

**Immission / Ambient Air Quality Monitoring at the
busy Traffic junction area of Kolkata during February
2004.**

By

West Bengal Pollution Control Board

Immission / Ambient Air Quality Monitoring at the busy Traffic junction area of Kolkata during February 2004.

Introduction:

Kolkata is the capital city of the state of West Bengal. The metropolitan city of Kolkata located on the eastern bank of the river Hooghly. The river is running from north to south and its longitude 88.24 E and latitude 22.34 N.

The exchange of the air in the city is due to the river breeze operates during all seasons. The city was one time the capital city of the British Empire and was developed around the Fort William surrounded by grassy plain land. The grassy plain with avenue trees function as breathing lungs of the city and is said to be a sink for the pollutants generated by the city.

There has been a rapid increase in the population of the city after partition of the country and being the gateway of eastern & north-eastern India, having one of the largest river ports, there has been a natural growth in industries, commerce and trade.

There has been a rapid increase in road transportation and as it has only 6% road surface area of the total city area, the traffic density has increased and so and increase in the air pollution due to vehicular pollution.

Scope of Study:

The study of the air pollutants in the atmosphere at the major traffic junction viz., Esplanade (commercial area) and B.B.D. Bag (Dalhousie) (administrative office area) during the winter season, the vehicular pollutants accumulating in the atmosphere and its dispersion. The dispersion or accumulation of the air pollutants, the average hourly variation of the air pollutants in the atmosphere at traffic junction was envisaged and so a sample study was organized.

National Ambient Air Quality Standard

Pollutants	Time weighted average	Industrial Areas	Residential, Rural & other areas	Sensitive Areas
Sulphur-dioxide (SO ₂)	Annual Average	80 µg/m ³	60 µg/m ³	15 µg/m ³
	24 hours average	120 µg/m ³	80 µg/m ³	30 µg/m ³
Oxides of Nitrogen as NO ₂	Annual Average	80 µg/m ³	60 µg/m ³	15 µg/m ³
	24 hours average	120 µg/m ³	80 µg/m ³	30 µg/m ³
Suspended Particulate Matter (SPM)	Annual Average	360 µg/m ³	140 µg/m ³	70 µg/m ³
	24 hours average	500 µg/m ³	200 µg/m ³	100 µg/m ³
Respirable Particulate Matter (RPM) (size less than 10 micron)	Annual Average	120 µg/m ³	60 µg/m ³	50 µg/m ³
	24 hours average	150 µg/m ³	100 µg/m ³	75 µg/m ³
Carbon-monoxide (CO)	8 hours	5 mg/m ³	2 mg/m ³	1 mg/m ³
	1 hour	10 mg/m ³	4 mg/m ³	2 mg/m ³

Ozone [O₃] USEPA Standard for 1-hour average is 120 ppb [parts per billion]

Time: Indian Standard Time (IST) and expressed in hour's of the day.

Analysis of the Results / Observation:

A] Esplanade:

The immission monitoring was done by placing the continuous monitoring mobile van at middle of the densely flowing road traffic and in between two traffic junctions with 250 metres apart. The traffic flow was more a clockwise forming a very low speed whirl pool of air. The immission values so observed were directly contributed from vehicle emission and road dust.

1.1 Graph – Esp-1 & 2 and Table – Esp-1:

Real time hourly variation of the meteorological parameters during 10th, 11th & 12th February, 2004 viz., wind speed (WS) in meter per second (m/sec.), wind direction (WD) in degrees, relative humidity (RH) in percentage (%) and ambient temperature (TEMP) in centigrade (°C).

Observation – Esp-1:

During the immission monitoring programme at the busy traffic junction of Esplanade, it has been observed that the average values of ambient temperature and relative humidity profiles from 10 hr to 18 hr was around 26 °C and 35 % respectively, where as the average values of ambient temperature and relative humidity from 19 hr to 9 hr was around 16 °C and 72 % respectively.

