 Common Stack

Particulate matter:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	6.39
PM Concentration, mg/m3	-	31.3
Emission load, gm/Sec	-	2.2954
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	6.39
SO_2 Concentration, mg/m3	-	386
Emission load, gm/Sec	-	28.3077
Plume rise, m	-	3

Oxides of Nitrogen as NO2:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	6.39
NOx Concentration, mg/m3	-	54
Emission load, gm/Sec	-	3.96015
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	70
Exit Velocity, m/Sec	-	6.39
CO Concentration, mg/m3	-	51
Emission load, gm/Sec	-	3.740
Plume rise, m	-	3

110 ATA/PCB Boiler

Particulate matter:

Stack Height, m	-	35
Exit Velocity, m/Sec	-	9.79
PM Concentration, mg/m3	-	36.4
Emission load, gm/Sec	-	8.20377
Plume rise, m	-	3

Sulphur dioxide as SO2:

Stack Height, m	-	35
Exit Velocity, m/Sec	-	9.79
SO_2 Concentration, mg/m3	-	14
Emission load, gm/Sec	-	3.15529
Plume rise, m	-	3

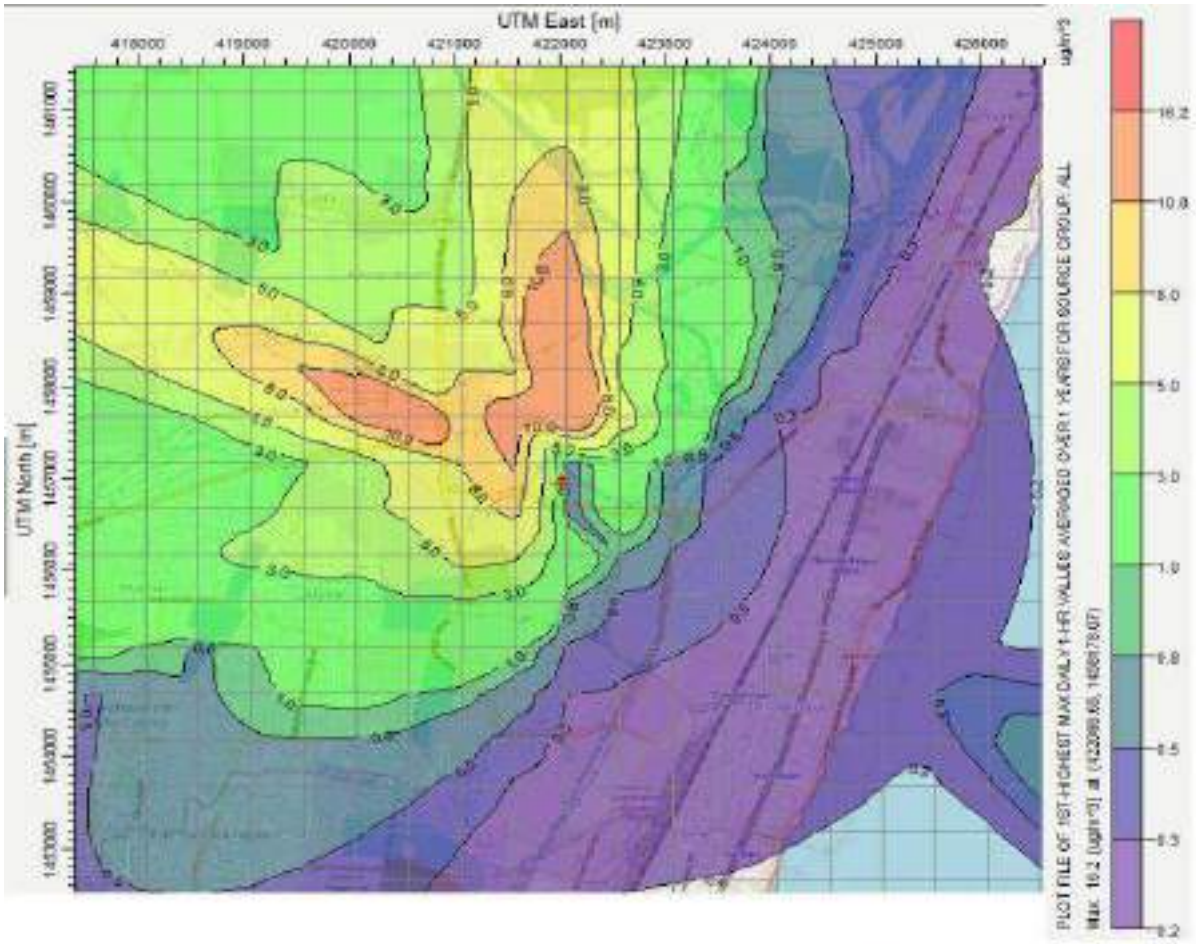
Oxides of Nitrogen as NO2:

Stack Height, m	-	35
Exit Velocity, m/Sec	-	9.79
NOx Concentration, mg/m3	-	293
Emission load, gm/Sec	-	66.0358
Plume rise, m	-	3

Carbon Monoxide as CO:

Stack Height, m	-	35
Exit Velocity, m/Sec	-	9.79
CO Concentration, mg/m3	-	22
Emission load, gm/Sec	-	4.9583
Plume rise, m	-	3

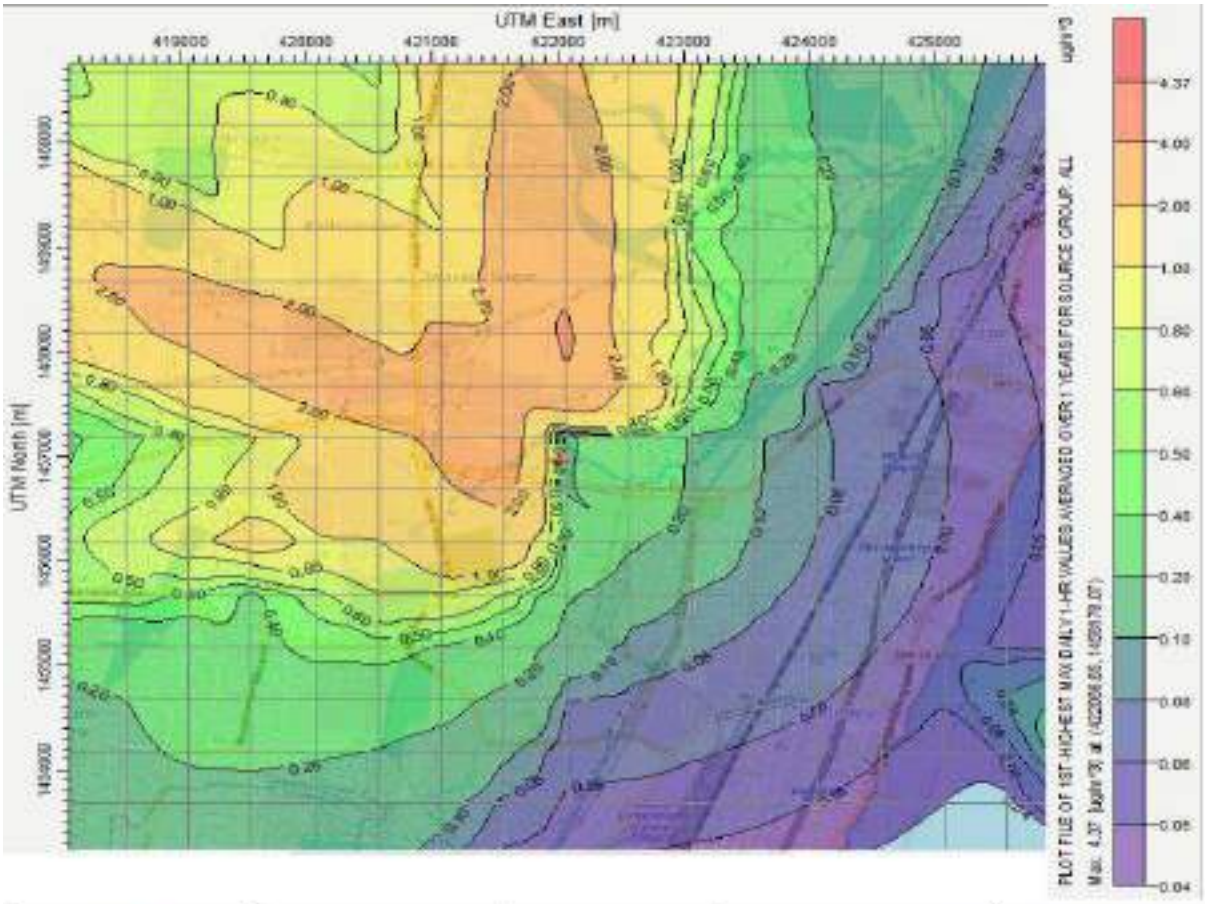
STACK EMISSION DISPERSION MODELLING -MFL NPK Common Stack Outlet @2 & 5 KM-Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
13	0.83	16.2	1.78	0.65

MFL NPK Common Stack Outlet of Particulate matter concentration is 13 mg/m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 16.2µg/m^3 at 2km dispersion Particulate matter is 1.78µg/m^3 and at 5km dispersion Particulate matter is 0.65µg/m^3 and the predominant wind direction is SSE.

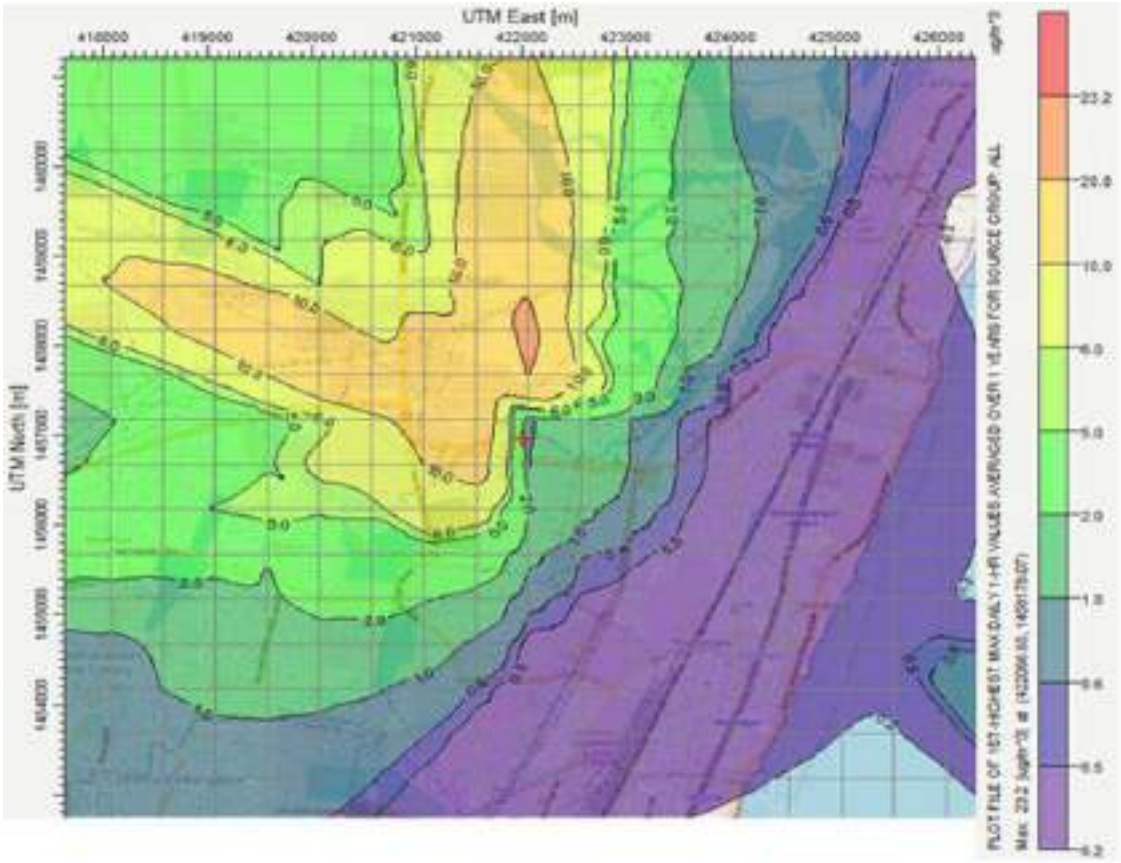
STACK EMISSION DISPERSION MODELLING –MFL NPK Common Stack Outlet @2 & 5 KM- Hydrogen Fluoride



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
3.5	0.91	4.37	1.23	0.45

MFL NPK Common Stack Outlet of Hydrogen Fluoride concentration is 3.5 mg/m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.37µg/m^3 at 2km dispersion Hydrogen Fluoride is 1.23µg/m^3 and at 5km dispersion Hydrogen Fluoride is 0.45µg/m^3 and the predominant wind direction is SSE.

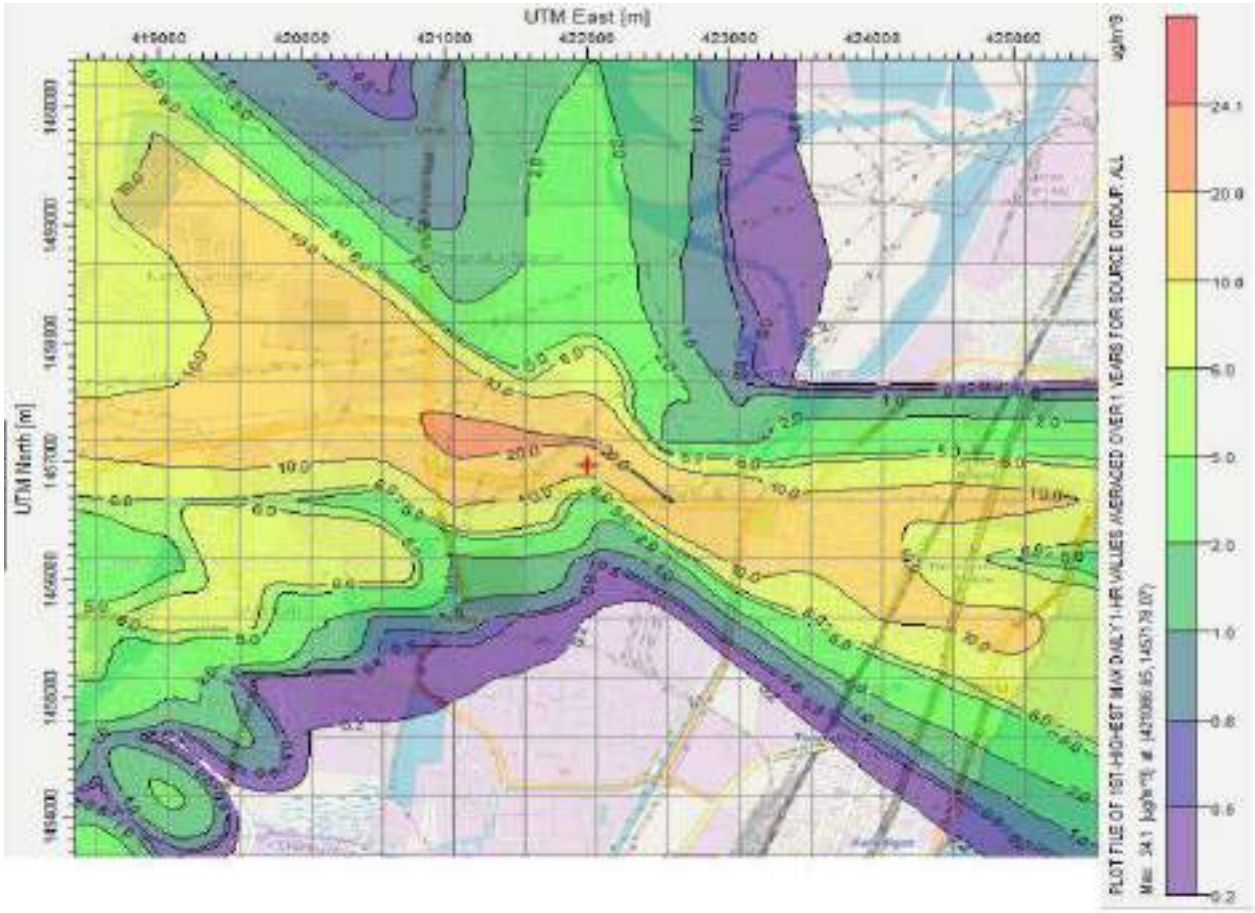
STACK EMISSION DISPERSION MODELLING –MFL NPK Common Stack Outlet @2 & 5 KM-Ammonia



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
243	0.79	23.2	4.22	0.89

MFL NPK Common Stack Outlet of Ammonia concentration is 243 mg/m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 23.2µg/m^3 at 2km dispersion Ammonia is 4.22µg/m^3 and at 5km dispersion Ammonia is 0.89µg/m^3 and the predominant wind direction is SSE.

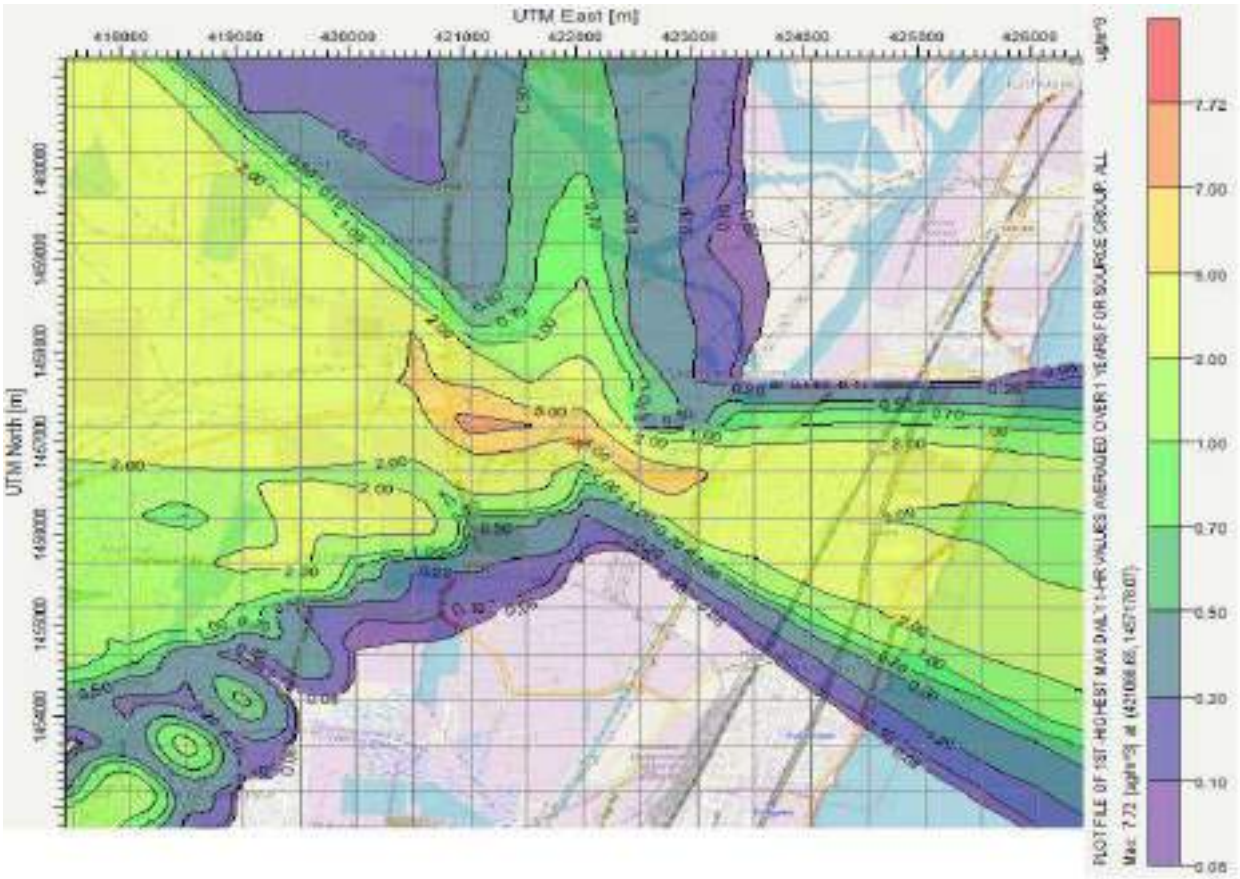
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-A Outlet @2 & 5 KM-Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
7	0.86	24.1	1.85	0.0987

MFL Urea Demister-A Outlet of Particulate matter concentration is 7 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 24.1µg/m^3 at 2km dispersion Particulate matter is 1.85µg/m^3 and at 5km dispersion Particulate matter is 0.0987µg/m^3 and the predominant wind direction is SSE.

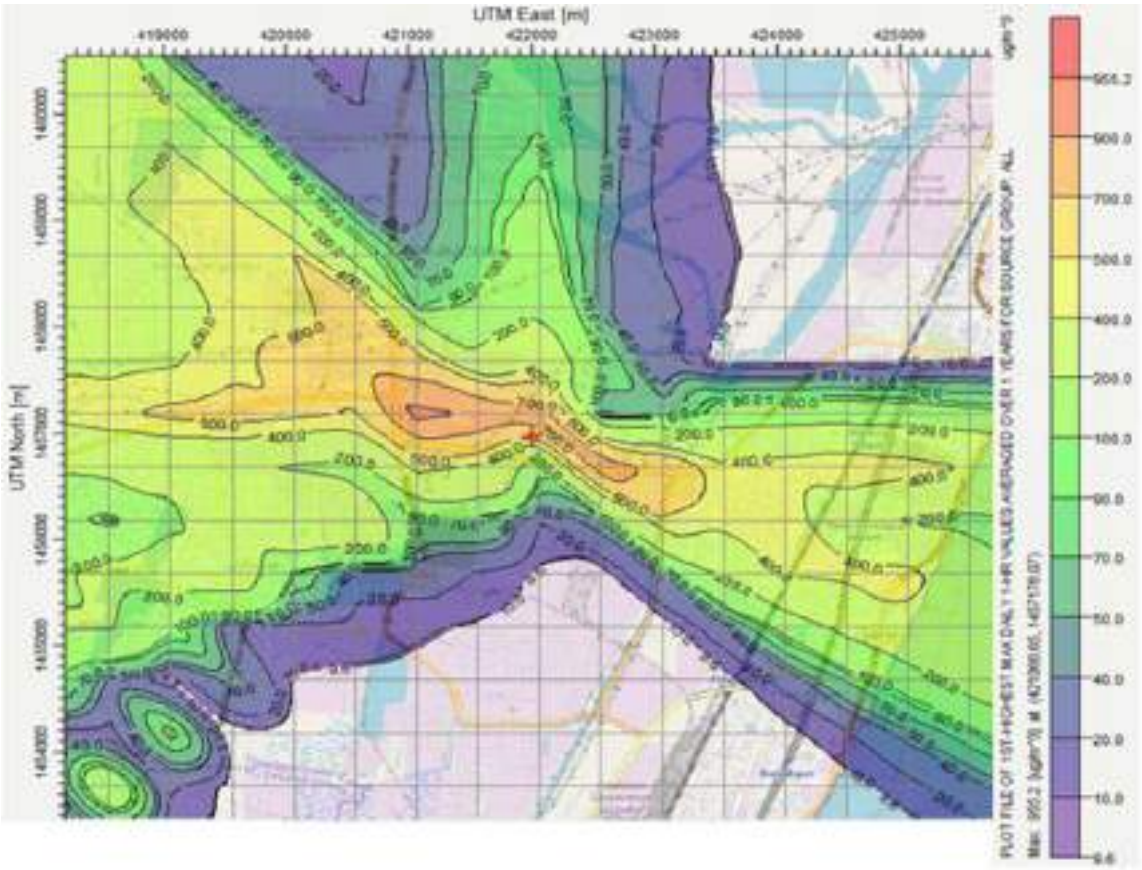
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-A Outlet @2 & 5 KM-Hydrogen Fluoride



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
1.5	0.91	7.72	0.65	0.0093

MFL Urea Demister-A Outlet of Hydrogen Fluoride concentration is 1.5 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 7.72µg/m^3 at 2km dispersion Hydrogen Fluoride is 0.65µg/m^3 and at 5km dispersion Hydrogen Fluoride is 0.0093µg/m^3 and the predominant wind direction is SSE.

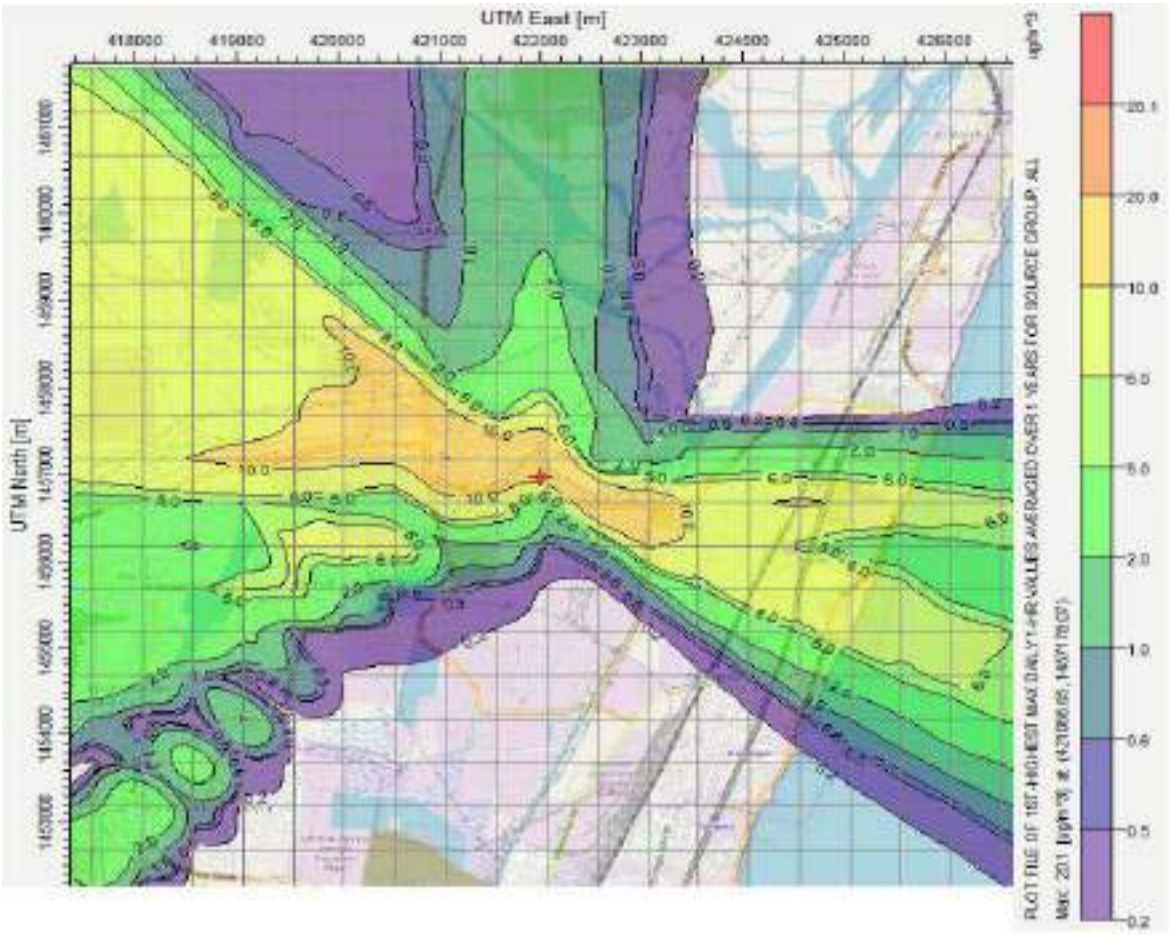
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-A Outlet @2 & 5 KM-Ammonia



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
253	0.68	955.2	67.84	3.177

MFL Urea Demister-A Outlet of Ammonia concentration is 253 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 955.2µg/m^3 at 2km dispersion Ammonia is 67.84µg/m^3 and at 5km dispersion Ammonia is 3.177µg/m^3 and the predominant wind direction is SSE.

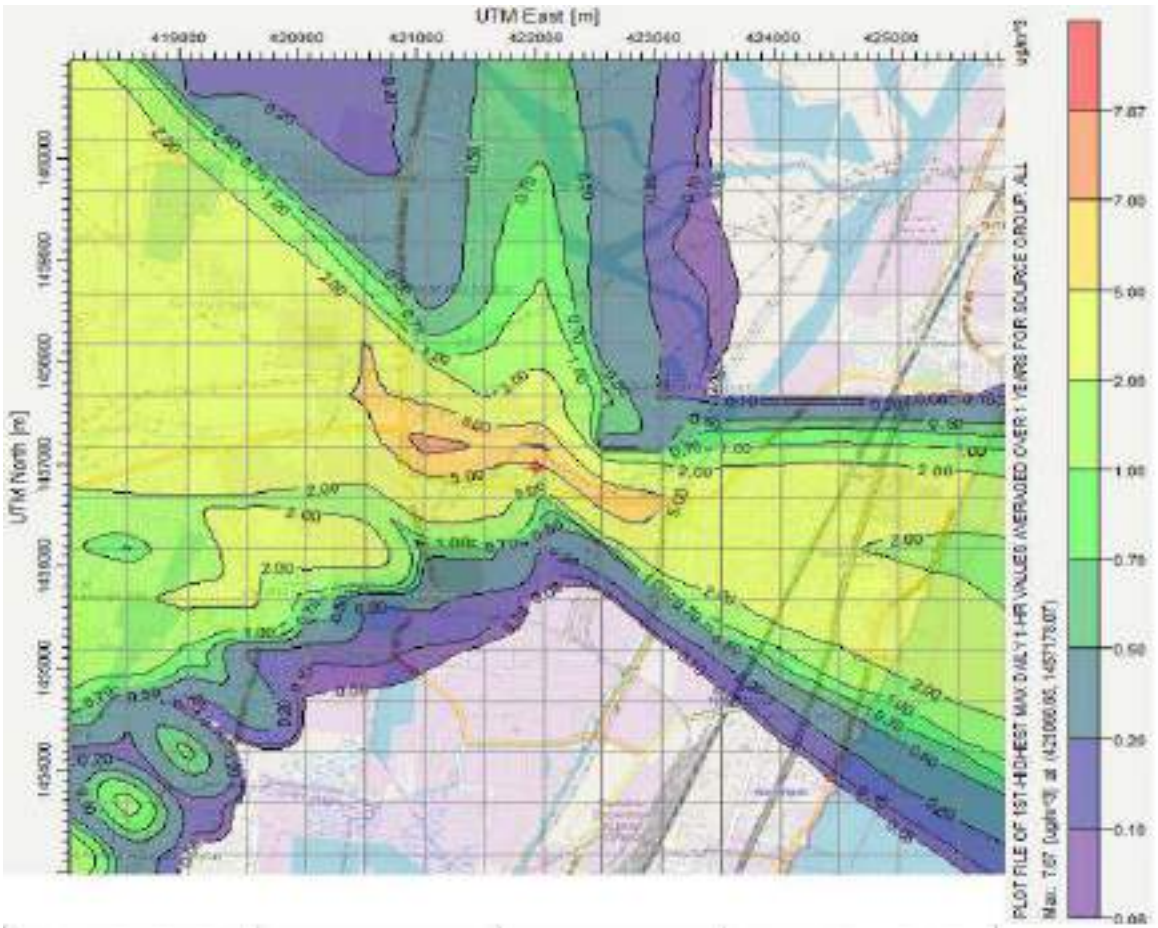
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-B Outlet @2 & 5 KM-Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
5.3	0.68	20.1	1.97	0.43

MFL Urea Demister-B Outlet of Particulate matter concentration is 5.3 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 20.1µg/m^3 at 2km dispersion Particulate matter is 1.97µg/m^3 and at 5km dispersion Particulate matter is 0.43µg/m^3 and the predominant wind direction is SSE.

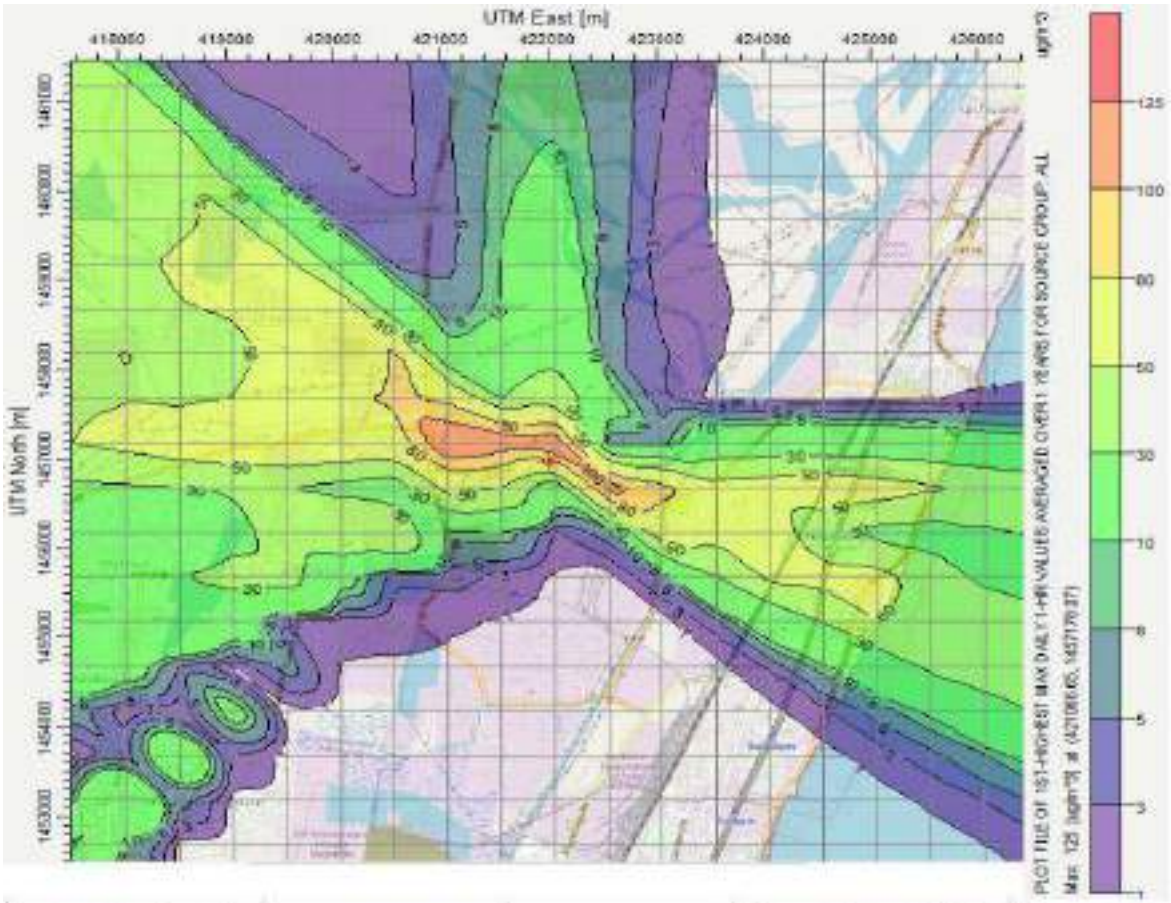
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-B Outlet @2 & 5 KM-Hydrogen Fluoride



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
1.5	0.79	7.67	1.09	0.24

MFL Urea Demister-B Outlet of Hydrogen Fluoride concentration is 1.5 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 7.67µg/m^3 at 2km dispersion Hydrogen Fluoride is 1.09µg/m^3 and at 5km dispersion Hydrogen Fluoride is 0.24µg/m^3 and the predominant wind direction is SSE.

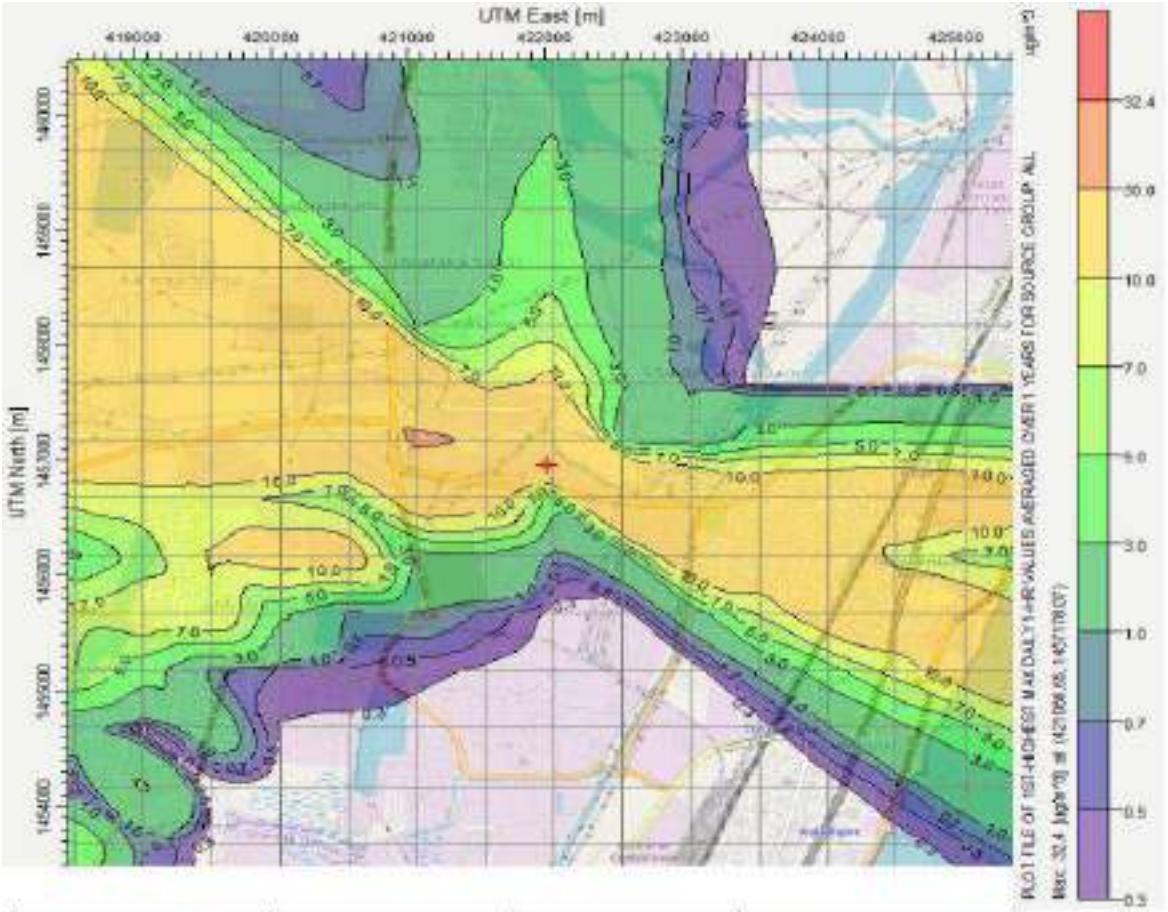
STACK EMISSION DISPERSION MODELLING -MFL Urea Demister-B Outlet @2 & 5 KM-Ammonia



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
45	0.82	125	3.11	0.56

MFL Urea Demister-B Outlet of Ammonia concentration is 45 mg/ m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 125µg/ m^3 at 2km dispersion Ammonia is 3.11µg/ m^3 and at 5km dispersion Ammonia is 0.56µg/ m^3 and the predominant wind direction is SSE.

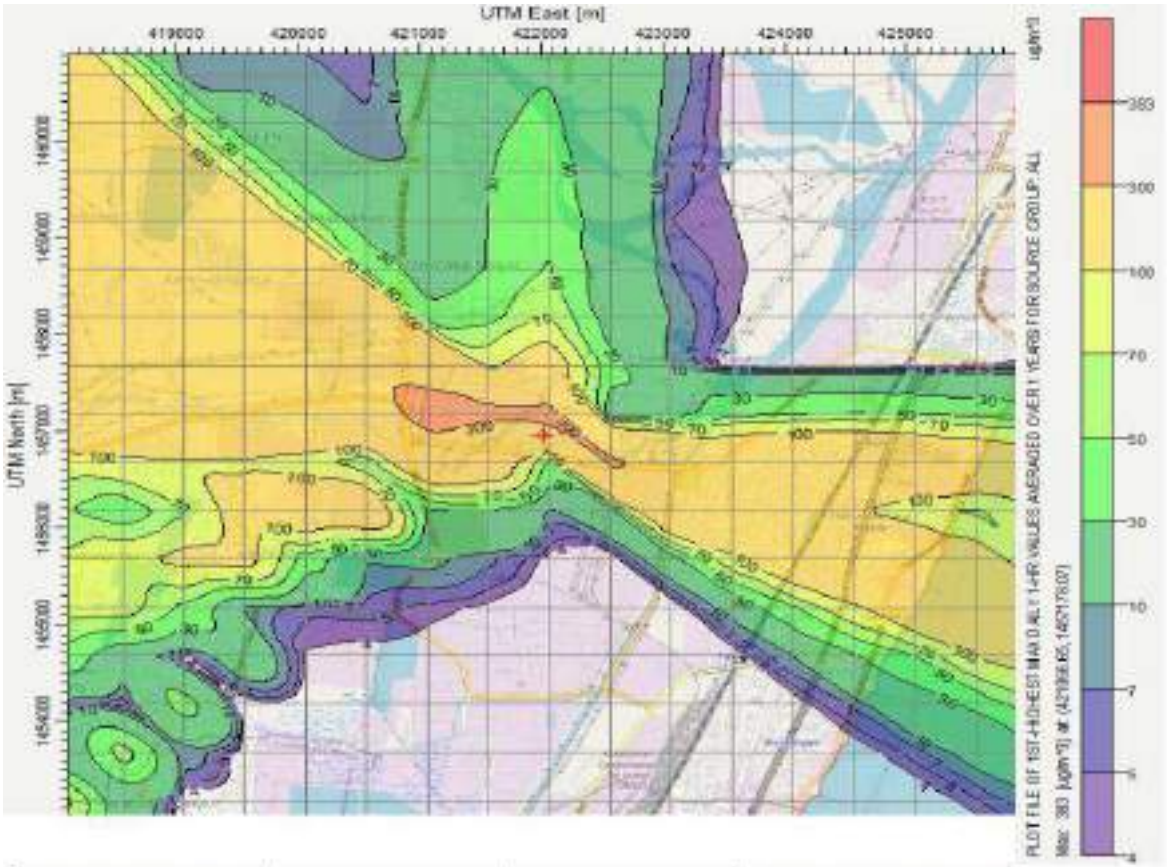
STACK EMISSION DISPERSION MODELLING –MFL Utility Boiler-1&2 @2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
31.3	0.86	32.4	2.29	0.6776

MFL Utility Boiler-1&2 of Particulate matter concentration is 31.3 mg/ m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 32.4µg/ m^3 at 2km dispersion Particulate matter is 2.29µg/ m^3 and at 5km dispersion Particulate matter is 0.6776µg/ m^3 and the predominant wind direction is SSE.