It was also observed that the prevailing wind direction was from North to South and South to North, the average wind speed during the immission monitoring programme was observed as 0.8 m/sec.

The temperature, relative humidity profile coupled with low wind speed shows that there was a smoggy atmosphere around the measuring station during night and early morning, which gave a high air pollutants trapped in the inversion layer.

1.2 Graph – Esp-3 & 4:

Real time hourly variation of the sulphur-dioxide [SO₂] during 10th, 11th & 12th February, 2004.

Observation – Esp-2:

The immission values of Sulphur-dioxide gas at the Esplanade traffic junction was due to the contribution of sulphur present in the diesel fuel. The SO₂ immission value increased around 21 hour due to the opening of the heavy vehicle traffic in the city road from 8 pm. The real time values of SO₂ was within the standard, specified for industrial area (24 hours average) as 120 µg/m³ and during 15 hr to 20 hr the values were within the standard, specified for residential, rural and other areas as 80 µg/m³.

		SO ₂ µg/m ³
11th Feb. 04 [Wednesday]	Maximum at 8 hr	147
10th Feb. 04 [Tuesday]	Minimum at 18 hr	13
Average		84
98 Percentile		146
50 Percentile		86

1.3 Graph – Esp-5 & 6:

Real time hourly variation of the oxides of nitrogen [NO_x], nitrogen dioxide [NO₂] and nitric oxide [NO] during monitoring program on 10th, 11th & 12th February, 2004.

Observation – Esp-3:

Real time hourly variation of the oxides of nitrogen [NO_x], nitrogen dioxide [NO₂] and nitric oxide [NO] during 10th, 11th & 12th February, 2004 was mainly due to the emission from diesel vehicles and it followed an unique pattern and is maximum between 22 hr to 23 hr due to the opening up of the road for free movement of heavy goods vehicles from 20 hr. (8 pm). The high values also attributed to the halting of the vehicles at the road junction for longer period. The low values were observed during solar activity between 9 hr to 17 hr and complete restriction in the movement of heavy goods vehicles from 8 am to 8 pm. All heavy vehicles uses the diesel engine.

All the measured values for the oxides of nitrogen and the average values were much above the standard, specified of industrial areas (24 hours average) 120 µg/m³ as NO₂.

		NO _x [µg/m ³]	NO ₂ [µg/m ³]	NO [µg/m ³]
11 th Feb. 04 [Wednesday]	Maximum at 22 hr	2,403		2,051
12 th Feb. 04 [Thursday]	Minimum at 15 hr	190		31
10 th Feb. 04 [Tuesday]	Maximum at 16 hr		447	
12 th Feb. 04 [Thursday]	Minimum at 7 hr		67	
Average		768	188	581
98 Percentile		2,282	357	2,038
75 Percentile		918	221	726
50 Percentile		592	181	415
25 Percentile		352	159	138
10 Percentile		241	93	73

1.4 Graph – Esp-7 & 8:

Real time hourly variation of the carbon-monoxide [CO] and non-condensed ozone during monitoring program on 10th, 11th & 12th February, 2004.

Observation – Esp-4:

The immission values of carbon-monoxide [CO] was basically due to the contribution from petrol driven vehicles and non-condensed ozone [O₃] gases was basically formed in atmosphere due to the contribution of oxides of nitrogen from the diesel vehicles at the center of the Esplanade traffic junction and low ultra-violet light generated from the halogen street lamps surrounding the measuring station. The low ultra-violet light breaks the oxides of nitrogen under the influence of soot acting as catalytic element forming ozone in the ambient air.

The carbon-monoxide and the non-condensed ozone graph followed more or less the same pattern of variation during the immission monitoring at a heavily traffic junction during post winter season from 10th to 12th February, 2004.

The maximum CO and O₃ value was during maximum traffic period at 22 hr (10 pm) and minimum value of CO observed at 14 and 15 hr (2 pm and 3 pm) and O₃ at 9 hr (9 am).