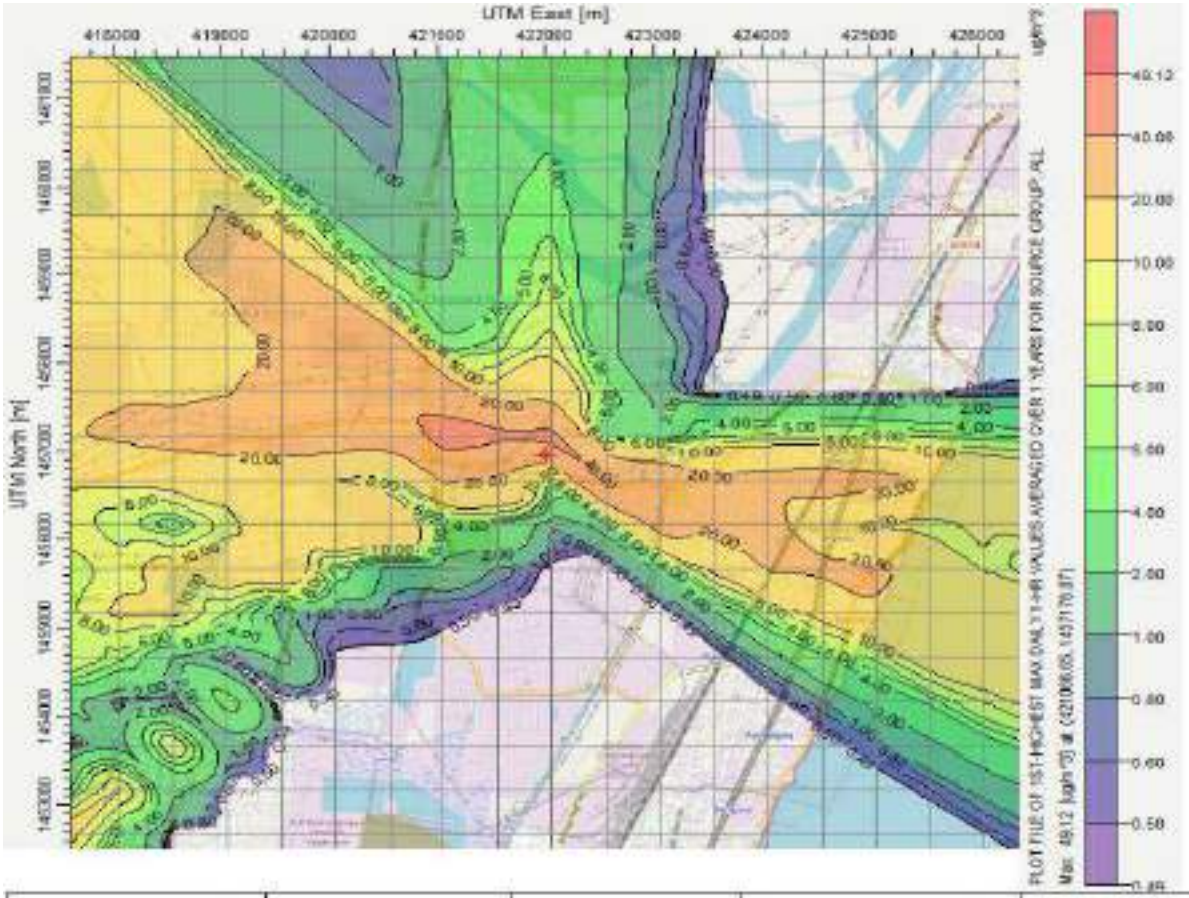
STACK EMISSION DISPERSION MODELLING –MFL Utility Boiler-1&2 @2 & 5 KM- Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
386	0.75	383	19.1	0.894

MFL Utility Boiler-1&2 of Sulphur dioxide concentration is 386 mg/ m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 383µg/ m^3 at 2km dispersion Sulphur dioxide is 19.1µg/ m^3 and at 5km dispersion Sulphur dioxide is 0.894µg/ m^3 and the predominant wind direction is SSE.

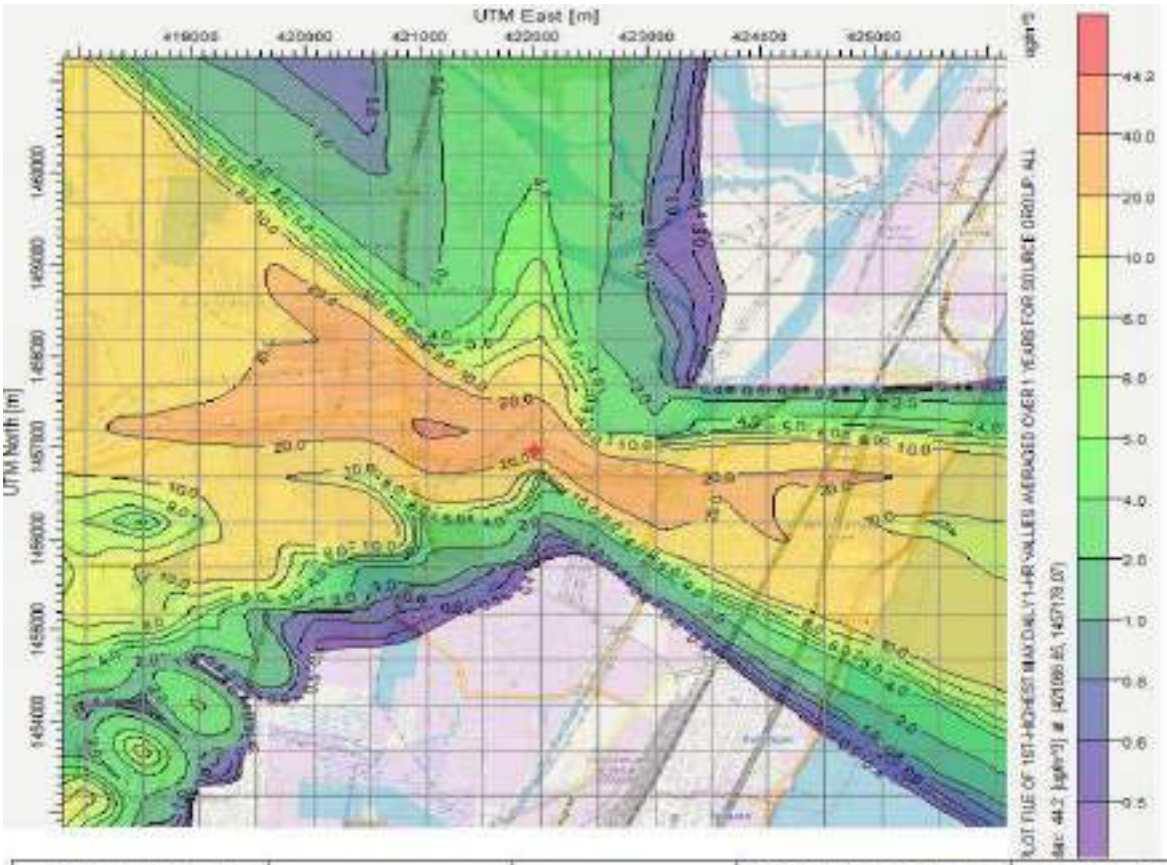
STACK EMISSION DISPERSION MODELLING -MFL Utility Boiler-1&2 @2 & 5 KM- Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
54	0.87	49.12	5.1	0.786

MFL Utility Boiler-1&2 of Oxides of Nitrogen concentration is 54 mg/ m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 49.12µg/ m^3 at 2km dispersion Oxides of Nitrogen is 5.1µg/ m^3 and at 5km dispersion Oxides of Nitrogen is 0.786µg/ m^3 and the predominant wind direction is SSE.

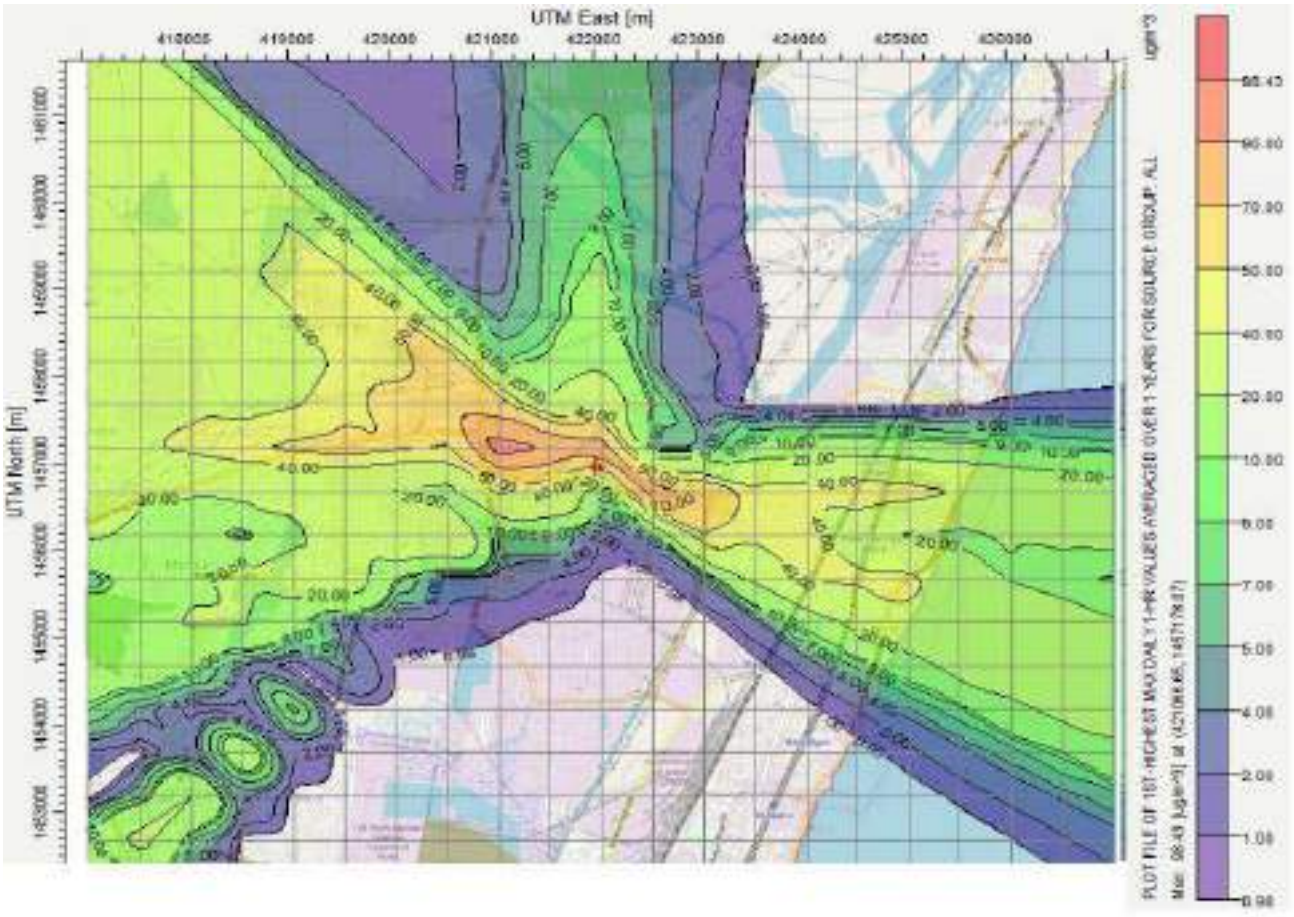
STACK EMISSION DISPERSION MODELLING -MFL Utility Boiler-1&2 @2 & 5 KM- Carbon Monoxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
51	0.74	44.2	2.93	0.346

MFL Utility Boiler-1&2 of Carbon Monoxide concentration is 51 mg/m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.74km at the concentration of 44.2µg/m^3 at 2km dispersion Carbon Monoxide is 2.93µg/m^3 and at 5km dispersion Carbon Monoxide is 0.346µg/m^3 and the predominant wind direction is SSE.

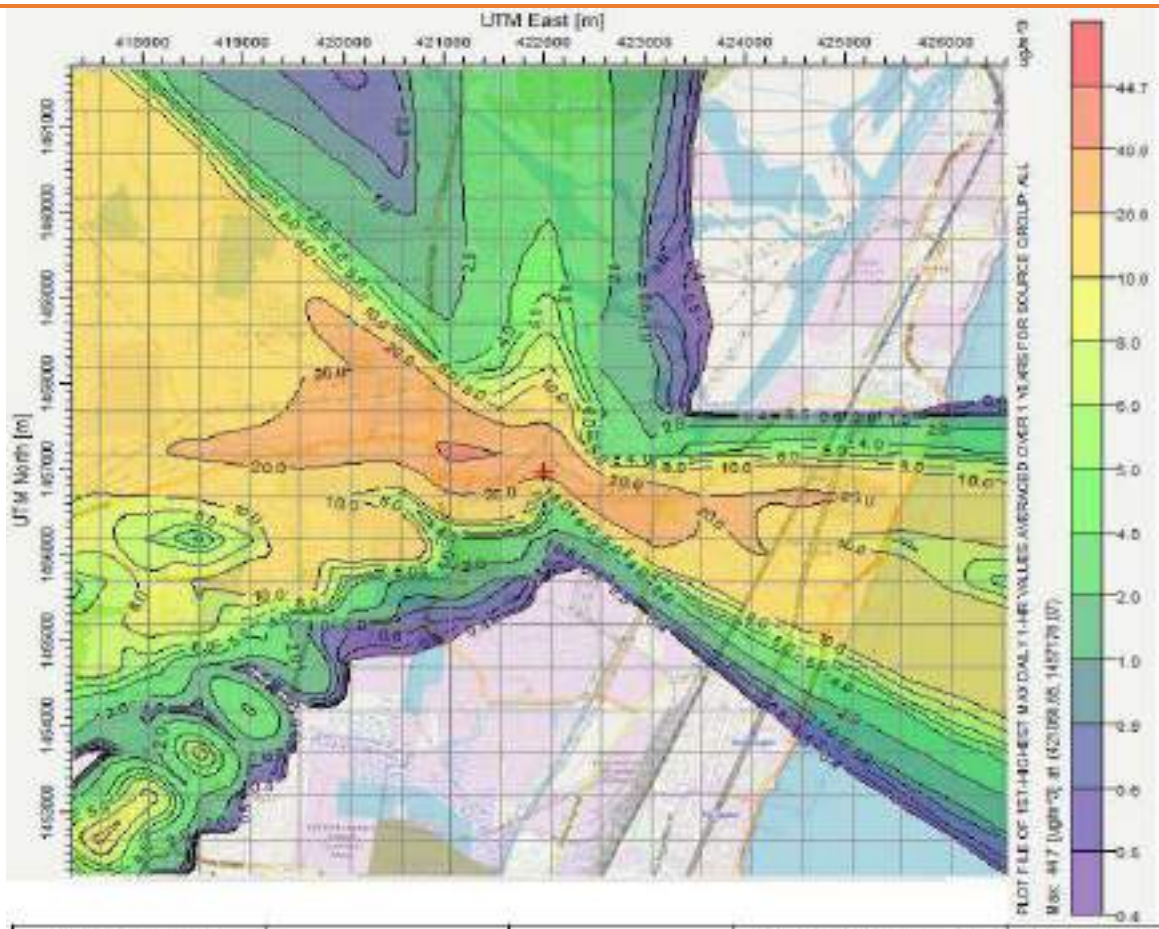
STACK EMISSION DISPERSION MODELLING –MFL 110 ATA PCB Boiler@2 & 5 KM- Particulate matter



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
36.4	0.71	98.43	2.22	0.643

MFL 110 ATA PCB Boiler of Particulate matter concentration is 36.4 mg/ m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 98.43µg/ m^3 at 2km dispersion Particulate matter is 2.22µg/ m^3 and at 5km dispersion Particulate matter is 0.643µg/ m^3 and the predominant wind direction is SSE.

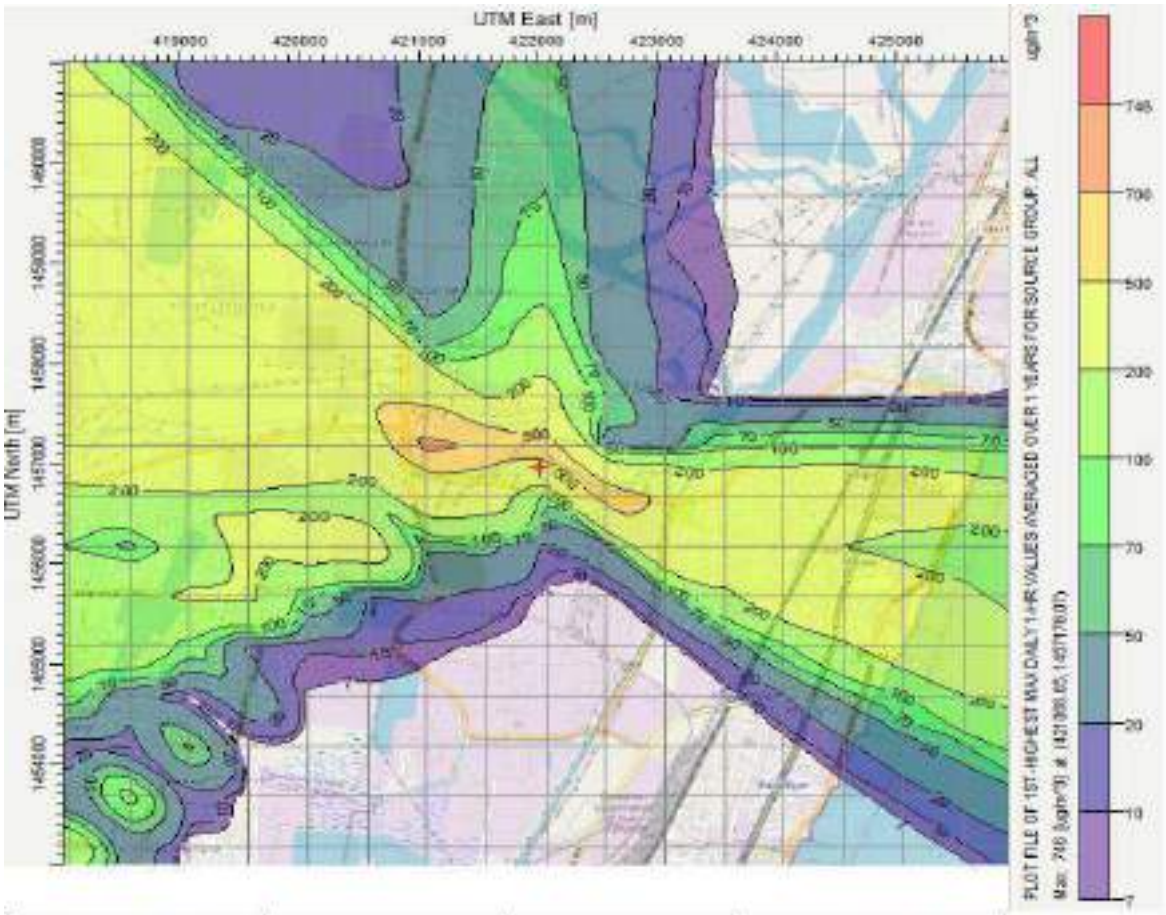
STACK EMISSION DISPERSION MODELLING –MFL 110 ATA PCB Boiler @2 & 5 KM- Sulphur dioxide



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
14	0.88	44.7	1.99	0.28

MFL 110 ATA PCB Boiler of Sulphur dioxide concentration is 14 mg/ m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 44.7µg/ m^3 at 2km dispersion Sulphur dioxide is 1.99µg/ m^3 and at 5km dispersion Sulphur dioxide is 0.28µg/ m^3 and the predominant wind direction is SSE.

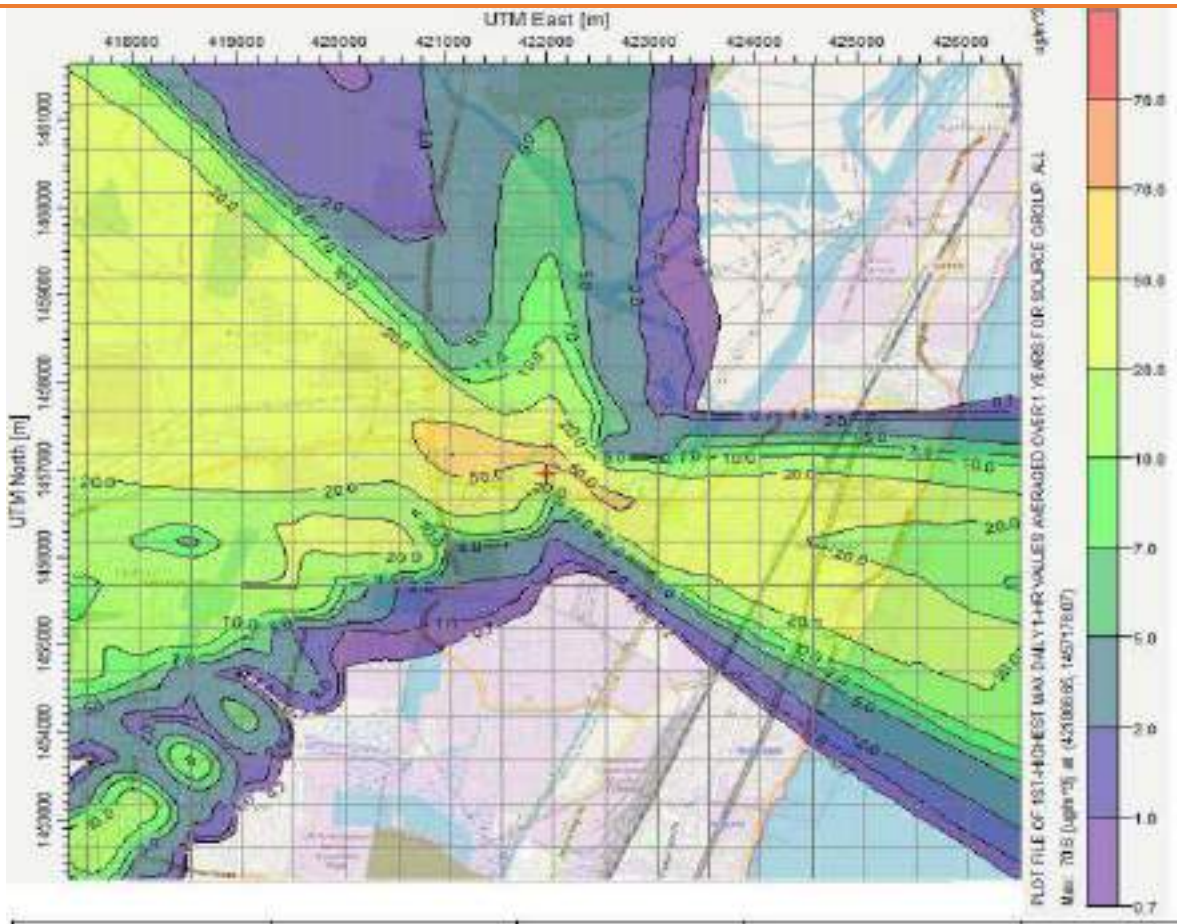
STACK EMISSION DISPERSION MODELLING -MFL 110 ATA PCB Boiler @2 & 5 KM- Oxides of Nitrogen



Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
293	0.91	746	34	0.99

MFL 110 ATA PCB Boiler of Oxides of Nitrogen concentration is 293 mg/ m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25ºC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 746µg/ m^3 at 2km dispersion Oxides of Nitrogen is 34µg/ m^3 and at 5km dispersion Oxides of Nitrogen is 0.99µg/ m^3 and the predominant wind direction is SSE.

STACK EMISSION DISPERSION MODELLING -MFL 110 ATA PCB Boiler @2 & 5 KM- Carbon Monoxide



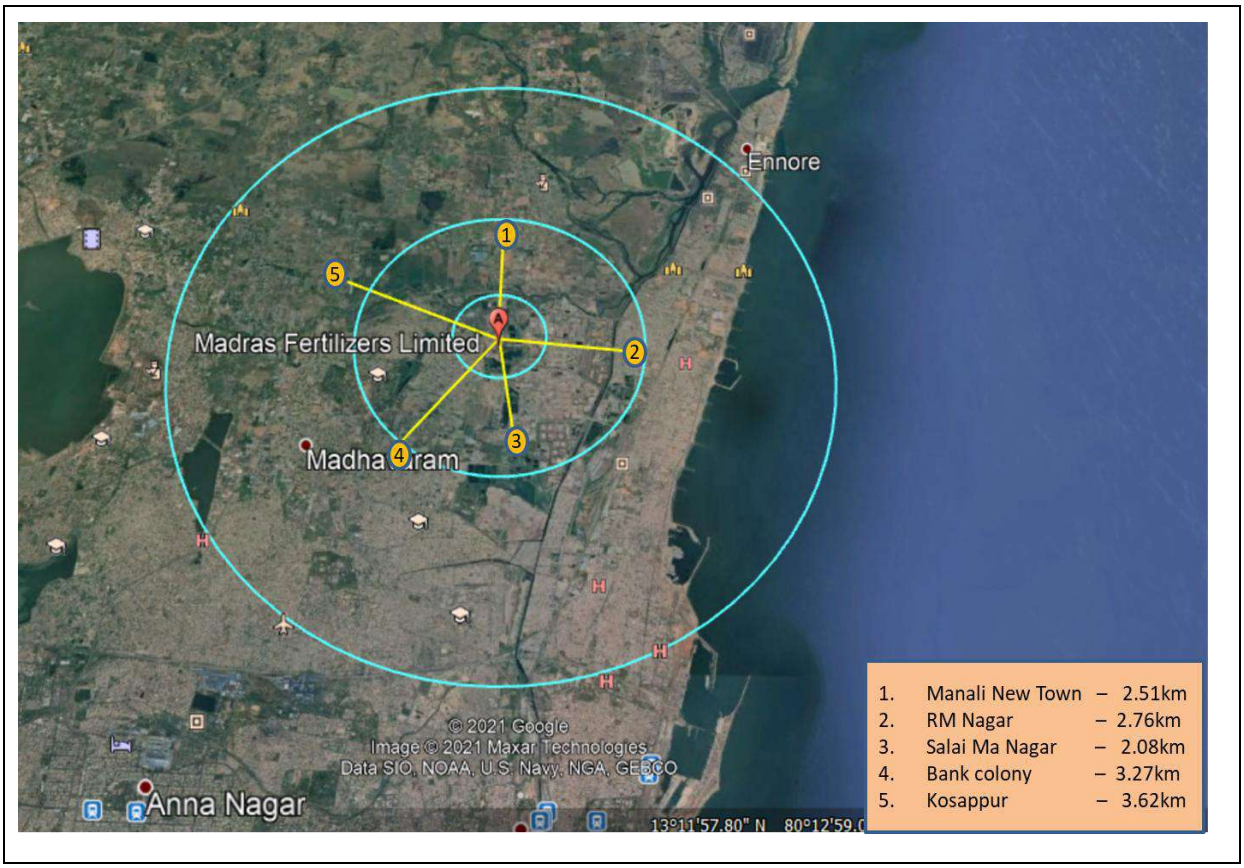
Concentration at Source (Milligm/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)	Average Concentration at 5 km (Microgm/m^3)
22	0.91	70.6	2.27	0.645

MFL 110 ATA PCB Boiler of Carbon Monoxide concentration is 22 mg/ m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 70.6µg/ m^3 at 2km dispersion Carbon Monoxide is 2.27µg/ m^3 and at 5km dispersion Carbon Monoxide is 0.645µg/ m^3 and the predominant wind direction is SSE.

9.0 Consolidated Stack Emission Dispersion Modelling Output Report

Stack Name	Parameter	Concentration at Sources (mg/m^3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km ($µg/m^3$)	Average concentration at 5 km ($µg/m^3$)
NPK Common Stack Outlet	PM	13	0.86	16.2	1.78	0.65
NPK Common Stack Outlet	HF	3.5	0.91	4.37	1.23	0.45
NPK Common Stack Outlet	NH3	243	0.79	23.2	4.22	0.89
Urea Demister A outlet	PM	7	0.86	24.1	1.85	0.0987
Urea Demister A outlet	HF	1.5	0.91	7.72	0.65	0.0093
Urea Demister A outlet	NH3	253	0.68	955.2	67.84	3.177
Urea Demister B outlet	PM	5.3	0.68	20.1	1.97	0.43
Urea Demister B outlet	HF	1.5	0.79	7.67	1.09	0.24
Urea Demister B outlet	NH3	45	0.82	125	3.11	0.56
Utility Boiler 1 & 2	PM	31.3	0.86	32.4	2.29	0.6776
Utility Boiler 1 & 2	SO2	386	0.75	383	19.1	0.894
Utility Boiler 1 & 2	NOx	54	0.87	49.12	5.1	0.786

Utility Boiler 1 & 2	CO	51	0.74	44.1	3.93	0.346
110 ATA Boiler	PM	36.4	0.71	98.43	2.22	0.643
110 ATA Boiler	SO2	14	0.88	44.7	1.99	0.28
110 ATA Boiler	NOx	293	0.91	746	34	0.99
110 ATA Boiler	CO	22	0.91	70.6	2.27	0.645



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10.0 CONCLUSION ON AIR POLLUTION MONITORING:

10.1 Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are NNE Side of the Plant, NW Side of the Plant, WSW Side of the Plant, ENE Side of the Plant, SE Side of the Plant, SSW Side of the Plant, Near Main Gate (Road Side) and Beside Road Towards Moolakadai (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 8.7 to 12.1µg/m^3. Highest value of 12.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 11.9 to 17.7µg/m^3. Highest value of 17.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 56.9 to 87.3µg/m^3. Highest value of 87.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.5 to 44.4µg/m^3. Highest value of 44.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ammonia (NH_3):* Ambient Air Quality values of NH_3 are ranging from 21.4 to 33.5µg/m^3. Highest value of 33.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 13.4 to 54.7µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 54.7 to 183.6µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

10.2 Stack Emission Monitoring

In Stack Emission monitoring at all stack complying all the parameters against the emission limit values.

MFL NPK Common Stack Outlet of Particulate matter concentration is 13 mg/ m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 16.2µg/ m^3 at 2km dispersion Particulate matter is 1.78µg/ m^3 and at 5km dispersion Particulate matter is 0.65µg/ m^3 and the predominant wind direction is SSE.

MFL NPK Common Stack Outlet of Hydrogen Fluoride concentration is 3.5 mg/ m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.37µg/ m^3 at 2km dispersion Hydrogen Fluoride is 1.23µg/ m^3 and at 5km dispersion Hydrogen Fluoride is 0.45µg/ m^3 and the predominant wind direction is SSE.

MFL NPK Common Stack Outlet of Ammonia concentration is 243 mg/ m^3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks

typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 23.2µg/ m^3 at 2km dispersion Ammonia is 4.22µg/ m^3 and at 5km dispersion Ammonia is 0.89µg/ m^3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Particulate matter concentration is 7 mg/ m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 24.1µg/ m^3 at 2km dispersion Particulate matter is 1.85µg/ m^3 and at 5km dispersion Particulate matter is 0.0987µg/ m^3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Hydrogen Fluoride concentration is 1.5 mg/ m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 7.72µg/ m^3 at 2km dispersion Hydrogen Fluoride is 0.65µg/ m^3 and at 5km dispersion Hydrogen Fluoride is 0.0093µg/ m^3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Ammonia concentration is 253 mg/ m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 955.2µg/ m^3 at 2km dispersion Ammonia is 67.84µg/ m^3 and at 5km dispersion Ammonia is 3.177µg/ m^3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Particulate matter concentration is 5.3 mg/ m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25°C. All the modelling

parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 20.1µg/ m^3 at 2km dispersion Particulate matter is 1.97µg/ m^3 and at 5km dispersion Particulate matter is 0.43µg/ m^3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Hydrogen Fluoride concentration is 1.5 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 7.67µg/m^3 at 2km dispersion Hydrogen Fluoride is 1.09µg/m^3 and at 5km dispersion Hydrogen Fluoride is 0.24µg/m^3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Ammonia concentration is 45 mg/m^3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 125µg/m^3 at 2km dispersion Ammonia is 3.11µg/m^3 and at 5km dispersion Ammonia is 0.56µg/m^3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Particulate matter concentration is 31.3 mg/m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 32.4µg/m^3 at 2km dispersion Particulate matter is 2.29µg/m^3 and at 5km dispersion Particulate matter is 0.6776µg/m^3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Sulphur dioxide concentration is 386 mg/m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 383µg/m^3 at 2km dispersion Sulphur dioxide is 19.1µg/m^3 and at 5km dispersion Sulphur dioxide is 0.894µg/m^3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Oxides of Nitrogen concentration is 54 mg/m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 49.12µg/m^3 at 2km dispersion Oxides of Nitrogen is 5.1µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.786µg/m^3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Carbon Monoxide concentration is 51 mg/m^3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.74km at the concentration of 44.2µg/m^3 at 2km dispersion Carbon Monoxide is 2.93µg/m^3 and at 5km dispersion Carbon Monoxide is 0.346µg/m^3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Particulate matter concentration is 36.4 mg/m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 98.43µg/m^3 at

2km dispersion Particulate matter is 2.22µg/m^3 and at 5km dispersion Particulate matter is 0.643µg/m^3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Sulphur dioxide concentration is 14 mg/m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 44.7µg/m^3 at 2km dispersion Sulphur dioxide is 1.99µg/m^3 and at 5km dispersion Sulphur dioxide is 0.28µg/m^3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Oxides of Nitrogen concentration is 293 mg/m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 746µg/m^3 at 2km dispersion Oxides of Nitrogen is 34µg/m^3 and at 5km dispersion Oxides of Nitrogen is 0.99µg/m^3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Carbon Monoxide concentration is 22 mg/m^3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 70.6µg/m^3 at 2km dispersion Carbon Monoxide is 2.27µg/m^3 and at 5km dispersion Carbon Monoxide is 0.645µg/m^3 and the predominant wind direction is SSE.

10.3 Overall Findings on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MFL to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit values. The MFL plant is surrounded by residential areas like 1.Manali New Town, 2.RM Nagar, 3.Salai Ma Nagar, 4.Bank Colony and 5.Kosappur. From MFL to Manali New Town arial distance is 2.51km, to RM Nagar is 2.76km, to Salai Ma Nagar is 2.08km, to Bank Colony is 3.27km and to Kosappur is 3.62km.

The cumulative particulate matter emissions from MFL through stacks is 94 mg/m^3. The average ground level concentration achieves at an average distance of 0.83km and the sum of PM concentration at GLC is 131 $\mu g/m^3$ which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 27.7 $\mu g/m^3$. It clearly indicates the PM10 & PM2.5 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from MFL through stacks is 400 mg/m^3. The average ground level concentration achieves at an average distance of 0.82km and the sum of Sulphur Dioxide concentration at GLC is 213.85 $\mu g/m^3$ which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 10.54 $\mu g/m^3$. It clearly indicates the SO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MFL through stacks is 347 mg/m^3. The average ground level concentration achieves at an average distance of 0.89km and the sum of Nitrogen Oxides concentration at GLC is 397.56 $\mu g/m^3$ which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 19.5 $\mu g/m^3$. It clearly indicates the NO_2 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative HF emissions from MFL through stacks is 6.5 mg/m^3. The average ground level concentration achieves at an average distance of 0.87km and the sum of HF concentration at GLC is 6.59 µg/m^3 which includes all the stacks at MFL. It clearly indicates the HF contribution to the nearby residential areas are minimum and there is no limit for the National Ambient Air Quality Standards.

The cumulative NH_3 emissions from MFL through stacks is 461 mg/m^3. The average ground level concentration achieves at an average distance of 0.76km and the sum of NH_3 concentration at GLC is 367.8 µg/m^3 which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 25.05 µg/m^3. It clearly indicates the NH_3 contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative CO emissions from MFL through stacks is 73 mg/m^3. The average ground level concentration achieves at an average distance of 0.83km and the sum of CO concentration at GLC is 57.35 µg/m^3 which includes all the stacks at MFL. It clearly indicates the CO contribution to the nearby residential areas are minimum and it is it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceeding the National ambient air quality standard for PM, SO_2, NO_2, CO and NH_3. Results from AERMOD simulation indicated that PM, SO2, NO_2, CO and NH3 emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM, SO_2, NO_2, CO and NH_3 with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load.

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Annexure-XII

Report On

AIR POLLUTION MONITORING AND SOURCE DISPERSION MODELLING At MANALI INDUSTRIAL AREA [TPL, MPL, MFL & CPCL]

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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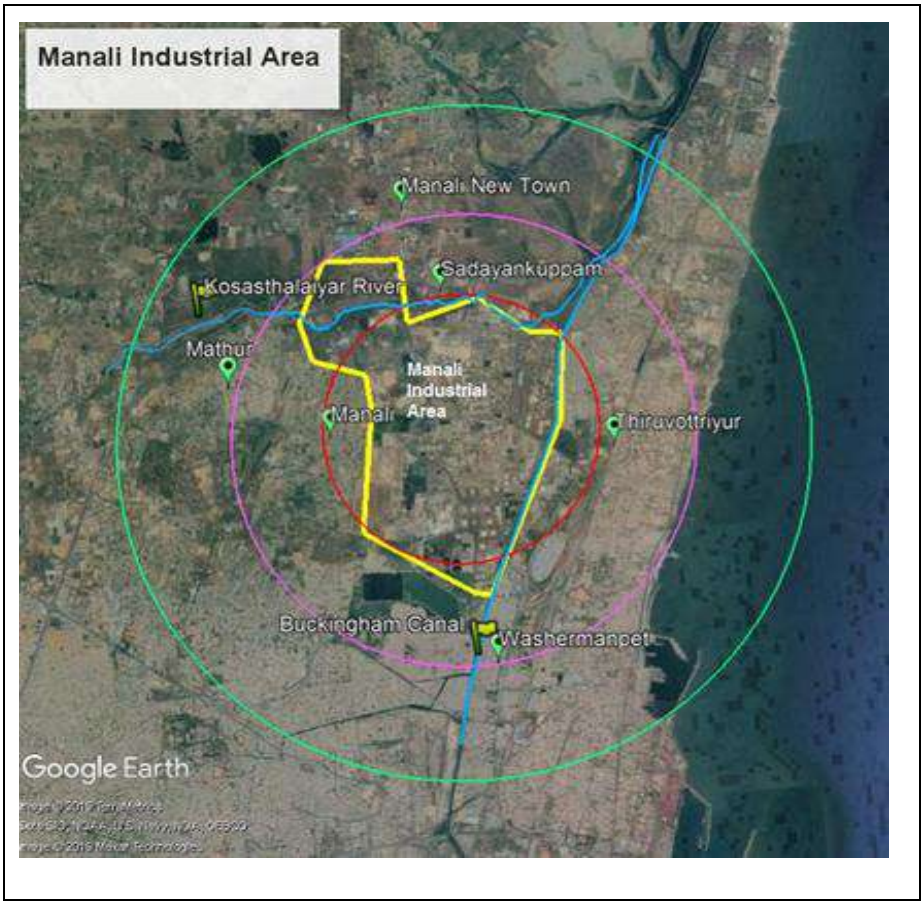
1.0 ABOUT MANALI INDUSTRIAL AREA:

Manali (latitude: 13°10'4"N, longitude: 80°15'43"E) is one of the major Indian industrial clusters located in the northern side of Chennai City, Tamil Nadu with a total population of around 36,000 (Census of India, 2011). This area has a typical tropical climate, with persistent higher temperatures throughout the year. The extent of Manali area is 20 km^2, in which more than 33% of the area is occupied by industries. A total of 26 major industries are located in Manali industrial area. SO_2, nitrogen dioxide (NO_2), and particulate matter (aerodynamic diameter <10 μm; PM_{10}) pollutants were identified as the three primary air pollutants that are significantly released from industries at this area.



Manali Industrial Complex is bounded by Buckingham canal & Tiruvottiyur on the east side and, south by Chennai city, north by Kossathaliyar River and Ponneri Taluk and west by villages of Manjambakkam, Mathur and Madhavaram of Tiruvallur District. Further this industrial complex is connected by east with Ennore High Road, and west by Chennai Kolkata NH-5A, north by Ponneri - Manali high road, and south by Madhavaram – Manali road. The Ennore port is situated at a distance of 15km from this industrial Complex and the nearest

railway station is Tiruvottiyur at 3km.

This industrial area lies on the thermal equator and is also on the coast, which prevents extreme variation in seasonal temperature. The weather is hot and humid for most of the year. This area gets most of its seasonal rainfall from the north–east monsoon winds, from mid–October to mid–December. Cyclones in the Bay of Bengal sometimes hit coast. The highest annual rainfall recorded is 257 cm (101 in) in 2005. Average rainfall is around 100-120 cm. The mean maximum temperature during summer is 45^0 C and the mean minimum temperature during winter is 20^0 C. The relative humidity is around 70 – 80%.

1.1 Brief Description of the Manali Industrial Area.

1. Location
2. Physiography
3. Climate
4. Drainage
5. Land-Use & Land Change
6. Industries

1.2 Physical Features:

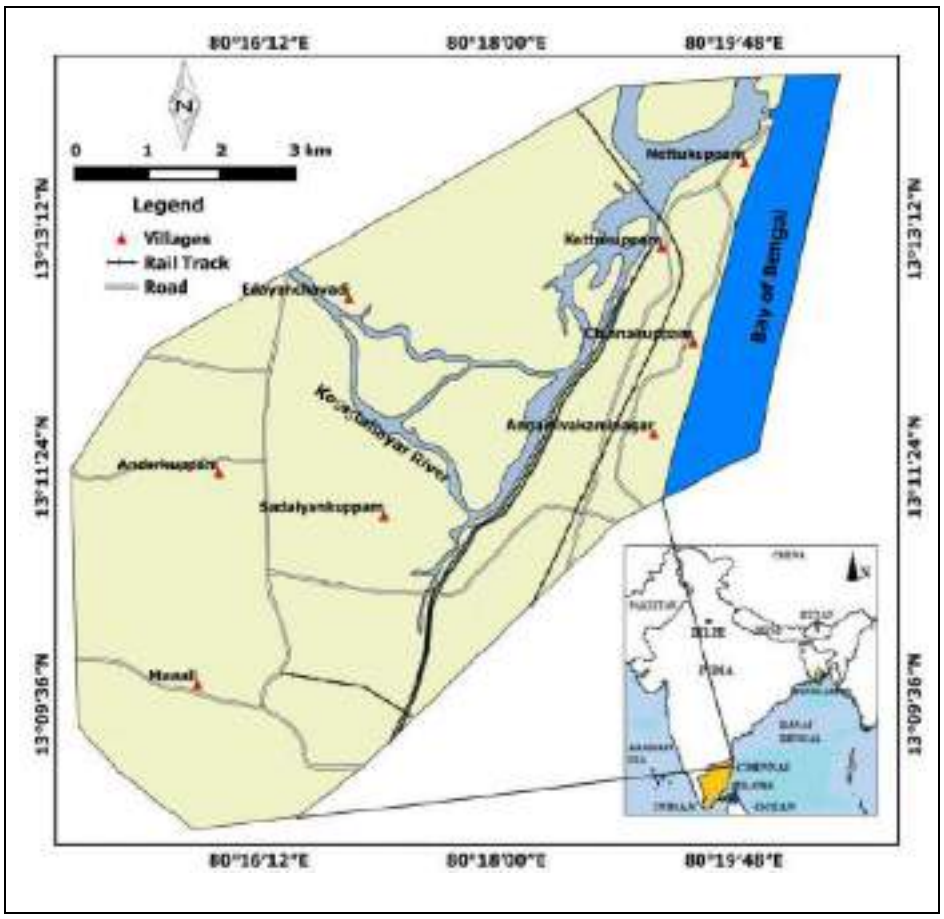
Manali is an industrial and residential suburb of Chennai, India. It is a zone in Greater Chennai Corporation located in the northern part of Chennai district in the Indian state of Tamil Nadu. This Manali Industrial Area is located at 13˚10'4" Northern latitude & 80˚15'43" eastern longitude and is about 20 km north of Chennai. This Industrial complex spreads over an area of 2000 hectares in the revenue village of Manali, Chinnacekadu, Voiyakadu Sadayankuppam & Amulavoyal Village of Ambattur Taluk Tiruvallur District of Tamil Nādu. Manali Industrial Complex is bounded by Buckingham canal & Tiruvottiyur on the east and, south by Chennai city, north by Kossathaliyar River in Ponneri talk and west by villages of Manjambakkam, Mathur and Madhavaram of Tiruvallur District.

The district comprises of three distinct *physiographic regions*: coastal belt, Midland plain terrain and malnad. The midland part between Western Ghats and the coast which constitutes more than 50 percent of geographical area, is upland plain terrain intercepted with forested low hilly topography with valleys. Udupi district has varied climatic zones. As the Western Ghats are located on the eastern part of the district, the rivers and streams of this district necessarily flow from east to west.

The Different *land use* types reflect different ecological sensitivity. Based on the landscape ecology, human activities tend to make the outline of a landscape patch. Due to industrial development and other developmental activities, the region is experiencing unprecedented changes in land use and land cover. Geographically, the district contains rock formation belonging to the earliest period of the earth's history, namely the Archean epoch, except on the coastal strip. The coastal region contains recent and sub-recent deposits and the lateritic formations.

According to 2011 census, Manali had a population of 35,248 with a sex-ratio of 968 females for every 1,000 males, much above the national average of 929.[1] A total of 4,208 were under the age of six, constituting 2,194 males and 2,014 females. Scheduled Castes and Scheduled Tribes accounted for 23.33% and 0.09% of the population respectively. The average literacy of the town was 74.52%, compared to the national average of 72.99%. The town had a total of : 9331 households. There was a total of 12,745 workers, comprising 25 cultivators, 49 main agricultural labourers, 127 in household industries, 11,293 other workers,

1,251 marginal workers, 12 marginal cultivators, 12 marginal agricultural labourers, 39 marginal workers in household industries and 1,188 other marginal workers.



The general description of the district reveals that the district is endowed with rich natural resources, this is a pointer to show that, if these resources are not handled properly, it would be disastrous for the ecology of the region in the name of the development and industrial development etc. only by adhering to strict environmental regulations it can be managed sustainably.