The average value of CO was much below the standard value for industrial areas 10 mg/m³ but above the standard value for residential, rural and other areas 4 mg/m³. The immission values of CO during 20 hr (8 pm) to 23 hr (9 pm) were above the industrial area standard which was due to the non restricted movement of heavy diesel vehicles after 20 hr (8 pm).

		CO [mg/m ³]	O ₃ [ppb]
11 th February, 2004 [Wednesday]	Maximum at 22 hr	15.6	10.4
12 th February, 2004 [Thursday]	Minimum at 14 & 15 hr	0.7	
12 th February, 2004 [Thursday]	Minimum at 9 hr		0.1
Average		5.6	3.4
98 Percentile		14.0	10.0
50 Percentile		4.8	2.8

1.5 Graph – Esp-9 & 10:

Real time hourly variation of the suspended respirable particulate matter [RSPM or PM<10μ] during monitoring program on 10th , 11th & 12th February, 2004.

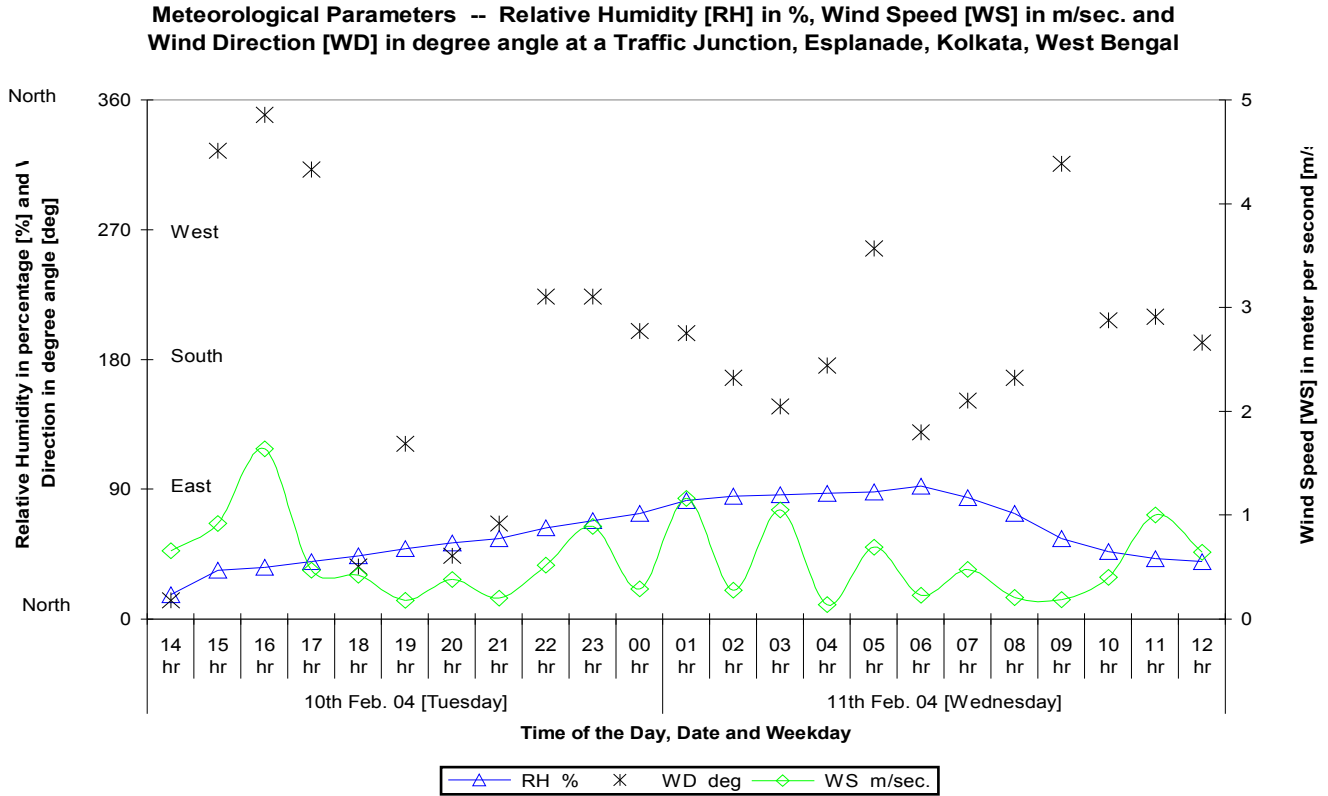
Observation – Esp-5:

The immission values of respirable suspended particulate matter [PM<10μ] at the Esplanade traffic junction was due to the basic contribution from diesel vehicles as carbon soot and also the contribution of road dust due to heavy traffic flow.

The immission values for the RSPM alias RPM alias PM<10μ at a busy traffic junction area was observed to be much above the standard, specified for industrial areas for RPM (24 hours average) as 150 μg/m³.

		RSPM<10μm μg/m ³
11 th February, 2004 [Wednesday]	Maximum at 23 hr	3,849
11 th February, 2004 [Wednesday]	Minimum at 14 hr	34
Average		1,273
98 Percentile		3,130
50 Percentile		1,127

Graph – Esp-1



Graph – Esp-2

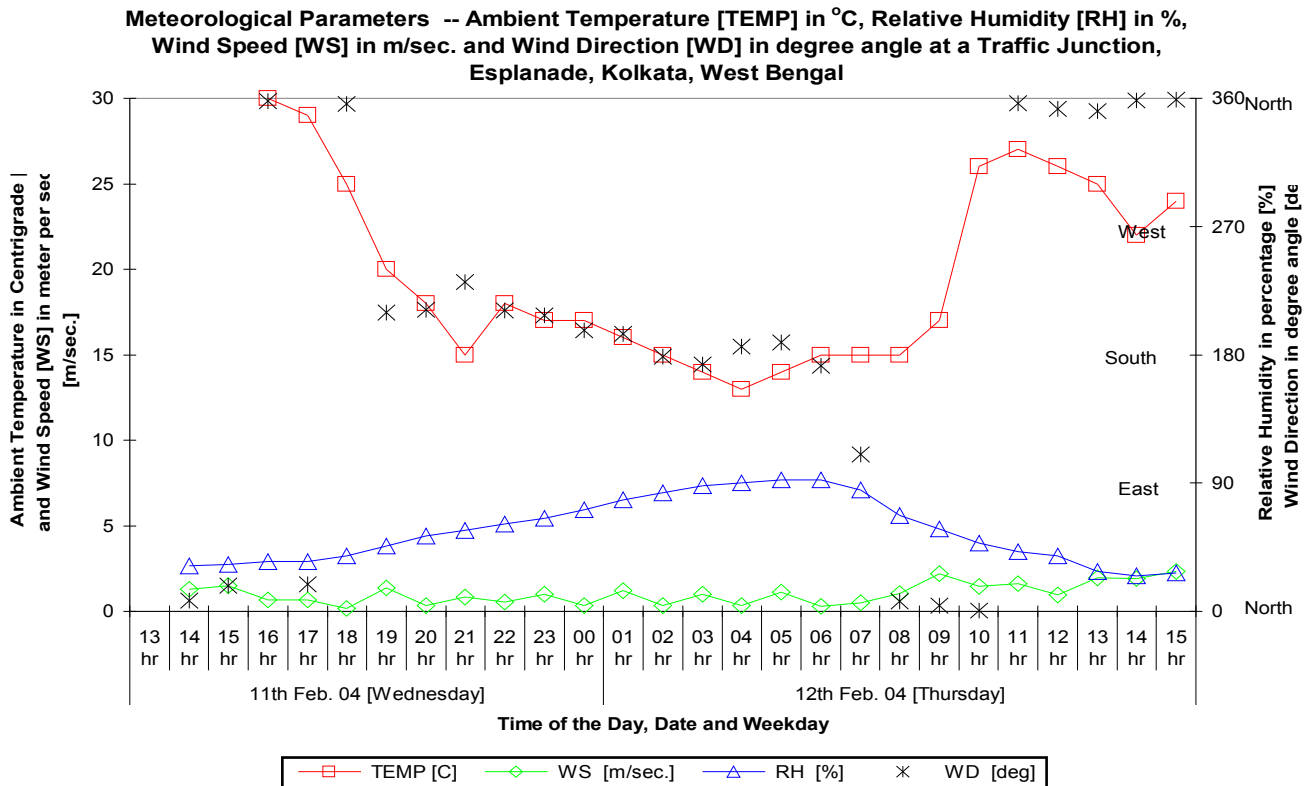


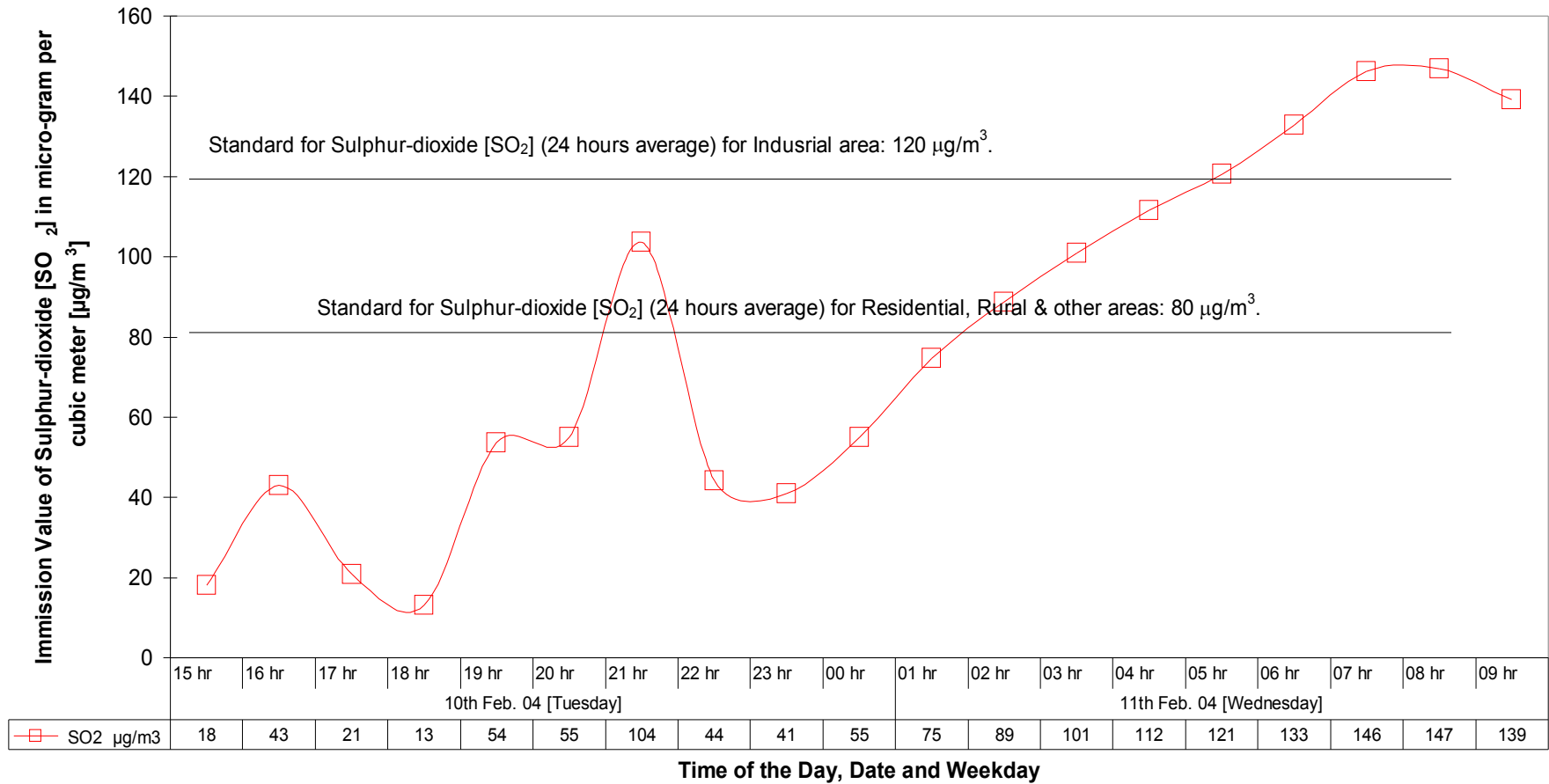
Table – Esp-1

Meteorological Parameters during Immission Monitoring at Traffic Junction, Esplanade, Kolkata, West Bengal

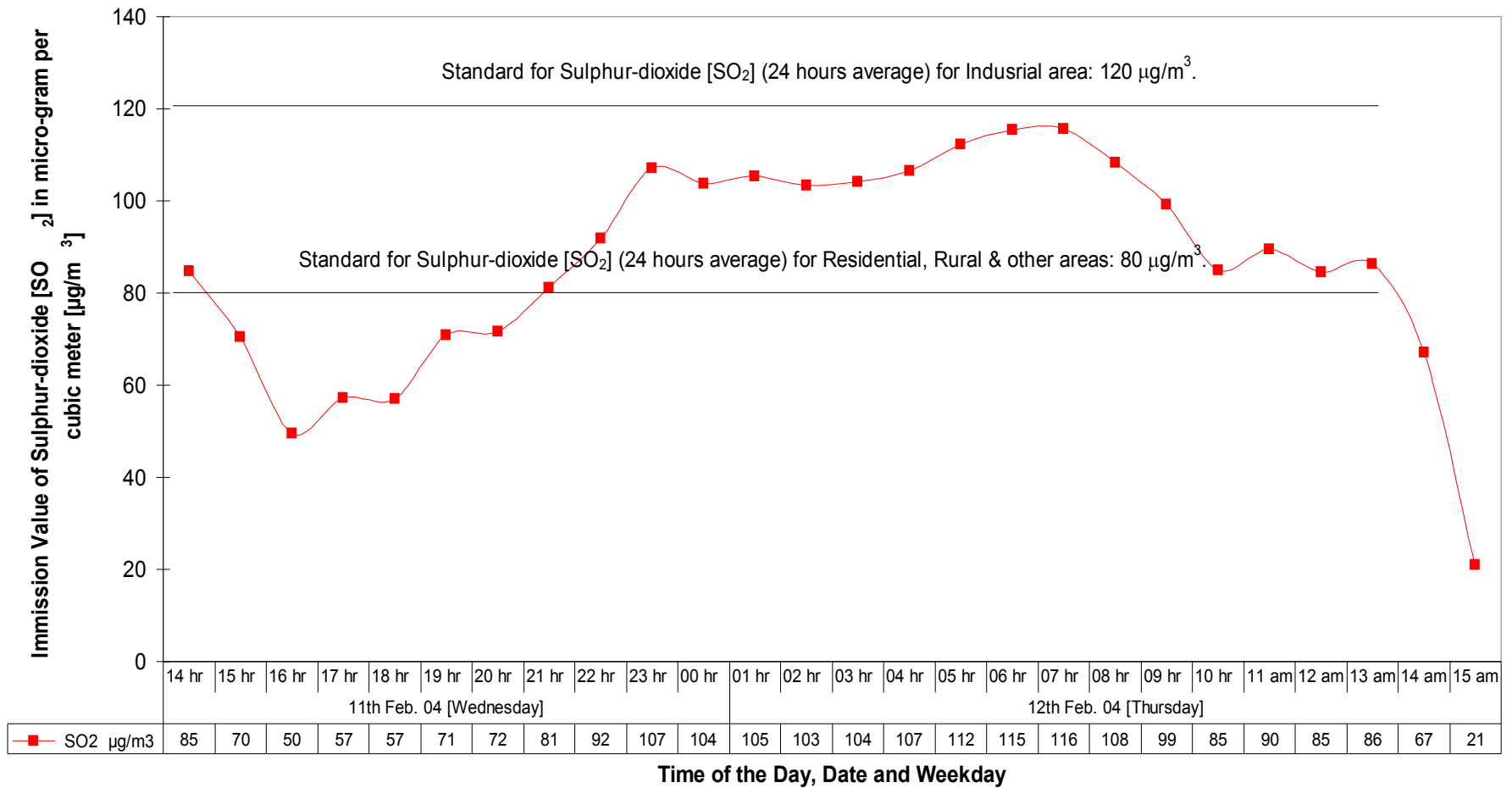
		TEMP [C]	WS m/sec.	RH %	WD deg
10 th February, 2004 [Tuesday]	14 hr	----	0.7	17	13
	15 hr	----	0.9	34	325
	16 hr	----	1.6	36	350
	17 hr	----	0.5	40	312
	18 hr	----	0.4	44	36
	19 hr	----	0.2	49	122
	20 hr	----	0.4	53	44
	21 hr	----	0.2	56	66
	22 hr	----	0.5	63	224
	23 hr	----	0.9	68	223
	00 hr	----	0.3	73	200
	01 hr	----	1.2	82	198
02 hr	----	0.3	85	167	
03 hr	----	1.1	86	148	
04 hr	----	0.1	87	176	
05 hr	----	0.7	88	257	
06 hr	----	0.2	92	130	
07 hr	----	0.5	84	152	
08 hr	----	0.2	73	167	
09 hr	----	0.2	56	316	
10 hr	----	0.4	47	207	
11 hr	----	1.0	42	210	
12 hr	----	0.6	40	192	