The Manali Zone was named as Zone 2 of Chennai Corporation. The Manali Zone contains 7 wards out of Chennai Corporation's 200 wards from ward 15 to ward 21. Manali is a neighbourhood of Chennai city. It borders Tiruvottiyur to the east, Madhavaram to the west, Kodungaiyur to the south, 100 ft road and Manali New Town to the North. The main thoroughfares in the area are Kamarajar Salai, Chinnamathur road, School Street, Nedunchezhian street and Parthasarathy street.

2.0 Critical Ecosystem & Biodiversity Hot spots in the region.

Standard methods were followed in identifying the Critical Ecosystem & Biodiversity Hot 7 Spots. The available Flora & Fauna have been identified and listed. Detailed methodology is given in the relevant chapter.

Manali is in a semi-urban industrial area and there are no National Parks / Wildlife Sanctuaries Critical Ecosystem /Reserve forests within 10 Km radius of the project site. But there are water bodies such as drains, lagoons, Estuarine and marine water bodies; freshwater reservoir such as the Puzhal Lake (Red Hills), Korattur Tank, Retteri Lake, Korttalai River, Nappalayam River and Adayar River. Nappalayam River is a tributary of Korttalai River, and they merge before draining into the Bay of Bengal. All the Rivers located in the buffer zone are more liked rains during the dry season. Within the buffer zone, the three Rivers are drained the Bay Bengal and there is influx of sea water. Most of the low-lying areas close to the boundary of the industry are waterlogged due to discharge of the sewage by the Chennai Metro Water and Sewerage board and the industries. Lot of eutrophication and luxurious growth of *Typha* and *Eichhornia crassipes* are characteristics of the drains and the stagnant wastewater pools. Kodungiyur Marsh Forest is the only forest present in the buffer zone. But there are few small to large; open to relatively thick patches of mangroves represented mostly by *Avicennia alba*. Most of the mud flats are colonized by mesquite (*Prosopis juliflora)*. Neem (*Azadirachta indica*) followed by Coconut (*Cocos nucifera)* are the most extensively cultivated trees in the entire buffer zone. Castor (*Ricinus communis*) was found widely scattered in all vacant places including roadsides. All the common, widely grown Indian avenue and fruit trees and some exotic naturalized tees are found in the buffer zone. A list of trees and ornamentals grown currently within the premises of the industry. Another list of trees, shrubs and ornamentals grown or growing currently within the 10 Km buffer zone of the industry is given in.

2.0 Carrying Capacity

The survival of human race depends upon the availability of abundant natural resources in a healthy and safe environment. Rapid social and economic development has brought issues of resources and environment, such as excessive resources consumption, environmental degradation and pollution, and the issues have become increasingly prominent across the globe (Liu et al 2013 & Jameson, S.C. and Ammar, M.S.A. 2007).

Carrying capacity is a concept which limits the potential ability of natural resources and species to withstand human intervention. It may be described as a test of the ability of land, water, and air to keep itself usable and toxicity free despite pollution and effluent discharges and harmful developments over it.

Carrying capacity also refers to the number of individuals who can be supported in each area within the limits of natural resources, and without degrading the social, cultural and economic environments for the present and future generations. The carrying capacity for any given area is not fixed. It can be extended to a certain level by improved technology, but mostly it is changed for the worse by pressures which accompany a population increase. As the environment is degraded, carrying capacity shrinks, leaving the environment with no ability to support even the number of people who could formerly have lived in the area on a sustainable basis.

Human activities may not be unsustainable in themselves but the thin line that separates them from being beneficial to mankind and becoming harmful is the environmental recognition of the concept of carrying capacity. If taken beyond carrying capacity, the activities may prove disastrous.

The carrying capacity of an environment is the maximum population size of a biological species that can be sustained in that specific environment, given the food, habitat, water, and other resources available for living. Therefore, the environment carrying capacity has become a great concern of research interest. Environmental carrying capacity includes multiple factors such as atmospheric environment, land environment, social economy, and dilution- related self-purification capacity of water environment and reflects the threshold of supporting capacity in a region with specific natural resources and ecological environment. The studies indicated that environmental degradation, resource exploitation and utilization have caused serious adverse effects on ecological environment, and resource and environment carrying capacity has been substantially reduced.

The concept of carrying capacity is rooted in demography, biology, and applied ecology (Clarke 2002). In ecology, carrying capacity is defined as the maximum population of a 623 species that a habitat can support without permanently impairing the habitat's productivity (Rees 1997). Carrying capacity is an indicator of regional sustainability and achieving regional sustainability is important because social institutions and ecological functions are closely linked at this scale (Graymore 2009). The concept of a sustainable carrying capacity is defined by a regional ecosystem's characteristics based on two premises. First, it must be

possible to sustain the regional ecosystem's normal operations. Therefore, researchers must calculate the quantity of resources and environmental capacity required to sustain these functions. Second, it is necessary to evaluate the regional population and intensity of activities that the natural resources can support after considering the needs of the ecosystem. The theory of environmental carrying capacity has been widely applied in environment planning and management. The carrying capacity depends strongly on environmental resources. However, there have also emerged some theoretical studies of carrying capacity based on regional different resources because this capacity is most often included within the larger theory of sustainable development. For example, Falkenmark and Lundqvist (1998) used estimates of the maximum global use of water resources to study how carrying capacity is determined by regional water resources (Falkenmark, Lundqvist .1998). Another example is a study of the Florida Keys Basin's carrying capacity in the United States (NRC 2002), in which researchers modelled carrying capacity under different land-use scenarios.

Carrying Capacity is a function of the following:

1. Environmental impacts and Natural resources
2. Infrastructure and Urban services
3. Public Perception
4. Institution Setting
5. Society Supporting Capacity

Therefore, studying the Environmental Carrying Capacity is always useful and acts as the basis for formulating sustainable development policies. It helps the policy makers to understand the ground reality of environment for a specific region and cause.

4.0 Methodology

A methodology suitable to achieve the above objectives essentially of studying the Environmental Carrying Capacity of the Manali Industrial Area was undertaken by the G-lens Innovation Labs Pvt Ltd. The brief of the methodology followed is given below. Sampling and monitoring were carried out as per the prescribed standards.

4.1 Field inspection and information review.

Meeting the Manali Industrial Area officials and collection of Data The team visited the Unit and met the officials of the MIL 9 visits. The team had a discussion and the officials explained the various Environmental Protection measures in place and escorted the team to the various locations to show the same. The first visit was made during the January2021, subsequently during February and followed by March 2021 with industrial officials, TNPCB officials and NGT committee members and the last visit was on August 2021.

4.2 Collection of the information as required for the Software and Running of the Software AERMOD 5.2 to arrive at the Carrying Capacity

Dispersion models are deterministic models, based upon physical theories that use source emission data, meteorology, and topography to create maps of pollutant concentrations. Such maps can be used to predict source-specific exposures.

The basic Gaussian plume-diffusion model is steady-state and hypothesizes that all meteorological, aerographic, and surface parameters are uniform and constant throughout the air layer into which the pollutants are discharged. The pollutants are released at a height above the ground that is given by the physical stack height and the rise of the plume due to its momentum and buoyancy. The degree of dilution is inversely proportional to the wind speed and pollutant material reaching the ground level is reflected into the atmosphere. The pollutant field is conservative; thus, it does not undergo any chemical reactions, transformation, or decay.

AERMOD is a steady-state plume dispersion model for the assessment of pollutant concentrations from point, volume, and area sources. The model employs hourly sequential pre-processed meteorological data to estimate concentrations by averaging times from one hour to one year.

AERMOD employs continuous variables to characterize atmospheric conditions, rather than a fixed number of categories used by traditional Gaussian models.

The AERMOD modelling system consists of two pre-processors and a core dispersion model. AERMET is the meteorological pre-processor for the AERMOD while AERMAP is the terrain pre-processor that characterizes the terrain, generates receptor grids, and facilitates the generation of hill height scales. Input data can come from hourly cloud cover observations, surface meteorological observations, and upper air soundings and may include surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

The model is very sensitive to land use parameters and complex coastal terrains. AERMOD is recommended by the EPA as the preferred dispersion model for general industrial modelling scenarios. Its performance was evaluated against observed concentrations for impacts emitted from MIA stack, Manali. For the present case simulations, the required source data input includes source type, emission rate, and location, stack height, stack gas exit velocity, stack inside diameter, stack gas temperature and elevation.

4.3 Quantification of Assimilative Capacity Using Dispersion Model

Critical assimilative capacity (ACc) can be defined as the maximum pollutant emission (load) an area can take at a given point of time without exceeding the permissible limits. In the present study, we considered National Ambient Air Quality Standards (NAAQS) prescribed by CPCB as the permissible standards (24-hr NAAQS for SO_2 = 80 µg/m^3, NO_2 = 80 µg/m^3, PM_{10} = 100 µg/m^3; CPCB, 2012).

In the present work, we computed assimilative capacity by AERMOD dispersion modelling method. SO_2, NO_2, and PM_{10} levels due to current stack emissions were modelled for our study domain. AERMOD (American Meteorological Society/U.S. Environmental Protection Agency Regulatory Model), an EPA-approved regulatory model, was used to predict ground-level concentrations for one seasons of 2021 (pre-monsoon). AERMOD is a steady-state dispersion model employed to understand the short-range (up to 50 km) dispersion of air pollutants from stationary industrial stacks.

The model consists of a meteorological data pre-processor (AERMET) and terrain pre-processor (AERMAP) (Venkatram, 2008). We obtained AERMET data for the year 2021 (pre-monsoon) for our study domain from M/s Lakes Environmental, Waterloo, Ontario, Canada. The meteorological data contain surface meteorological data and upper air meteorological data. Surface meteorological data contain hourly averaged values of 20 meteorological parameters, which include wind speed (m/sec), wind direction (degrees), surface friction velocity (m/sec), sensible heat flux (W/m^2), convective velocity (m/sec), surface roughness length (m), albedo, Bowen ratio, potential temperature gradient above the mixing height (K/m), convectively driven mixing height (m), mechanically driven mixing height (m), and direction (m), temperature (°C), reference height for temperature (m), precipitation type, precipitation amount (mm/hr), relative humidity (%), station pressure (mb), and cloud cover (tenths). Upper air meteorological data contain a total of five meteorological parameters, which include wind direction

and speed (degrees, m/sec), temperature (°C), standard deviation of the lateral wind direction (degrees), and standard deviation of the vertical wind speed (m/sec).

4.4 Inventory:

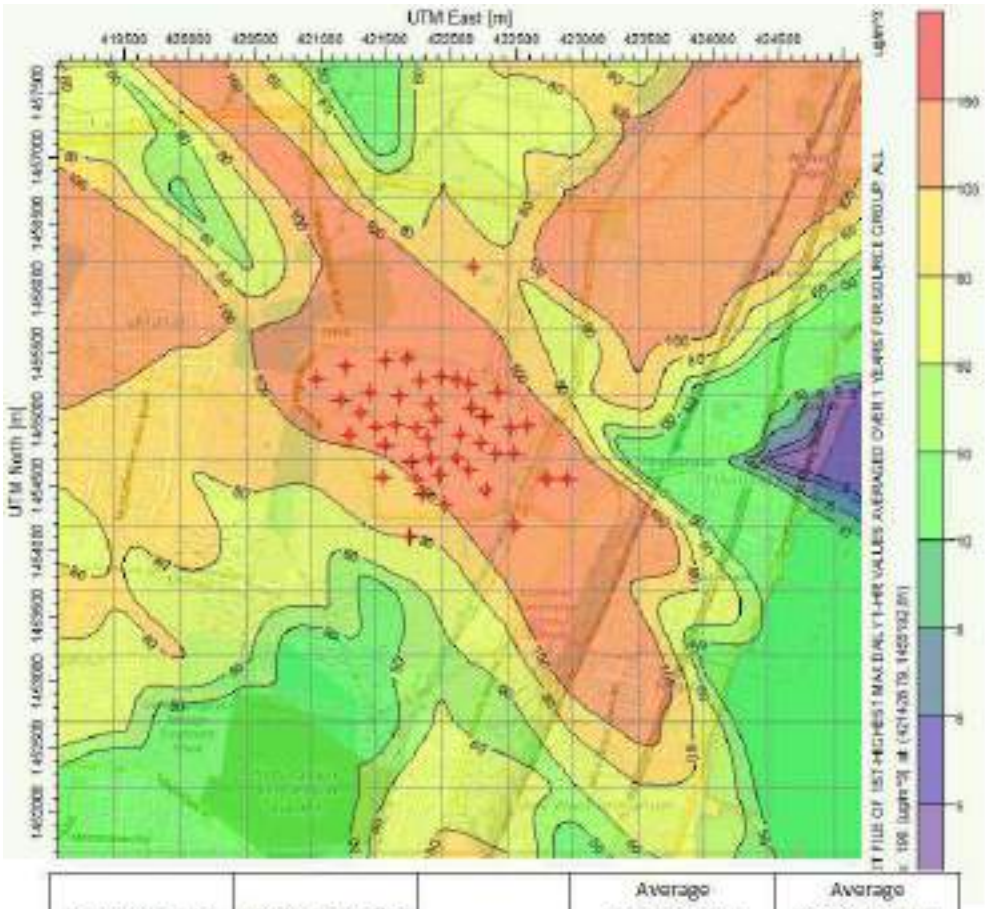
a) Monitoring of Ambient Air and Stack emissions and its analysis

Samplers have been sited to meet the goals of the specific monitoring requirement. For this study, sampling is carried out to determine the compliance with the National Ambient Air Quality Standards (NAAQS) and sampler sitting as described in CPCB guidelines. The monitoring has been done outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Stack Emission Monitoring: The assessment is exercised as per the technical and quality aspects to meet the requirements of standard test method.

Assimilative Capacity of Manali Industrial Area through AERMOD Dispersion Model:

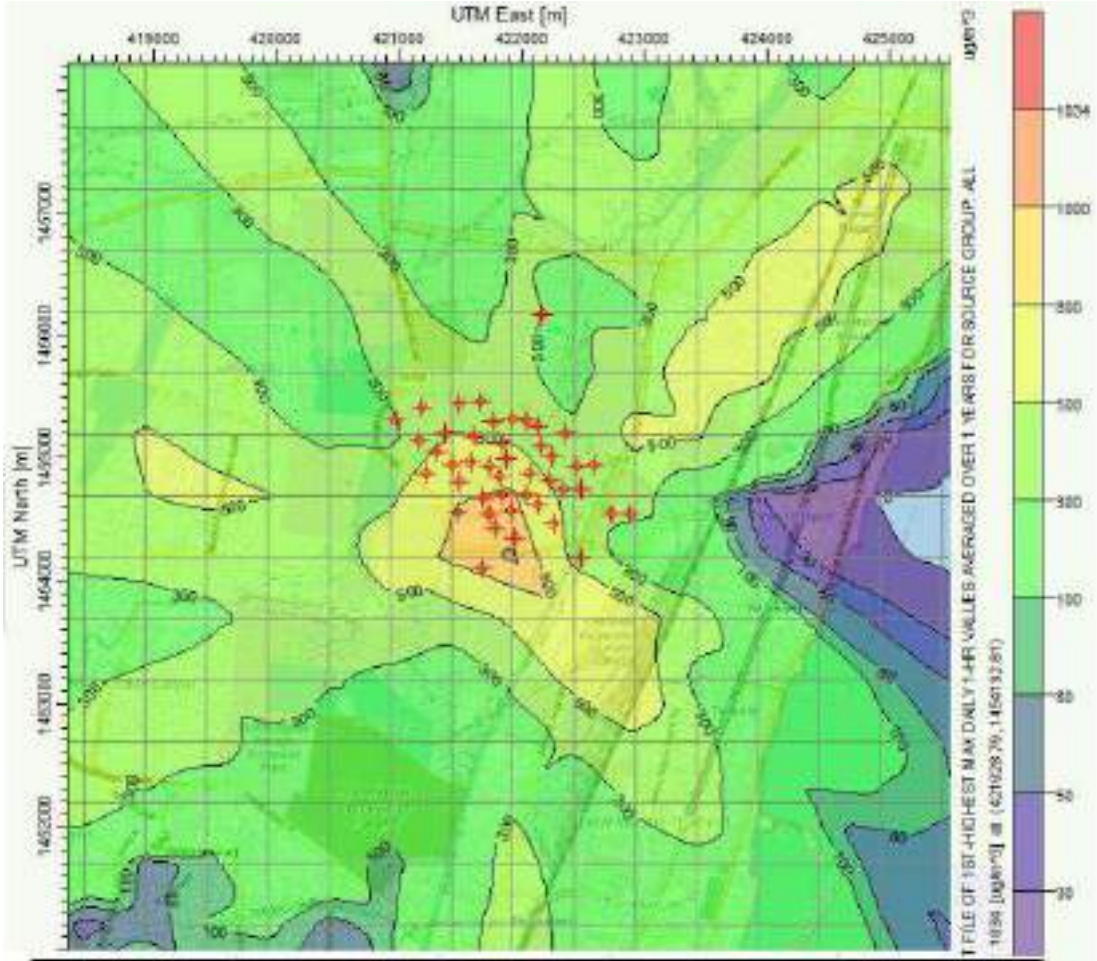
ASIMILATIVE CAPACITY OF PARTICULATE MATTER IN MANALI INDUSTRIAL AREA



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
1068	0.56	190	17.57	9.765

MPL Unit-I & II, TPL – Lab, PO, HCD Division, MFL and CPCL combined (Assimilative Particulate matter concentration is 1068mg/m3 and dispersed at the respective effective stack height (Stack height + Plume Height) with exit velocity of and the flue gas temperature are considered on individual stack wise . All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the combined GLC reached at 0.56kmkm at the concentration of 190µg/m3 at 2km dispersion Particulate matter is 17.57µg/m3 and at 5km dispersion Particulate matter is 9.76µg/m3 and the predominant wind direction is SSE.

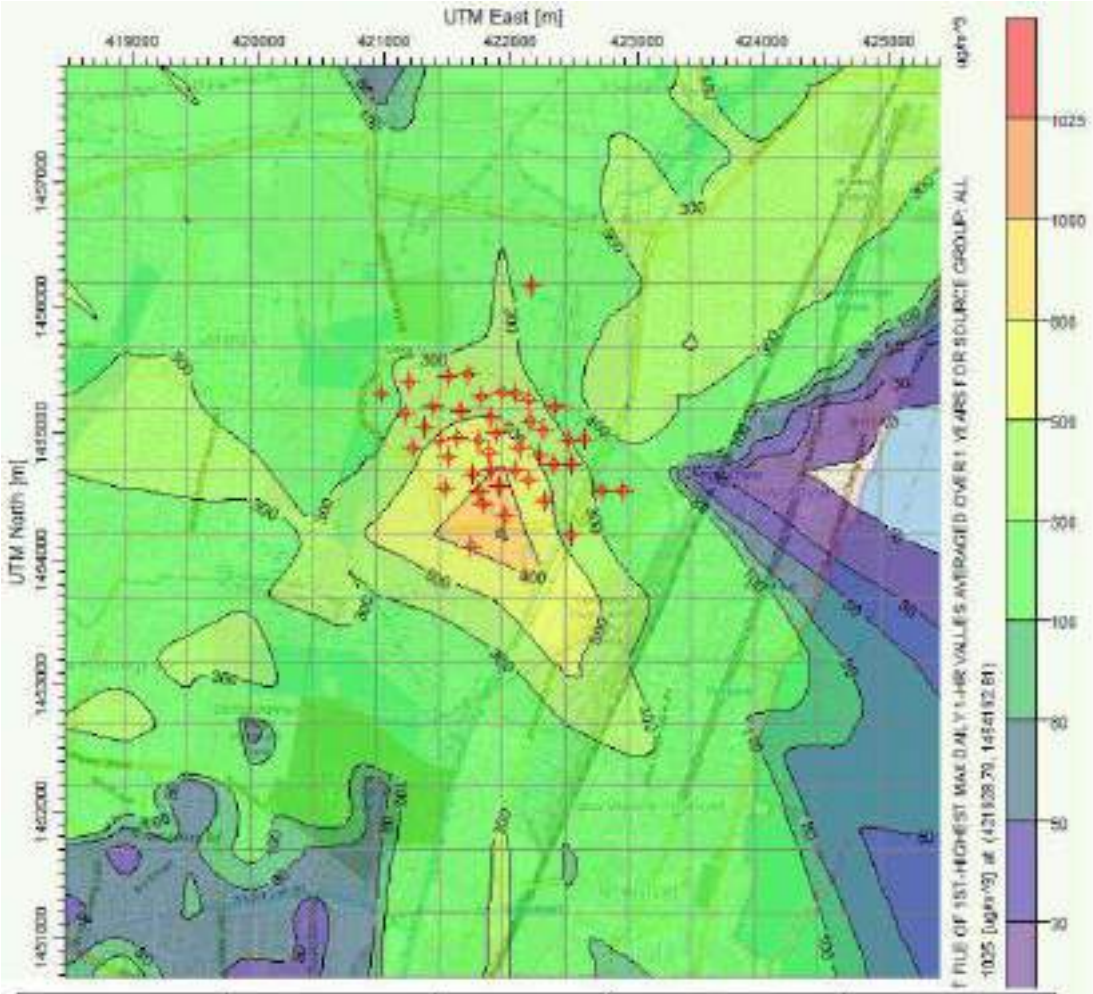
ASIMILATIVE CAPACITY OF NITROGEN OXIDES[NOx] IN MANALI INDUSTRIAL AREA



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
7397	0.65	1034	95.72	54.11

MPL Unit-I & II, TPL – Lab, PO, HCD Division, MFL and CPCL combined (Assimilative NOx concentration is 7397mg/m3 and dispersed at the respective effective stack height (Stack height + Plume Height) with exit velocity of and the flue gas temperature are considered on individual stack wise. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the combined GLC reached at 0.65km at the concentration of 1034µg/m3 at 2km dispersion Nitrogen Oxides is 54.51µg/m3 and the predominant wind direction is SSE.

ASIMILATIVE CAPACITY OF SULFUR DIOXIDE[SO2] IN MANALI INDUSTRIAL AREA



Concentration at Source (milligram/m^3)	Distance Travelled to reach GLC (km)	Maximum GLC (Microgm/m^3)	Average Concentration at 1 km (Microgm/m^3)	Average Concentration at 2 km (Microgm/m^3)
7397	0.65	1025	81.5	13.6

MPL Unit-I & II, TPL – Lab, PO, HCD Division, MFL and CPCL combined (Assimilative SO2 concentration is 7397mg/m3 and dispersed at the respective effective stack height (Stack height + Plume Height) with exit velocity of and the flue gas temperature are considered on individual stack wise . All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the combined GLC reached at 0.65km at the concentration of 1025µg/m3 at 2km dispersion Nitrogen Oxides is 13.6µg/m3 and the predominant wind direction is SSE.

CONSOLIDATED CONCLUSION OF MANALI CARRYING CAPACITY ENVIRONMENTAL MONITORING STUDY

I. TAMILNADU PETROPRODUCTS LTD, PROPYLENE OXIDE PLANT:

(i) Ambient Air Quality Monitoring Results :

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Main Gate 3, Near Fire Water Pump House, Near Ambient Air Station, Near Sub Station, Near PO Bullet South, Near Gate 4, Plant outside Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.8 to 26.3µg/m^3. Highest value of 26.3µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 19.7 to 30.4µg/m^3. Highest value of 30.4µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 55.2 to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 16.1 to 4771.1µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 17 to 8657.8µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) STACK EMISSION AND AERMOD DISPERSION MODELLING RESULTS:

a. Boiler Stack Emission:

ECH Division Boiler of Particulate matter concentration is 9.6mg/m3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 0.481µg/m3 at 2km dispersion Particulate matter is 0.354µg/m3 and at 5km dispersion Particulate matter is 0.00878µg/m3 and the predominant wind direction is SSE.

ECH Division Boiler of Carbon Monoxide concentration is 31 mg/m3 and dispersed at the effective stack height of 47.4m (Stack height 47.4m + Plume Height 3m) with exit velocity of 12.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.99µg/m3 at 2km dispersion Carbon Monoxide is 0.0961µg/m3 and at 5km dispersion Carbon Monoxide is 0.00667µg/m3 and the predominant wind direction is SSE.

b. Chlorine Scrubber

ECH Division Chlorine Scrubber of Chlorine concentration is 2.6 mg/m3 and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 11.89m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 0.09µg/m3 at 2km dispersion Chlorine is

0.0115µg/m3 and at 5km dispersion Chlorine is 0.00543µg/m3 and the predominant wind direction is SSE.

(iii) Overall Conclusion on Source Dispersion Modelling and Carrying Capacity

The source dispersion modelling output results showed the pollutants contribution from TPL – PO Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – PO division through stacks is 35 mg/m3. The average ground level concentration achieves at an average distance of 0.71km and the sum of PM concentration at GLC is 1.11 µg/m3 which includes all the stacks at TPL – PO division. It clearly indicates the PM contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from TPL – PO division through stacks is 31 mg/m3. The average ground level concentration achieves at an average

distance of 0.85km and the sum of Nitrogen Oxides concentration at GLC is 0.99 µg/m3 which includes all the stacks at TPL – PO division. It clearly indicates the CO contribution to the nearby residential areas are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative chlorine emissions from TPL – PO division through stacks is 2.6 mg/m3. The average ground level concentration achieves at an average distance of 0.76km and the sum of chlorine concentration at GLC is 0.09 µg/m^3 which includes all the stacks at TPL – PO division. It clearly indicates the Cl2 contribution to the nearby residential areas are minimum and there is no limit for the National Ambient Air Quality Standards.

Predicted GLC concentrations were not exceed the National ambient air quality standard for PM (0.71 µg/m^3) and CO (0.91 µg/m^3). Results from AERMOD simulation indicated that PM and CO emissions from the TPL PO division had no significant impact on nearby communities and Manali Industrial complex. For Chlorine there is no ambient air quality standard and the predicted concentrations also in trace level so that the impact on nearby communities and Manali Industrial complex is negligible.

The overall combined source mass emission load of PM and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity (available around 100%) pertaining to this industries source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are very much less.

II. TAMILNADU PETROPRODUCTS LTD, HEAVY CHEMICALS DIVISION

(i) Ambient Air Quality Monitoring Results

In Ambient Air Quality monitoring six sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Metro Water Storage Tank, Near CPP Radiator, Salt Yard South Side, Near Fabrication Yard, Ward Plant – West Side, Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.5 to 24.3µg/m^3. Highest value of 24.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 23.7 to 30.2µg/m^3. Highest value of 30.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.3 to 88.9µg/m^3. Highest value of 88.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.8 to 42.7µg/m^3. Highest value of 42.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 6.35 to 1247.3µg/m^3. Which is very high when compared to NAAQM standards of 60 µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.35 to 10253.9µg/m^3. Which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission

and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) Stack Emission Monitoring Results

a. Boiler Stack:

HCD Division Boiler of Particulate matter concentration is 7.2 mg/m3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 0.78µg/m3 at 2km dispersion Particulate matter is 0.034µg/m3 and at 5km dispersion Particulate matter is 0.00081µg/m3 and the predominant wind direction is SSE.

HCD Division Boiler of Sulphur dioxide concentration is 4.8 mg/m3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.627µg/m3 at 2km dispersion Sulphur dioxide is 0.11µg/m3 and at 5km dispersion Sulphur dioxide is 0.0267µg/m3 and the predominant wind direction is SSE.

HCD Division Boiler of Oxides of Nitrogen concentration is 212 mg/m3 and dispersed at the effective stack height of 18 m (Stack height 30m + Plume Height 2m) with exit velocity of 15.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 27.8µg/m3 at 2km dispersion Oxides of Nitrogen is 0.876µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.00777µg/m3 and the predominant wind direction is SSE.

b. HCL Scrubber Stack*: **HCD Division HCL Scrubber of Chlorine*** concentration is 2.8 mg/m3 and dispersed at the effective stack height of 30 m (Stack height 30m + Plume Height 2m) with exit velocity of 1.26 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 0.58µg/m3 at 2km dispersion Chlorine is 0.0873µg/m3 and at 5km dispersion Chlorine is 0.00221µg/m3 and the predominant wind direction is SSE.

c. WAD Scrubber Stack

HCD Division WAD Scrubber of Chlorine concentration is 2.9 mg/m3 and dispersed at the effective stack height of 16 m (Stack height 16m + Plume Height 2m) with exit velocity of 3.32 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 0.17µg/m3 at 2km dispersion Chlorine is 0.0232µg/m3 and at 5km dispersion Chlorine is 0.00985µg/m3 and the predominant wind direction is SSE.

(iii) Overall Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from TPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – HCD division through stacks is 17.2 mg/m3. The average ground level concentration achieves at an average distance of 0.85km and the sum of PM concentration at GLC is 2.8 µg/m3

which includes all the stacks at TPL – HCD division. It clearly indicates the PM contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from TPL – HCD division through stacks is 4.8 mg/m3. The average ground level concentration achieves at an average distance of 0.85km and the sum of Sulphur Dioxide concentration at GLC is 6.27 µg/m3 which includes all the stacks at TPL – HCD division. It clearly indicates the SO_2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from TPL – HCD division through stacks is 212 mg/m3. The average ground level concentration achieves at an average distance of 0.78km and the sum of Nitrogen Oxides concentration at GLC is 27.8 µg/m3 which includes all the stacks at TPL – HCD division. It clearly indicates the NOx contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative chlorine emissions from TPL – HCD division through stacks is 5.7 mg/m3. The average ground level concentration achieves at an average distance of 0.905km and the sum of chlorine concentration at GLC is 0.375 µg/m^3 which includes all the stacks at TPL – HCD division. It clearly indicates the Cl2 contribution to the nearby communities and Manali Industrial area are minimum and there is no limit for the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2 and NO2 and for Chlorine there is not Ambient Air quality standards. Results from AERMOD simulation indicated that PM, SO2 and NO2 emissions from the TPL HCD division had no significant impact on nearby communities and Manali Industrial complex. For Chlorine there is no ambient air quality standard and the predicted concentrations also in trace level so that the impact on nearby communities and Manali Industrial complex is negligible.

The overall combined source mass emission load of PM is 7.5kg/day and the maximum ground level concentration is 2.8 µg/m^3 which is well below withing the NAAQMS and have enough carrying capacity of around 28.6 times.

The overall combined source mass emission load of NOx is 213.5kg/day and the maximum ground level concentration is 27.8 µg/m^3 which is well below withing the NAAQMS and have enough carrying capacity of around 2.9 times.

The overall combined source mass emission load of SO2 is 4.83kg/day and the maximum ground level concentration is 0.63µg/m^3 which is well below withing the NAAQMS and have enough carrying capacity of around 127 times.

PM, SO2 and NO2 with the maximum ground level concentrations of PM is 0.78 µg/m^3, SO2 is 0.63 µg/m^3 and for NOx is 27.8 µg/m^3 which are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are minimum.

III. TAMILNADU PETROPRODUCTS LTD, LAB DIVISION

(i) Ambient Air Quality Monitoring:

In Ambient Air Quality monitoring seven sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Gate 2, Near Guard Pond, Near PACOL Heater, Tank No 1920 A South Side, 1901 A West Side, 1906 A West Side, Visitor Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 14.5 to 25.5µg/m^3. Highest value of 25.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 21.8 to 33.1µg/m^3. Highest value of 33.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 45.5 to 88.3µg/m^3. Highest value of 88.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 24.7 to 43.1µg/m^3. Highest value of 43.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):* The measured $PM_{2.5}$ values are ranging from 5.93 to 801.82µg/m^3 which is very high when compared to NAAQM standards of 60 µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 6.47 to 2469.4µg/m^3. which is very high when compared to NAAQM standards of 100 µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind

direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) Stack Emission Monitoring

a. Boiler Stack:

BOILER emission of Particulate matter concentration is 8.3mg/m3 and dispersed at the effective stack height of 33m (Stack height 33m + Plume Height 2.0m) with exit velocity of 9.93m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 1.11µg/m3 at 2km dispersion Particulate matter is 0.196µg/m3 and at 5km dispersion Particulate matter is 0.079µg/m3 and the predominant wind direction is SSE

b. Captive Power Plant:

CPP emission of Particulate matter concentration is 35.5 mg/m3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08 m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 5.04µg/m3 at 2km dispersion Particulate matter is 0.11µg/m3 and at 5km dispersion Particulate matter is 0.0076µg/m3 and the predominant wind direction is SSE.

CPP emission of Sulphur dioxide concentration is 68.5mg/m3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3.0m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 6.16µg/m3 at 2km dispersion Sulphur dioxide is 0.168µg/m3 and at 5km dispersion Sulphur dioxide is 0.0998µg/m3 and the predominant wind direction is SSE.

CPP emission of Oxides of Nitrogen concentration is 458mg/m3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 1.07km at the concentration of 45.24µg/m3 at 2km dispersion Oxides of Nitrogen is 1.11µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0545µg/m3 and the predominant wind direction is SSE.

CPP emission of Carbon Monoxide concentration is 35 mg/m3 and dispersed at the effective stack height of 31.5m (Stack height 31.5m + Plume Height 3m) with exit velocity of 12.08m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.92km at the concentration of 2.71µg/m3 at 2km dispersion Carbon Monoxide is 0.54µg/m3 and at 5km dispersion Carbon Monoxide is 0.087µg/m3 and the predominant wind direction is SSE.

c. Hot Oil Heater:

Hot Oil Heater of Particulate matter concentration is 6.2mg/m3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 0.38µg/m3 at 2km dispersion Particulate matter is 0.054µg/m3 and at 5km dispersion Particulate matter is 0.00232µg/m3 and the predominant wind direction is SSE.

Hot Oil Heater of Sulphur dioxide concentration is 4.9 mg/m3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 8.68µg/m3 at 2km dispersion Sulphur dioxide is 1.56µg/m3 and at 5km dispersion Sulphur dioxide is 0.0651µg/m3 and the predominant wind direction is SSE.

Hot Oil Heater of Oxides of Nitrogen concentration is 3 mg/m3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 2.73µg/m3 at 2km dispersion Oxides of Nitrogen is 0.167µg/m3 and at 5km dispersion Oxides of Nitrogenis 0.0341µg/m3 and the predominant wind direction is SSE.

Hot Oil Heater of Carbon Monoxide concentration is 36 mg/m3 and dispersed at the effective stack height of 76m (Stack height 76m + Plume Height 3m) with exit velocity of 9.3m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 35.5µg/m3 at 2km dispersion Carbon Monoxide is 0.987µg/m3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m3 and the predominant wind direction is SSE.

d. PACOL Charge Heater:

PACOL Charge Heater of Particulate matter concentration is 9.6 mg/m3 and dispersed at the effective stack height of 56m (Stack height 56m + Plume Height 3m) with exit velocity of 11m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 0.481µg/m3 at 2km dispersion Particulate matter is 0.354µg/m3 and at 5km dispersion Particulate matter is 0.00878µg/m3 and the predominant wind direction is SSE.

e. Hydrobon Water F1201 R:

Hydrobon Water F1201 R of Particulate matter concentration is 7.9 mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.01m/sec and the flue gas temperature are 25°C. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 0.98µg/m3 at 2km dispersion Particulate matter is 0.0557µg/m3 and at 5km

dispersion Particulate matter is 0.00316µg/m3 and the predominant wind direction is SSE.

III. Overall Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from TPL – Lab Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The TPL plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From TPL to Burma Nagar aerial distance is 1.1km, to Manali New Town is 2.33km, to Salai Ma Nagar is 1.82km, to Thanthai Periyar Nagar is 2.54km and to Balakrishna Nagar is 1.2km.

The cumulative particulate matter emissions from TPL – Lab division through stacks is 74.6mg/m3. The average ground level concentration achieves at an average distance of 0.85km and the sum of PM concentration at GLC is 19.8 µg/m3 which includes all the stacks at TPL – Lab division. It clearly indicates the PM contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from TPL – Lab division through stacks is 73.4 mg/m3. The average ground level concentration achieves at an average distance of 0.865km and the sum of Sulphur Dioxide concentration at GLC is 7.72 µg/m3 which includes all the stacks at TPL – Lab division. It clearly indicates the SO_2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from TPL – Lab division through stacks is 461 mg/m3. The average gound level concentration achieves at a average distance of 0.93km and the sum of Nitrogen Oxides concentration at GLC is 48 µg/m3 which includes all the stacks at TPL – Lab division. It clearly indicates the NO_2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2 and NO2. Results from AERMOD simulation indicated that PM, SO2 and NO2 emissions from the TPL Lab division had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM is 71.54kg/day and the maximum ground level concentration is 19.8µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 4 times.

The overall combined source mass emission load of SO2 is 64.97kg/day and the maximum ground level concentration is 14.84µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 5.4 times.

The overall combined source mass emission load of NOx is 288.3kg/day and the maximum ground level concentration is 48µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 2 times.

PM, SO2 and NO2 with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel so that the emissions from the combustion sources are very much less.

IV. MANALI PETROCHEMICALS LTD, UNIT-1

(i) Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Car Parking, Near RO Plant Opposite, Near Weigh Bridge, Near ETP- Raw Water Unloading Area, Near RVDF Opposite, Near Drumming Plant, Visitor Gate and Material Gate.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 10.1 to 19.7µg/m^3. Highest value of 19.7µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 15.07 to 20.51µg/m^3. Highest value of 20.51µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 59.1to 91.3µg/m^3. Highest value of 91.3µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.3 to 44.3µg/m^3. Highest value of 41µg/m^3 is obtained and however the values are within the NAAQM standards.
- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 28.35 to 240.91µg/m^3.
- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 68.82 to 359.51µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) Stack Emission Monitoring

MPL-1 18 TON BOILER emission of Particulate matter concentration is 7.8mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 0.86µg/m^3 at 2km dispersion Particulate matter is 0.0776µg/m^3 and at 5km dispersion Particulate matter is 0.0017µg/m^3 and the predominant wind direction is ENE.

MPL-1 18 TON BOILER emission of Carbon Monoxide concentration is 11.14mg/m^3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 3.42µg/m3 at 2km dispersion Carbon Monoxide is 0.118µg/m3 and at 5km dispersion Carbon Monoxide is 0.0322µg/m3 and the predominant wind direction is ENE.

MPL-1 18 TON BOILER emission of Oxides of Nitrogen concentration is 47.9mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3.0m) with exit velocity of 3.16m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 4.46µg/m3 at 2km dispersion Oxides of Nitrogen is 0.273µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0908µg/m3 and the predominant wind direction is ENE.

(iii) Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The MPL plant is surrounded by residential areas like 1.Manali New Town, 2.RM Nagar, 3.Salai Ma Nagar, 4.Chinnasekkadu and 5.Kanniyammanpettai village. From MPL to Manali New Town aerial distance is 2.18km, to RM Nagar is 1.27km, to Salai Ma Nagar is 1.33km, to Chinnasekkadu is 1.66km and to Kanniyammanpettai village is 3.23km.

The cumulative particulate matter emissions from MPL through stacks is 22.1 mg/m3. The average gound level concentration achieves at a average distance of 0.87km and the sum of PM concentration at GLC is 7.05 µg/m3 which includes all the stacks at MPL. It clearly indicates the PM contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from MPL through stacks is 11.14 mg/m3. The average ground level concentration achieves at a average distance of 0.8km and the sum of Sulphur Dioxide concentration at GLC is 3.42 µg/m3 which includes all the stacks at MPL. It clearly indicates the CO contribution to the

nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MPL through stacks is 47.9 mg/m3. The average ground level concentration achieves at a average distance of 0.77km and the sum of Nitrogen Oxides concentration at GLC is 4.46 µg/m3 which includes all the stacks at MPL. It clearly indicates the NOx contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, NO2 and CO. Results from AERMOD simulation indicated that PM, NO2 and CO emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM is 2.19kg/day and the maximum ground level concentration is 7.0µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 11.4 times.

The overall combined source mass emission load of NOx is 13.47kg/day and the maximum ground level concentration is 4.46µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 5.9 times.

The overall combined source mass emission load of CO is 3.13kg/day and the maximum ground level concentration is 3.42µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 23.4 times.

The overall combined source mass emission load of PM, NO_X and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel in most of the emissions sources so that the emissions from the combustion sources are much less.

V. MANALI PETROCHEMICALS UNIT-II

(i) Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Near Security Gate, Near Control Room, Near MMS Transformer, Near Furnace Oil Storage Tank, Near ETP Area, Near Raw Material Godown, Near Main Gate (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 15.7 to 21.5µg/m^3. Highest value of 21.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 22.9 to 28.5µg/m^3. Highest value of 28.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 58.4 to 91.4µg/m^3. Highest value of 91.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.9 to 44.3µg/m^3. Highest value of 44.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$): The measured* $PM_{2.5}$ values are ranging from 14.13 to 77.55µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 57.94 to 241.97µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy vehicle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind

direction is from NE, N to NNW, E then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission and it is purely because of outside vehicular emissions. So that outside vehicular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) Stack Emission Monitoring:

MPL-2 18 TON BOILER emission of Particulate matter concentration is 26 mg/Nm3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.33µg/m3 at 2km dispersion Particulate matter is 0.245µg/m3 and at 5km dispersion Particulate matter is 0.0432µg/m3 and the predominant wind direction is SSE.

MPL-2 18 TON BOILER emission of Carbon Monoxide concentration is 5.0mg/Nm3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.72µg/m3 at 2km dispersion Carbon Monoxide is 0.28µg/m3 and at 5km dispersion Carbon Monoxide is 0.0842µg/m3 and the predominant wind direction is SSE.

MPL-2 18 TON BOILER emission of Sulphur dioxide concentration is 308mg/Nm3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous

basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 39.12µg/m3 at 2km dispersion Sulphur dioxide is 6.76µg/m3 and at 5km dispersion Sulphur dioxide is 0.97µg/m3 and the predominant wind direction is ESE.

MPL-2 18 TON BOILER emission of Oxides of Nitrogen concentration is 363mg/Nm3 and dispersed at the effective stack height of 30.5m (Stack height 30.5m + Plume Height 3.0m) with exit velocity of 4.41m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 56.4µg/m3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m3 and the predominant wind direction is SSE.

(iii) Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MPL – HCD Division to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit vaues. The MPL plant is surrounded by residential areas like 1.Manali New Town, 2.Indira Gandhi Nagar, 3.Shastri Nagar, 4.Tendral Nagar and 5.Bhaktavatsala Nagar. From MPL to Manali New Town aerial distance is 4.47km, to Indira Gandhi Nagar is 2.11km, to Shastri Nagar is 1.69km, to Tendral Nagar is 2.01km and to Bhaktavatsala Nagar is 1.85km.

The cumulative particulate matter emissions from MPL through stacks is 26 mg/m3. The average ground level concentration achieves at an average distance of 0.78km and the sum of PM concentration at GLC is 13.3 µg/m3 which includes all the stacks at MPL. The residential areas are more than 1.5km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the PM contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Carbon monoxide emissions from MPL through stacks is 5 mg/m3. The average ground level concentration achieves at an average distance of 0.76km and the sum of Carbon monoxide concentration at GLC is 8.72 µg/m3 which includes all the stacks at MPL. The residential areas are more than 1.5km radius and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the CO contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MPL through stacks is 744 mg/m3. The average ground level concentration achieves at an average distance of 0.82km and the sum of Nitrogen Oxides concentration at GLC is 58.9 µg/m3 which includes all the stacks at MPL. The residential areas are more than 1.5km radium and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the NO2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur dioxide emissions from MPL through stacks is 618 mg/m3. The average ground level concentration achieves at an average distance of 0.76km and the sum of Sulphur dioxide concentration at GLC is 49.12 µg/m3 which includes all the stacks at MPL. The residential areas are more than 1.5km radius and the expected ground level concentration will be further less than maximum GLC. It clearly indicates the SO2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2, NO_2 and CO. Results from AERMOD simulation indicated that PM, SO2, NO_2 and CO emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM is 11.66kg/day and the maximum ground level concentration is 1.33µg/m^{3-}which is well below within the ambient air quality standards and have enough carrying capacity of around 60 times.

The overall combined source mass emission load of NOx is 333.7kg/day and the maximum ground level concentration is 58.9µg/m^{3-}which is below the ambient air quality standards and have enough carrying capacity of around 1.4 times.

The overall combined source mass emission load of SO_2 is 277.17kg/day and the maximum ground level concentration is 49.1µg/m^{3-}which is below the ambient air quality standards and have enough carrying capacity of around 1.63 times.

The overall combined source mass emission load of CO is 2.24kg/day and the maximum ground level concentration is 8.72µg/m^{3-}which is below the ambient air quality standards and have enough carrying capacity of around 9.2 times.

The overall combined source mass emission load of PM, SO2, NO_2 and CO with the maximum ground level concentrations are not exceeding the national ambient air quality standards and there is enough carrying capacity pertaining to this industry source emission load. Since the industry is using gaseous fuel in most of the emissions sources so that the emissions from the combustion sources are much less.

VI. MADRAS FERTILIZERS LTD

(i) Ambient Air Quality:

In Ambient Air Quality monitoring eight sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are NNE Side of the Plant, NW Side of the Plant, WSW Side of the Plant, ENE Side of the Plant, SE Side of the Plant, SSW Side of the Plant, Near Main Gate (Road Side) and Beside Road Towards Moolakadai (Road Side).

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 8.7 to 12.1µg/m^3. Highest value of 12.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 11.9 to 17.7µg/m^3. Highest value of 17.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 56.9 to 87.3µg/m^3. Highest value of 87.3µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 28.5 to 44.4µg/m^3. Highest value of 44.4µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ammonia (NH_3):* Ambient Air Quality values of NH_3 are ranging from 21.4 to 33.5µg/m^3. Highest value of 33.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road ($PM_{2.5}$):The measured* $PM_{2.5}$ values are ranging from 13.4 to 54.7µg/m^3.

- *Ambient Air Quality Monitoring outside the Plant and nearby Road (PM_{10}): The measured* PM_{10} values are ranging from 54.7 to 183.6µg/m^3.

PM10 and PM2.5 are very high in the road side collected samples is due to lot of heavy veichle movement specifically container movement towards port. These dust emissions are further dispersion into ambient atmosphere. Whenever the wind direction is from NE, N to SW, S then the contribution of PM10 and PM2.5 to industry is maximum and those dust concentration is not due to industrial emission

and it is purely because of outside veichular emissions. So that outside veichular emissions are one of the major contributory sources for PM10 and PM2.5.

(ii) Stack Emission Monitoring

In Stack Emission monitoring at all stack complying all the parameters against the emission limit values.

MFL NPK Common Stack Outlet of Particulate matter concentration is 13 mg/m3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 16.2µg/m3 at 2km dispersion Particulate matter is 1.78µg/m3 and at 5km dispersion Particulate matter is 0.65µg/m3 and the predominant wind direction is SSE.

MFL NPK Common Stack Outlet of Hydrogen Fluoride concentration is 3.5 mg/m3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.37µg/m3 at 2km dispersion Hydrogen Fluoride is 1.23µg/m3 and at 5km dispersion Hydrogen Fluoride is 0.45µg/m3 and the predominant wind direction is SSE.

MFL NPK Common Stack Outlet of Ammonia concentration is 243 mg/m3 and dispersed at the effective stack height of 45m (Stack height 45m + Plume Height 2m) with exit velocity of 12.8 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 23.2µg/m3 at 2km dispersion Ammonia is 4.22µg/m3 and at 5km dispersion Ammonia is 0.89µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Particulate matter concentration is 7 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 24.1µg/m3 at 2km dispersion Particulate matter is 1.85µg/m3 and at 5km dispersion Particulate matter is 0.0987µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Hydrogen Fluoride concentration is 1.5 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 7.72µg/m3 at 2km dispersion Hydrogen Fluoride is 0.65µg/m3 and at 5km dispersion Hydrogen Fluoride is 0.0093µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-A Outlet of Ammonia concentration is 253 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 955.2µg/m3 at 2km dispersion Ammonia is 67.84µg/m3 and at 5km dispersion Ammonia is 3.177µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Particulate matter concentration is 5.3 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis

with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 20.1µg/m3 at 2km dispersion Particulate matter is 1.97µg/m3 and at 5km dispersion Particulate matter is 0.43µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Hydrogen Fluoride concentration is 1.5 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.31 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 7.67µg/m3 at 2km dispersion Hydrogen Fluoride is 1.09µg/m3 and at 5km dispersion Hydrogen Fluoride is 0.24µg/m3 and the predominant wind direction is SSE.

MFL Urea Demister-B Outlet of Ammonia concentration is 45 mg/m3 and dispersed at the effective stack height of 73m (Stack height 73m + Plume Height 2m) with exit velocity of 3.4 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 125µg/m3 at 2km dispersion Ammonia is 3.11µg/m3 and at 5km dispersion Ammonia is 0.56µg/m3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Particulate matter concentration is 31.3 mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 32.4µg/m3 at 2km dispersion Particulate matter is 2.29µg/m3 and at 5km dispersion Particulate matter is 0.6776µg/m3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Sulphur dioxide concentration is 386 mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the

modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 383µg/m3 at 2km dispersion Sulphur dioxide is 19.1µg/m3 and at 5km dispersion Sulphur dioxide is 0.894µg/m3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Oxides of Nitrogen concentration is 54 mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 49.12µg/m3 at 2km dispersion Oxides of Nitrogen is 5.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.786µg/m3 and the predominant wind direction is SSE.

MFL Utility Boiler-1&2 of Carbon Monoxide concentration is 51 mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 6.39 m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.74km at the concentration of 44.2µg/m3 at 2km dispersion Carbon Monoxide is 2.93µg/m3 and at 5km dispersion Carbon Monoxide is 0.346µg/m3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Particulate matter concentration is 36.4 mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 98.43µg/m3 at 2km dispersion

Particulate matter is 2.22µg/m3 and at 5km dispersion Particulate matter is 0.643µg/m3 and the predominant wind direction is SSE.

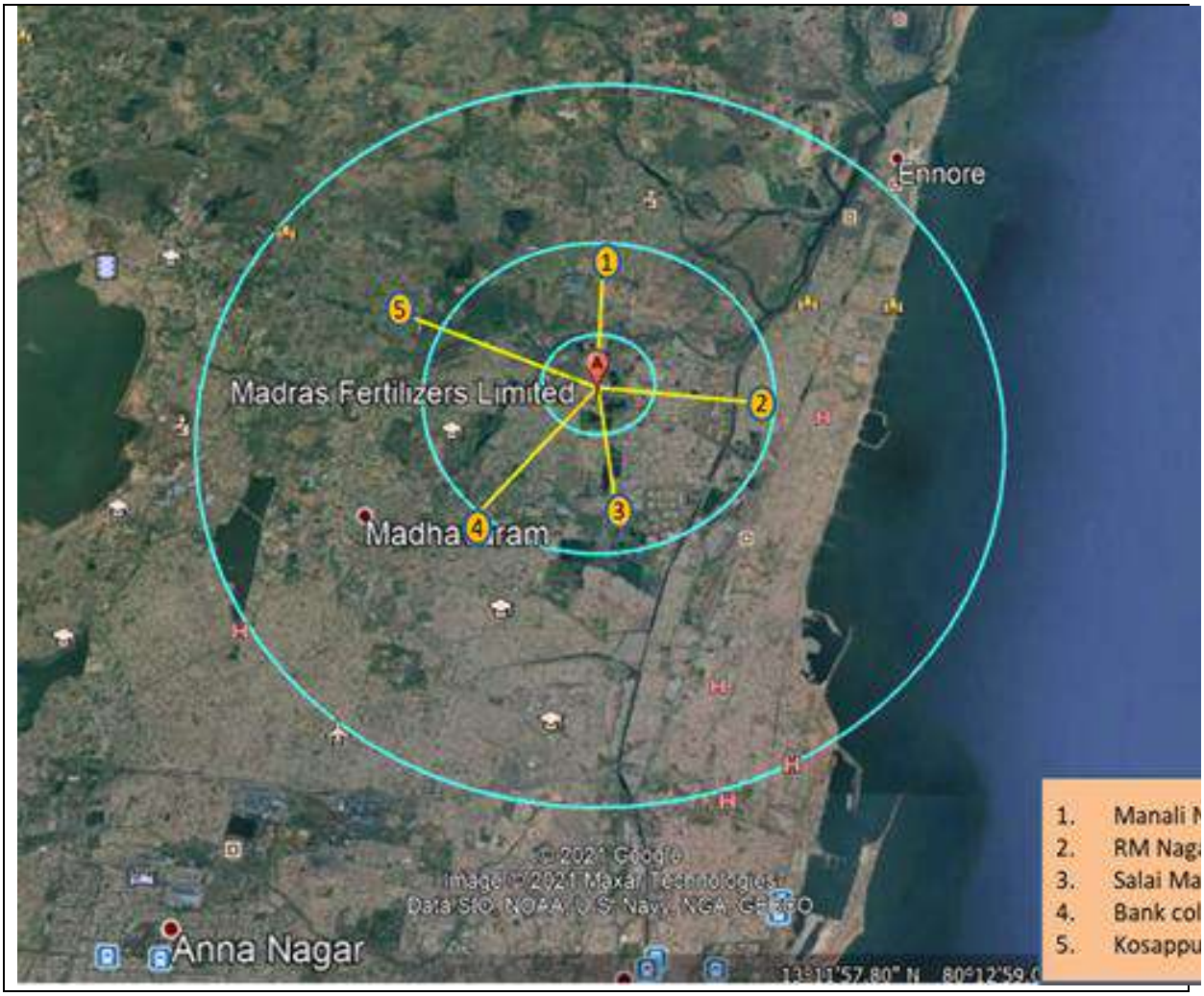
MFL 110 ATA PCB Boiler of Sulphur dioxide concentration is 14 mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 44.7µg/m3 at 2km dispersion Sulphur dioxide is 1.99µg/m3 and at 5km dispersion Sulphur dioxide is 0.28µg/m3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Oxides of Nitrogen concentration is 293 mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 746µg/m3 at 2km dispersion Oxides of Nitrogen is 34µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.99µg/m3 and the predominant wind direction is SSE.

MFL 110 ATA PCB Boiler of Carbon Monoxide concentration is 22 mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 9.79 m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 70.6µg/m3 at 2km dispersion Carbon Monoxide is 2.27µg/m3 and at 5km dispersion Carbon Monoxide is 0.645µg/m3 and the predominant wind direction is SSE.

(iii) Overall Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from MFL to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit values. The MFL plant is surrounded by residential areas like 1.Manali New Town, 2.RM Nagar, 3.Salai Ma Nagar, 4.Bank Colony and 5.Kosappur. From MFL to Manali New Town arial distance is 2.51km, to RM Nagar is 2.76km, to Salai Ma Nagar is 2.08km, to Bank Colony is 3.27km and to Kosappur is 3.62km.



The cumulative particulate matter emissions from MFL through stacks is 94 mg/m3. The average ground level concentration achieves at an average distance of 0.83km and the sum of PM concentration at GLC is 131 µg/m^3 which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 27.7 µg/m^3. It clearly indicates the PM10 & PM2.5 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Sulphur Dioxide emissions from MFL through stacks is 400 mg/m3. The average ground level concentration achieves at an average distance of 0.82km and the sum of Sulphur Dioxide concentration at GLC is 213.85 µg/m3 which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 10.54 µg/m^3. It clearly indicates the SO_2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative Nitrogen Oxides emissions from MFL through stacks is 347 mg/m3. The average ground level concentration achieves at an average distance of 0.89km and the sum of Nitrogen Oxides concentration at GLC is 397.56 µg/m3 which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 19.5 µg/m^3. It clearly indicates the NO_2 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative HF emissions from MFL through stacks is 6.5 mg/m3. The average ground level concentration achieves at a average distance of 0.87km and the sum of HF concentration at GLC is 6.59 µg/m3 which includes all the stacks at MFL. It clearly indicates the HF contribution to the nearby communities and Manali Industrial area are minimum and there is no limit for the National Ambient Air Quality Standards.

The cumulative NH3 emissions from MFL through stacks is 461 mg/m3. The average ground level concentration achieves at an average distance of 0.76km and the sum of NH3 concentration at GLC is 367.8 µg/m3 which includes all the stacks at MFL. Most of the residential areas are at more than 2km radius and the ground level concentration at 2km radius is 25.05 µg/m^3. It clearly indicates the NH_3 contribution to the nearby communities and Manali Industrial area are minimum and it is well below within the National Ambient Air Quality Standards.

The cumulative CO emissions from MFL through stacks is 73 mg/m3. The average ground level concentration achieves at a average distance of 0.83km and the sum of CO concentration at GLC is 57.35 µg/m3 which includes all the stacks at MFL. It clearly indicates the CO contribution to the nearby communities and Manali Industrial area are minimum and it is it is well below within the National Ambient Air Quality Standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2, NO_2, CO and NH3. Results from AERMOD simulation indicated that PM, SO2, NO_2, CO and NH3 emissions from the MPL Unit-1 had no significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM is 1271kg/day and the maximum ground level concentration is 191.2µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 1.9 times. Whereas the communities are in the distance of more than 2,0km whereas the GLC at 0.86km. At 2.0km the GLC PM concentration is 10.1 µg/m^3 which is below the ambient air quality standards and having the carrying capacity around 8 times.

The overall combined source mass emission load of SO2 is 2718.4kg/day and the maximum ground level concentration is 428µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 5.35 times. Whereas the communities are in the distance of more than 2.0km whereas the GLC at 0.8km. At 2.0km the GLC SO_2 concentration is 21.1 µg/m^3 which is below the ambient air quality standards and having the carrying capacity around 3.8 times.

The overall combined source mass emission load of NOx is 6047kg/day and the maximum ground level concentration is 795µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 9.94 times. Whereas the communities are in the distance of more than 2.0km whereas the GLC at 0.88km. At 2.0km the GLC SO_2 concentration is 39.1 µg/m^3 which is below the ambient air quality standards and having the carrying capacity around 2 times.

The overall combined source mass emission load of CO is 5.37kg/day and the maximum ground level concentration is 12.1µg/m^{3-}which is below the ambient air quality standards and having the enough carrying capacity of around 165 times.

The overall combined source mass emission load of NH3 is 8411.5kg/day and the maximum ground level concentration is 1103.4µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 2.75 times. Whereas the communities are in the distance of more than 2.0km whereas the GLC at 0.88km. At 2.0km the GLC SO_2 concentration is 75.17 µg/m^3 which is below the ambient air quality standards and having the enough carrying capacity of around 5.32 times.

The overall combined source mass emission load of HF is 90.51kg/day and the maximum ground level concentration is 19.76µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 2.75 times. Whereas the communities are in the distance of more than 2.0km whereas the GLC at 0.88km. At 2.0km the GLC SO_2 concentration is 2.97 µg/m^3 which is below the ambient air quality standards and having the enough carrying capacity of around 5.32 times.

The overall combined source mass emission load of PM, SO2, NO_2 and NH3 with the maximum ground level concentrations are not exceeding the national ambient air quality standards whereas considering the communities receptor at 2km radius is complying with NAAQMS and there is enough carrying capacity pertaining to this industry source emission load.

VII. CHENNAI PETROLEUM CORPORATION LTD

(i) Ambient Air Quality:

In Ambient Air Quality monitoring ten locations were identified as source of emission of Gaseous and Particulate matter. Those are, R & D, SRU, CPP, Temple, SS-5, ETP-2, TTP, Polytanic, Isomer (Cabin) & Refinery 2 Maintains Field Room.

- *Sulphur Dioxide as SO_2 :* Ambient Air Quality values of SO_2 are ranging from 14.7 to 24.7 µg/m^3. Highest value of 24.7 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Nitrogen Dioxide as NO_2 :* Ambient Air Quality values of NO_2 are ranging from 30.2 to 34.6 µg/m^3. Highest value of 37.61 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter (PM_{10}) :* Ambient Air Quality values of PM_{10} are ranging from 43.6 to 57.5 µg/m^3. Highest value of 57.5 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Particulate Matter ($PM_{2.5}$) :* Ambient Air Quality values of $PM_{2.5}$ are ranging from 26 to 35.1 µg/m^3. Highest value of 35.1 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Lead as Pb :* Ambient Air Quality values of Pb are ranging from 0.0 to 0.0295 µg/m^3. Highest value of 0.0295 µg/m^3 is obtained and however the value is within the NAAQ standards.

- *Benzene :* Ambient Air Quality values of Benzene are ranging from 0 to 4.4 µg/m^3.

- *Nickel as Ni:* Ambient Air Quality values of Nickel are ranging from 0 to 2.56 µg/m^3.

(ii) STACK EMISSION MONITORING CONCLUSIONS:

a. Stack - 14F1

Stack - 14F1 emission of Carbon Monoxide concentration is 152mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 8.78µg/m3 at 2km dispersion Oxides of Nitrogen is 0.87µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0177µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Particulate matter concentration is 15.4mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 0.932µg/m3 at 2km dispersion Particulate matter Particulate matter isµg/m3 and at 5km dispersion Particulate matter is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Sulphur dioxide concentration is 116mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and

contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 6.73µg/m3 at 2km dispersion Sulphur dioxide is 1.23µg/m3 and at 5km dispersion Sulphur dioxide is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 14F1 emission of Oxides of Nitrogen concentration is 356mg/m3 and dispersed at the effective stack height of 32.38m (Stack height 32.38m + Plume Height 5.0m) with exit velocity of 12.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 20.5µg/m3 at 2km dispersion Oxides of Nitrogen is 2.28µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.776µg/m3 and the predominant wind direction is ESE.

b. Stack - 14F101

Stack - 14F101 emission of Carbon Monoxide concentration is 140mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.799km at the concentration of 6.76µg/m3 at 2km dispersion Carbon Monoxide is 1.786µg/m3 and at 5km dispersion Carbon Monoxide is 0.57µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Particulate matter concentration is 8.1mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.995km at the concentration of 0.401µg/m3 at 2km dispersion

Particulate matter is 0.0334µg/m3 and at 5km dispersion Particulate matter is 0.00631µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Oxides of Nitrogen concentration is 331mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 20.8µg/m3 at 2km dispersion Oxides of Nitrogen is 2.78µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.892µg/m3 and the predominant wind direction is ESE.

Stack - 14F101 emission of Sulphur dioxide concentration is 42mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 14.08m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.831km at the concentration of 2.005µg/m3 at 2km dispersion Sulphur dioxide is 0.211µg/m3 and at 5km dispersion Sulphur dioxide is 0.0856µg/m3 and the predominant wind direction is ESE.

c. Stack - 15F1A

Stack - 15F1A emission of Carbon Monoxide is 149mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 20.8µg/m3 at 2km dispersion Carbon Monoxide is 2.22µg/m3 and at 5km dispersion Carbon Monoxide is 1.788µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Particulate matter is 17.9mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 3.002µg/m3 at 2km dispersion Particulate matter is 1.11µg/m3 and at 5km dispersion Particulate matter is 0.534µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Sulphur dioxide is 76mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 12.6µg/m3 at 2km dispersion Sulphur dioxide is 2.22µg/m3 and at 5km dispersion Sulphur dioxide is 0.45µg/m3 and the predominant wind direction is ESE.

Stack - 15F1A emission of Oxides of Nitrogen is 12.4 mg/m3 and dispersed at the effective stack height of 63.1m (Stack height 63.1m + Plume Height 3.0m) with exit velocity of 7.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8 km at the concentration of 30.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.38µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.782µg/m3 and the predominant wind direction is ESE.

d. Stack – 15F1B:

Stack - **15F1B** emission of Carbon Monoxide is 103mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling

parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 9.04µg/m3 at 2km dispersion Carbon Monoxide is 2.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.52µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Particulate matter is 19.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.72km at the concentration of 1.51µg/m3 at 2km dispersion Carbon Monoxide is 0.76µg/m3 and at 5km dispersion Carbon Monoxide is 0.099µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 4.583µg/m3 at 2km dispersion Sulphur dioxide is 0.78µg/m3 and at 5km dispersion Sulphur dioxide is 0.0753µg/m3 and the predominant wind direction is ESE.

Stack - **15F1B** emission of Oxides of Nitrogen is 172mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3.0m) with exit velocity of 8.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 13.4µg/m3 at 2km dispersion Oxides of Nitrogen is 4.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.11µg/m3 and the predominant wind

direction is ESE.

e. Stack - 15F2A

Stack - **15F2A** emission of Carbon Monoxide is 119mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.78µg/m3 at 2km dispersion Carbon Monoxide is 1.8µg/m3 and at 5km dispersion Carbon Monoxide is 0.54µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Particulate matter is 18.5mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 0.879µg/m3 at 2km dispersion Particulate matter is 0.08µg/m3 and at 5km dispersion Particulate matter is 0.005µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Sulphur dioxide is 61mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 9.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 2.95µg/m3 at 2km dispersion Sulphur dioxide is 0.62µg/m3 and at 5km dispersion Sulphur dioxide is 0.0736µg/m3 and the predominant wind direction is ESE.

Stack - **15F2A** emission of Oxides of Nitrogen is 306mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit

velocity of 9.95m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 14.9µg/m3 at 2km dispersion Oxides of Nitrogen is 5.55µg/m3 and at 5km dispersion Oxides of Nitrogen is 2.22µg/m3 and the predominant wind direction is ESE.

f. Stack - 15F2B

Stack - **15F2B** emission of Carbon Monoxide is 84mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 6.9µg/m3 at 2km dispersion Carbon Monoxide is 0.876µg/m3 and at 5km dispersion Carbon Monoxide is 0.07212µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Particulate matter is 20.3mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.912km at the concentration of 1.68µg/m3 at 2km dispersion Particulate matter is 0.522µg/m3 and at 5km dispersion Particulate matter is 0.086µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Sulphur dioxide is 187mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant

emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8657km at the concentration of 15.3µg/m3 at 2km dispersion Sulphur dioxide is 0.987µg/m3 and at 5km dispersion Sulphur dioxide is 0.0467µg/m3 and the predominant wind direction is ESE.

Stack - **15F2B** emission of Oxides of Nitrogen is 192mg/m3 and dispersed at the effective stack height of 32m (Stack height 32m + Plume Height 4.0m) with exit velocity of 11.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.888km at the concentration of 15.7µg/m3 at 2km dispersion Oxides of Nitrogen is 2.2354µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.987µg/m3 and the predominant wind direction is ESE.

g. Stack - 16F1

Stack - **16F1** emission of Carbon Monoxide is 148mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 20.4µg/m3 at 2km dispersion Oxides of Nitrogen is 8.32µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.952µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Particulate matter is 17.4mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 56.2µg/m3 at 2km dispersion

Particulate matter is 9.91µg/m3 and at 5km dispersion Particulate matter is 2.19µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Sulphur dioxide is 59mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.855µg/m3 and at 5km dispersion Sulphur dioxide is 0.072µg/m3 and the predominant wind direction is ESE.

Stack - **16F1** emission of Oxides of Nitrogen is 408mg/m3 and dispersed at the effective stack height of 58.2m (Stack height 58.2m + Plume Height 3.0m) with exit velocity of 10.74m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 56.2µg/m3 at 2km dispersion Oxides of Nitrogen is 10.11µg/m3 and at 5km dispersion Oxides of Nitrogen is 1.47µg/m3 and the predominant wind direction is ESE.

h. Stack - 16F3

Stack - **16F3** emission of Carbon Monoxide is 142mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.889km at the concentration of 18.7µg/m3 at 2km dispersion Carbon Monoxide is 1.56µg/m3 and at 5km dispersion Carbon Monoxide is 0.321µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Particulate matter is 9.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.785km at the concentration of 1.28µg/m3 at 2km dispersion Particulate matter is 0.11µg/m3 and at 5km dispersion Particulate matter is 0.0693µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Oxides of Nitrogen is 43mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 5.52µg/m3 at 2km dispersion Oxides of Nitrogen is 1.789µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.809µg/m3 and the predominant wind direction is ESE.

Stack - **16F3** emission of Sulphur dioxide is 10mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5.0m) with exit velocity of 14.99m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.869km at the concentration of 1.36µg/m3 at 2km dispersion Sulphur dioxide is 0.19µg/m3 and at 5km dispersion Sulphur dioxide is 0.0461µg/m3 and the predominant wind direction is ESE.

i. Stack - 9F201

Stack - **9F201** emission of Particulate matter is 24.4mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the

modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 5.52µg/m3 at 2km dispersion Particulate matter is 2.16µg/m3 and at 5km dispersion Particulate matter is 0.42µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Oxides of Nitrogen is 421mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 29.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.89µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Carbon Monoxide is 185 mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.789km at the concentration of 13.2µg/m3 at 2km dispersion Carbon Monoxide is 1.31µg/m3 and at 5km dispersion Carbon Monoxide is 0.0866µg/m3 and the predominant wind direction is ESE.

Stack - **9F201** emission of Sulphur dioxide is 41mg/m3 and dispersed at the effective stack height of 47.93m (Stack height 47.93m + Plume Height 3.0m) with exit velocity of 7.32m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.982km at the concentration of 2.97µg/m3 at 2km dispersion Sulphur

dioxide is 0.666µg/m3 and at 5km dispersion Sulphur dioxide is 0.0231µg/m3 and the predominant wind direction is ESE.

j. Stack - 9F301

Stack - **9F301** emission of Carbon Monoxide is 159mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 5.52µg/m3 at 2km dispersion Oxides of Nitrogen is 2.42µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.56µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Particulate matter is 25.6mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 5.67µg/m3 at 2km dispersion Particulate matter is 2.11µg/m3 and at 5km dispersion Particulate matter is 0.36µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Sulphur dioxide is 71.4mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with exit velocity of 9.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 2.49µg/m3 at 2km dispersion Sulphur dioxide is 0.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.0925µg/m3 and the predominant wind direction is ESE.

Stack - **9F301** emission of Oxides of Nitrogen is 425mg/m3 and dispersed at the effective stack height of 36.4m (Stack height 36.4m + Plume Height 4.0m) with

exit velocity of 9.46m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.8µg/m3 at 2km dispersion Oxides of Nitrogen is 3.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.541µg/m3 and the predominant wind direction is ESE.

k. Stack – 205F2

Stack – 205F2 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.44µg/m3 at 2km dispersion Carbon Monoxide is 0.92µg/m3 and at 5km dispersion Carbon Monoxide is 0.0667µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Particulate matter concentration is 24.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 5.49µg/m3 at 2km dispersion Particulate matter is 1.05µg/m3 and at 5km dispersion Particulate matter is 0.0132µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and

contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.65km at the concentration of 1.71µg/m3 at 2km dispersion Sulphur dioxide is 0.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.064µg/m3 and the predominant wind direction is ESE.

Stack – 205F2 emission of Oxides of Nitrogen concentration is 25.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 14.4m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 5.49µg/m3 at 2km dispersion Oxides of Nitrogen is 0.43µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0792µg/m3 and the predominant wind direction is ESE.

l. Stack – 206F1-F2

Stack – 206F1-F2 emission of Carbon Monoxide concentration is 23.0mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.0697µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Particulate matter concentration is 15.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 0.764µg/m3 at 1km dispersion

Particulate matter is 0.12µg/m3 and at 2km dispersion Particulate matter is 0.097µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Sulphur dioxide concentration is 259mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.934µg/m3 and at 5km dispersion Sulphur dioxide is 0.765µg/m3 and the predominant wind direction is ESE.

Stack – 206F1-F2 emission of Oxides of Nitrogen concentration is 217mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 6.28m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.9km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.875µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0522µg/m3 and the predominant wind direction is ESE.

m. Stack – 206F3-F6

Stack – 206F3-F6 emission of Carbon Monoxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 4.22µg/m3 at 2km dispersion Carbon Monoxide is 0.621µg/m3 and at 5km dispersion Carbon Monoxide is 0.022µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Sulphur dioxide concentration is 84.4mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 7.47µg/m3 at 2km dispersion Sulphur dioxide is 0.841µg/m3 and at 5km dispersion Sulphur dioxide is 0.0941µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Particulate matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 1.72µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.0567µg/m3 and the predominant wind direction is ESE.

Stack – 206F3-F6 emission of Oxides of Nitrogen concentration is 230mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 13.76m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 19.8µg/m3 at 2km dispersion Oxides of Nitrogen is 1.87µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.126µg/m3 and the predominant wind direction is ESE.

n. Stack – 207F1

Stack – 207F1 emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25^{o}C. All the

modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.793km at the concentration of 1.01µg/m3 at 2km dispersion Carbon Monoxide is 0.14µg/m3 and at 5km dispersion Carbon Monoxide is 0.0641µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Particulate matter concentration is 9.3mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.879km at the concentration of 0.725µg/m3 at 2km dispersion Particulate matter is 0.086µg/m3 and at 5km dispersion Particulate matter is 0.0043µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Oxides of Nitrogen concentration is 31mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 3.11µg/m3 at 2km dispersion Oxides of Nitrogen is 0.42µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0314µg/m3 and the predominant wind direction is ESE.

Stack – 207F1 emission of Sulphur dioxide concentration is 7.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 5m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.824km at the concentration of 0.561µg/m3 at 2km dispersion Sulphur dioxide is 0.0431µg/m3

and at 5km dispersion Sulphur dioxide is 0.00856µg/m3 and the predominant wind direction is ESE.

o. Stack 212F1

Stack – 212F1 emission of Carbon Monoxide concentration is 54mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.57km at the concentration of 4.731µg/m3 at 2km dispersion Carbon Monoxide is 0.681µg/m3 and at 5km dispersion Carbon Monoxide is 0.8654µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Particulate matter concentration is 8.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 0.802µg/m3 at 2km dispersion Particulate matter is 0.0766µg/m3 and at 5km dispersion Particulate matter is 0.00599µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Oxides of Nitrogen concentration is 27mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 3.01µg/m3 at 2km dispersion Oxides of Nitrogen is 1.03µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0929µg/m3 and the predominant wind direction is ESE.

Stack – 212F1 emission of Sulphur dioxide concentration is 47mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 6.3m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 4.09µg/m3 at 2km dispersion Sulphur dioxide is 0.261µg/m3 and at 5km dispersion Sulphur dioxide is 0.07867µg/m3 and the predominant wind direction is ESE.

p. Stack – Gas Turbine-1

Stack – Gas Turbine-1 emission of Carbon Monoxide concentration is 2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.61km at the concentration of 0.415µg/m3 at 2km dispersion Carbon Monoxide is 0.055µg/m3 and at 5km dispersion Carbon Monoxide is 0.0097µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-1 emission of Particulate Matter concentration is 28.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 0.415µg/m3 at 2km dispersion Particulate Matter is 0.0735µg/m3 and at 5km dispersion Particulate Matter is 0.0872µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-1 emission of Sulphur dioxide concentration is 12.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All

the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 2.59µg/m3 at 2km dispersion Sulphur dioxide is 0.71µg/m3 and at 5km dispersion Sulphur dioxide is 0.088µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-1 emission of Oxides of Nitrogen concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 2.39µg/m3 at 2km dispersion Oxides of Nitrogen is 0.13µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0955µg/m3 and the predominant wind direction is ESE.

q. Stack – Gas Turbine-2

Stack – Gas Turbine-2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 1.21µg/m3 at 2km dispersion Carbon Monoxide is 0.2µg/m3 and at 5km dispersion Carbon Monoxide is 0.0785µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-2 emission of Particulate Matter concentration is 22.2mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous

basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 4.42µg/m3 at 2km dispersion Particulate Matter is 0.24µg/m3 and at 5km dispersion Particulate Matter is 0.098µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-2 emission of Sulphur dioxide concentration is 10.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.11µg/m3 at 2km dispersion Sulphur dioxide is 0.865µg/m3 and at 5km dispersion Sulphur dioxide is 0.0351µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-2 emission of Oxides of Nitrogen concentration is 10mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.84m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.91µg/m3 at 2km dispersion Oxides of Nitrogen is 0.75µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0767µg/m3 and the predominant wind direction is ESE.

r. Stack – Gas Turbine-3

Stack – Gas Turbine-3 emission of Carbon Monoxide concentration is 8mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.07µg/m3 at 2km dispersion Carbon

Monoxide is 0.124µg/m3 and at 5km dispersion Carbon Monoxide is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-3 emission of Particulate Matter concentration is 26.9mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 3.6µg/m3 at 2km dispersion Particulate Matter is 0.97µg/m3 and at 5km dispersion Particulate Matter is 0.083µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-3 emission of Sulphur dioxide concentration is 15.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 2.07µg/m3 at 2km dispersion Sulphur dioxide is 0.85µg/m3 and at 5km dispersion Sulphur dioxide is 0.0963µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbine-3 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 10.05m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.777km at the concentration of 2.3µg/m3 at 2km dispersion Oxides of Nitrogen is 0.83µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0981µg/m3 and the predominant wind direction is ESE.

s. Stack – 207F102

Stack – 207F102 emission of Carbon Monoxide concentration is 17mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.84km at the concentration of 2.29µg/m3 at 2km dispersion Carbon Monoxide is 0.461µg/m3 and at 5km dispersion Carbon Monoxide is 0.0666µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Particulate Matter concentration is 15.6mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 2.06µg/m3 at 2km dispersion Particulate Matter is 0.7654µg/m3 and at 5km dispersion Particulate Matter is 0.0893µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Sulphur dioxide concentration is 437.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.19km at the concentration of 58.3µg/m3 at 2km dispersion Sulphur dioxide is 14.9µg/m3 and at 5km dispersion Sulphur dioxide is 0.98µg/m3 and the predominant wind direction is ESE.

Stack – 207F102 emission of Oxides of Nitrogen concentration is 167mg/m3 and dispersed at the effective stack height of 30m (Stack height 30m + Plume Height 3m) with exit velocity of 5.2m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis

with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 22.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.421µg/m3 and the predominant wind direction is ESE.

t. Stack – 207F201

Stack – 207F201 emission of Oxides of Nitrogen concentration is 8.9mg/m3 and dispersed at the effective stack height of 35m (Stack height 35m + Plume Height 3m) with exit velocity of 6.14m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Oxides of Nitrogen is 0.0654µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.00331µg/m3 and the predominant wind direction is ESE.

u. Stack – Boiler-1

Stack – Boiler-1 emission of Carbon Monoxide concentration is 40mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 0.764µg/m3 at 2km dispersion Carbon Monoxide is 0.086µg/m3 and at 5km dispersion Carbon Monoxide is 0.00713µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-1 emission of Particulate Matter concentration is 57.3mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis

with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 11µg/m3 at 2km dispersion Particulate Matter is 2.768µg/m3 and at 5km dispersion Particulate Matter is 0.64µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-1 emission of Sulphur dioxide concentration is 922.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.1m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.03km at the concentration of 177µg/m3 at 2km dispersion Sulphur dioxide is 34.5µg/m3 and at 5km dispersion Sulphur dioxide is 4.67µg/m3 and the predominant wind direction is ESE.

v. Stack – Boiler-3

Stack – Boiler-3 emission of Carbon Monoxide concentration is 28mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 5.41µg/m3 at 2km dispersion Carbon Monoxide is 0.77µg/m3 and at 5km dispersion Carbon Monoxide is 0.075µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Particulate Matter concentration is 60.5mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.89km at the concentration of 11.6µg/m3 at 2km dispersion

Particulate Matter is 2.21µg/m3 and at 5km dispersion Particulate Matter is 0.865µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Sulphur dioxide concentration is 998mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.34km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 1.89µg/m3 and at 5km dispersion Sulphur dioxide is 0.536µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-3 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.768km at the concentration of 52.2µg/m3 at 2km dispersion Oxides of Nitrogen is 18.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.1µg/m3 and the predominant wind direction is ESE.

w. Stack – Boiler-4

Stack – Boiler-4 emission of Carbon Monoxide concentration is 12mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 23.8µg/m3 at 2km dispersion Carbon Monoxide is 5.34µg/m3 and at 5km dispersion Carbon Monoxide is 0.984µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Particulate Matter concentration is 53mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.809km at the concentration of 105µg/m3 at 2km dispersion Particulate Matter is 39.5µg/m3 and at 5km dispersion Particulate Matter is 9.77µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Sulphur dioxide concentration is 943mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.07km at the concentration of 1868µg/m3 at 2km dispersion Sulphur dioxide is 454.78µg/m3 and at 5km dispersion Sulphur dioxide is 96.456µg/m3 and the predominant wind direction is ESE.

Stack – Boiler-4 emission of Oxides of Nitrogen concentration is 400mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 15.6m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.08km at the concentration of 792µg/m3 at 2km dispersion Oxides of Nitrogen is 98.7µg/m3 and at 5km dispersion Oxides of Nitrogen is 12.56µg/m3 and the predominant wind direction is ESE.

x. Stack – Gas Turbinee-4

Stack – Gas Turbinee-4 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the

modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 2.25µg/m3 at 2km dispersion Carbon Monoxide is 0.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.0678µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbinee-4 emission of Particulate Matter concentration is 17.4mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.55µg/m3 at 2km dispersion Particulate Matter is 0.9µg/m3 and at 5km dispersion Particulate Matter is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbinee-4 emission of Sulphur dioxide concentration is 5.1mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 3.55µg/m3 at 2km dispersion Sulphur dioxide is 0.86µg/m3 and at 5km dispersion Sulphur dioxide is 0.094µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbinee-4 emission of Oxides of Nitrogen concentration is 32mg/m3 and dispersed at the effective stack height of 100m (Stack height 100m + Plume Height 3m) with exit velocity of 14.9m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.794km at the concentration of 3.55µg/m3 at 2km dispersion Oxides of

Nitrogen is 0.85µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.09µg/m3 and the predominant wind direction is ESE.

Stack – Gas Turbinee-4 emission of Oxides of Nitrogen concentration is 71mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.67km at the concentration of 12.3µg/m3 at 2km dispersion Oxides of Nitrogen is 1.589µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.934µg/m3 and the predominant wind direction is ESE.

y. Stack – 86F1

Stack – 86F1 emission of Carbon Monoxide concentration is 11mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.867km at the concentration of 2.005µg/m3 at 2km dispersion Carbon Monoxide is 0.24µg/m3 and at 5km dispersion Carbon Monoxide is 0.0357µg/m3 and the predominant wind direction is ESE.

Stack – 86F1 emission of Oxides of Nitrogen concentration is 11mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0867km at the concentration of 2.005µg/m3 at 2km dispersion Oxides

of Nitrogen is 0.24µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0357µg/m3 and the predominant wind direction is ESE.

Stack – 86F1 emission of Particulate matter concentration is 8.6mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 3m) with exit velocity of 4.8m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.789km at the concentration of 1.52µg/m3 at 2km dispersion Particulate matter is 0.157µg/m3 and at 5km dispersion Particulate matter is 0.0681µg/m3 and the predominant wind direction is ESE.

z. Stack – 211F1

Stack – 211F1 emission of Carbon Monoxide concentration is 124mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.623km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.45µg/m3 and at 5km dispersion Carbon Monoxide is 0.456µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Particulate Matter concentration is 23.7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.83km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.2µg/m3 and at 5km dispersion Particulate Matter is 0.076µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Sulphur dioxide concentration is 49mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with

exit velocity of 5.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.931km at the concentration of 3.51µg/m3 at 2km dispersion Sulphur dioxide is 0.75µg/m3 and at 5km dispersion Sulphur dioxide is 0.0923µg/m3 and the predominant wind direction is ESE.

Stack – 211F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 5.5m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.97km at the concentration of 2.22µg/m3 at 2km dispersion Oxides of Nitrogen is 0.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0874µg/m3 and the predominant wind direction is ESE.

aa. Stack – 1F1B

Stack – 1F1B emission of Carbon Monoxide concentration is 13mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 8.94µg/m3 at 2km dispersion Carbon Monoxide is 1.74µg/m3 and at 5km dispersion Carbon Monoxide is 0.976µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Particulate Matter concentration is 22.9mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and

contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 1.68µg/m3 at 2km dispersion Particulate Matter is 0.43µg/m3 and at 5km dispersion Particulate Matter is 0.0618µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Sulphur dioxide concentration is 48.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 3.67µg/m3 at 2km dispersion Sulphur dioxide is 0.55µg/m3 and at 5km dispersion Sulphur dioxide is 0.0751µg/m3 and the predominant wind direction is ESE.

Stack – 1F1B emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 9.4m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 17.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.31µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.551µg/m3 and the predominant wind direction is ESE.

ab. Stack – 206F1

Stack – 206F1 emission of Particulate Matter concentration is 9.4mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 2.22µg/m3 at 2km dispersion

Particulate Matter is 0.59µg/m3 and at 5km dispersion Particulate Matter is 0.0823µg/m3 and the predominant wind direction is ESE.

Stack – 206F1 emission of Sulphur dioxide concentration is 212mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 5.73µg/m3 at 2km dispersion Sulphur dioxide is 0.356µg/m3 and at 5km dispersion Sulphur dioxide is 0.065µg/m3 and the predominant wind direction is ESE.

Stack – 206F1 emission of Oxides of Nitrogen concentration is 193mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 4m) with exit velocity of 5.66m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 5.19µg/m3 at 2km dispersion Oxides of Nitrogen is 0.86µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.0621µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Carbon Monoxide concentration is 6mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.79km at the concentration of 0.153µg/m3 at 2km dispersion Carbon Monoxide is 0.098µg/m3 and at 5km dispersion Carbon Monoxide is 0.0113µg/m3 and the predominant wind direction is ESE.

ac.Stack – 206F2

Stack – 206F2 emission of Particulate Matter concentration is 9.8mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.93km at the concentration of 0.229µg/m3 at 2km dispersion Particulate Matter is 0.0976µg/m3 and at 5km dispersion Particulate Matter is 0.0034µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Sulphur dioxide concentration is 289mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.99km at the concentration of 7.79µg/m3 at 2km dispersion Sulphur dioxide is 0.751µg/m3 and at 5km dispersion Sulphur dioxide is 0.0134µg/m3 and the predominant wind direction is ESE.

Stack – 206F2 emission of Oxides of Nitrogen concentration is 272mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4m) with exit velocity of 5.0m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.82km at the concentration of 7.33µg/m3 at 2km dispersion Oxides of Nitrogen is 1.56µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.75µg/m3 and the predominant wind direction is ESE.

ad. Stack – 214F1

Stack – 214F1 emission of Carbon Monoxide concentration is 7mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the

modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 1.99µg/m3 at 2km dispersion Carbon Monoxide is 0.12µg/m3 and at 5km dispersion Carbon Monoxide is 0.0431µg/m3 and the predominant wind direction is ESE.

Stack – 214F1 emission of Particulate Matter concentration is 9.1mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 2.29µg/m3 at 2km dispersion Particulate Matter is 0.787µg/m3 and at 5km dispersion Particulate Matter is 0.011µg/m3 and the predominant wind direction is ESE.

Stack – 214F1 emission of Oxides of Nitrogen concentration is 29mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 3m) with exit velocity of 21.58m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.85km at the concentration of 2.21µg/m3 at 2km dispersion Oxides of Nitrogen is 2.21µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.97µg/m3 and the predominant wind direction is ESE.

ae. Stack – 1F3

Stack – 1F3 emission of Particulate Matter concentration is 18.2mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis

with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 1.53µg/m3 at 2km dispersion Particulate Matter is 0.53µg/m3 and at 5km dispersion Particulate Matter is 0.017µg/m3 and the predominant wind direction is ESE.

Stack – 1F3 emission of Sulphur dioxide concentration is 222.9mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 15.7µg/m3 at 2km dispersion Sulphur dioxide is 1.876µg/m3 and at 5km dispersion Sulphur dioxide is 0.592µg/m3 and the predominant wind direction is ESE.

Stack – 1F3 emission of Oxides of Nitrogen concentration is 191mg/m3 and dispersed at the effective stack height of 40m (Stack height 40m + Plume Height 3m) with exit velocity of 11.46m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.96km at the concentration of 13.1µg/m3 at 2km dispersion Oxides of Nitrogen is 2.88µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.813µg/m3 and the predominant wind direction is ESE.

af. Stack - 1F1A East

Stack - 1F1A East emission of Particulate matter concentration is 14.5mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.874km at the concentration of 1.05µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A East emission of Sulphur dioxide concentration is 164mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.832km at the concentration of 2.09µg/m3 at 2km dispersion Sulphur dioxide is 0.27µg/m3 and at 5km dispersion Sulphur dioxide is 0.076µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A East emission of Oxides of Nitrogen concentration is 125mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.02m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 12.6µg/m3 at 2km dispersion Oxides of Nitrogen is 2.18µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.896µg/m3 and the predominant wind direction is ESE.

ag. Stack - 1F1A WEST

Stack - 1F1A west emission of Carbon Monoxide concentration is 56mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.877km at the concentration of 16.4µg/m3 at 2km dispersion Carbon Monoxide is 1.87µg/m3 and at 5km dispersion Carbon Monoxide is 0.977µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Particulate matter concentration is 12.4mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature,

and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.911km at the concentration of 2.81µg/m3 at 2km dispersion Particulate matter is 0.111µg/m3 and at 5km dispersion Particulate matter is 0.0552µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Sulphur dioxide concentration is 149mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 43.7µg/m3 at 2km dispersion Sulphur dioxide is 21.2µg/m3 and at 5km dispersion Sulphur dioxide is 17.76µg/m3 and the predominant wind direction is ESE.

Stack - 1F1A west emission of Oxides of Nitrogen concentration is 101mg/m3 and dispersed at the effective stack height of 63.4m (Stack height 63.4m + Plume Height 3.0m) with exit velocity of 8.51m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.721km at the concentration of 3.67µg/m3 at 2km dispersion Oxides of Nitrogen is 0.41µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.075µg/m3 and the predominant wind direction is ESE.

ah. Stack - 10F101

Stack - 10F101 emission of Carbon Monoxide concentration is 111mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 16.9µg/m3 at 2km dispersion Carbon

Monoxide is 5.323µg/m3 and at 5km dispersion Carbon Monoxide is 0.927µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Particulate matter concentration is 19.1mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 4.08µg/m3 at 2km dispersion Particulate matter is 1.11µg/m3 and at 5km dispersion Particulate matter is 0.534µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Sulphur dioxide concentration is 40.8mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.78km at the concentration of 46.29µg/m3 at 2km dispersion Sulphur dioxide is 18.21µg/m3 and at 5km dispersion Sulphur dioxide is 8.11µg/m3 and the predominant wind direction is ESE.

Stack - 10F101 emission of Oxides of Nitrogen concentration is 232mg/m3 and dispersed at the effective stack height of 42.7m (Stack height 42.7m + Plume Height 5.0m) with exit velocity of 9.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 35.3µg/m3 at 2km dispersion Oxides of Nitrogen is 15.16µg/m3 and at 5km dispersion Oxides of Nitrogen is 6.61µg/m3 and the predominant wind direction is ESE.

ai.Stack - 71F1

Stack - 71F1 emission of Carbon Monoxide concentration is 143mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.75km at the concentration of 41.8µg/m3 at 2km dispersion Carbon Monoxide is 12.78µg/m3 and at 5km dispersion Carbon Monoxide is 2.412µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Particulate matter concentration is 29.7mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 8.58µg/m3 at 2km dispersion Particulate matter is 1.65µg/m3 and at 5km dispersion Particulate matter is 0.823µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Sulphur dioxide concentration is 157.3mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 16.4µg/m3 at 2km dispersion Sulphur dioxide is 4.44µg/m3 and at 5km dispersion Sulphur dioxide is 0.76µg/m3 and the predominant wind direction is ESE.

Stack - 71F1 emission of Oxides of Nitrogen concentration is 335mg/m3 and dispersed at the effective stack height of 45.82m (Stack height 45.82m + Plume Height 4.0m) with exit velocity of 7.79m/sec and the flue gas temperature are 25oC. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous

basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.98km at the concentration of 97.09µg/m3 at 2km dispersion Oxides of Nitrogen is 38.91µg/m3 and at 5km dispersion Oxides of Nitrogen is 24.11µg/m3 and the predominant wind direction is ESE.

aj. Stack - 73F101

Stack - 73F101 emission of Carbon Monoxide concentration is 135mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.68km at the concentration of 14.7µg/m3 at 2km dispersion Carbon Monoxide is 3.67µg/m3 and at 5km dispersion Carbon Monoxide is 0.781µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Particulate matter concentration is 27mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 2.96µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.075µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Sulphur dioxide concentration is 51mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.88km at the concentration of 3.16µg/m3 at 2km dispersion Sulphur

dioxide is 1.45µg/m3 and at 5km dispersion Sulphur dioxide is 0.86µg/m3 and the predominant wind direction is ESE.

Stack - 73F101 emission of Oxides of Nitrogen concentration is 94mg/m3 and dispersed at the effective stack height of 53.38m (Stack height 53.38m + Plume Height 4.0m) with exit velocity of 7.95m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 10.2µg/m3 at 2km dispersion Oxides of Nitrogen is 2.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.64µg/m3 and the predominant wind direction is ESE.

ak. Stack - 73F102

Stack - 73F102 emission of Carbon Monoxide concentration is 15mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.66km at the concentration of 1.64µg/m3 at 2km dispersion Carbon Monoxide is 0.86µg/m3 and at 5km dispersion Carbon Monoxide is 0.0578µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Particulate matter concentration is 15.3mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.71km at the concentration of 1.74µg/m3 at 2km dispersion Particulate matter is 0.534µg/m3 and at 5km dispersion Particulate matter is 0.087µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Sulphur dioxide concentration is 10mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.12µg/m3 at 2km dispersion Sulphur dioxide is 0.565µg/m3 and at 5km dispersion Sulphur dioxide is 0.089µg/m3 and the predominant wind direction is ESE.

Stack - 73F102 emission of Oxides of Nitrogen concentration is 16mg/m3 and dispersed at the effective stack height of 48.85m (Stack height 48.85m + Plume Height 3.0m) with exit velocity of 6.8m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.7km at the concentration of 1.74µg/m3 at 2km dispersion Oxides of Nitrogen is 0.98µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.11µg/m3 and the predominant wind direction is ESE.

al.Stack - 76F11

Stack - 76F11 emission of Carbon Monoxide concentration is 152mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.76km at the concentration of 47.44µg/m3 at 2km dispersion Carbon Monoxide is 8.86µg/m3 and at 5km dispersion Carbon Monoxide is 1.32µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Particulate matter concentration is 33.1mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are

25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.87km at the concentration of 10.3µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.076µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Sulphur dioxide concentration is 20.6mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.95km at the concentration of 6.44µg/m3 at 2km dispersion Sulphur dioxide is 0.97µg/m3 and at 5km dispersion Sulphur dioxide is 0.0318µg/m3 and the predominant wind direction is ESE.

Stack - 76F11 emission of Oxides of Nitrogen concentration is 33mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 4.0m) with exit velocity of 30.7m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.86km at the concentration of 10.3µg/m3 at 2km dispersion Oxides of Nitrogen is 2.25µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.341µg/m3 and the predominant wind direction is ESE.

am. Stack - 77F1

Stack - 77F1 emission of Carbon Monoxide concentration is 31mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis

with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 1.33µg/m3 at 2km dispersion Carbon Monoxide is 0.123µg/m3 and at 5km dispersion Carbon Monoxide is 0.057µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Particulate matter concentration is 18.4mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.77km at the concentration of 1.54µg/m3 at 2km dispersion Particulate matter is 0.65µg/m3 and at 5km dispersion Particulate matter is 0.033µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Sulphur dioxide concentration is 21mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.81km at the concentration of 10.4µg/m3 at 2km dispersion Sulphur dioxide is 1.99µg/m3 and at 5km dispersion Sulphur dioxide is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 77F1 emission of Oxides of Nitrogen concentration is 21mg/m3 and dispersed at the effective stack height of 49.25m (Stack height 49.25m + Plume Height 5.0m) with exit velocity of 10.21m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.745km at the concentration of 2.77µg/m3 at 2km dispersion Oxides of Nitrogen is 0.752µg/m3 and at 5km dispersion Oxides of Nitrogen is 0.011µg/m3 and the predominant wind direction is ESE.

an. Stack - 205F1

Stack - 205F1 emission of Carbon Monoxide concentration is 136mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.736km at the concentration of 89.1µg/m3 at 2km dispersion Carbon Monoxide is 7.731µg/m3 and at 5km dispersion Carbon Monoxide is 0.8966µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Particulate matter concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 1.32µg/m3 at 2km dispersion Particulate matter is 0.54µg/m3 and at 5km dispersion Particulate matter is 0.0865µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Oxides of Nitrogen concentration is 55mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 1.01km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 16.1µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.58µg/m3 and the predominant wind direction is ESE.

Stack - 205F1 emission of Sulphur dioxide concentration is 16.2mg/m3 and dispersed at the effective stack height of 60m (Stack height 60m + Plume Height 4.0m) with exit velocity of 5.93m/sec and the flue gas temperature are 25°C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and

contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.977km at the concentration of 11.8µg/m3 at 2km dispersion Sulphur dioxide is 0.462µg/m3 and at 5km dispersion Sulphur dioxide is 0.0756µg/m3 and the predominant wind direction is ESE.

ao. Stack - 201F1&F2

Stack - 201F1&F2 emission of Carbon Monoxide concentration is 180mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.8km at the concentration of 8.72µg/m3 at 2km dispersion Carbon Monoxide is 0.96µg/m3 and at 5km dispersion Carbon Monoxide is 0.078µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2 emission of Particulate matter concentration is 14.4mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.69km at the concentration of 1.33µg/m3 at 2km dispersion Particulate matter is 0.89µg/m3 and at 5km dispersion Particulate matter is 0.022µg/m3 and the predominant wind direction is ESE.

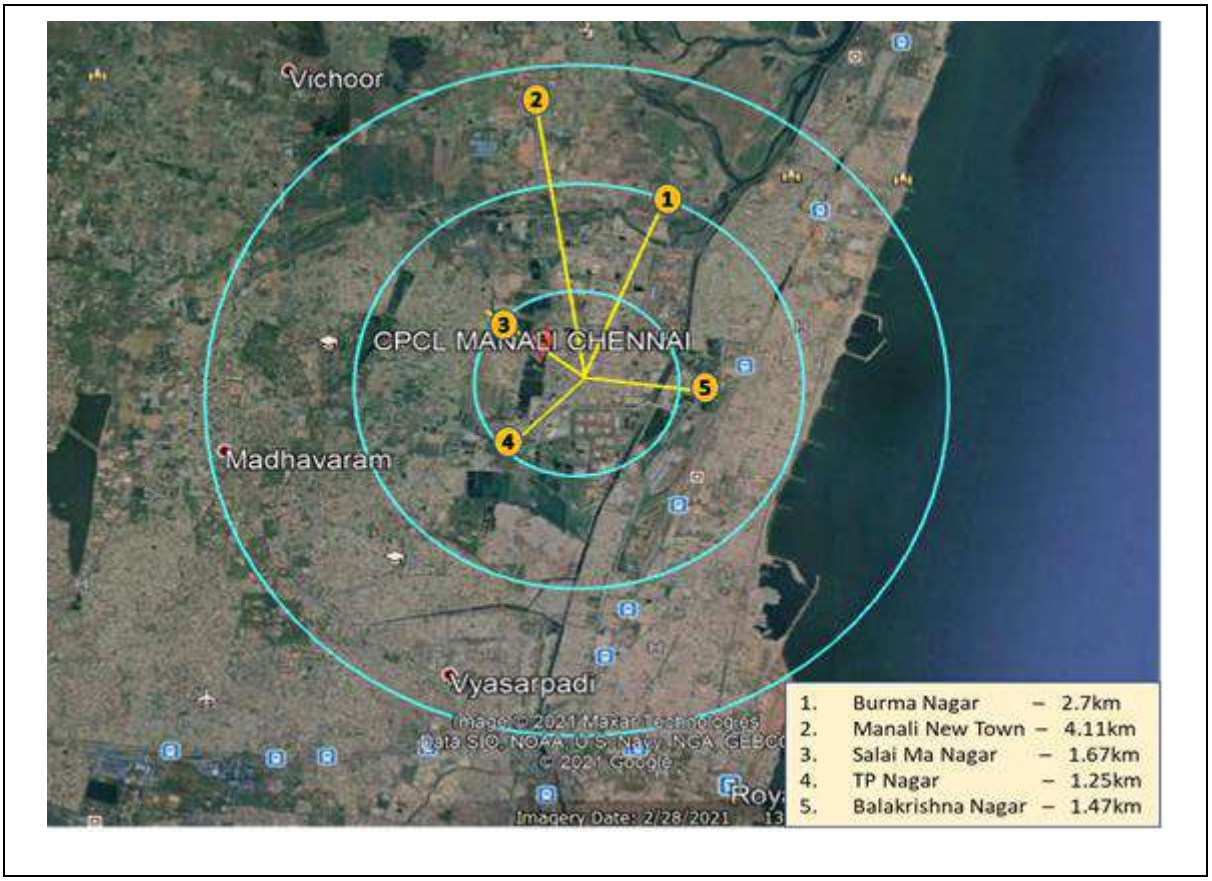
Stack - 201F1&F2 emission of Sulphur dioxide concentration is 367mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.91km at the concentration of 49.12µg/m3 at 2km dispersion Sulphur

dioxide is 8.79µg/m3 and at 5km dispersion Sulphur dioxide is 0.97µg/m3 and the predominant wind direction is ESE.

Stack - 201F1&F2 emission of Oxides of Nitrogen concentration is 239mg/m3 and dispersed at the effective stack height of 70m (Stack height 70m + Plume Height 5.0m) with exit velocity of 18.5m/sec and the flue gas temperature are 25^{o}C. All the modelling parameters are considered like location, base elevation, stack height, stack diameter, stack gas exit velocity, stack gas exit temperature, and contaminant emission rate. These stacks typically operate on a continuous basis with relatively emission rates. Based on the dispersion parameters the GLC reached at 0.73km at the concentration of 58.9µg/m3 at 2km dispersion Oxides of Nitrogen is 19.96µg/m3 and at 5km dispersion Oxides of Nitrogen is 4.11µg/m3 and the predominant wind direction is ESE.

(iii) Overall Conclusion on Source Dispersion Modelling:

The source dispersion modelling output results showed the pollutants contribution from CPCL – Manali specific to Particulate Matter to nearby villages are minimum and the environmental and health impacts are well below within the limit of National Ambient Air Quality standards and OSHA / ACGIH occupational exposure limit values but the combined concentration for Nitrogen Dioxide and Sulfur Dioxide is exceeding the NAAQM standards and there is no further carrying capacity for these two parameters in manali industrial area available. The CPCL – Manali plant is surrounded by residential areas like 1.Burma Nagar, 2.Manali New Town, 3.Salai Ma Nagar, 4.Thanthai Periyar Nagar and 5.Balakrishna Nagar. From CPCL to Burma Nagar aerial distance is 2.7km, to Manali New Town is 4.11km, to Salai Ma Nagar is 1.67km, to Thanthai Periyar Nagar is 1.25km and to Balakrishna Nagar is 1.47km.



The combined particulate matter emissions of all stacks from CPCL – Manali is 799.8 mg/m3. The average ground level concentration achieves at an average distance of 1.01km and the sum of PM concentration at GLC is 135 µg/m3 which includes all the stacks at CPCL – Manali. The total particulate matter emissions reached at 1.01km at the concentration of 135 µg/m3 which is more than NAAQM specification standard. But most of the residential areas are in the distance between 1.25 to 4km and more. It clearly indicates the PM10 and PM2.5 contribution to the nearby communities are minimum since the residential areas are more than 1.25km radius from the CPCL plant centre and it is below the National Ambient Air Quality Standards.

The combined Sulphur Dioxide emissions from CPCL – Manali through stacks is 6300mg/m^3. The average ground level concentration achieves at an average distance of 0.98km and the sum of Sulphur Dioxide concentration at GLC is 1064 µg/m^3 which includes all the stacks at CPCL – Manali. It clearly indicates the SO_2 contribution to the nearby communities and Manali industrial area are exceeding the National Ambient Air Quality Standards (80 µg/m^3) up to 2km radius and more than 2km radius is below the NAAQM standards. The carrying capacity within 2km

radius of CPCL is not available pertaining to SO2 since the maximum ground level concentration is exceeding 13.3 times of NAAQM standards.

The combined Nitrogen Oxides emissions from CPCL – Manali through stacks is 6910 mg/m3. The average ground level concentration achieves at an average distance of 1.01km and the sum of Nitrogen Oxides concentration at GLC is 1167 µg/m3 which includes all the stacks at CPCL – Manali. It clearly indicates the NO_2 contribution to the nearby communities and Manali industrial area are exceeding the National Ambient Air Quality Standards (80 µg/m^3) up to 2km radius and more than 2km radius is below the NAAQM standards. The carrying capacity within 2km radius of CPCL is not available pertaining to NO2 since the maximum ground level concentration is exceeding 14.6 times of NAAQM standards.

The cumulative Carbon monoxide emissions from CPCL – Manali through stacks is 2835mg/m3. The average ground level concentration achieves at an average distance of 0.98km and the sum of Carbon Monoxide concentration at GLC is 478 µg/m3 which includes all the stacks at CPCL – Manali. It clearly indicates the CO contribution to the nearby communities and Manali industrial area are minimum and it is well below within the National Ambient Air Quality Standards (2000 µg/m^3). The carrying capacity of CO in CPCL available since the maximum ground level concentration is below 4.2 times of NAAQM standards.

Predicted concentrations were not exceed the National ambient air quality standard for PM and CO. Results from AERMOD simulation indicated that PM and CO emissions from the CPCL had no significant impact on nearby communities and Manali Industrial complex. But for the predicted concentrations of SO2 and NO2 were exceeding the NAAQM standard and the results from AERMOD simulation indicated that these emissions from the CPCL had significant impact on nearby communities and Manali Industrial complex.

The overall combined source mass emission load of PM is 2291kg/day and the maximum ground level concentration is 275µg/m^{3-}which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 2.7 times. Whereas the communities are in the distance of more than 1.25km to 4.11km whereas the GLC at 0.85km. At 2.0km the GLC of PM concentration is 77.4 µg/m^3 which is below the ambient air quality standards and having the carrying capacity around 1.03 times.

The overall combined source mass emission load of NOx is 16042kg/day and the maximum ground level concentration is 1489µg/m^{3-}which is above the ambient air

quality standards and not having the carrying capacity and exceedingly around 18.61 times. Whereas the communities are in the distance of more than 1.25km to 4.11km whereas the GLC at 0.85km. At 2.0km the GLC of NOx concentration is 276 $\mu g/m^3$ which is also above the ambient air quality standards and not having the carrying capacity.

The overall combined source mass emission load of SO2 is 30542kg/day and the maximum ground level concentration is 2422$\mu g/m^{3-}$which is above the ambient air quality standards and not having the carrying capacity and exceedingly around 30.3 times. Whereas the communities are in the distance of more than 1.25km to 4.11km whereas the GLC at 0.85km. At 2.0km the GLC of NOx concentration is 583 $\mu g/m^3$ which is also above the ambient air quality standards and not having the carrying capacity.

The overall combined source mass emission load of CO is 4362kg/day and the maximum ground level concentration is 426$\mu g/m^{3-}$which is below the ambient air quality standards and having the enough carrying capacity and available around 4.7 times.

The overall combined source mass emission load of SO2 and NO_2 with the maximum ground level concentrations are exceeding the national ambient air quality standards and carrying capacity for these two parameters is not further available in nearby communities and Manali industrial area pertaining to this industry source emission load.

CONCLUSION ON ENVIORNMENTAL MONITORING AND CARRYING CAPACITY AT MANALI INDUSTRIAL AREA:

Environmental systems integrated with air pollutant monitoring and atmospheric dispersion models is being used to obtain a good representation of concentration patterns in a Manali area. As for this purpose, AERMOD has been widely used for evaluation of impact of emission sources to the level of air pollutants. The AERMOD modelling system for environmental impact assessment of NO2, SO2, PM and CO emissions from Petrochemical and Fertilizer industries in Manali Industrial complex. The Simulated values of SO2, NO2, PM and CO concentrations were compared with those obtained from measurements. It was found that, the quantile-quantile plot of concentrations is not fit because always the predicted concentrations are high than the actual ambient air quality measurement values.

AERMOD is a regulatory dispersion model of U.S. Environmental Protection Agency. It has been widely used for environmental impact assessment purpose. AERMOD system consists of three main processors: AERMAP as the terrain processor, AERMET as the meteorological processor, and AERMOD as the main dispersion model processor. The AERMOD system is considered accurate for dispersion modelling at distances not exceeding 50 km from the emission source. In this study, dispersion of PM, SO2, NO2 and CO were modelled to evaluate their maximum ground level concentrations in the Manali industrial area. Statistical analysis was employed to determine performance of the model in predicting overall concentrations and extreme high-end concentrations.

It should be noted that spatial distributions of annual concentration of SO2 and NO2 were also relevant to wind characteristics in the study area. During the dry season (November - March), this area is governed by the north east wind. However, in the wet season (April - October), the south west wind plays as the dominant wind direction. Therefore, it was found from model simulation that mostly of air pollutants were transported to the north and northeast directions from emission sources.

This study is aimed to evaluate ground level concentrations of Particulate Matter (PM10 & PM2.5), Sulfur Dioxide (SO2), Nitrogen Dioxide (NO2) and Carbon Monoxide (CO) emitted from factories in Manali Industrial complex and that too specific to Tamil Nadu Petroproducts Ltd, Manali Petroproducts Ltd, Chennai Petroleum Corporation Ltd and Manali Fertilizers Ltd based on Honourable NGT order. Contributions of each factory to the maximum ground level concentration are analysed. These findings will be useful in prioritization of appropriate mitigation

measures to control and bring down the emissions to achieve the require carrying capacity in Manali Industrial area.

The model had done for only pre-monsoon and found the maximum ground level concentration is exceeded with the National ambient air quality standards and it will be still worse in other two seasons. So that the study is limited to pre-monsoon only.

Contribution of those four industries to the concentrations of PM, SO2 and NO2 were larger than the power plants (NTECL & NCTPS-1) located far away (more than 5km) from Manali industrial area and even though their emissions were almost 10 times lower than emissions of power plants. This could be because of heights of stacks of the power plants are much taller than petrochemical plants. These characteristics enhanced the dilution abilities of emissions from power plant and reducing concentrations of air pollutants at the ground surface level. Transportation of plume emitted from the power plants probably might not reach the ground level within the modelling domain because it may travel to the longer distant than the study area prior reaching the ground.

In order to evaluate the influence of power plants to the ground level concentrations, AERMOD was also simulated to acquire the maximum concentration of PM, SO_2 and NO_2 in the study area. For NCTPS – 1 model results indicated that the maximum ground level concentration of SO_2 is 79.1µg/m^3 & 86.4 µg/m^3 at a GLC distance of 1.99km, NOx is 20µg/m^3 & 25 µg/m^3 at a GLC distance of 2.10km and PM is 173 µg/m^3 & 56.7 µg/m^3 at a GLC distance of 2.2km. For NCTPS – 2 model results indicated that the maximum ground level concentration of SO_2 is 70.0µg/m^3 & 48.8 µg/m^3 at a GLC distance of 2.1km, NOx is 67.3µg/m^3 & 48.8 µg/m^3 at a GLC distance of 2.0km and PM is 117µg/m^3 & 173µg/m^3 at a GLC distance of 2.0km. For NTECL model results indicated that the maximum ground level concentration of SO_2 is 43.4 µg/m^3, 60.0µg/m^3 & 63.4 µg/m^3 at a GLC distance of 1.7km, NOx is 10.3 µg/m^3, 13.9µg/m^3 & 14.4µg/m^3 at a GLC distance of 1.7km and PM is 1.18 µg/m^3, 1.12 µg/m^3 & 1.15µg/m^3 at a GLC distance of 1.9km.These predicted values are much lower than the National ambient air quality standards and contribution of these power plant sources are negligible to Manali industrial area.

Predicted concentrations were not exceed the National ambient air quality standard for PM, SO2, NO2 and CO as individual point source emissions. The combined source emission results from AERMOD simulation indicated that PM, SO2, NO2 and CO emissions from the TPL PO division, TPL HCD division, TPL Lab

division, MPL Unit-1 & 2 and MFL had no significant impact on nearby communities and Manali Industrial complex. Specific to MFL Fertilizer industry the Ammonia source emission results based on the AERMOD simulation had no significant impact on nearby communities and Manali Industrial complex. The combined ground level concentration of each individual industry mentioned above are complying with National ambient air quality standards and had much carrying capacity for PM, SO2, NO2 and CO.

Predicted concentrations were not exceeded the National ambient air quality standard for PM and CO as individual point source emissions at CPCL, Manali. The combined source emission results from AERMOD simulation indicated that PM and CO emissions from CPCL had no significant impact on nearby communities and Manali Industrial complex. But for the combined source emission results from AERMOD simulation indicated that SO2 and NO2 emissions from CPCL had significant impact on nearby communities and Manali Industrial complex. The combined source emissions results from AERMOD are exceeding the National ambient air quality standards and there is no further carrying capacity specific to SO2 and NO2 in Manali Industrial complex.

The overall combined source mass emission load of PM is 3654.62kg/day for which the combined maximum ground level concentration is 497.3µg/m3 and exceeding the NAAQMS standards for about 5 times. The carrying capacity of particulate matter pertaining to these four industries is not available at Manali industrial area for the pre-monsoon study period and this will still higher in winter period.

The overall combined source mass emission load of NOx (considering 100% conversion of NO2) is 22939kg/day for which the combined maximum ground level concentration is 2424µg/m3 and exceeding the NAAQMS standards for about 30 times. The carrying capacity of Nitrogen Dioxide pertaining to these four industries is not available at Manali industrial area for the pre-monsoon study period and this will still higher in winter period.

The overall combined source mass emission load of SO2 is 33607kg/day for which the combined maximum ground level concentration is 2914µg/m3 and exceeding the NAAQMS standards for about 36 times. The carrying capacity of Sulfur Dioxide pertaining to these four industries is not available at Manali industrial area for the pre-monsoon study period and this will still higher in winter period.

Results from this analysis revealed that in order to manage SO2 and NO2 pollution in the industrial area controlling of emission from Refinery should be given the first

priority. Intermittent control scheme can be applied to intensive controlling of emissions from refinery.

NITROGEN OXIDES MASS EMISSION LOAD AND DISPERSION FROM MANALI INDUSTRIAL AREA PERTAINING TO FOUR INDUSTRIES

Company Name	Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)	Flow rate (Nm3/Hr)	Emission load kg/day
GPCL	14F1	NOX	356	0.85	20.5	3.28	0.776	20667	171.48
GPCL	14F101	NOX	331	0.75	20.8	2.78	0.892	21669	172.14
GPCL	15F1A	NOX	12.4	0.8	36.2	2.56	0.782	95678	28.47
GPCL	15F1B	NOX	172	0.89	13.4	4.56	1.11	44656	184.34
GPCL	15F2A	NOX	326	0.87	14.9	5.95	3.32	27760	203.80
GPCL	15F2B	NOX	192	0.888	15.7	2.2254	0.987	36747	169.23
GPCL	16F1	NOX	408	0.83	56.2	10.11	1.47	63804	624.77
GPCL	16F3	NOX	45	0.81	5.52	1.789	0.809	59179	61.07
GPCL	9F201	NOX	421	0.88	29.2	2.89	0.35	32147	324.81
GPCL	9F301	NOX	405	0.68	14.8	3.76	0.541	16143	164.66
GPCL	205F2	NOX	25	0.88	5.48	0.42	0.0792	88556	53.13
GPCL	206F1-F3	NOX	217	0.9	2.28	0.875	0.0522	29911	155.78
GPCL	206F3-F6	NOX	230	0.8	19.8	1.87	0.126	64247	354.84
GPCL	207F1	NOX	31	0.77	3.11	0.42	0.0314	28758	21.37
GPCL	212 F1	NOX	27	0.86	3.01	1.03	0.0929	39245	25.43
GPCL	Gas Turbin-1	NOX	12	0.83	2.28	0.12	0.0958	69012	19.88
GPCL	Gas Turbin-2	NOX	10	0.78	1.91	0.75	0.0767	69812	16.75
GPCL	Gas Turbin-3	NOX	16	0.777	2.3	0.83	0.0981	62807	24.12
GPCL	207F102	NOX	167	0.98	22.2	2.86	0.421	28758	115.10
GPCL	207F201	NOX	8.9	0.98	0.764	0.0654	0.00331	34932	7.33
GPCL	Boiler-3	NOX	272	0.768	52.2	10.14	4.1	91580	997.83
GPCL	Boiler-4	NOX	400	1.08	790	98.7	12.56	910556	8962.14
GPCL	Gas Turbine-4	NOX	32	0.794	3.55	0.85	0.09	96150	73.84
GPCL	86F1	NOX	71	0.67	12.3	1.569	0.954	81421	138.74
GPCL	211F1	NOX	29	0.97	2.22	0.21	0.0824	33999	23.66
GPCL	1F1B	NOX	232	0.8	17.1	2.21	0.351	34829	193.93
GPCL	206F1	NOX	193	0.98	5.19	0.86	0.0621	12714	58.89
GPCL	206F2	NOX	272	0.82	7.23	1.56	0.75	24413	159.37
GPCL	214F1	NOX	29	0.85	8.33	2.21	0.97	134818	93.83
GPCL	1F3	NOX	191	0.96	13.1	2.88	0.813	32148	147.37
GPCL	1F1A EAST	NOX	125	0.87	12.6	2.10	0.896	57896	291.29
GPCL	1F1A WEST	NOX	101	0.721	3.67	0.41	0.075	180104	242.88
GPCL	30F101	NOX	332	0.77	35.3	15.16	6.61	18099	100.78
GPCL	71F1	NOX	335	0.98	97.99	38.91	24.11	14932	120.05
GPCL	73F101	NOX	94	0.77	19.2	2.1	0.64	38271	86.14
GPCL	73F102	NOX	16	0.7	1.24	0.98	0.11	27144	14.26
GPCL	76F11	NOX	33	0.86	10.3	2.25	0.349	109900	87.04
GPCL	77F1	NOX	60	0.745	2.27	0.752	0.011	14932	21.58
GPCL	209F1	NOX	55	1.01	58.9	16.1	4.58	33448	44.15
GPCL	201F1&F2	NOX	239	0.73	58.9	19.96	6.11	293962	1686.28
MFL	Utility Boiler 1 & 2	NOx	54	0.87	49.12	5.1	0.786	284018	342.16
MFL	110 ATA Boiler	NOx	293	0.91	746	34	0.99	811362	5705.50
MFL-1	16 ton Boiler	NOx	47.9	0.77	4.46	0.373	0.0908	11713	13.47
MFL-2	16 TON Boiler	NOx	744	0.82	58.9	1.344	0.0456	18687	333.68
TPLHCD	Boiler	NOX	212	0.78	27.8	0.876	0.00777	41955	213.47
TPL - LAB DIVISION	CPP	NOx	458	1.07	45.24	1.11	0.545	24889	273.58
TPL - LAB DIVISION	Hot Oil Heater	NOx	3	0.79	2.73	0.167	0.0341	284487	14.72
								TOTAL	21939.13

SULFUR DIOXIDE MASS EMISSION LOAD AND DISPERSION FROM MANALI INDUSTRIAL AREA PERTAINING TO FOUR INDUSTRIES

Company Name	Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (ug/m3)	Average concentration at 2 km (ug/m3)	Average concentration at 3 km (ug/m3)	Flow rate (Nm3/Hr)	Emission load kg/day
CPCL	14F1	SO2	116	0.78	6.73	1.23	0.76	23067	55.87
CPCL	14F101	SO2	42	0.831	2.005	0.211	0.0856	21669	21.84
CPCL	15F1A	SO2	79	0.81	12.9	2.22	0.49	99678	174.52
CPCL	15F1B	SO2	59	0.7	4.583	0.78	0.0753	44656	63.23
CPCL	15F2A	SO2	61	0.82	2.95	0.62	0.0736	27750	40.63
CPCL	15F2B	SO2	187	0.8657	15.3	0.987	0.0467	36747	164.92
CPCL	16F1	SO2	59	0.83	2.48	0.655	0.072	63804	90.35
CPCL	16F3	SO2	10	0.869	1.36	0.19	0.0461	59179	14.20
CPCL	9F201	SO2	41	0.982	2.97	0.666	0.0231	32147	31.63
CPCL	9F101	SO2	71	0.73	2.49	0.44	0.0625	16143	27.51
CPCL	206F2	SO2	7.7	0.65	1.71	0.89	0.064	88556	16.37
CPCL	206F1-F2	SO2	259	0.81	2.11	0.934	0.765	29911	185.93
CPCL	206F3-F6	SO2	84.4	0.87	7.47	0.041	0.0941	64247	130.14
CPCL	207 F1	SO2	7.7	0.824	0.561	0.0431	0.00856	28718	5.31
CPCL	212 F1	SO2	47	0.91	4.09	0.361	0.07867	39245	46.27
CPCL	Gas Turbin-1	SO2	12.9	0.69	2.59	0.71	0.088	69013	21.37
CPCL	Gas Turbin-2	SO2	10.3	0.91	2.11	0.065	0.0351	69812	17.26
CPCL	Gas Turbin-3	SO2	15.4	0.8	2.07	0.85	0.0963	62807	23.21
CPCL	207F100	SO2	437.3	1.15	58.3	14.9	3.98	38718	361.60
CPCL	Boiler 1	SO2	922.4	1.03	177	34.5	4.67	90370	2000.57
CPCL	Boiler 3	SO2	998	1.34	11.8	1.89	0.536	91580	2195.52
CPCL	Boiler 4	SO2	943	1.07	1868	464.78	96.456	933556	21120.24
CPCL	Gas Turbine-4	SO2	5.1	0.95	3.55	0.86	0.094	95150	11.77
CPCL	211F1	SO2	49	0.931	3.91	0.79	0.0923	33999	39.98
CPCL	9F1B	SO2	48.8	0.76	3.67	0.55	0.0751	34829	40.79
CPCL	206F1	SO2	212	0.87	5.73	0.356	0.065	12714	64.69
CPCL	206F2	SO2	289	0.99	7.79	0.751	0.0134	24413	169.33
CPCL	1F3	SO2	222.9	0.81	15.7	1.076	0.592	32148	171.98
CPCL	1F1A EAST	SO2	184	0.833	2.09	0.27	0.076	97096	382.17
CPCL	1F1A	SO2	149	0.81	43.7	21.2	17.76	32148	114.96
CPCL	18F101	SO2	40.8	0.78	46.29	18.21	8.11	18099	17.72
CPCL	71F1	SO2	157.3	0.66	16.4	4.44	3.76	14932	56.37
CPCL	73F101	SO2	51	0.88	3.16	1.45	3.86	38271	46.84
CPCL	73F102	SO2	10	0.77	1.12	0.565	0.089	37144	8.91
CPCL	76F11	SO2	20.6	0.95	6.44	0.97	0.0318	109900	54.34
CPCL	77F1	SO2	21	0.81	10.4	1.99	0.078	14932	7.53
CPCL	205F1	SO2	16.2	0.977	11.8	0.462	0.0756	33448	13.00
CPCL	201F1&F2	SO2	367	0.91	49.12	8.79	0.97	291982	2589.39
MFL	Utility Boiler 1 & 2	SO2	386	0.79	383	18.1	0.894	264019	3448.79
MFL	110 ATA Boiler	SO2	14	0.88	44.7	1.99	3.28	811362	271.62
MFL-2	10 TOH Boiler	SO2	610	0.76	49.12	2.25	0.111	10667	277.17
TPL HCO	Boiler	SO2	4.8	0.77	0.027	0.11	0.0267	41955	4.83
TPL - LAB DIVISION	CPP	SO2	68.5	0.65	6.16	0.166	0.0998	24889	40.92
TPL - LAB DIVISION	Hot Oil Heater	SO2	4.9	0.88	8.68	1.98	0.0651	204487	24.05
								TOTAL	33607.43

PARTICULATE MATTER MASS EMISSION LOAD AND DISPERSION FROM MANALI INDUSTRIAL AREA PERTAINING TO FOUR INDUSTRIES

Company Name	Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)	Flow rate (Nm3/Hr)	Emission load kg/day
CFCL	14F1	PM	15.4	0.82	0.432	0.155	0.76	20067	7.41
CFCL	14F101	PM	8.1	0.995	0.401	0.0334	0.00631	23669	4.23
CFCL	15F1A	PM	17.9	0.71	1.002	1.31	2.534	95678	41.10
CFCL	15F1B	PM	19.4	0.72	1.01	0.76	1.099	44656	20.79
CFCL	15F2A	PM	18.5	0.73	0.879	0.08	1.008	27750	12.31
CFCL	15F2B	PM	20.3	0.912	1.68	0.922	1.086	26747	17.90
CFCL	1MF1	PM	17.4	0.78	96.2	9.91	2.79	63984	26.84
CFCL	1MF3	PM	9.7	0.788	1.68	0.11	1.0091	59179	13.75
CFCL	1F201	PM	24.4	0.77	3.32	2.76	0.42	32147	18.83
CFCL	1F201	PM	25.6	0.78	3.67	2.11	0.36	16143	9.92
CFCL	28MF2	PM	24.9	0.89	9.49	1.09	1.0032	88966	52.91
CFCL	28MF1-F2	PM	15.8	0.9	0.364	0.12	1.007	39911	11.34
CFCL	28MF3-F4	PM	9.8	0.79	1.33	0.89	1.0067	64287	16.11
CFCL	28TF1	PM	9.5	0.879	0.715	0.086	1.0041	28715	6.41
CFCL	2F2 F1	PM	8.9	0.86	0.603	0.0766	0.00849	39245	8.38
CFCL	Gas Turbin-1	PM	28.2	0.7	0.415	0.0735	1.0872	69015	46.71
CFCL	Gas Turbin-2	PM	22.2	0.89	4.42	0.24	1.098	69812	37.20
CFCL	Gas Turbin-3	PM	26.9	0.98	3.6	0.97	1.083	62867	40.55
CFCL	28TF102	PM	15.6	0.99	2.06	0.7654	1.0991	28715	10.75
CFCL	Boiler-1	PM	67.3	0.78	11	2.768	0.64	90370	124.28
CFCL	Boiler-3	PM	60.5	0.89	11.6	2.21	1.065	91580	132.97
CFCL	Boiler-4	PM	50	0.909	905	38.5	9.77	931556	1127.48
CFCL	Gas Turbine-4	PM	17.4	0.88	3.55	0.9	1.065	96150	40.15
CFCL	8MF1	PM	8.6	0.789	1.32	0.157	1.0681	85421	16.81
CFCL	21SF1	PM	23.7	0.83	1.68	0.2	1.036	33999	19.28
CFCL	1F1B	PM	22.9	0.91	1.68	0.43	1.0618	34829	19.14
CFCL	28MF1	PM	9.4	0.91	2.22	0.59	1.0823	12714	2.87
CFCL	28MF2	PM	9.8	0.93	0.239	0.0976	1.0034	24415	5.74
CFCL	21MF1	PM	9.1	0.86	2.29	0.787	1.011	134818	29.44
CFCL	1F3	PM	18.2	0.87	1.53	0.53	1.017	32148	14.04
CFCL	1F1A	PM	0.874	1.05	1.05	0.89	1.078	32148	0.67
CFCL	1F1A WEST	PM	12.4	0.911	2.81	0.131	1.0952	100284	29.81
CFCL	18F101	PM	19.7	0.81	4.08	1.11	1.034	18099	8.80
CFCL	7MF1	PM	29.7	0.76	8.53	1.65	1.023	14932	10.64
CFCL	75F101	PM	27	0.87	2.46	0.89	1.015	38871	24.80
CFCL	75F102	PM	15.3	0.71	1.74	0.534	1.087	37144	13.64
CFCL	7MF11	PM	33.1	0.67	90.3	0.86	1.036	109401	87.31
CFCL	7TF1	PM	18.4	0.77	1.14	0.65	1.033	14932	6.59
CFCL	28SF1	PM	16.2	0.877	1.12	0.54	1.0865	13449	13.09
CFCL	28TF15F2	PM	14.4	0.69	1.13	0.89	1.032	291982	101.60
MRL	APK Common Stack Outlet	PM	11	0.86	96.2	1.78	0.65	210690	65.74
MRL	Urea Derriser A outlet	PM	7	0.86	24.1	1.85	1.0687	1001958	168.30
MRL	Urea Derriser B outlet	PM	5.5	0.68	20.1	1.97	0.43	1021868	134.98
MRL	Utility Boiler 1 & 2	PM	31.3	0.86	32.4	2.29	1.6776	264010	198.32
MRL	110 ATA Boiler	PM	36.4	0.71	98.43	2.22	1.643	811362	708.81
MRL-1	18 ton Boiler	PM	7.8	0.87	7.05	0.376	1.0098	11713	2.19
MRL-2	18 TON Boiler	PM	28	0.78	1.33	0.245	1.0432	18687	11.66
TRL HCB	Boiler	PM	7.2	0.89	2.8	0.78	1.082	47995	7.25
TRL - LAB DIVISION	Boiler	PM	8.1	0.88	1.11	0.196	1.079	42710	8.51
TRL - LAB DIVISION	CPP	PM	35.5	0.83	5.04	0.11	1.0076	24889	21.21
TRL - LAB DIVISION	Hot Oil Heater	PM	7.5	1.01	12.1	0.561	0.00232	204487	36.81
TRL - LAB DIVISION	PACOL Charge	PM	7.8	0.92	0.567	0.334	1.0904	22016	4.12
TRL - LAB DIVISION	Hydroban Water	PM	7.9	0.77	0.98	0.0557	0.00316	4141	0.80
								TOTAL	3654.62

PARTICULATE MATTER MASS EMISSION LOAD AND DISPERSION FROM MANALI INDUSTRIAL AREA PERTAINING TO FOUR INDUSTRIES

Company Name	Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC km	GLC (µg/m3)	Average concentration at 2 km (µg/m3)	Average concentration at 5 km (µg/m3)	Flow rate (Nm3/Hr)	Emission load kg/day
CPCL	14F1	CO	152	0.78	8.79	0.87	0.0177	20967	71.20
CPCL	14F101	CO	140	0.799	6.76	1.786	0.57	21669	71.81
CPCL	15F1A	CO	149	0.89	20.8	2.22	1.788	95678	342.14
CPCL	15F1B	CO	103	0.77	9.04	2.8	0.52	44656	110.39
CPCL	15F2A	CO	119	0.78	5.78	1.8	0.54	27750	79.25
CPCL	15F2B	CO	84	0.89	6.9	0.876	0.07210	36747	74.08
CPCL	1WF1	CO	148	0.97	20.4	8.32	0.952	63804	226.63
CPCL	1WF3	CO	142	0.889	18.7	1.56	0.321	59179	201.68
CPCL	9F201	CO	185	0.788	13.2	1.31	0.0866	32147	142.73
CPCL	9F301	CO	159	0.7	5.51	1.42	0.56	16143	61.60
CPCL	236F3	CO	11	0.91	2.46	0.92	0.0667	88556	21.38
CPCL	236F1/F2	CO	33	0.78	1.21	0.45	0.0607	29911	16.51
CPCL	236F3/F6	CO	49	0.98	4.22	0.621	0.022	64247	75.55
CPCL	237F1	CO	13	0.791	1.01	0.14	0.0641	28718	8.96
CPCL	2/2 F1	CO	54	1.57	4.731	0.681	0.8654	39245	50.86
CPCL	Gas Turbin-1	CO	2	0.61	0.415	0.055	0.0097	69813	3.31
CPCL	Gas Turbin-2	CO	6	0.98	1.21	0.2	0.0788	69812	10.05
CPCL	Gas Turbin-3	CO	8	0.8	1.07	0.124	0.065	62807	11.06
CPCL	237F102	CO	17	0.84	2.29	0.461	0.0666	28718	11.72
CPCL	Boiler-1	CO	40	0.98	0.764	0.086	0.00713	90070	86.76
CPCL	Boiler-3	CO	28	0.99	5.41	0.77	0.075	91580	61.54
CPCL	Boiler-4	CO	12	0.96	23.8	5.34	0.984	933056	268.86
CPCL	Gas Turbine-4	CO	11	0.98	2.25	0.45	0.0678	96150	25.38
CPCL	86F1	CO	11	0.867	2.085	0.24	0.0351	81421	21.50
CPCL	211F1	CO	124	0.633	8.96	1.46	0.456	33999	101.18
CPCL	1F1B	CO	13	0.91	8.94	1.74	0.976	34829	10.87
CPCL	236F2	CO	6	0.79	0.153	0.098	0.0113	24413	3.52
CPCL	2/4F1	CO	7	0.78	1.99	0.12	0.0431	134818	22.69
CPCL	1F1A WEST	CO	56	0.877	16.4	1.87	0.977	100104	134.67
CPCL	13F101	CO	111	0.73	16.9	5.323	0.927	18899	48.22
CPCL	7/F1	CO	143	0.75	41.8	12.78	2.412	14932	51.25
CPCL	72F101	CO	135	0.68	14.7	3.67	0.781	38271	124.00
CPCL	73F102	CO	15	0.66	1.64	0.86	0.0578	37144	13.37
CPCL	7WF11	CO	152	0.76	47.44	8.86	1.32	109903	400.93
CPCL	77F1	CO	31	0.8	1.33	0.123	0.057	14932	11.11
CPCL	235F1	CO	136	0.736	89.1	7.731	0.8966	33448	109.17
CPCL	231F1&F2	CO	180	0.8	8.72	0.96	0.078	293982	1270.00
MFL	Utility Boiler 1 & 2	CO	51	0.74	44.1	5.93	0.346	264010	323.15
MFL	110 ATA Boiler	CO	22	0.91	20.6	3.27	0.445	811162	428.40
MPL-1	18 ton Boiler	CO	11.14	0.8	3.43	0.118	0.0322	11713	3.13
MPL-2	18 TOH Boiler	CO	5	0.76	8.72	0.28	0.0842	19607	2.24
TPL - LAB DIVISION	Hot Oil Heater	CO	36	0.84	39.5	0.987	0.0322	204487	176.68
TPL - ECH	Boiler	CO	31	0.85	0.99	0.0961	0.00667	10214	7.60
								TOTAL	5303.11

AMMONIA AND HYDROGEN FLUORIDE MASS EMISSION LOAD AND DISPERSION FROM MANALI INDUSTRIAL AREA PERTAINING TO FOUR INDUSTRIES								
Stack Name	Parameter	Concentration at Sources (mg/m3)	Distance travelled to reach GLC	GLC	Average concentration at 2 km	Average concentration at 5 km	Flow Rate, Nm3/Hr	Emission Load, kg/day
			km	(µg/m3)	(µg/m3)	(µg/m3)		
NPK Common Stack Outlet	HF	3.5	0.91	4.37	1.23	0.45	210690	17.69
NPK Common Stack Outlet	NH3	245	0.79	23.2	4.22	0.89	210690	1228.7
Urea Demister A outlet	HF	1.5	0.91	7.72	0.65	0.0093	1001188	36.04
Urea Demister A outlet	NH3	253	0.68	955.2	67.84	3.177	1001188	6079.2
Urea Demister B outlet	HF	1.5	0.79	7.47	1.09	0.24	1021868	36.78
Urea Demister B outlet	NH3	45	0.82	125	3.11	0.56	1021868	1103.6

Annexure-XIII

Report On

AMBIENT AIR QUALITY MONITORING AND ANALYSIS AT MANALI INDUSTRIAL AREA

Prepared By

The Joint Committee in the Matter of OA 256 of 2020 Before the Honourable NGT Southern Zone, Chennai

Year 2021 - 2022

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1. METHODOLOGY FOR THE MEASUREMENT OF AMBIENT AIR SAMPLING AND ANALYSIS

1.1 Sitting Requirements

Samplers have sited to meet the goals of the specific monitoring project. For this study sampling to determine compliance with the National Ambient Air Quality Standards (NAAQS), sampler sitting is described in CPCB guidelines. The monitoring has been done at outside the zone of influence of sources located within the designated zone of representation for the monitoring site.

Height of the inlet kept to be 3 – 10 m above the ground level also at a suitable distance from any direct pollution source including traffic.

Large nearby buildings and trees extending above the height of the monitor may present barriers or deposition surfaces for PM. Distance of the sampler to any air flow obstacle i.e. buildings, has been considered to be more than two times the height of the obstacle above the sampler. Certain trees may also be sources of PM in the form of detritus, pollen, or insect parts to avoid this have been located the sampler > 20 m from nearby trees. Also care has been taken between PM10 & PM2.5 the minimum distance between two Samplers maintained more than 2 m.

1.2 Methodology for sampling and analysis of Particulate Matter (PM10) in ambient air (Gravimetric Method) Standard

The national ambient air quality standards for Particulate Matter PM_{10} is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM10, $\mu g/m^3$	Annual * 24 Hours **	60 100	60 100

*Annual Arithmetic mean of minimum 104 measurements in a Year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

Air is drawn through a size-selective inlet and through a 20.3 X 25.4 cm (8 X 10 in) filter at a flow rate, which is typically 1132 L/min. Particles with aerodynamic diameter less than the cut-point of the inlet are collected, by the filter. The mass of these particles is determined by the difference in filter weights prior to and after sampling. The concentration of PM10 in the designated size range is calculated by dividing the weight gain of the filter by the volume of air sampled.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of Particulate Matter PM10 in ambient air:

Analytical balance: 5 digits with valid calibrations

Sampler: High Volume Sampler with size selective inlet for PM10

Calibrated flow-measuring device to control the airflow at 1100 to 1300 l/min.

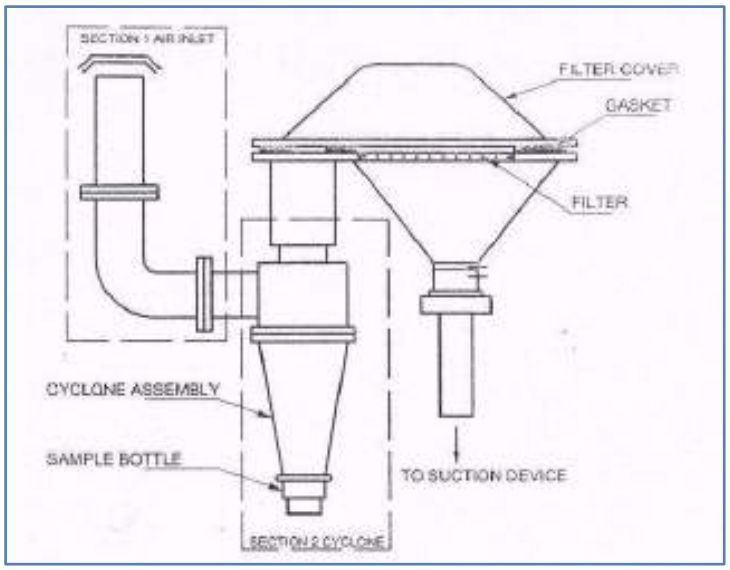
Reagents / Chemicals

Filter Media – A MCE filter of 20.3 X 25.4 cm (8 X 10 in) size (Whatmann)

Sampling

Field Sampling - Tilt back the inlet and secure it according to manufacturer's instructions. Loosen the faceplate wing nuts and remove the faceplate. Remove the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replace the faceplate and tighten the wing nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate and elapsed time meter on the data sheet. The length of sampling is fixed for 24 hours. During this period, several reading (hourly) of flow rate has been taken and recorded in the field data sheet.

After the required time of sampling, recorded the flow meter reading, taken out the filter media from the sampler, and kept in a envelope marked sample ID.



PM10 Sampler (Cyclonic Inlet)

Analysis

Applied the code to the filter and conditioned the filter in conditioning room maintained within 20-30° C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the initial weight of the filter paper (Wi) before sampling. Condition the filter after sampling in conditioning room maintained within 20-30 C and 40-50% relative humidity or in an airtight desiccator for 24 hours. Taken the final weight of filter paper (Wf).

Calculation

C_{PM10} µg/m3 = $(Wf - Wi) \times 10^6 / V$

Where,

C_{PM10} = Concentration of Particulate Matter, µg/m^3

Wf = Final weight of filter in g

Wi = Initial weight of filter in g

10^6 = Conversion of g to µg

V = Volume of air sampled, m^3

Quality Control

Quality Control (QC) is the techniques which AC TECH is used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring includes the preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

FLOW CHART FOR MEASUREMENT OF PM10
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flowrate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM10 in µg/m3

Reference:

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable suspended Particulate Matter (PM10) cyclonic flow technique.

1.3 Methodology for determination of PM2.5 in ambient air (Gravimetric Method)

Standard

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Particulate Matter, PM2.5, µg/m3	Annual *	40	40
	24 Hours **	60	60

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a volumetric flow controller into specially designed inertial particle-size separator (impactors) where the suspended particulate matter in the PM2.5 size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE) filter over a 24 hours sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter. The mass concentration in the ambient air is computed as the total mass of collected particles in the PM2.5 size ranges divided by the actual volume of air sampled, and is expressed in µg/m3.

Moisture content can affect filter weight. Filters are equilibrated for a minimum of 24 hours in a controlled environment prior to pre- and post- weighing. The Humidity chamber relative humidity were maintained at a mean value range of 45 ± 5 % and its air temperature were maintained at a mean value range of 25.0 ± ºC.

Apparatus and Materials

Sampling equipment designated as FEM (Federal Equivalent Method)
Electronic microbalance with a minimum resolution of 0.001 mg and a precision of ± 0.001 mg, supplied with a balance pan. The microbalance is positioned on a vibration-damping balance support table.

Calibration weights, utilized as Mass Reference Standards, should be non-corroding, range in weight from 100 mg to 200 mg, and be certified as traceable to NIST mass standards. The weights should be ASTM Class1 category with a tolerance of 0.025 mg.

- Non-serrated forceps for handling filters.
- Non-metallic, non-serrated forceps for handling weights.
- 47 mm Filter: Teflon membrane, 46.2 mm effective diameter with a polypropylene
  support ring
- Filter support cassettes and covers.
- Relative Humidity / Temperature recorder.
- Zip-lock plastic bags, 6"x 9".
- Disposable laboratory wipes.
- Impactor oil/grease

Filter Conditioning

Gravimetric measurement is the net mass on a filter by weighing the filter before and after sampling with a balance in a temperature and relative humidity controlled environment as described in SOPs. To minimize particle volatilization and aerosol liquid water bias, as per PM2.5 reference methods the filters are equilibrated for 24 hours at a constant (within ±5%) relative humidity 45 % and at a constant (within ±2ºC) temperature between 25ºC. These filter equilibrium conditions are intended to minimize the liquid water associated with soluble compounds and to minimize the loss of volatile species.

Weighing of Filters

Handled the pre-conditioned filters by forceps one by one and weighed properly. Recorded the mass in data sheet and log books against respective filter code.

- Always used gloved hands and blunt tweezers to handle filters.
- Replaced and closed the filter container (Petri dishes). Previous Weighed one Control Filters (Archived one) with each batch of ten weighing. Kept separate controls for Pre (Blank filter) and Post (Exposed) sampling filters.
- Put the sample code on from Plastic petri-slide filter containers (Filter Cassette).
- Take out conditioned filter from Plastic petri-slide filter containers (Filter Cassette).
- Weighed the preconditioned filter.
- Recorded and stored it in laboratory coded filter cassette.

Field sampling

On the Field Data sheet, filled in the top portion of the form including: the date/time of

visit, the site identification, sampler identification, site name, filter ID number, sample start and stop dates and times, and field operator initials.

- Performed all necessary pre-sampling procedures as described above.
- Performed QA/QC checks or maintenance
- Removed the filter is to be installed from its protective filter cassette carrier.
- Fixed the filter following manufacturer's instructions into place against the bottom of the WINS impactor.

Calculation and Reporting of Mass Concentrations

The equation to calculate the mass of fine particulate matter collected on a Teflon filter is as below:

$M_{2.5} = (Mf - Mi)\ mg \times 10^3\ \mu g$

Where,

$M_{2.5}$ = total mass of fine particulate collected during sampling period (µg)

Mf = final mass of the conditioned filter after sample collection (mg)

Mi = initial mass of the conditioned filter before sample collection (mg)

10^3 = unit conversion factor for milligrams (mg) to micrograms (µg)

Field records of PM2.5 samplers will provide measurements of the total volume of ambient air passing through the sampler (V) in cubic meters at the actual temperatures and pressures measured during sampling. Use the following formula if V is not available directly from the sampler:

$V = Qavg \times t \times 10^{-3}\ m^3$ Where,

V = total sample value (m^3)

Qavg = average flow rate over the entire duration of the sampling period (L/min)

T = duration of sampling period (min)

10^3= unit conversion factor for liters (L) into cubic meters (m^3)

The equation given below can be used to determine $PM_{2.5}$ mass concentration:

$PM_{2.5} = M_{2.5} / V$

Where,

$PM_{2.5}$ = mass concentration of $PM_{2.5}$ particulates (µg/m^3)

$PM_{2.5}$ = total mass of fine particulate collected during sampling period (µg)

V = total volume of air sampled (m^3)

FLOW CHART FOR MEASUREMENT OF PM2.5
Check the filter for any physical damages
⇩
Mark identification number on the filter
⇩
Condition the filter in conditioning room / desiccator for 24 hours
⇩
Record initial weight
⇩
Place the filter on the sampler
⇩
Run the sampler for eight hours
⇩
Record the flow rate on hourly basis
⇩
Remove the filter from the sampler
⇩
Keep the exposed filter in a proper container
⇩
Record the total time of sampling & average flow rate
⇩
Again condition the filter in conditioning room / desiccator for 24 hours
⇩
Record final weight
⇩
Calculate the concentration of PM2.5 in µg/m3

References

1. 40 CFR Parts 53 and 58 Revised Requirements for Designation of Reference and Equivalent Methods for PM2.5 and Ambient Air Quality Surveillance for Particulate Matter; Final Rule

2. PM2.5 Gravimetric Analysis - Revision 7, August 14, 2003, Page 2 of 24 RTI (Research Triangle Institute, US)

1.4 METHODOLOGY FOR SAMPLING AND ANALYSIS OF SULPHUR DIOXIDE IN AMBIENT AIR (IMPROVED WEST AND GEAKE METHOD)

Standard

The National Ambient Air Quality standards for Sulphur Dioxide is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual *	50	20
	24 Hours **	80	80
*Annual Arithmetic mean of minimum 104 measurements in a year, at a particular site, taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the Method

Modified West & Gaeke Method (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide): Sulphur dioxide from air is absorbed in a solution of potassium tetrachloro- mercurate (TCM). A dichlorosulphitomercurate complex, which resists oxidation by the oxygen in the air, is formed. Once formed, this complex is stable to strong oxidants such as ozone and oxides of nitrogen and therefore, the absorber solution may be stored for some time prior to analysis. The complex is made to react with para-rosaniline and formaldehyde to form the intensely colored pararosaniline methylsulphonic acid. The absorbance of the solution is measured by means of a suitable spectrophotometer

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Capable of maintaining an air pressure differential greater than 0.7 atmosphere at the desired flow rate

Calibrated flow-measuring device to control the airflow from 0.2 to 1 l/min.

Absorber: all glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 560 nm equipped with 1 cm

path length cells.

Glass wares: low actinic glassware must be used for analysis.

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Mercuric chloride

Potassium chloride / Sodium chloride

EDTA di sodium salt

Absorbing Reagent, 0.04 M Potassium Tetrachloro mercurate (TCM) - Dissolved 10.86 g, mercuric chloride, 0.066 g EDTA, and 6.0 g potassium chloride or sodium chloride 4.68 gm in water and make up into 1 liter. The pH of this reagent fixed to be approximately 4.0 but, it has been shown that there is no appreciable difference in collection efficiency over the range of pH 5 to pH 3. The absorbing reagent is normally stable for six months. If, any precipitate forms, then we can discard the reagent after recovering the mercury.

Sulphamic Acid (0.6%) - Dissolved 0.6 g sulphamic acid in 100 ml distilled water and prepared freshly.

Formaldehyde (0.2%) - Diluted 5 ml formaldehyde solution (36-38%) to 1 litre with distilled water and prepared freshly.

Purified Pararosaniline Stock Solution (0.2% Nominal): Dissolved 0.5 gm of specially purified pararosaniline (PRA) in 100 ml of distilled water and keep for 2 days (48 hours) before using.

Pararosaniline Working Solution - 10 ml of stock PRA is taken in a 250 ml volumetric flask. Add 15 ml conc. HCL and make up to volume with distilled water.

Stock Iodine Solution (0.1 N) - Placed 12.7 g iodine in a 250 ml beaker, add 40 g potassium iodide and 25 ml water and checked until all is dissolved, then diluted to 1 litre with distilled water.

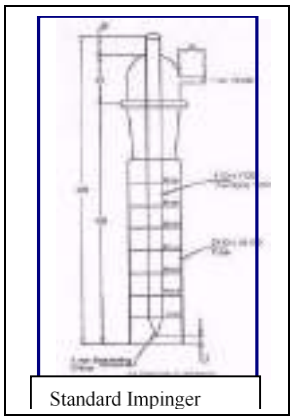
Iodine Solution (0.01 N) - Prepared approximately 0.01 N iodine solution by diluting 50 ml of stock solution to 500 ml with distilled water.

Starch Indicator Solution - Triturate 0.4 gm soluble starch and 0.002 g mercuric iodide preservative with a little water and added the paste slowly to 200 ml boiling water. Continue boiling until the solution is clear, cool, and transfer to a glass-stoppered bottle.
Stock Sodium Thiosulfate Solution (0.1 N) - Prepared a stock solution by placing 25 g sodium thiosulfate pentahydrate in a beaker, add 0.1 g sodium carbonate and dissolved using boiled, cooled distilled water making the solution up to a final volume of 1 litre. Allowed the solution to stand one day before standardizing.

Sodium Thiosulphate Titrant (0.01 N) - Diluted 100 ml of the stock thiosulfate solution to 1 litre with freshly boiled and cooled distilled water.

Standardized Sulphite Solution for Preparation of Working Sulphite- TCM Solution - Dissolve 0.30 g sodium metabisulphite ($Na_2S_2O_5$) or 0.40 g sodium sulphite (Na_2SO_3) in 500 ml of recently boiled, cooled, distilled water. Sulphite solution is unstable; it is, therefore, important to use water of the highest purity to minimize this instability. This solution contains the equivalent of 320-400 µg/ml of SO_2.

Working Sulphite-TCM Solution - Measured 2 ml of the standard solution into a 100 ml volumetric flask by pipette and brought to mark with 0.04 M TCM. Calculated the concentration of sulphur dioxide in the working solution in micrograms of sulphur dioxide per millilitre. This solution is stable for 30 days by keeping in the refrigerator at 5^oC.



Standard Impinger

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hours at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred in to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber. Mixed thoroughly, pipette out 10 ml of the collected sample into a 25 ml volumetric flask. Added 1 ml 0.6% sulphamic acid and allow reacting for 10 minutes to destroy the nitrite resulting from oxides of nitrogen. Added 2 ml of 0.2% formaldehyde solution and 2 ml pararosaniline solution and made up to 25 ml with distilled water. Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent. After a 30 min color development interval, measured and recorded the absorbance of samples and reagent blank at 560 nm.

Preparation of Standards

Measured 0.5 ml, 1.0 ml, 1.5 ml, 2.0 ml, 2.5 ml, 3.0 ml, 3.5 ml and 4.0 ml of working sulphite TCM solution in 25 ml volumetric flask. Added sufficient TCM solution to each

flask to bring the volume to approximately 10 ml. Then added the remaining reagents as described in the procedure for analysis. A reagent blank with 10 ml absorbing solution is also prepared. Recorded the absorbance of each standard and reagent blank and draw the linear graph.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

Concentration of sulphite solution:

Where,

$$C = \frac{(V1-V2) \times N \times K}{V}$$

C = SO_2 concentration in µg/ml
V1 = Volume of thiosulfate for blank, ml
V2 = Volume of thiosulfate for sample, ml
N = Normality of thiosulfate
K = 32000 (Milliequivalent weight SO_2/µg)
V = Volume of standard sulphite solution, ml

$$C\ (SO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s/V_a \times V_t$$

Where,

C SO_2 = Concentration of Nitrogen dioxide, µg/m^3
A_s = Absorbance of sample
A_b = Absorbance of reagent blank
CF = Calibration factor
V_a = Volume of air sampled, m^3
V_s = Volume of sample, ml
V_t = Volume of aliquot taken for analysis, ml

Quality Control

Quality Control (QC) is the techniques that are used to fulfill requirements for quality. The QC procedures for the air sampling and monitoring sections of this protocol include preventative maintenance of equipment, calibration of equipment, analysis of field blanks and lab blanks.

Reference

IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur Dioxide

FLOW CHART FOR MEASUREMENT OF SULPHUR DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas-sampling manifold of gas sampling device (RDS/HVS).
⇩
Draw air at a sampling rate of 0.5 lpm for eight hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10/20 ml. aliquot of sample in 25 ml. Vol. Flask
⇩
Take 10/20 ml. of unexposed sample in 25 ml. Vol. Flask (blank)
⇩
Add 1 ml Sulphamic acid. Keep it 10 minutes
⇩
Add 2 ml formaldehyde
⇩
Add 2 ml working PRA
⇩
Make up to mark (25 ml.) with distilled water.
⇩
Keep it 30 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 560 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Sulphur Dioxide in $\mu g/m^3$

1.5 METHODOLOGY FOR SAMPLING AND ANALYSIS OF NITROGEN DIOXIDE IN AMBIENT AIR (MODIFIED JACOB AND HOCHHEISER METHOD)

Standard

The National Ambient Air Quality Standard for Nitrogen Dioxide is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Nitrogen Dioxide (NO_2), µg/m^3	Annual *	40	30
	24 Hours **	80	80
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.			
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two			

Principle of the method

Modified Jacobs & Hochheiser Method (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of nitrogen).

Ambient nitrogen dioxide (NO_2) is collected by bubbling air through a solution of sodium hydroxide and sodium arsenite. The concentration of nitrite ion (NO^-_2) produced during sampling is determined calorimetrically by reacting the nitrite ion with phosphoric acid, sulfanilamide, and N-(1-naphthyl)- ethylenediamine di-hydrochloride (NEDA) and measuring the absorbance of the highly coloured azo-dye at 540 nm.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of nitrogen dioxide in ambient air:

Analytical balance:

Vacuum pump: Vacuum pump used of having 0.6 atmospheres across the flow control device. Flow control device capable of maintaining a constant flow of 200-1000 ml per minute through the sampling solution

Calibrated flow measuring device: To control the airflow from 0.2 to 1 l/min.

Absorber: a midget impinger

Spectrophotometer: Capable of measuring absorbance at 540 nm equipped with 1 cm

path length cells.

Glass wares: low actinic glasswares are used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

Sodium hydroxide

Sodium Arsenite

Absorbing solution (Dissolved 4.0 g of sodium hydroxide in distilled water, add 1.0 g of sodium Arsenite, and diluted to 1,000 ml with distilled water)

Sulphanilamide - Melting point 165 to 167^{o}C

N-(1-Naphthyl)-ethylenediamine Di-hydrochloride (NEDA) - A 1% aqueous solution should have only one absorption peak at 320 nm over the range of 260-400 nm. NEDA showing more than one absorption peak over this range is impure and should not be used

Hydrogen Peroxide - 30%

Phosphoric Acid - 85%

Sulphanilamide Solution - Dissolved 20 g of sulphanilamide in 700 ml of distilled water. Add, with mixing, 50 ml of 85% phosphoric acid and diluted to 1,000 ml. This solution is stable for one month and it will be stored at refrigerated

NEDA Solution - Dissolved 0.5 g of NEDA in 500 ml of distilled water. This solution is stable for one month, This solution kept at refrigerated and protected from light.

Hydrogen Peroxide Solution - Diluted 0.2 ml of 30% hydrogen peroxide to 250 ml with distilled water. This solution has been used for one month and the prepared solution is kept in refrigerated and protected from light

Sodium nitrite - Assay of 97% $NaNO_2$ or greater

Sodium Nitrite stock solution (1000 µg NO_2/ml)

Sodium Nitrite solution (10 µg NO_2/ml.)

Sodium Nitrite working solution (1 µg NO_2/ml) (Diluted with absorbing reagent, prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sample for eight hour at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transfered to a sample storage bottle.

Analysis

Replaced the water lost by evaporation during sampling by adding distilled water up to the calibration mark on the absorber, mix thoroughly.

Pipetted out 10 ml of the collected sample into a 50 ml volumetric flask. Pipette in 1 ml of hydrogen peroxide solution, 10 ml of sulphanilamide solution, and 1.4 ml of NEDA solution, with thorough mixing after the addition of each reagent and make up to 50 ml with distilled water.

Prepared a blank in the same manner using 10 ml of unexposed absorbing reagent.

After a 10 min colour development interval, measured and recorded the absorbance of samples and reagent blank at 540 nm.

Used distilled water; not the reagent blank, as the optical reference

Samples with an absorbance greater than 1.0 must be re-analyzed after diluting an aliquot of the collected samples with an equal quantity of unexposed absorbing reagent.

A randomly selected 5-10% of the samples are being re-analyzed as apart of an internal quality assurance program.

Calibration

Preparation of Standards

Pipette 5, 10, 15, 20 and 25 ml of working standard solution in to 50 ml volumetric flask. Fill to 20 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Add reagents to each volumetric flask as in the procedure for analysis. Recorded the absorbance of each standard and reagent blank against distilled water reference.

Standard Curve:

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$\mathbf{C\ (NO_2\ \mu g/m^3) = (A_s - A_b) \times CF \times V_s / V_a \times V_t \times 0.82}$$

Where,

$C\ NO_2$	=	Concentration of Nitrogen dioxide, $\mu g/m^3$
A_S	=	Absorbance of sample
A_b	=	Absorbance of reagent blank

CF = Calibration factor

Va = Volume of air sampled, m^3

V_S = Volume of sample, ml

V_t = Volume of aliquot taken for analysis, ml

0.82 = Sampling efficiency

Reference

IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen

FLOW CHART FOR MEASUREMENT OF NITROGEN DIOXIDE
Place 30 ml of absorbing media in an impinger
⇩
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS)
⇩
Draw air at a sampling rate of 0.5 lpm for 8 hours
⇩
Check the volume of sample at the end of sampling and record it
⇩
Transfer the exposed samples in storage bottle and preserve
⇩
Prepare calibration graph as recommended in method
⇩
Take 10 ml. aliquot of sample in 50 ml. Vol. Flask
⇩
Take 10 ml. of unexposed sample in 50 ml. Vol. Flask (blank)
⇩
Add 1ml hydrogen peroxide,
⇩
Add 10ml Sulphanilamide
⇩
Add 1.4 ml NEDA
⇩
Make up to mark (50 ml.) with distilled water.
⇩
Keep it 10 minutes for reaction
⇩
Set Zero of spectrophotometer with Distilled water
⇩
Measure absorbance at 540 nm
⇩
Calculate concentration using calibration graph
⇩
Calculate concentration of Nitrogen Dioxide in $\mu g/m^3$

1.6 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR OZONE IN AMBIENT AIR (CHEMICAL METHOD)

Standard

The national ambient air quality standards for ozone is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ozone (O3), µg/m^3	8 Hours *	100	100
	1 Hour **	180	180
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.			
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere). Micro-amounts of ozone and the oxidants liberate iodine when absorbed in a 1% solution of potassium iodine buffered at pH 6.8 $\pm$ 0.2. The iodine is determined spectrophotometrically by measuring the absorption of tri-iodide ion at 352 nm.

The stoichiometry is approximated by the following reaction:

$$O_3 + 3\ KI + H_2O \rightarrow KI_3 + 2\ KOH + O_2$$

Instrument/Equipment

The following items are necessary to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance:

Vacuum pump: Any suction pump capable of drawing the required sample flow rate of 1 to 2 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 l/min.

Absorber: All glass midget impinger

Spectrophotometer: Capable of measuring absorbance at 352 nm.

Glass wares: low actinic glassware must be used for analysis

Reagents / Chemicals

All the chemicals used are meets specifications of Analytical Reagent grade

Distilled water

Absorbing Solution (1% KI in 0.1M Phosphate Buffer) - Dissolved 13.6g of potassium dihydrogen phosphate (KH_2PO_4), 14.2g of disodium hydrogen phosphate (Na_2HPO_4), and 10.0 g of potassium iodide in sequence and dilute the mixture to 1 L with water. Measured pH and adjust to 6.8 $\pm$ 0.2 with NaOH. This solution has to be stored for several months in a glass stoppered brown bottle at room temperature without deterioration.

Stock Solution 0.025 M I_2 (0.05N) - Dissolved 16 g of potassium iodide and 3.173 g of re-sublimed iodine successively and diluted the mixture to exactly 500 ml with water. Kept at room temperature for 1day before use. The sodium thiosulfate has been standardized against primary standard potassium dichromate ($K_2Cr_2O_7$).

M I_2 Solution - Pipette exactly 4.00 ml of the 0.025 M Stock solution into a 100 ml volumetric flask and diluted to the mark with absorbing solution.

Sampling

Placed 35 ml of absorbing solution in a standard impinger and sample for one hour at the flow rate of 1 L/min. Precaution taken not expose the absorbing reagent to direct sunlight. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Appreciable evaporation of the absorbing solution occurs during sampling, added water to bring the liquid volume to 35 ml. Within 30 minutes after sample collection, recorded the absorbance in a cuvette at 352 nm against a reference cuvette containing distilled water. Measured the absorbance of the unexposed reagent and subtracted the value from the absorbance of the sample.

Calibration

Preparation of Standards

Calibrating Iodine Solution - For calibration exactly 5.1 ml of the 0.001 M I_2 solution is diluted with absorbing solution just before use to 100 ml (final volume) to made the final concentration equivalent to 1 µl of O_3/ml. This solution preparation accounts for the stoichiometry described in Section 3 at standard conditions of 101.3 kPa and 25^{o}C.

Obtain a range of calibration points containing from 1 µl to 10 µl of ozone equivalent per 35.0 ml of solution. Prepared by individually adding 1.0, 2.0, 4.0, 6.0, 8.0 and 10.0 mL of the calibrating iodine solution to 10.0 ml volumetric flasks.

Brought each to the calibration mark with absorbing reagent. Read the absorbance of each of the prepared calibration solutions at 352 nm against distilled water reference.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (O_3\ \mu g/m^3) = (A_S - A_b) \times CF \times 1.962 / V_a$$

Where,

$C\ NH_3$	=	Concentration of Ammonia in $\mu g/m^3$
A_s	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3
1.962	=	Conversion factor, µl to µg

Reference

Method 411, Air Sampling and Analysis, 3rd Edition (Determination of oxidizing substances in the atmosphere).

FLOW CHART FOR MEASUREMENT OF OZONE (CHEMICAL METHOD)
Place10 ml of absorbing media in an impinger
Connect it to the gas sampling manifold of gas sampling device (RDS/HVS).
Draw air at a sampling rate of 1 lpm for 60 minutes
Do not expose the absorbing reagent to direct sunlight
Add de ionized water to make up the evaporation loss during sampling and bring the volume to 10 ml.
Prepare calibration graph as recommended in method
Within 30 to 60 minutes after sample collection, read the absorbance in a cuvette at 352 nm against a reference cuvette containing de ionized water
Calculate concentration using calibration graph
Calculate concentration of Ozone in µg/m^3

1.7 METHODOLOGY FOR SAMPLING AND ANALYSIS PROTOCOL FOR AMMONIA IN AMBIENT AIR (INDOPHENOL BLUE METHOD)

Standard

The national ambient air quality standard for ammonia is presented in the table:

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Ammonia (NH_3), $\mu g/m^3$	Annual *	100	100
	24 Hours **	400	400
* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals. ** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.			

Principle of the method

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition) 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 in the sample is analyzed colorimetrically by reaction with phenol and alkaline sodium hypochlorite to produce indophenol. The reaction is accelerated by the addition of Sodium Nitroprusside as catalyst.

Instrument/Equipment

The following items are used to perform the monitoring and analysis of ammonia in ambient air:

Analytical balance

Vacuum pump to maintain a flow rate up to 5 litre per minute

Calibrated flow measuring device to control the air flow from 1 to 2 litre/min.

Absorber: a midget impinger or a fritted bubbler

Spectrophotometer capable of measuring absorbance at 630 nm.

Glass ware: low actinic glass wares must be used for analysis

Reagents / Chemicals

All the chemicals used are Analytical Reagent grade

Distilled water

N Sulphuric Acid (Absorbing solution)

Sodium Nitroprusside

6.75 M sodium hydroxide

Sodium hypochlorite solution

Phenol solution 45% v/v

Sodium phosphate

Ammonium chloride

Hydrochloric acid

Ammonia stock solution (1 mg NH_3/ml)

Ammonia working solution (10 µg NH_3/ml) (Prepare fresh daily)

Sampling

Placed 35 ml of absorbing solution in an impinger and sampled for eight hour (3 x 8hours) at the flow rate of 0.5 L/min. After sampling measured the volume of sample and transferred to a sample storage bottle.

Analysis

Transferred contents of the sample bottle to a 25 ml glass stopper graduated cylinder. Maintained all the solutions and sample at 25^{o}C. Added 2 ml buffer followed by added 5 ml of working phenol solution, mixed and filled to about 22 ml. Add 2.5 ml of working hypochlorite solution and rapidly mixed. Diluted to 25 ml, mix and stored in the dark for 30 minutes to develop colour. Measured the absorbance of the solution at 630 nm on a spectrophotometer using 1cm cells. Prepared a reagent blank and field blank and measured the absorbance as done in the analysis of samples.

Calibration

Preparation of Standards

Pipet 0.5, 1.0, 1.5, 2.0 ml of working standard solution in to 25 ml glass stoppered graduated cylinders. Filled to 10 ml mark with absorbing solution. A reagent blank with 10 ml absorbing solution is also prepared. Added the reagents to each cylinder as in the procedure for analysis. Read the absorbance of each standard against reagent blank.

Standard Curve

Plot a curve absorbance (Y axis) versus concentration (X axis). Draw a line of best fit and determine the slope. The reciprocal of slope gives the calibration factor (CF).

Calculation

$$C\ (\ NH_3\ \mu g/m^3\ ) = (A_s - A_b) \times CF / V_a$$

Where,

C_{NH_3}	=	Concentration of Ammonia in $\mu g/m^3$
A_S	=	Absorbance of sample
A_b	=	Absorbance of reagent blank
CF	=	Calibration factor
V_a	=	Volume of air sampled in m^3

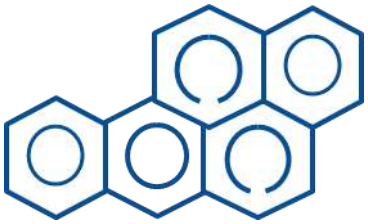
Reference

Indophenol method (Method 401, Air Sampling and Analysis, 3rd Edition), Lewis publishers Inc.

FLOW CHART FOR MEASUREMENT OF AMMONIA
Dilute 10ml of concentrated HCl (12M) to 100 ml with distilled water. Wash the glassware with the water and finally rinse it thrice with distilled water ⇩
Adjust the Flow rate at 1L/min of the rotameter and the manifolds of the attached APM 411/APM 460Dx ⇩
Place 10 ml of absorbing media in each midget impinger for samples and field blanks Assemble (in order) prefilter &holder, flowmeter, impinger and pump. Sample at the rate of 1L/min for 1hour duration ⇩
Record the sampling time, average flow rate and final volume of the solution After the sample collection, transfer the solution in the impinger to polyethylene bottle and recap it tightly for transport to laboratory for analysis ⇩
Prepare the absorbing media, various reagents and working solutions as per the method described in protocol Standardize the sodium thiosulphate solution by titrating it against potassium iodate and Sodium hypochlorite by titrating it against standardized sodium thiosulphate solution ⇩
Take 25 ml measuring flasks and rinse with distilled water. Transfer the contents from polyethylene bottles to 25 ml measuring flasks (Maintain all the solutions at 25°C) Add 2 ml of buffer (to maintain p H) Add 5 ml of working phenol solution, mix, fill to about 22 ml with distilled water and then add 2.5 ml of working hypochlorite solution & mix rapidly, Store in the dark for 30 mins to develop colour. Measure the absorbance of the solution at 630 nm using UV Spectrophotometer ⇩
Pipette 0.5, 1.0 and 1.5 ml of working standard solution (working ammonia solution) in 25 ml measuring flasks Fill to 10 ml mark with absorbing solution (0.1 M H_2SO_4). Add the reagents as to each flask as in the procedure for analysis Read the absorbance of each standard against the reagent blank. ⇩
Plot the calibration curve ⇩
Calculate the concentration of NH_3 in $\mu g/m^3$

1.8 METHODOLOGY FOR SAMPLING AND ANALYSIS OF BENZO(A)PYRENE & OTHER PAHS IN AMBIENT AIR (SOLVENT EXTRACTION & GC MS ANALYSIS)

Benzo (a) Pyrene (BaP) is one of the most important constituent of PAH compounds and also one of the most potent carcinogens. This can be measured in both particulate phase and vapour phase. In the vapour phase the concentration of B(a)P is significantly less than the particulate phase. Therefore, more care to be taken for the measurement of Benzo (a) Pyrene in the particulate phase. The molecular formula of B(a)P is $C_{20}H_{12}$ having molecular weight 252 and structural formula is given in following figure:



Structural Formula of Benzo (a) Pyrene (BaP)

Standard

The national ambient air quality standard for Benzo(a)pyrene is presented in table

Pollutant	Time weighted Average	Concentration in Ambient Air (ng/m^3)	
		Industrial, Residential, Rural & other Areas	Ecologically Sensitive Area (Notified by Central Government)
Benzo(a)pyrene	Annual	01	01

*Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the Method

It is based on BIS method IS 5182 (Part 12):2004 and USEPA method (TO-13). This method is designed to collect particulate phase PAHs in ambient air and fugitive emissions and to determine individual PAH compounds using capillary gas chromatograph equipped with flame ionization detector. It is a high volume (1.2m^3/min) sampling method capable of detecting sub.ng/m^3 concentration of PAH in 24 hours sample (i.e. collected in 3 shifts of 8 hour each with 480 m^3 sampling volume of air).

Equipment/Instruments

PM_{10} high volume sampler,

Whatman Glass fibre (EPM-2000),

Ultra Sonicator (~40kHz frequency),

Rotary Evaporator (Buchi type),

Gas Chromatograph with MS,

Syringes (5 & 10 micro litre capacity),

Variable volume micropipettes (0.5 & 1.0 ml capacity),

Beakers (250 ml),

Amber colour Vials 3ml and 5ml capacity

Chemical/Solvents

All chemicals, calibration /reference standards of B(a)P , other PAHs, solvents like Toluene, Cyclohexane (with minimum residue less than 0.005%) etc.) & other chemicals like Silica -Gel (60- 80 mesh size) should be of highest purity & of reputed make with traceability/purity and analysis certificate.

Sampling

Instrument/Filter Selection

24 hr. sampling used PM_{10} high volume sampler with 24 hourly samples using EPM-2000 glass fibre (Whatmann).

Sampling Frequency

Particulate laden Benzo(a)Pyrene samples are collected on glass fibre filter (EPM 2000) using PM_{10} sampler at a flow rate of 1.1m^3/min per minute, at selected location(s).

Sampling Height

Sampling height has been selected between 3-10 meters from the ground level for ambient air quality monitoring.

Sample Filter Storage

After sampling, filters are kept in the controlled laboratory conditions (20-25˚C) in an envelope marked with necessary identification information, wrapped the filters in Aluminium foil & kept it in refrigerator at 4°C in dark to avoid photo oxidation of PAHs.

Sample Processing

Extraction:

Filter papers (half of all the filters papers collected in a day) are cut into strips used scissors and transfered to 250 ml beaker. Added ~50 ml. of Toluene (GC/HPLC grade). These samples are extracted with toluene using ultra sonic bath for about 30 minutes.

Repeated the procedure twice (50ml x 2 times) for complete extraction.. Sample processing steps are shown in Figure – 1.

Filtration:

Filter the extracted samples with Whatman filter paper no.41 containing 2 gm of Anhydrous Sodium Sulphate (to remove moisture).

Concentration:

After filtration, the filtrate is concentrated used Rotary vacuum evaporator (Figure-2) to 2ml final volume.

Filter Extraction with Ultrasonicate

Rotary Evaporator for Sample Concentration

PAH Sample Processing:

Clean-up with silica Gel:

To clean up the impurities, passed 2 ml of concentrated sample through silica gel column (pre conditioned, 60-80 mesh, and 200-250mm×10 mm with Teflon stopcock). After cleaning added 5ml cyclohexane and collected theelute in 25 ml beaker. Repeated the process for 3 times and collected it in the same beaker. Followed by Solid Phase Extraction (SPE) is used for clean up the impurities of sample.

Re-concentration with rotary vacuum evaporator:

The Cleaned up extract/filtrate (approximately 17 ml) is further concentrated using rotary evaporator and it is evaporated to nearly dryness with Nitrogen.

Final Sample volume:

The dried sample is re-dissolved in 1ml of toluene and transfer into 4 or 5 ml amber vials final analysis.

8 Preparation of Standard Calibration Mixture

Stock Standard Solution PAH mix standard solution of 16 Compounds including B(a)P (Dr. Ehrenstorfer, Germany make PAH mix 63) of concentration 1000mg/l in Toluene.

Working Standard Solution Working Standard Solutions (5, 10, 15, 20, 25 ng/µl concentrations) are prepared from stock solution by diluting 200 to 40 times the stock B(a)P or other PAH solution of 1000mg/l (or 1000ng/µl) concentration with Toluene.

Internal Standard 1, 2, 3-Tri Phenyl Benzene of concentration ~1000ng/µl is added in the working standard solution so that the final concentration of Internal standard is 10 ng/µl.

Calibration of GC

Internal Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) and plot the area ratio of analyte PAH Compound [i.e. B(a)P] and the corresponding internal standard against the concentration for each compound and internal standard. The instrument is calibrated as per its manual/software.

External Calibration

Inject 1µl of each Working Standard (5, 10, 15, 20, 25 ng/µl) made in Toluene into GC-MS and plot the area of analyte viz. PAH Compound [i.e. B(a)P] against the corresponding concentration of the standard. The instrument is calibrated as per its manual/software.

The quantification of that analyte will be based on peak area response of respective compounds with respect to working calibration standard, that is calibration factor (the ratio of response to the amount of mass injected).The retention time of various PAHs compounds are obtained under the above GC conditions.

Sample injection

2µl of sample from the amber vial is automatically injected in to the capillary GCMS using auto vial instrument for analysis. Recorded the resulting concentration of each PAH compound including B(a)P. A 10ng/µl concentration B(a)P or other PAH standards injected in GCMS instrument with every batch of samples.

Calculations

Calculated the concentration in ng/µl of each identified analyte or B(a)P in the sample extract (Cs) as follows:

Calculated the air volume from the periodic flow reading taken during sampling using the following equation:

$$V = Q \times T$$

Where,

Q = Average flow rate of sampling m^3/min

T = sampling time, in min.

V = total sample volume in m^3 Concentration of analyte i.e B(a)P:

The concentration of PAH compound or Benzo(a)pyrene in ng /m^3 in the air sampled is given by:

$$C\ (ng/m^3) = Cs * Ve / Vi * Vs$$

Where,

Cs : Concentration of Benzo (a) pyrene in ng / µl in the sample extract recorded by GC.

Ve : Final volume of extract in µl (i.e 1000)

Vi : Injection Volume (i.e 1µl)

Vs : Volume of air sample in m^3

References

BIS Method IS 5182 (Part 12):2004 USEPA Method TO-13,

FLOW CHART FOR MEASUREMENT OF BENZO(A)PYRENE
EPM 2000 filter paper
⇩
Ultrasonic extraction with Toluene (50 ml × 3 times)
⇩
Filter & dry with Anhydrous Sodium Sulphate
⇩
Concentration with Rotary Evaporator
⇩
Clean up with Silica Gel Column Chromatography
⇩
Elution with Cyclo-Hexane (5 ml × 3 times)
⇩
Evaporate to nearly dryness under Nitrogen
⇩
Re-dissolved in 0.5 to 1.0 ml Toluene
⇩
Capillary GC-MS

.9 METHODOLOGY FOR SAMPLING AND ANALYSIS OF LEAD, NICKEL AND ARSENIC IN AMBIENT AIR (INDUCTIVE COUPLED PLASMA [ICP MS] METHOD)

Standard

The national ambient air quality standards for lead, nickel and arsenic is presented in the table

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)
Lead (Pb), µg/m^3	Annual *	0.50	0.50
	24 Hours **	1.0	1.0
Nickel (Ni), ng/m^3	Annual *	20	20
Arsenic (As), ng/m^3	Annual *	06	06

* Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 8 hourly or 1 hourly monitored value, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Principle of the method

The ICPMS technique makes use of plasma to assess the concentration of an analyte in the sample. The method is based on active sampling using PM10 High Volume Sampler and then sample analysis is done by ICPMS.

Instrument/Equipment

The following items are necessary to perform the protocol for monitoring of lead Arsenic and nickel in ambient air:

PM10 sampler (high volume design based)

Hot plate

Microwave Digestive System

Analytical balance

Digestion chamber

Polyethylene or polypropylene bottle

Glassware

Top loading orifice kit

ICPMS

Reagents / Chemicals

Filter Paper**:** EPM 2000 or equivalent, 20.3 X 25.4 cm (8 X 10 in)

Hydrochloric Acid (HCl) Concentrated (AR grade)

Nitric Acid (HNO3) Concentrated (AR grade)

Sulphuric Acid (H2SO4) Concentrated (AR grade)

Metal Standard Solutions (Certified standard)

Sodium borohydride (GR/AR grade).

Potassium iodide (GR/AR grade)

Distilled / De-ionized

Sampling

Sampling procedure

Tilt back the inlet and secure it according to manufacturer's instructions. Loosened the face-plate wing-nuts and removeed the face plate. Removeed the filter from its jacket and centre it on the support screen with the rough side of the filter facing upwards. Replaced the face-plate and tighten the wing-nuts to secure the rubber gasket against the filter edge. Gently lower the inlet. Recorded the designated flow rate on the data sheet. Recorded the reading of the elapsed time meter. The specified length of sampling is fixed 24 hours. During this period, several reading (hourly) of flow rate should be taken. After the required time of sampling, recorded the flow meter reading and take out the filter media from the sampler and put in an envelope.

Sample storage

After collected the samples, transported the filters to the laboratory, taken care to minimize contamination and loss of the sample. Glass fibre filters has transported in an envelope. Stored these protective envelopes up to 30 °C until analyses.

ANALYSIS

Extraction of Samples

The collected sample on glass fiber filters are extracted by microwave extraction (Method IO-3.1)**.**

Microwave extraction

Cut 1"x 8" half the filter from the 8"x10" filter sample and placed on its edge in a labelled centrifuge tube used vinyl gloves. Used the plastic forceps, crushed the filter strip down into the lower portion of the centrifuge tube to ensured acid volume will cover entire filter. Add 10.0 ml of the extraction solution to each of the centrifuge tubes (3% conc. HNO3 and 8% conc. HCl). Placed the centrifuge tubes in a Teflon vessel containing 31 ml of deionized water. Placed the vessel caps with the pressure release valves on the vessels hand-tight and tighten using the capping station to a constant torque of 12 ft-lb. Placed the vessels in the microwave carousel. Connected each sample vessel to the overflow vessel using the Teflon connecting tubes. Placed the carousel containing the 8 vessels on to the turntable of the microwave unit. Irradiate the sample vessels at 486 W (power output) for 45 min.

Allowed the pressure to dissipate, then removed the carousel containing the vessels and cool in tap water for 10 min. used the caping station uncapped the microwave vessels, removed the labelled centrifuge tube containing samples. Add 10ml of deionized water to each centrifuge tube. Caped the centrifuge tube tightly and mix the contents thoroughly for 2-3 minutes to complete extraction. The final extraction volume is 20ml based upon the above procedure. Filtered the extracted fluid with Whatman No. 41 and made up the final volume to 100 ml, the filtered sample is now ready for analysis.

Analysis of Samples : ICPMS Analysis

Instrument Operational Conditions

Plasma Forward Power	:	1500W
RF Matching	:	1.8 V
Sample depth	:	7 mm
Carrier gas	:	0.9L/min.
Makeup gas	:	0.25 L/min.
Auxillary gas	:	1.0 L/min
Plasma gas	:	15.0 L/min
Nebulizer pump	:	0.18 rps
Sample Pump	:	0.02 rps
S/C Temperature	:	2°C
Mass Range	:	7 – 240 amu

Determination

Preparation of Standard Curve:

The calibration curve (concentration versus counts/cps) is plotted and checked for linearity with minimum five concentration from minimum to maximum range. A standard check is performed within the concentration range of linearity to ensure the repeatability. Run a quality control check for every twenty samples.

Sample analysis:

Determine the sample under the same condition at which standard curve is prepared.

Dilute the sample with diluent, if the response or concentration of element in sample is falling

out of the range calibration curve. If the sample concentration is less than the lowest calibration standard, it should be considered as below detection limit.

Calculate the analyte concentration in sample by adopting the following formula

Analyte concentration = (Sample concentration – Blank concentration) x Dilution factor

Recovery:

$$\text{Recovery, \%} = \frac{\text{(Spiked sample concentration - sample concentration) x100}}{\text{Spiked concentration}}$$

Sequence of Analysis:

Standard blank
Calibration standards
QC check
Samples
Spike sample
QC check

Calibration

Preparation of Stock dilutions of Mixed Standard solution

Conc. Of Stock Solution (mg/L)	Volume of Stock (mL)	Volume of Diluent* (mL)	Made up Volume (mL)	Final Conc. (mg/L)
1000	5	45	50	100
100	5	45	50	10
10	5	45	50	1
10	10	40	50	2
10	25	25	50	5
1	5	45	50	0.1
2	5	45	50	0.2
5	5	45	50	0.5
0.1	5	45	50	0.01
0.2	5	45	50	0..02
0.5	5	45	50	0.05
0.05	5	45	50	0.005
0.02	5	45	50	0.002
0.01	5	45	50	0.001
0.005	5	45	50	0.0005
0.002	5	45	50	0.0002
0.001	5	45	50	0.0001

*The Diluent used is 2% nitric acid solution

Calculations

Sample Air Volume

Sample air volume can be calculated by using the following equation: V = (Q) (t)

Where,

V	=	Volume of air, m^3
Q	=	Average sampling rate, m^3/min.
T	=	Time in minutes.

Metal Concentration

C = (Ms – Mb) x Vs x Fa/V x Ft

Where,

C	=	Concentration, µg Metal/M^3.
Ms	=	Metal Concentration µg/ml
Mb	=	Blank Concentration µg/ml
Vs	=	Total Volume of Extraction in ml
Fa	=	Total Area of Exposed Filter in Cm^2
V	=	Volume of Air Sampled in M^3
Ft	=	Area of Filter Taken for Digestion in Cm^2

References

Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM10 Using High Volume (HV) Sampler

Method 501, Air Sampling and Analysis, 3rd Edition, Lewis publishers Inc.

IS 5182 Part 23 Method of Measurement of Air Pollution: Respirable Suspended Particulate Matter (PM10) cyclonic flow technique

EPA compendium method IO 3

EPA compendium method IO 3.1

EPA compendium method IO 3.2

Standard Method- American Public Health Association (APHA), 20th Edition, 1998.

NATIONAL AMBIENT AIR QUALITY STANDARD - 2009

S. No.	Pollutant	Time-weighted average	Concentration in ambient air		Methods of Measurement
			Industrial Areas, Residential, Rural & other Area	Ecological Sensitive Area	
1	Sulphur Dioxide (SO_2)	Annual Average	50 µg/ m^3	20 µg/ m^3	-Improved West and Greek method -Ultraviolet Flurorescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
2	Oxides of Nitrogen as (NO_2)	Annual Average	40 µg/ m^3	30 µg/ m^3	-Modified Jacob and Hochheiser -Chemiluminescence
		24 hours	80 µg/ m^3	80 µg/ m^3	
3	Suspended Particulate Matter	Annual Average	60 µg/ m^3	60 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	100 µg/ m^3	100 µg/ m^3	
4	Respirable Suspended Particulate Matter	Annual Average	40 µg/ m^3	40 µg/ m^3	-Gravimetric -TOEM -Beta attenuation
		24 hours	60 µg/ m^3	60 µg/ m^3	
5	Ozone (O_3)	8 hours	100 µg/ m^3	100 µg/ m^3	-UV Photometric -Chemiluminescence - Chemical Method
		1 hours	180 µg/ m^3	180 µg/ m^3	
6	Lead	Annual Average	0.5 µg/ m^3	0.5 µg/ m^3	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
		24 hours	1.0 µg/ m^3	1.0 µg/ m^3	
7	Carbon Monoxide (CO)	8 hours	2 mg/ m^3	2 mg/ m^3	-Non Dispersive Infra Red (NDIR) spectroscopy
		1 hours	4 mg/ m^3	4 mg/ m^3	
8	Ammonia	Annual Average	100 µg/ m^3	100 µg/ m^3	-Chemiluminescence -Indophenol blue method
		24 hours	400 µg/ m^3	400 µg/ m^3	
9	Benzene (C_6H_6)	Annual Average	5 µg/ m^3	5 µg/ m^3	-Gas chromatography based continuous analyzer -Adsorption followed by GC analysis
10	Benzo (a) Pyrene (BaP)-particulate phase only	Annual Average	1 ng/ m^3	1 ng/ m^3	-Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As)	Annual Average	6 ng/ m^3	6 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper
12	Nickel (Ni)	Annual Average	20 ng/ m^3	20 ng/ m^3	-AAS/ ICP method after sampling on EPM 2000 or equivalent filter paper

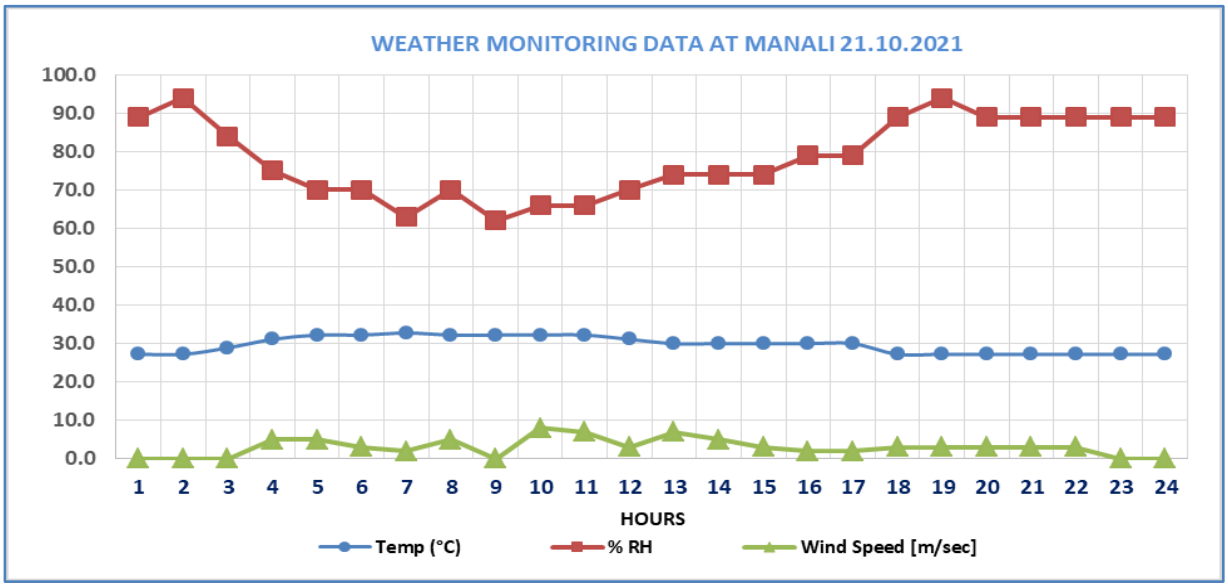
*** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.**

**** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.**

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

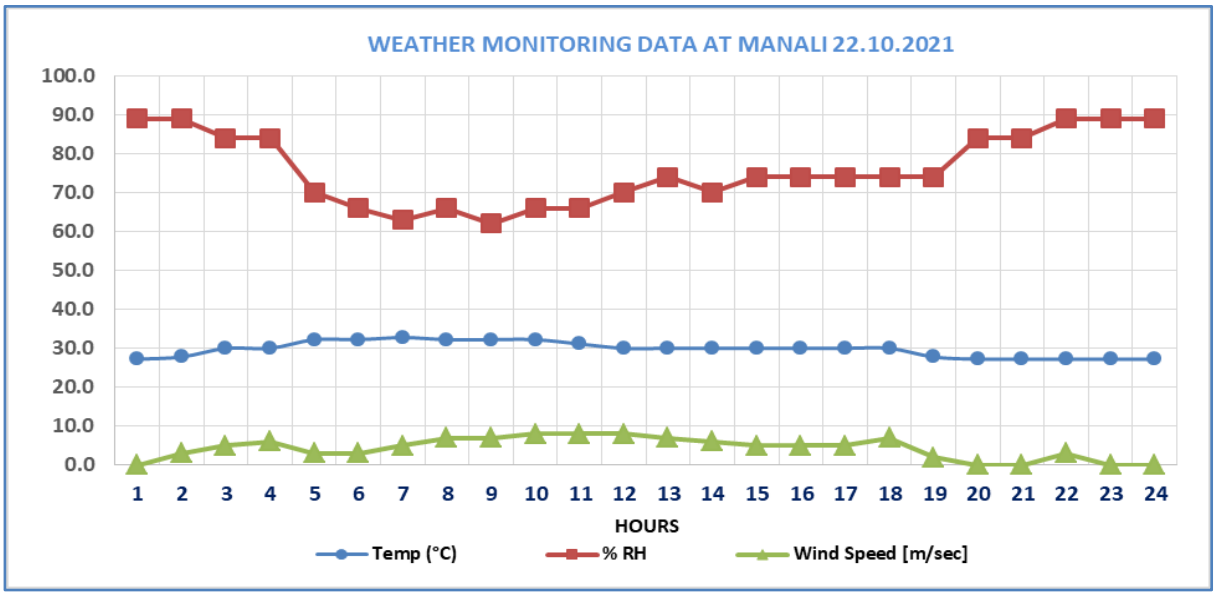
2.0 Weather Monitoring Data

WEATHER MONITORING DATA AT MANALI INDUSTRIAL ASSOCIATION - MANALI					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir. (Deg)**
21.10.2021	1:00 AM	27.2	89	0	CALM
21.10.2021	2:00 AM	27.2	94	0	CALM
21.10.2021	3:00 AM	28.9	84	0	CALM
21.10.2021	4:00 AM	31.1	75	5	WNW
21.10.2021	5:00 AM	32.2	70	5	W
21.10.2021	6:00 AM	32.2	70	3	NNE
21.10.2021	7:00 AM	32.8	63	2	VAR
21.10.2021	8:00 AM	32.2	70	5	ESE
21.10.2021	9:00 AM	32.2	62	0	CALM
21.10.2021	10:00 AM	32.2	66	8	SE
21.10.2021	11:00 AM	32.2	66	7	S
21.10.2021	12:00 PM	31.1	70	3	SSE
21.10.2021	1:00 PM	30.0	74	7	SSE
21.10.2021	2:00 PM	30.0	74	5	SSE
21.10.2021	3:00 PM	30.0	74	3	S
21.10.2021	4:00 PM	30.0	79	2	VAR
21.10.2021	5:00 PM	30.0	79	2	VAR
21.10.2021	6:00 PM	27.2	89	3	W
21.10.2021	7:00 PM	27.2	94	3	WNW
21.10.2021	8:00 PM	27.2	89	3	WNW
21.10.2021	9:00 PM	27.2	89	3	WNW
21.10.2021	10:00 PM	27.2	89	3	WNW
21.10.2021	11:00 PM	27.2	89	0	CALM
21.10.2021	12:00 AM	27.2	89	0	CALM
MIN		27.2	62.0	0	
MAX		32.8	94.0	8	
AVG		29.7	78.6	3	



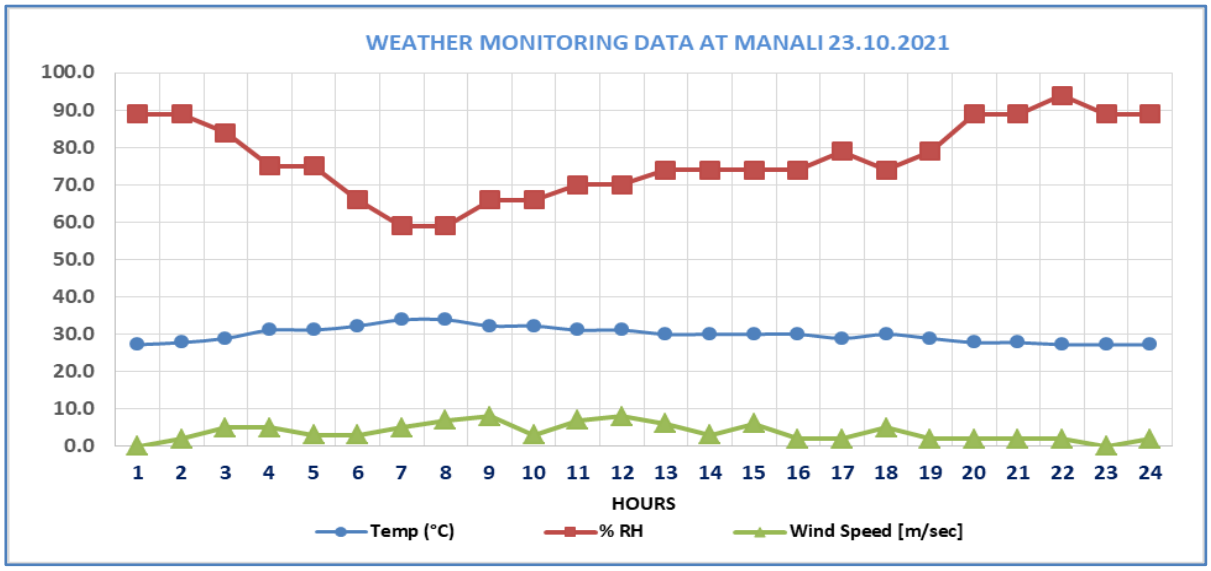
WEATHER MONITORING DATA AT MANALI INDUSTRIAL ASSOCIATION - MANALI					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir. (Deg)**
22.10.2021	1:00 AM	27.2	89	0	CALM
22.10.2021	2:00 AM	27.8	89	3	W
22.10.2021	3:00 AM	30.0	84	5	NW
22.10.2021	4:00 AM	30.0	84	6	WNW
22.10.2021	5:00 AM	32.2	70	3	SW
22.10.2021	6:00 AM	32.2	66	3	W
22.10.2021	7:00 AM	32.8	63	5	SSE
22.10.2021	8:00 AM	32.2	66	7	ESE
22.10.2021	9:00 AM	32.2	62	7	SE
22.10.2021	10:00 AM	32.2	66	8	ESE
22.10.2021	11:00 AM	31.1	66	8	ESE
22.10.2021	12:00 PM	30.0	70	8	SE
22.10.2021	1:00 PM	30.0	74	7	ESE
22.10.2021	2:00 PM	30.0	70	6	SSE
22.10.2021	3:00 PM	30.0	74	5	SSE
22.10.2021	4:00 PM	30.0	74	5	SSE
22.10.2021	5:00 PM	30.0	74	5	SSE
22.10.2021	6:00 PM	30.0	74	7	S
22.10.2021	7:00 PM	27.8	74	2	VAR
22.10.2021	8:00 PM	27.2	84	0	CALM
22.10.2021	9:00 PM	27.2	84	0	CALM
22.10.2021	10:00 PM	27.2	89	3	W

22.10.2021	11:00 PM	27.2	89	0	CALM
22.10.2021	12:00 AM	27.2	89	0	CALM
MIN		27.2	62	0	
MAX		32.8	89	8	
AVG		30	76	4.3	



WEATHER MONITORING DATA AT MANALI INDUSTRIAL ASSOCIATION - MANALI					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir. (Deg)**
23.10.2021	1:00 AM	27.2	89	0	CALM
23.10.2021	2:00 AM	27.8	89	2	VAR
23.10.2021	3:00 AM	28.9	84	5	WNW
23.10.2021	4:00 AM	31.1	75	5	WNW
23.10.2021	5:00 AM	31.1	75	3	WNW
23.10.2021	6:00 AM	32.2	66	3	WNW
23.10.2021	7:00 AM	33.9	59	5	SSW
23.10.2021	8:00 AM	33.9	59	7	SSE
23.10.2021	9:00 AM	32.2	66	8	SSW
23.10.2021	10:00 AM	32.2	66	3	SSW
23.10.2021	11:00 AM	31.1	70	7	SSE
23.10.2021	12:00 PM	31.1	70	8	SE
23.10.2021	1:00 PM	30.0	74	6	S
23.10.2021	2:00 PM	30.0	74	3	SSE
23.10.2021	3:00 PM	30.0	74	6	SSW
23.10.2021	4:00 PM	30.0	74	2	VAR

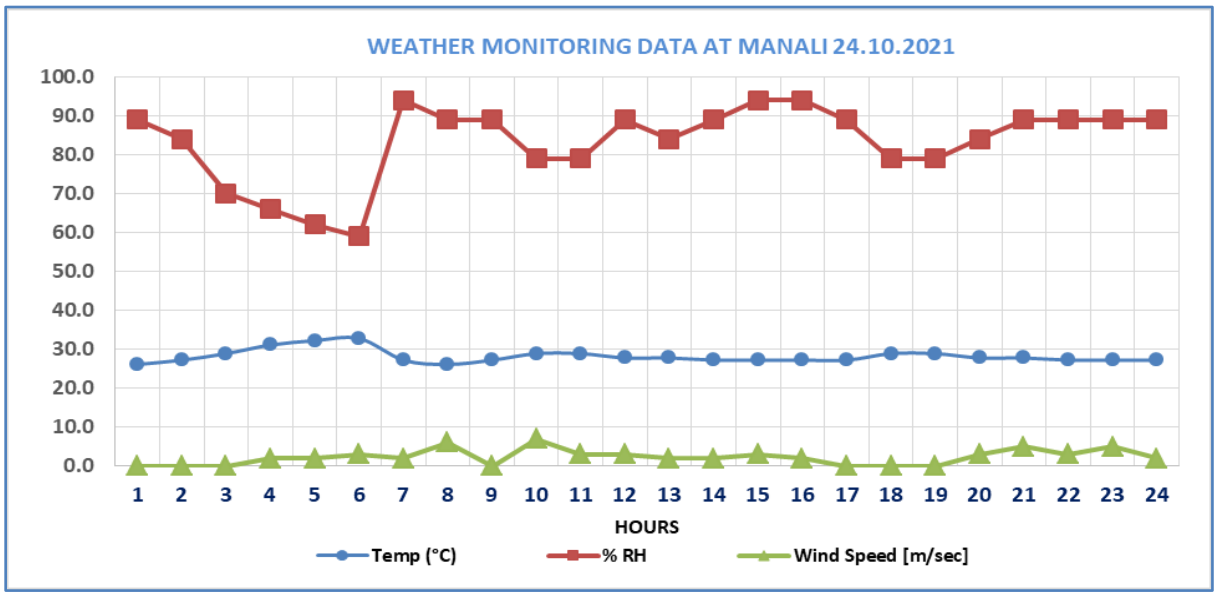
23.10.2021	5:00 PM	28.9	79	2	VAR
23.10.2021	6:00 PM	30.0	74	5	SSE
23.10.2021	7:00 PM	28.9	79	2	VAR
23.10.2021	8:00 PM	27.8	89	2	VAR
23.10.2021	9:00 PM	27.8	89	2	VAR
23.10.2021	10:00 PM	27.2	94	2	VAR
23.10.2021	11:00 PM	27.2	89	0	CALM
23.10.2021	12:00 AM	27.2	89	2	VAR
MIN		27.2	59	0	
MAX		33.9	94	8	
AVG		30	77	4	



WEATHER MONITORING DATA AT MANALI INDUSTRIAL ASSOCIATION - MANALI

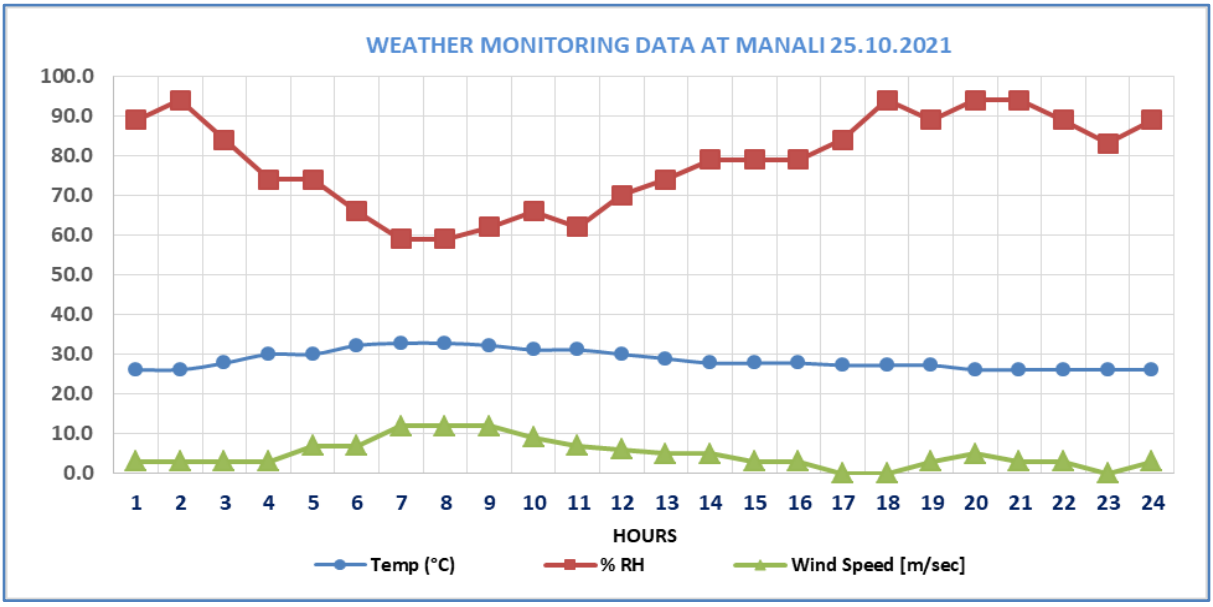
Date	Time	Temp (°C)	% RH	Wind Speed [m/sec]	Wind Dir. (Deg)
24.10.2021	1:00 AM	26.1	89	0	CALM
24.10.2021	2:00 AM	27.2	84	0	CALM
24.10.2021	3:00 AM	28.9	70	0	CALM
24.10.2021	4:00 AM	31.1	66	2	VAR
24.10.2021	5:00 AM	32.2	62	2	VAR
24.10.2021	6:00 AM	32.8	59	3	VAR
24.10.2021	7:00 AM	27.2	94	2	VAR
24.10.2021	8:00 AM	26.1	89	6	W
24.10.2021	9:00 AM	27.2	89	0	CALM
24.10.2021	10:00 AM	28.9	79	7	E
24.10.2021	11:00 AM	28.9	79	3	NE
24.10.2021	12:00 PM	27.8	89	3	ENE

24.10.2021	1:00 PM	27.8	84	2	VAR
24.10.2021	2:00 PM	27.2	89	2	VAR
24.10.2021	3:00 PM	27.2	94	3	WNW
24.10.2021	4:00 PM	27.2	94	2	VAR
24.10.2021	5:00 PM	27.2	89	0	CALM
24.10.2021	6:00 PM	28.9	79	0	CALM
24.10.2021	7:00 PM	28.9	79	0	CALM
24.10.2021	8:00 PM	27.8	84	3	W
24.10.2021	9:00 PM	27.8	89	5	WNW
24.10.2021	10:00 PM	27.2	89	3	WNW
24.10.2021	11:00 PM	27.2	89	5	W
24.10.2021	12:00 AM	27.2	89	2	VAR
MIN		26.1	59	0	
MAX		32.8	94	7	
AVG		28	83	2	



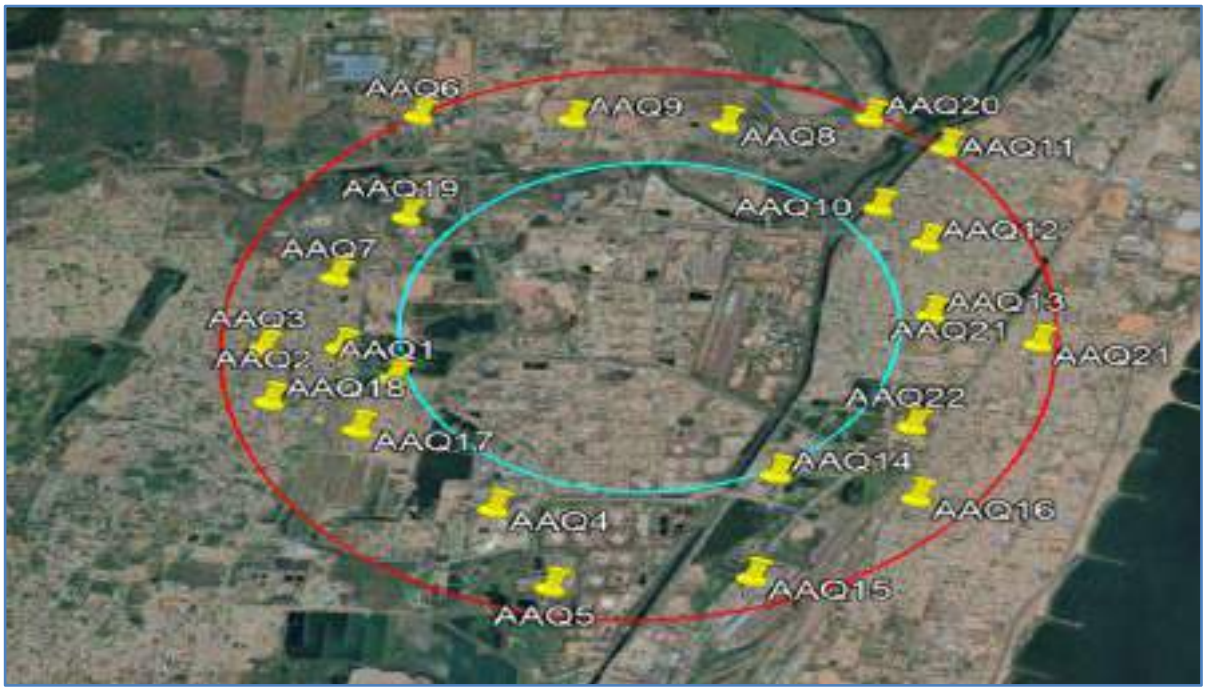
WEATHER MONITORING DATA AT MANALI INDUSTRIAL ASSOCIATION - MANALI					
Date	**Time**	**Temp (°C)**	**% RH**	**Wind Speed [m/sec]**	**Wind Dir. (Deg)**
25.10.2021	1:00 AM	26.1	89	3	NW
25.10.2021	2:00 AM	26.1	94	3	NW
25.10.2021	3:00 AM	27.8	84	3	NW
25.10.2021	4:00 AM	30.0	74	3	N
25.10.2021	5:00 AM	30.0	74	7	NE
25.10.2021	6:00 AM	32.2	66	7	NE

25.10.2021	7:00 AM	32.8	59	12	NE
25.10.2021	8:00 AM	32.8	59	12	ENE
25.10.2021	9:00 AM	32.2	62	12	ENE
25.10.2021	10:00 AM	31.1	66	9	NE
25.10.2021	11:00 AM	31.1	62	7	NE
25.10.2021	12:00 PM	30.0	70	6	NE
25.10.2021	1:00 PM	28.9	74	5	NE
25.10.2021	2:00 PM	27.8	79	5	NE
25.10.2021	3:00 PM	27.8	79	3	NNE
25.10.2021	4:00 PM	27.8	79	3	NE
25.10.2021	5:00 PM	27.2	84	0	CALM
25.10.2021	6:00 PM	27.2	94	0	CALM
25.10.2021	7:00 PM	27.2	89	3	NW
25.10.2021	8:00 PM	26.1	94	5	WNW
25.10.2021	9:00 PM	26.1	94	3	N
25.10.2021	10:00 PM	26.1	89	3	NNW
25.10.2021	11:00 PM	26.1	83	0	CALM
25.10.2021	12:00 AM	26.1	89	3	W
MIN		26	59	0	
MAX		33	94	12	
AVG		29	79	5	



3.0 GOOGLE EARTH MAP – SAMPLING LOCATION

Ambient Air Quality Monitoring Sampling Location



4.0 SAMPLING DETAILS

AMBIENT AIR QUALITY MONITORING - DAY-1			
S.No	**Date**	**Time**	**Location of Sampling**
1	21.10.2021 to 22.10.2021	08:30 – 08:30 Hrs	FIRE STATION
2	21.10.2021 to 22.10.2021	08:40 – 08:40 Hrs	PRAVEENA HOUSE RAJESNDRAPARSAD STREET
3	21.10.2021 to 22.10.2021	08:50 – 08:50 Hrs	GOVERNMENT SCHOOL PADASALALISTREET
4	21.10.2021 to 22.10.2021	09.00 – 09.00 Hrs	CPCL ETP
5	21.10.2021 to 22.10.2021	09.10 – 09.10 Hrs	CPCL TTP
6	21.10.2021 to 22.10.2021	09.20 – 09.20 Hrs	CPCL GAS PLANT
7	21.10.2021 to 22.10.2021	09.30 – 09.30 Hrs	CPCL POLYTECHNIC COLLEGE
8	21.10.2021 to 22.10.2022	10.00 – 10.00 Hrs	TKP NAGAR 2nd STREET
9	21.10.2021 to 22.10.2023	10.10 – 10.10 Hrs	PRECISION TOOLS MATHURA EXPRESS ROAD
10	23.10.2021 to 24.10.2025	10.10 – 10.10 Hrs	PRIMARY HEALTH CENTRE KALAINGAR NAGAR
11	23.10.2021 to 24.10.2025	10.20 – 10.20 Hrs	RAMESH HOUSE KARGIL NAGAR
12	23.10.2021 to 24.10.2026	10.30 – 10.30 Hrs	PARAMESHWAR NAGAR
13	23.10.2021 to 24.10.2027	10.45 – 10.45 Hrs	NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
14	23.10.2021 to 24.10.2028	11:00 – 11:00 Hrs	RAJIV NAGAR 3rd STREET THIRUVOTIYUR
15	23.10.2021 to 24.10.2029	11:20 – 11:20 Hrs	29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE)
16	23.10.2021 to 24.10.2030	11:30 – 11:30 Hrs	PARATHASARATHY STREET
17	23.10.2021 to 24.10.2031	11:50 – 11:50 Hrs	MAHATMA GANDHI MEMORIAL SCHOOL
18	23.10.2021 to 24.10.2032	12:25 – 12:25 Hrs	VICTORY METRIC SCHOOL VILLAGE STREET
19	23.10.2021 to 24.10.2033	12:30 – 12:30 Hrs	KCP POLYTECHNIC COLLEGE

AMBIENT AIR QUALITY MONITORING - DAY-2			
S.No	**Date**	**Time**	**Location of Sampling**
1	22.10.2021 to 23.10.2021	08:30 – 08:30 Hrs	FIRE STATION
2	22.10.2021 to 23.10.2021	08:40 – 08:40 Hrs	PRAVEENA HOUSE RAJESNDRAPARSAD STREET
3	22.10.2021 to 23.10.2021	08:50 – 08:50 Hrs	GOVERNMENT SCHOOL PADASALALISTREET
4	22.10.2021 to 23.10.2021	09.00 – 09.00 Hrs	CPCL ETP
5	22.10.2021 to 23.10.2021	09.10 – 09.10 Hrs	CPCL TTP
6	22.10.2021 to 23.10.2021	09.20 – 09.20 Hrs	CPCL GAS PLANT
7	22.10.2021 to 23.10.2021	09.30 – 09.30 Hrs	CPCL POLYTECHNIC COLLEGE
8	22.10.2021 to 23.10.2021	10.00 – 10.00 Hrs	TKP NAGAR 2nd STREET
9	22.10.2021 to 23.10.2021	10.10 – 10.10 Hrs	PRECISION TOOLS MATHURA EXPRESS ROAD
10	24.10.2021 to 25.10.2021	10.20 – 10.20 Hrs	PRIMARY HEALTH CENTRE KALAINGAR NAGAR
11	24.10.2021 to 25.10.2021	10.25 – 10.25 Hrs	RAMESH HOUSE KARGIL NAGAR
12	24.10.2021 to 25.10.2021	10.30 – 10.30 Hrs	PARAMESHWAR NAGAR
13	24.10.2021 to 25.10.2021	10.45 – 10.45 Hrs	NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
14	24.10.2021 to 25.10.2021	11:00 – 11:00 Hrs	RAJIV NAGAR 3rd STREET THIRUVOTIYUR
15	24.10.2021 to 25.10.2021	11:20 – 11:20 Hrs	29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE)
16	24.10.2021 to 25.10.2021	11:35 – 11:35 Hrs	PARATHASARATHY STREET
17	24.10.2021 to 25.10.2021	11:50 – 11:50 Hrs	MAHATMA GANDHI MEMORIAL SCHOOL
18	24.10.2021 to 25.10.2021	12:15 – 12:15 Hrs	VICTORY METRIC SCHOOL VILLAGE STREET
19	24.10.2021 to 25.10.2021	12:25 – 12:25 Hrs	KCP POLYTECHNIC COLLEGE

5.0 DETAILS OF RESULTS AND DISCUSSIONS AMBIENT AIR QUALITY MONITORING

DAY-1 STATION- 1: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – FIRE STATION - MANALI			
SAMPLING DATE & TIME 21.10.2021 [08:30 Hrs] – 22.10.2021 [08:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.8
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	43.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	67.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	37.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 2: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRAVEENA HOUSE RAJESNDRAPARSAD STREET, MANALI			
SAMPLING DATE & TIME 21.10.2021 [08:40 Hrs] – 22.10.2021 [08:40 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.3
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	48.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	56.2
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.9
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)

12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 3: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – GOVERNMENT SCHOOL PADASALALISTREET, MANALI			
SAMPLING DATE & TIME 21.10.2021 [08:50 Hrs] – 22.10.2021 [08:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	29.2
2	Nitrogen Dioxide as NO_2	µg/m^3	45.7
3	Particulate Matter (PM_{10})	µg/m^3	59.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	37.6
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 4: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI, MANALI

LOCATION – CPCL ETP, MANALI			
SAMPLING DATE & TIME 21.10.2021 [09:00 Hrs] – 22.10.2021 [09:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	30.1
2	Nitrogen Dioxide as NO_2	µg/m^3	40.5
3	Particulate Matter (PM_{10})	µg/m^3	65.2
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	35.9
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)

12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-1</u> STATION- 5: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL TTP, MANALI			
SAMPLING DATE & TIME 21.10.2021 [09:10 Hrs] – 22.10.2021 [09:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	32.1
2	Nitrogen Dioxide as NO_2	µg/m^3	38.8
3	Particulate Matter (PM_{10})	µg/m^3	58.7
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	35.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-1</u> STATION- 6: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI, MANALI

LOCATION – CPCL GAS PLANT, MANALI			
SAMPLING DATE & TIME 21.10.2021 [09:20 Hrs] – 22.10.2021 [09:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	29.8
2	Nitrogen Dioxide as NO_2	µg/m^3	43.9
3	Particulate Matter (PM_{10})	µg/m^3	50.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	32.5
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)

11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 7: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL POLYTECHNIC COLLEGE, MANALI			
SAMPLING DATE & TIME 21.10.2021 [09:30 Hrs] – 22.10.2021 [09:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	29.1
2	Nitrogen Dioxide as NO_2	µg/m^3	40.4
3	Particulate Matter (PM_{10})	µg/m^3	58.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	34
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 8: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – TKP NAGAR 2nd STREET, MANALI			
SAMPLING DATE & TIME 21.10.2021 [10:00 Hrs] – 22.10.2021 [10:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	31.9
2	Nitrogen Dioxide as NO_2	µg/m^3	40.6
3	Particulate Matter (PM_{10})	µg/m^3	56.6
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	35.2
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)

11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 9: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRECISION TOOLS MATHURA EXPRESS ROAD, MANALI			
SAMPLING DATE & TIME 21.10.2021 [10:10 Hrs] – 22.10.2021 [10:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	35.1
2	Nitrogen Dioxide as NO_2	µg/m^3	41
3	Particulate Matter (PM_{10})	µg/m^3	59.4
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	33.5
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 10: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRIMARY HEALTH CENTRE KALAINGAR NAGAR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:10 Hrs] – 24.10.2021 [10:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	30.5
2	Nitrogen Dioxide as NO_2	µg/m^3	43.7
3	Particulate Matter (PM_{10})	µg/m^3	59.4
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	33.5
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)

10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 11: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – RAMESH HOUSE KARGIL NAGAR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:20 Hrs] – 24.10.2021 [10:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	29.2
2	Nitrogen Dioxide as NO_2	µg/m^3	45.5
3	Particulate Matter (PM_{10})	µg/m^3	54.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	34.8
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 12: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PARAMESHWAR NAGAR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:30 Hrs] – 24.10.2021 [10:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	27.5
2	Nitrogen Dioxide as NO_2	µg/m^3	43.4
3	Particulate Matter (PM_{10})	µg/m^3	54.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	34.8
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)

10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 13: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:45 Hrs] – 24.10.2021 [10:45 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	34.7
2	Nitrogen Dioxide as NO_2	µg/m^3	43.2
3	Particulate Matter (PM_{10})	µg/m^3	60.6
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	32.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 14: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – RAJIV NAGAR 3rd STREET THIRUVOTIYUR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [11:00 Hrs] – 24.10.2021 [11:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	33.7
2	Nitrogen Dioxide as NO_2	µg/m^3	39.7
3	Particulate Matter (PM_{10})	µg/m^3	60.6
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	32.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)

10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-1</u> STATION- 15: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – 29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE), MANALI			
SAMPLING DATE & TIME 23.10.2021 [11:20 Hrs] – 24.10.2021 [11:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	34.1
2	Nitrogen Dioxide as NO_2	µg/m^3	38.5
3	Particulate Matter (PM_{10})	µg/m^3	55.2
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	32.9
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-1</u> STATION- 16: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PARATHASARATHY STREET,CHINNASEKADAI, MANALI			
SAMPLING DATE & TIME 23.10.2021 [11:35 Hrs] – 24.10.2021 [11:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	28.4
2	Nitrogen Dioxide as NO_2	µg/m^3	39.1
3	Particulate Matter (PM_{10})	µg/m^3	52.2
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	32.3
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)

9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 17: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – MAHATMA GANDHI MEMORIAL SCHOOL, MANALI			
SAMPLING DATE & TIME 23.10.2021 [11:50 Hrs] – 24.10.2021 [11:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	34.5
2	Nitrogen Dioxide as NO_2	µg/m^3	40.8
3	Particulate Matter (PM_{10})	µg/m^3	59.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	36.4
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-1 STATION- 18: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – VICTORY METRIC SCHOOL VILLAGE STREET, MANALI			
SAMPLING DATE & TIME 23.10.2021 [12:25 Hrs] – 24.10.2021 [12:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	28.4
2	Nitrogen Dioxide as NO_2	µg/m^3	43.5
3	Particulate Matter (PM_{10})	µg/m^3	56.3
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	31
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)

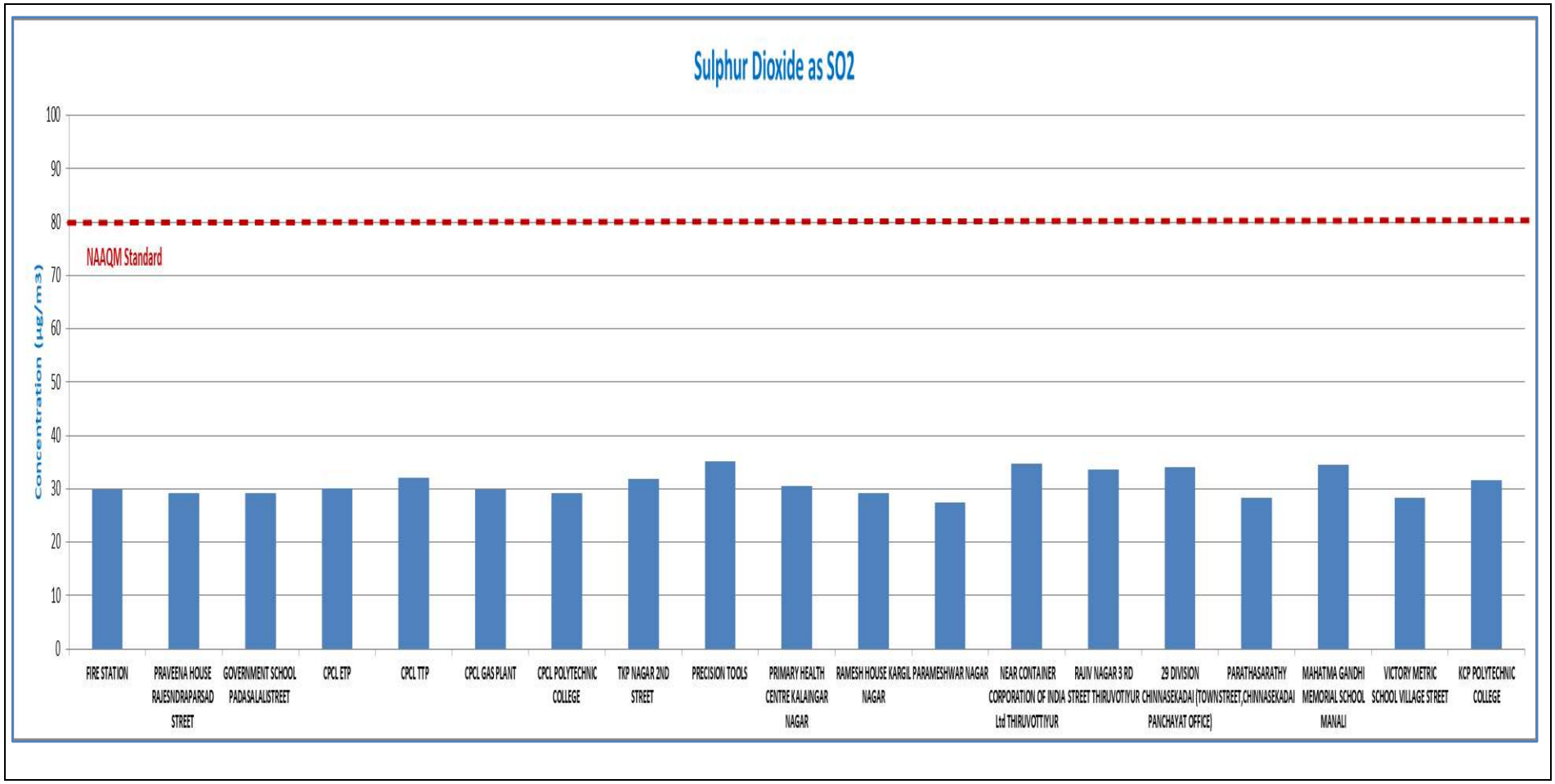
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

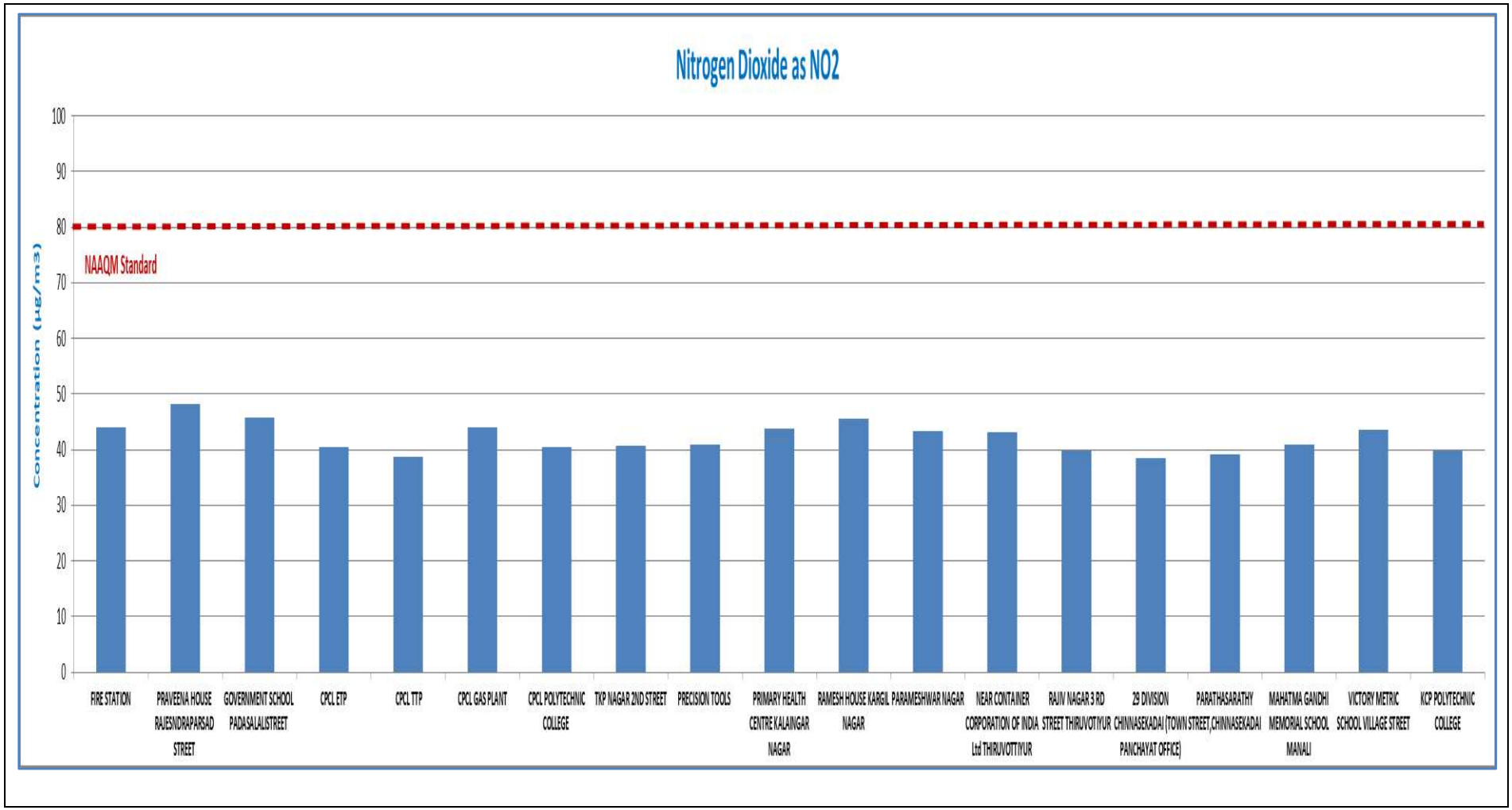
<u>DAY-1</u> STATION- 19: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

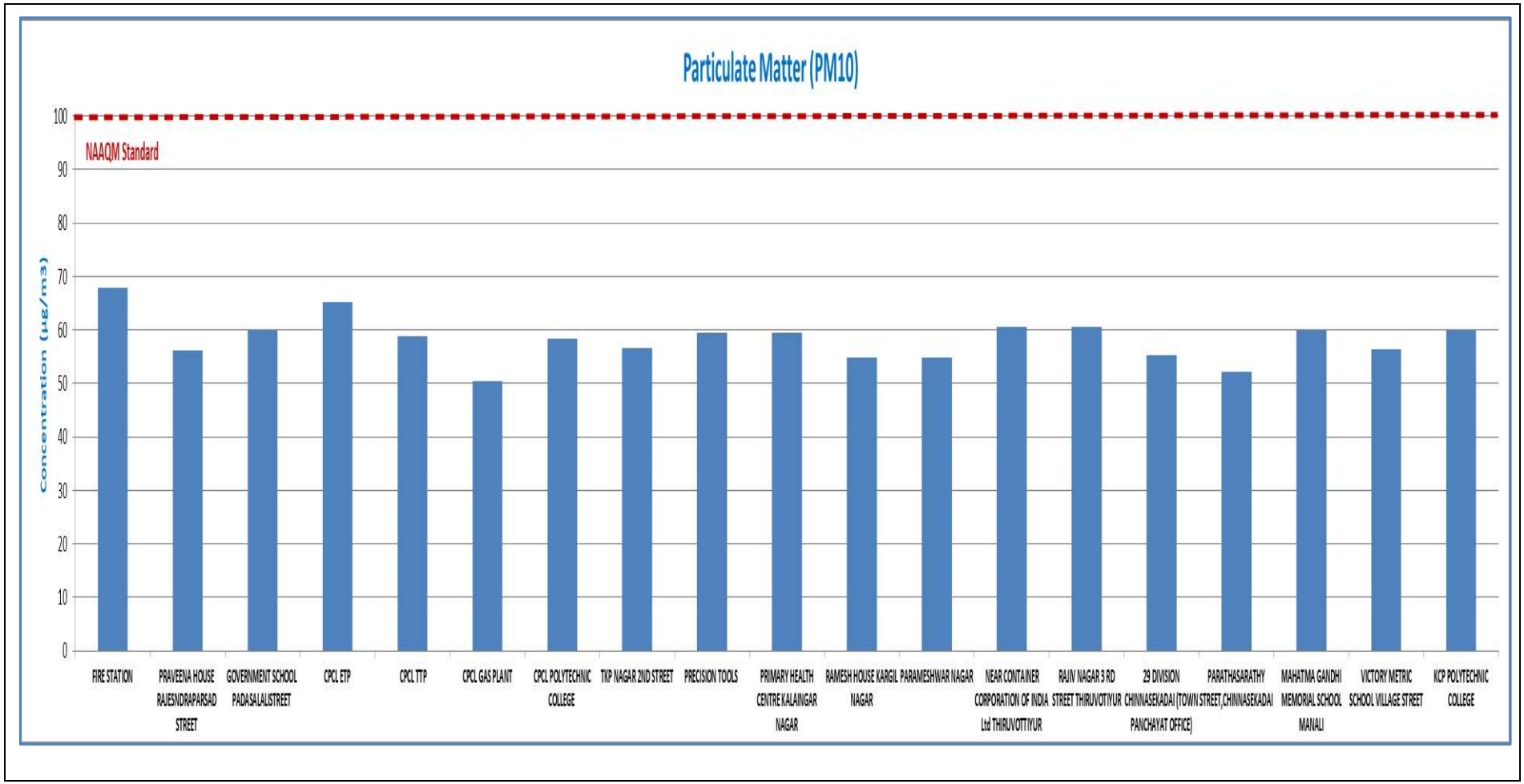
LOCATION – KCP POLYTECHNIC COLLEGE, MANALI			
SAMPLING DATE & TIME 23.10.2021 [12:30 Hrs] – 24.10.2021 [12:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	31.7
2	Nitrogen Dioxide as NO_2	µg/m^3	39.9
3	Particulate Matter (PM_{10})	µg/m^3	59.9
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	36.4
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

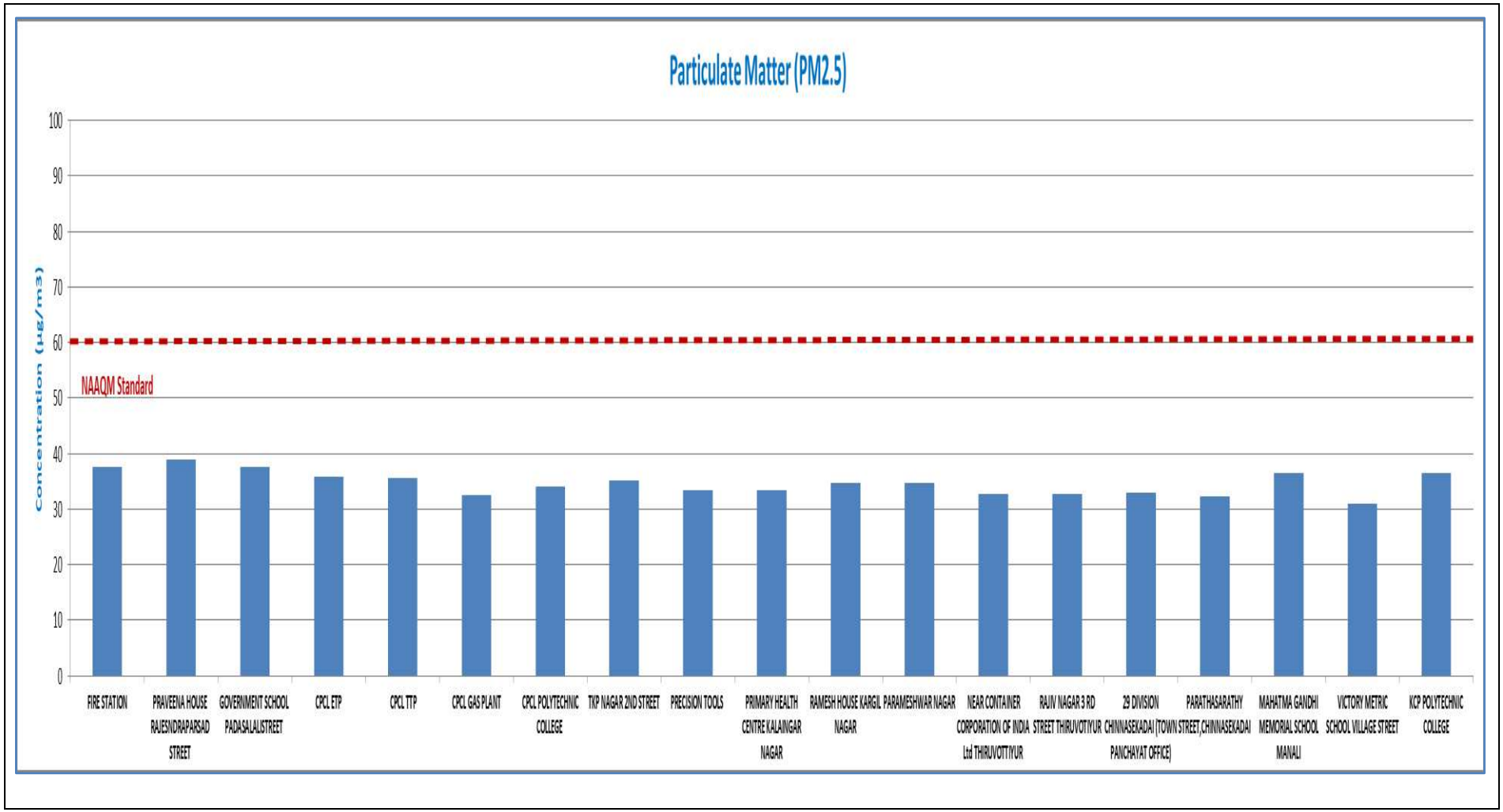
DAY-1 AAQM Consolidated Monitoring Results:

DAY-1 AAQM Consolidated Monitoring Results (µg/m3)				
[21.10.2021 to 24.10.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
Fire Station	29.8	43.9	67.9	37.6
Praveena House rajendra prasad Street	29.3	48.2	56.2	38.9
Government School Padasalali street	29.2	45.7	59.9	37.6
CPCL ETP	30.1	40.5	65.2	35.9
CPCL TTP	32.1	38.8	58.7	35.7
CPCL Gas Plant	29.8	43.9	50.3	32.5
CPCL Polytechnic College	29.1	40.4	58.3	34
TKP Nagar 2nd Street	31.9	40.6	56.6	35.2
Precision Tools	35.1	41	59.4	33.5
Primary Health Centre Kalaingar Nagar	30.5	43.7	59.4	33.5
Ramesh House Kargil Nagar	29.2	45.5	54.9	34.8
Parameshwar Nagar	27.5	43.4	54.9	34.8
Near Container Corporation Of India Ltd - Thiruvottiyur	34.7	43.2	60.6	32.7
Rajiv Nagar 3rd Street Thiruvotiyur	33.7	39.7	60.6	32.7
29 Division Chinnasekadai (Town Panchayat Office)	34.1	38.5	55.2	32.9
Parathasarathy Street,Chinnasekadai	28.4	39.1	52.2	32.3
Mahatma Gandhi Memorial School Manali	34.5	40.8	59.9	36.4
Victory Metric School Village Street	28.4	43.5	56.3	31
KCP Polytechnic College	31.7	39.9	59.9	36.4


Sulphur Dioxide as SO2
Concentration (µg/m3)
NAAQM Standard
100
90
80
70
60
50
40
30
20
10
0
FIRE STATION
PRAVEENA HOUSE RAJESNDRAPARSAD STREET
GOVERNMENT SCHOOL PADASALALISTREET
CPCL ETP
CPCL TTP
CPCL GAS PLANT
CPCL POLYTECHNIC COLLEGE
TKP NAGAR 2ND STREET
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET THIRUVOTTIYUR
29 DIVISION CHINNASEKADAI (TOWNSTREET,CHINNASEKADAI PANCHAYAT OFFICE)
PARATHASARATHY
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Nitrogen Dioxide as NO2
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
NAAQM Standard
FIRE STATION
PRAVEENA HOUSE RAJESNDRAPARSAD STREET
GOVERNMENT SCHOOL PADASALALSTREET
CPCL ETP
CPCL TTP
CPCL GAS PLANT
CPCL POLYTECHNIC COLLEGE
TKP NAGAR 2ND STREET
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET THIRUVOTTIYUR
29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE)
PARATHASARATHY STREET,CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Particulate Matter (PM10)
NAAQM Standard
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
FIRE STATION
PRAVEENA HOUSE RAJESNDRAPARSAD STREET
GOVERNMENT SCHOOL PADASALALISTREET
CPCL ETP
CPCL TTP
CPCL GAS PLANT
CPCL POLYTECHNIC COLLEGE
TKP NAGAR 2ND STREET
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET THIRUVOTIYUR
29 DIVISION CHINNASEKADAI PANCHAYAT OFFICE)
PARATHASARATHY (TOWN STREET,CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Particulate Matter (PM2.5)
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
NAAQM Standard
FIRE STATION
PRAVEENA HOUSE RAJESNDRAPARSAD STREET
GOVERNMENT SCHOOL PADASALALISTREET
CPCL ETP
CPCL TTP
CPCL GAS PLANT
CPCL POLYTECHNIC COLLEGE
TKP NAGAR 2ND STREET
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET THIRUVOTTIYUR
29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE)
PARATHASARATHY STREET,CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE

<u>DAY-2</u> STATION- 1: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – FIRE STATION - MANALI			
SAMPLING DATE & TIME 22.10.2021 [08:30 Hrs] – 23.10.2021 [08:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	30.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	44.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	60.6
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	29.1
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 2: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRAVEENA HOUSE RAJESNDRAPARSAD STREET, MANALI			
SAMPLING DATE & TIME 22.10.2021 [08:40 Hrs] – 23.10.2021 [08:40 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	32.6
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	44.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	57.1
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	32.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 3: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – GOVERNMENT SCHOOL PADASALALI STREET, MANALI			
SAMPLING DATE & TIME 22.10.2021 [08:50 Hrs] – 23.10.2021 [08:50 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	32.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	46.1
3	Particulate Matter (PM_{10})	$\mu g/m^3$	54.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	35.3
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 4: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL ETP, MANALI			
SAMPLING DATE & TIME 22.10.2021 [09:00 Hrs] – 23.10.2021 [09:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	30.4
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	42.2
3	Particulate Matter (PM_{10})	$\mu g/m^3$	62.2
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	34.5
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 5: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL TTP, MANALI			
SAMPLING DATE & TIME 22.10.2021 [09:10 Hrs] – 23.10.2021 [09:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	31.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	44.6
3	Particulate Matter (PM_{10})	$\mu g/m^3$	55.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 6: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL GAS PLANT, MANALI			
SAMPLING DATE & TIME 22.10.2021 [09:20 Hrs] – 23.10.2021 [09:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	30.6
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	41.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	49.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	35.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 7: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – CPCL POLYTECHNIC COLLEGE, MANALI			
SAMPLING DATE & TIME 22.10.2021 [09:30 Hrs] – 23.10.2021 [09:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.7
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	42.5
3	Particulate Matter (PM_{10})	$\mu g/m^3$	56.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	36.6
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 8: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – TKP NAGAR 2ND STREET, MANALI			
SAMPLING DATE & TIME 22.10.2021 [10:00 Hrs] – 23.10.2021 [10:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.9
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	44.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	59.9
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 9: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRECISION TOOLS MATHURA EXPRESS ROAD, MANALI			
SAMPLING DATE & TIME 22.10.2021 [10:10 Hrs] – 23.10.2021 [10:10 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	33.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	47.7
3	Particulate Matter (PM_{10})	$\mu g/m^3$	68.7
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	38.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 10: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PRIMARY HEALTH CENTRE KALAINGAR NAGAR, MANALI			
SAMPLING DATE & TIME 24.10.2021 [10:20 Hrs] – 25.10.2021 [10:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	33.5
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	45.8
3	Particulate Matter (PM_{10})	$\mu g/m^3$	70.3
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	33.1
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 11: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – RAMESH HOUSE KARGIL NAGAR, MANALI			
SAMPLING DATE & TIME 24.10.2021 [10:25 Hrs] – 25.10.2021 [10:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	30.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	42.6
3	Particulate Matter (PM_{10})	$\mu g/m^3$	64.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	40.7
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 12: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PARAMESHWAR NAGAR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:30 Hrs] – 24.10.2021 [10:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	31.1
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	39.6
3	Particulate Matter (PM_{10})	$\mu g/m^3$	53.8
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 13: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – NEAR CONTAINER CORPORATION OF INDIA Ltd THIRUVOTTIYUR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [10:45 Hrs] – 24.10.2021 [10:45 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	32.6
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	40.3
3	Particulate Matter (PM_{10})	$\mu g/m^3$	59.5
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31.4
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 14: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – RAJIV NAGAR 3rd STREET THIRUVOTIYUR, MANALI			
SAMPLING DATE & TIME 23.10.2021 [11:00 Hrs] – 24.10.2021 [11:00 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	31
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	39.9
3	Particulate Matter (PM_{10})	$\mu g/m^3$	63.7
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	31
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 15: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – 29 DIVISION CHINNASEKADAI (TOWN PANCHAYAT OFFICE), MANALI			
SAMPLING DATE & TIME 24.10.2021 [11:20 Hrs] – 25.10.2021 [11:20 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	31.4
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	41.4
3	Particulate Matter (PM_{10})	$\mu g/m^3$	71.4
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	32.2
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-2</u> STATION- 16: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – PARATHASARATHY STREET,CHINNASEKADAI, MANALI			
SAMPLING DATE & TIME 24.10.2021 [11:35 Hrs] – 25.10.2021 [11:35 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	32.5
2	Nitrogen Dioxide as NO_2	µg/m^3	47.9
3	Particulate Matter (PM_{10})	µg/m^3	72.2
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	36.8
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

DAY-2 STATION- 17: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

LOCATION – MAHATMA GANDHI MEMORIAL SCHOOL, MANALI			
SAMPLING DATE & TIME 24.10.2021 [12:15 Hrs] – 25.10.2021 [12:15 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.9
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	46.5
3	Particulate Matter (PM_{10})	$\mu g/m^3$	57.1
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	33.1
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

<u>DAY-2</u> STATION- 18: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

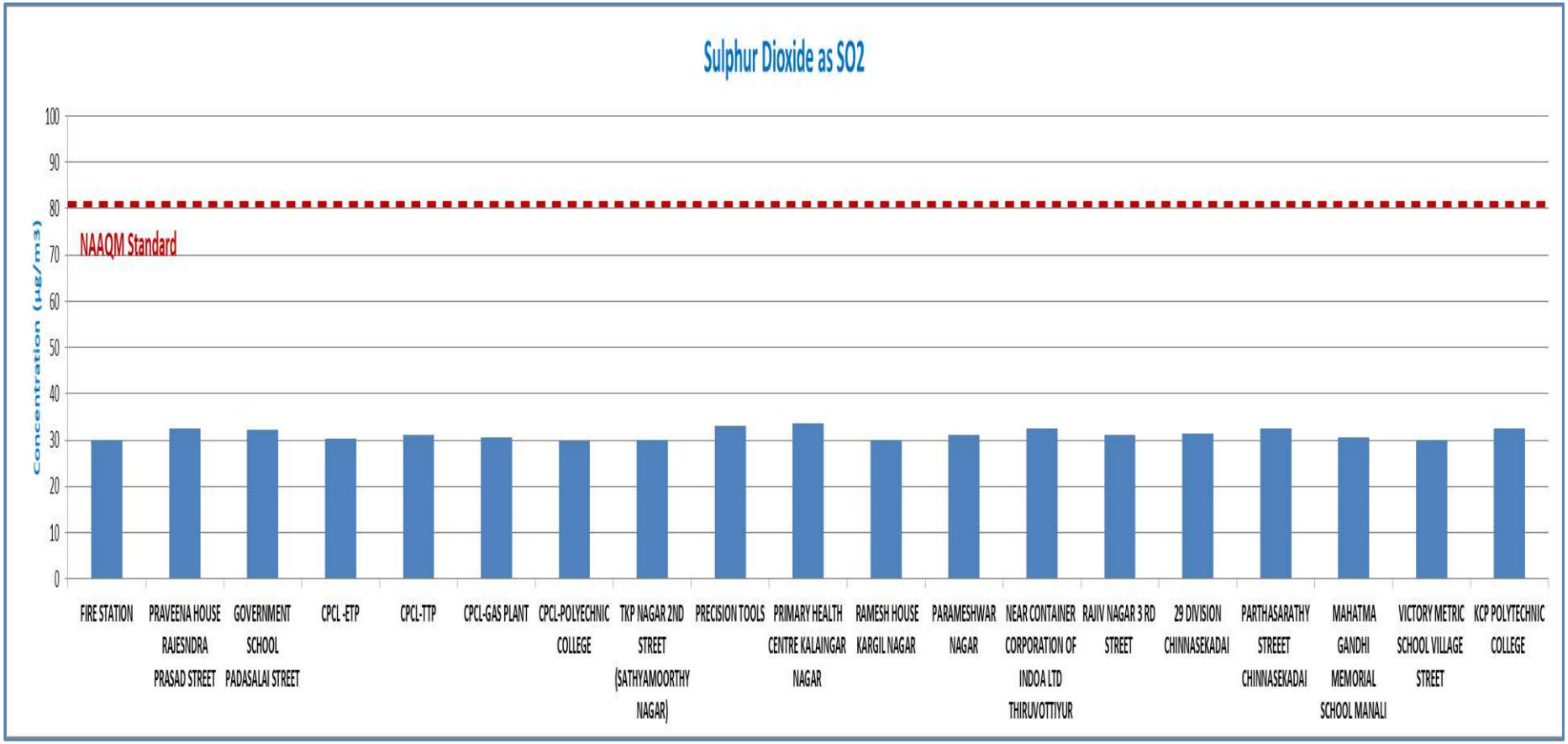
LOCATION – VICTORY METRIC SCHOOL VILLAGE STREET, MANALI			
SAMPLING DATE & TIME 24.10.2021 [12:25 Hrs] – 25.10.2021 [12:25 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	$\mu g/m^3$	29.9
2	Nitrogen Dioxide as NO_2	$\mu g/m^3$	46.5
3	Particulate Matter (PM_{10})	$\mu g/m^3$	57.1
4	Particulate Matter ($PM_{2.5}$)	$\mu g/m^3$	33.1
5	Lead as Pb	$\mu g/m^3$	BLQ(LOQ:0.002)
6	Ammonia as NH3	$\mu g/m^3$	BDL(DL:20)
7	Ozone as O3	$\mu g/m^3$	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	$\mu g/m^3$	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

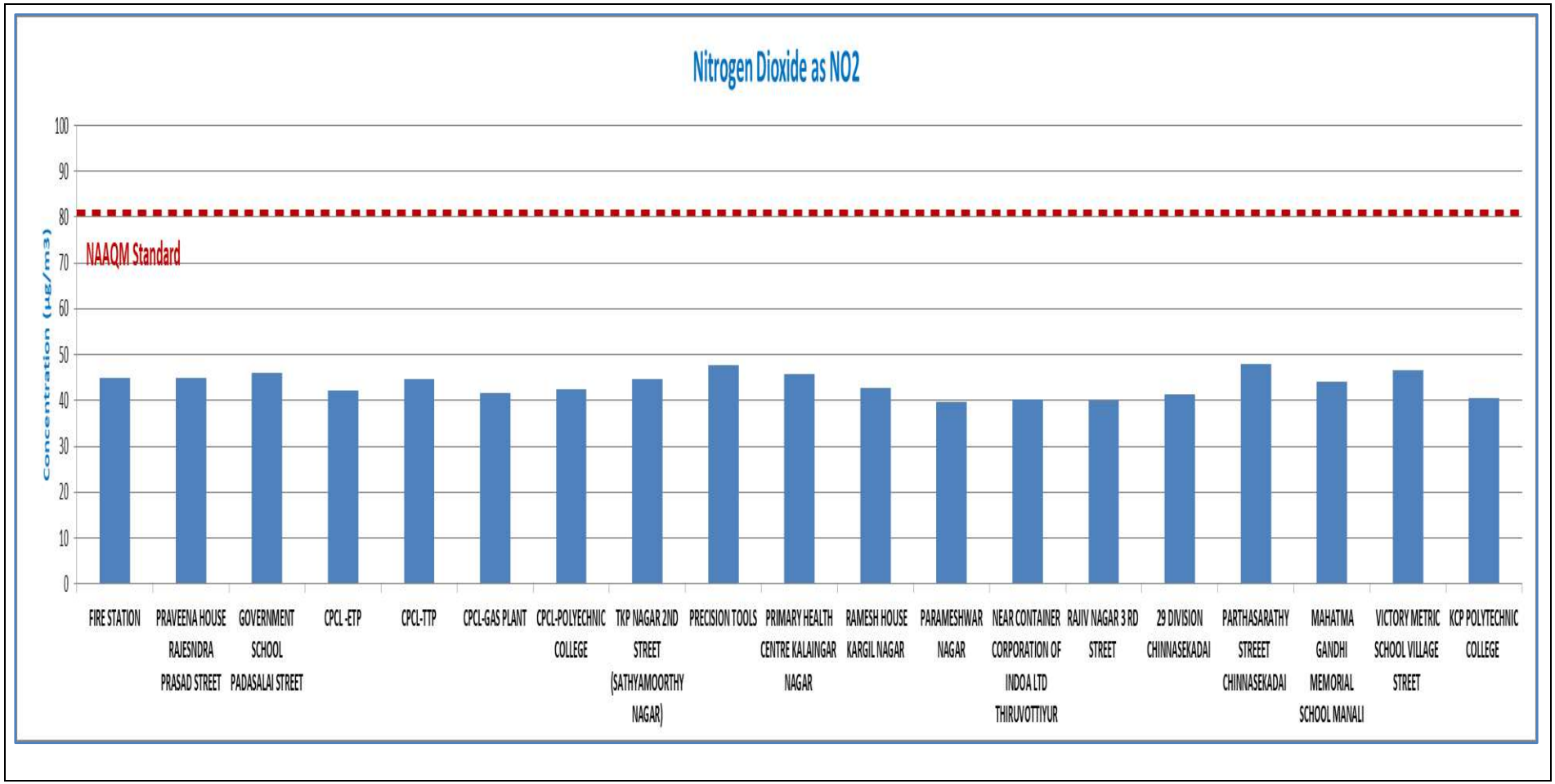
<u>DAY-2</u> STATION- 19: M/s. MANALI INDUSTRIAL ASSOCIATION, MANALI

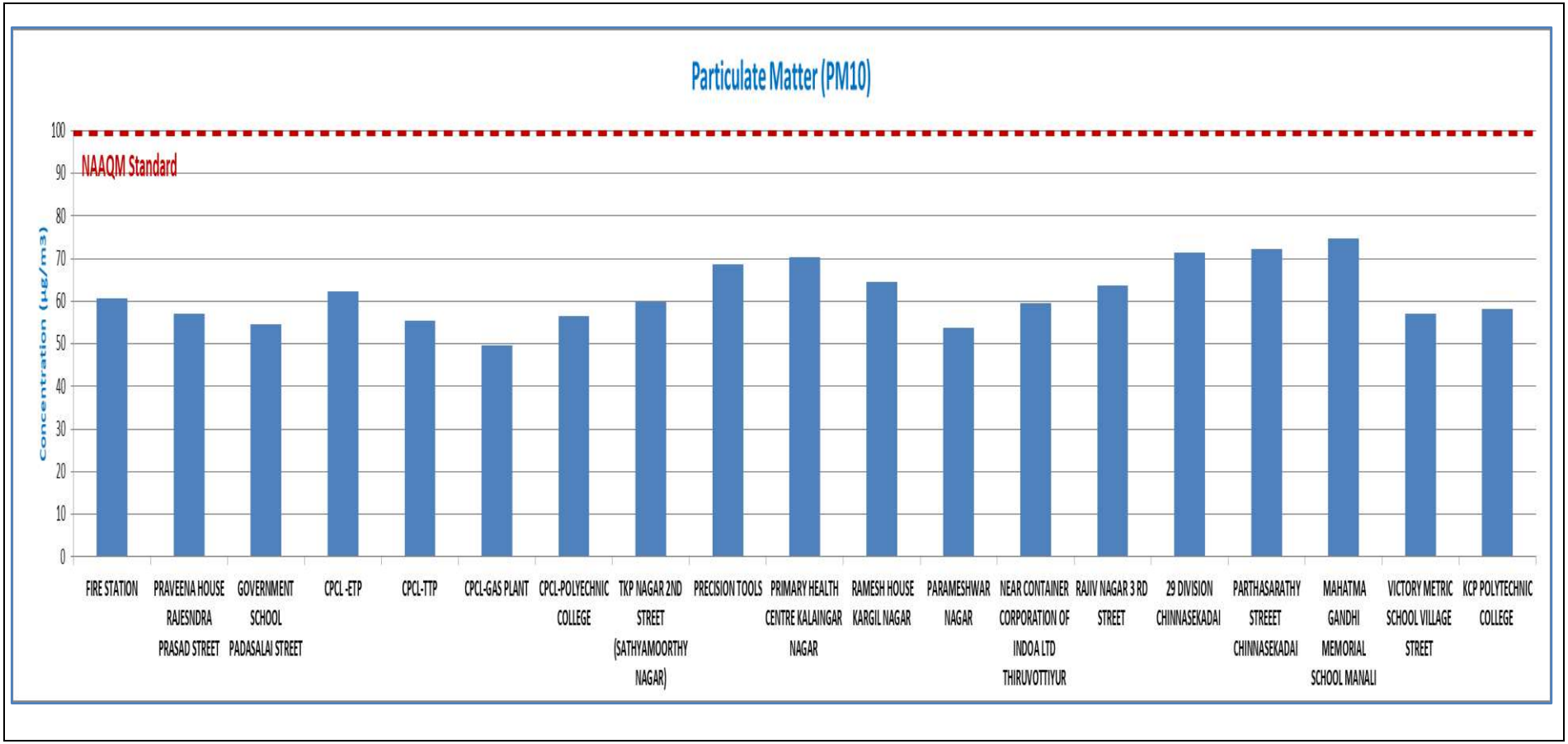
LOCATION – KCP POLYTECHNIC COLLEGE, MANALI			
SAMPLING DATE & TIME 23.10.2021 [12:30 Hrs] – 24.10.2021 [12:30 Hrs]			
S.NO	**POLLUTANT**	**UNIT**	**RESULT**
1	Sulphur Dioxide as SO_2	µg/m^3	32.6
2	Nitrogen Dioxide as NO_2	µg/m^3	40.4
3	Particulate Matter (PM_{10})	µg/m^3	58.2
4	Particulate Matter ($PM_{2.5}$)	µg/m^3	37.7
5	Lead as Pb	µg/m^3	BLQ(LOQ:0.002)
6	Ammonia as NH3	µg/m^3	BDL(DL:20)
7	Ozone as O3	µg/m^3	BDL(DL:20)
8	Carbon Monoxide as CO	mg/m3	BDL(DL:1.14)
9	Benzene	µg/m^3	BLQ(LOQ:4.0)
10	Benzo(a)Pyrene	ng/m^3	BLQ(LOQ:0.03)
11	Arsenic as As	ng/m^3	BLQ(LOQ:2.0)
12	Nickel as Ni	ng/m^3	BLQ(LOQ:2.0)

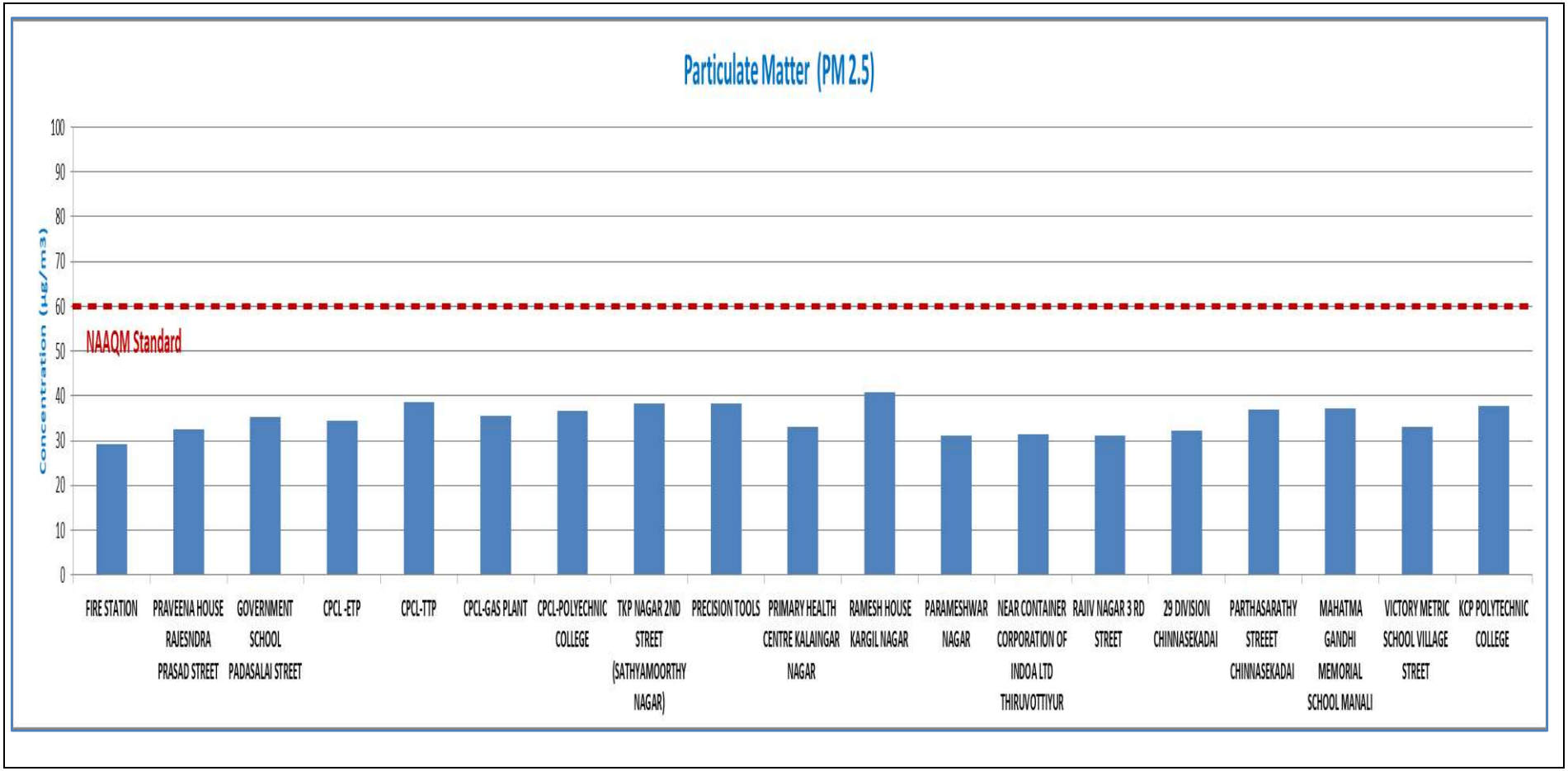
DAY-2 AAQM Consolidated Monitoring Results:

DAY-2 AAQM Consolidated Monitoring Results (µg/m3)				
[22.10.2021 to 25.10.2021]				
Sampling Location	**SO2**	**NO2**	**PM10**	**PM2.5**
Fire Station	30.1	44.9	60.6	29.1
Praveena House rajendra prasad Street	32.6	44.9	57.1	32.6
Government School Padasalali street	32.1	46.1	54.5	35.3
CPCL ETP	30.4	42.2	62.2	34.5
CPCL TTP	31.1	44.6	55.3	38.6
CPCL Gas Plant	30.6	41.7	49.5	35.6
CPCL Polytechnic College	29.7	42.5	56.5	36.6
TKP Nagar 2nd Street	29.9	44.7	59.9	38.2
Precision Tools	33.1	47.7	68.7	38.2
Primary Health Centre Kalaingar Nagar	33.5	45.8	70.3	33.1
Ramesh House Kargil Nagar	30.1	42.6	64.5	40.7
Parameshwar Nagar	31.1	39.6	53.8	31
Near Container Corporation Of India Ltd - Thiruvottiyur	32.6	40.3	59.5	31.4
Rajiv Nagar 3rd Street Thiruvotiyur	31	39.9	63.7	31
29 Division Chinnasekadai (Town Panchayat Office)	31.4	41.4	71.4	32.2
Parathasarathy Street,Chinnasekadai	32.5	47.9	72.2	36.8
Mahatma Gandhi Memorial School Manali	30.5	44.2	74.7	37.3
Victory Metric School Village Street	29.9	46.5	57.1	33.1
KCP Polytechnic College	32.6	40.4	58.2	37.7


Sulphur Dioxide as SO2
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
NAAQM Standard
FIRE STATION
PRAVEENA HOUSE RAJESNDRA PRASAD STREET
GOVERNMENT SCHOOL PADASALAI STREET
CPCL -ETP
CPCL-TTP
CPCL-GAS PLANT
CPCL-POLYECHNIC COLLEGE
TKP NAGAR 2ND STREET (SATHYAMOORTHY NAGAR)
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDOA LTD THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET
29 DIVISION CHINNASEKADAI
PARTHASARATHY STREEET CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Nitrogen Dioxide as NO2
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
NAAQM Standard
FIRE STATION
PRAVEENA HOUSE RAJESNDRA PRASAD STREET
GOVERNMENT SCHOOL PADASALAI STREET
CPCL -ETP
CPCL-TTP
CPCL-GAS PLANT
CPCL-POLYECHNIC COLLEGE
TKP NAGAR 2ND STREET (SATHYAMOORTHY NAGAR)
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDOA LTD THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET
29 DIVISION CHINNASEKADAI
PARTHASARATHY STREEET CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Particulate Matter (PM10)
NAAQM Standard
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
FIRE STATION
PRAVEENA HOUSE RAJESNDRA PRASAD STREET
GOVERNMENT SCHOOL PADASALAI STREET
CPCL -ETP
CPCL-TTP
CPCL-GAS PLANT
CPCL-POLYECHNIC COLLEGE
TKP NAGAR 2ND STREET (SATHYAMOORTHY NAGAR)
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDOA LTD THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET
29 DIVISION CHINNASEKADAI
PARTHASARATHY STREEET CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE


Particulate Matter (PM 2.5)
Concentration (µg/m3)
100
90
80
70
60
50
40
30
20
10
0
NAAQM Standard
FIRE STATION
PRAVEENA HOUSE RAJESNDRA PRASAD STREET
GOVERNMENT SCHOOL PADASALAI STREET
CPCL -ETP
CPCL-TTP
CPCL-GAS PLANT
CPCL-POLYECHNIC COLLEGE
TKP NAGAR 2ND STREET (SATHYAMOORTHY NAGAR)
PRECISION TOOLS
PRIMARY HEALTH CENTRE KALAINGAR NAGAR
RAMESH HOUSE KARGIL NAGAR
PARAMESHWAR NAGAR
NEAR CONTAINER CORPORATION OF INDOA LTD THIRUVOTTIYUR
RAJIV NAGAR 3 RD STREET
29 DIVISION CHINNASEKADAI
PARTHASARATHY STREEET CHINNASEKADAI
MAHATMA GANDHI MEMORIAL SCHOOL MANALI
VICTORY METRIC SCHOOL VILLAGE STREET
KCP POLYTECHNIC COLLEGE

6.0 CONCLUSION:

DAY-1 Ambient Air Quality

In Ambient Air Quality monitoring nineteen sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Fire Station, Praveena House rajendra prasad Street , Government School Padasalai Street, CPCL –ETP, CPCL-TTP, CPCL-Gas Plant, CPCL-Polyechnic College, TKP Nagar 2nd Street (Sathyamoorthy Nagar), Precision Tools, Primary Health Centre Kalaingar Nagar, Ramesh House Kargil Nagar, Parameshwar Nagar, Near Container Corporation of Indoa Ltd -Thiruvottiyur, Rajiv Nagar 3rd Street, 29th Division Chinnasekadai, Parthasarathy Streeet Chinnasekadai, Mahatma Gandhi Memorial School Manali, Victory Metric School Village Street and KCP Polytechnic College.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 27.5 to 35.1µg/m^3. Highest value of 35.1µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 38.5 to 48.2µg/m^3. Highest value of 48.2µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 50.3 to 67.9µg/m^3. Highest value of 67.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 31 to 38.9µg/m^3. Highest value of 38.9µg/m^3 is obtained and however the values are within the NAAQM standards.

DAY-2 Ambient Air Quality

In Ambient Air Quality monitoring nineteen sampling locations were identified to assess the GLC of point source emission of Gaseous and Particulate matter. The sampling locations are Fire Station, Praveena House rajendra prasad Street, Government School Padasalai Street, CPCL –ETP, CPCL-TTP, CPCL-Gas Plant, CPCL-Polyechnic College, TKP Nagar 2nd Street (Sathyamoorthy Nagar), Precision Tools, Primary Health Centre Kalaingar Nagar, Ramesh House Kargil Nagar, Parameshwar Nagar, Near Container Corporation of Indoa Ltd -Thiruvottiyur, Rajiv Nagar 3rd Street, 29th Division Chinnasekadai, Parthasarathy Streeet Chinnasekadai, Mahatma Gandhi Memorial School Manali, Victory Metric School Village Street and KCP Polytechnic College.

- *Sulphur Dioxide as SO_2:* Ambient Air Quality measurement values of SO_2 are ranging from 29.7 to 33.5µg/m^3. Highest value of 33.5µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Nitrogen Dioxide as NO_2:* Ambient Air Quality values of NO_2 are ranging from 39.6 to 47.9µg/m^3. Highest value of 47.9µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter (PM_{10}):* Ambient Air Quality values of PM_{10} are ranging from 49.5 to 74.7µg/m^3. Highest value of 74.7µg/m^3 is obtained and however the values are within the NAAQM standards.

- *Particulate Matter ($PM_{2.5}$):* Ambient Air Quality values of $PM_{2.5}$ are ranging from 29.1 to 40.7µg/m^3. Highest value of 40.7µg/m^3 is obtained and however the values are within the NAAQM standards.

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