		TEMP [C]	WS [m/sec.]	RH [%]	WD [deg]
11 th February, 2004 [Wednesday]	13 hr	----	----	----	----
	14 hr	----	1.3	32	7
	15 hr	----	1.5	33	18
	16 hr	30	0.7	35	358
	17 hr	29	0.7	35	19
	18 hr	25	0.2	39	356
	19 hr	20	1.4	46	210
	20 hr	18	0.3	53	212
	21 hr	15	0.8	57	231
	22 hr	18	0.5	61	211
	23 hr	17	1.0	65	208
	00 hr	17	0.3	71	197
12 th February, 2004 [Thursday]	01 hr	16	1.2	78	195
	02 hr	15	0.3	83	179
	03 hr	14	1.0	88	173
	04 hr	13	0.3	90	186
	05 hr	14	1.1	92	189
	06 hr	15	0.3	92	172
	07 hr	15	0.5	85	110
	08 hr	15	1.1	67	7
	09 hr	17	2.2	58	4
	10 hr	26	1.5	48	1
	11 hr	27	1.6	42	356
	12 hr	26	1.0	39	352
13 hr	25	2.0	28	351	
14 hr	22	1.9	25	358	
15 hr	24	2.3	27	359	

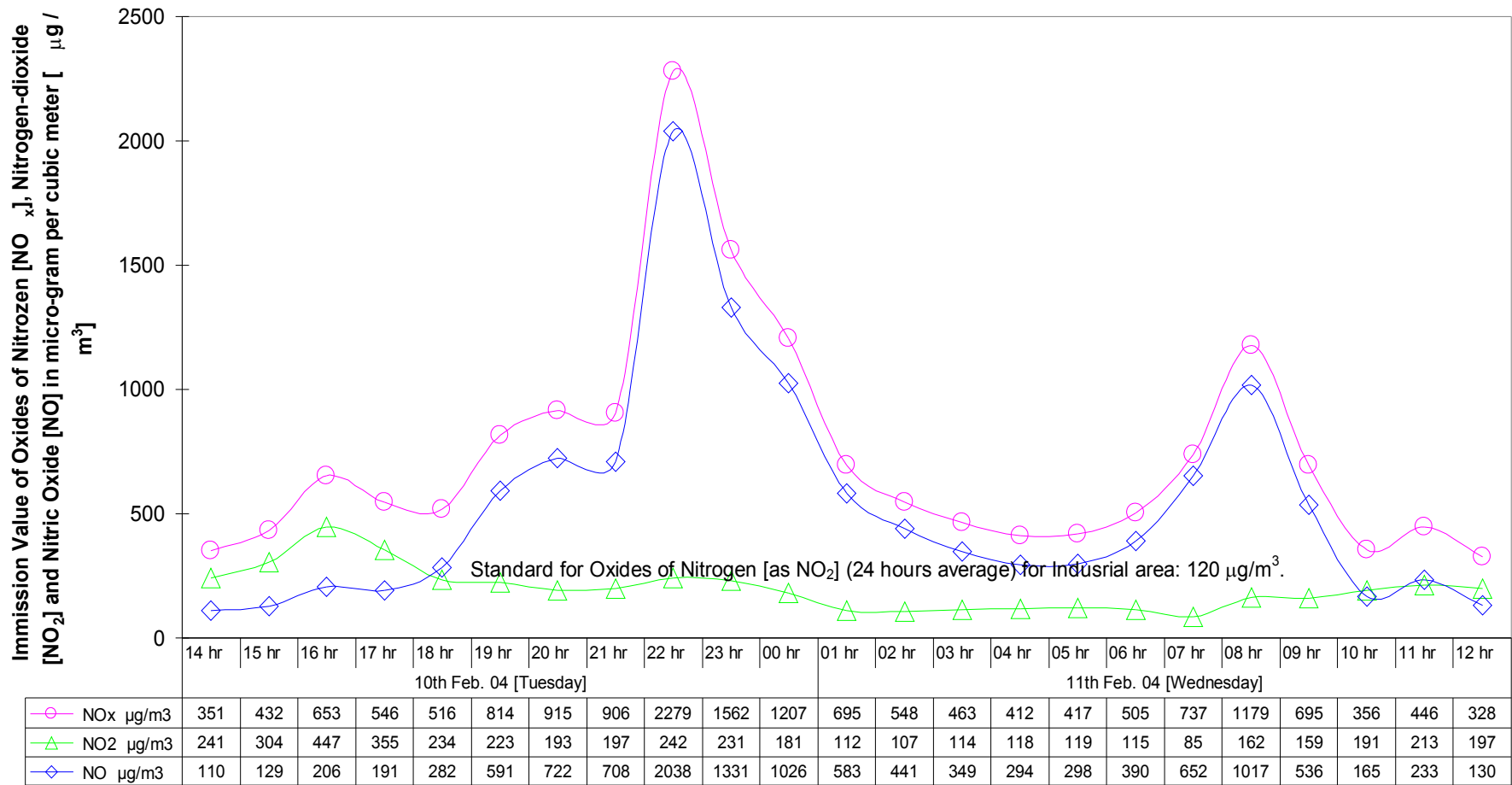
Traffic Ambient Air Quality / Immission Monitoring of Sulphur-dioxide [SO₂ in µg/m³] at Esplanade, Kolkata, West Bengal



Traffic Ambient Air Quality / Immission Monitoring of Sulphur-dioxide [SO₂ in µg/m³] at Esplanade, Kolkata, West Bengal

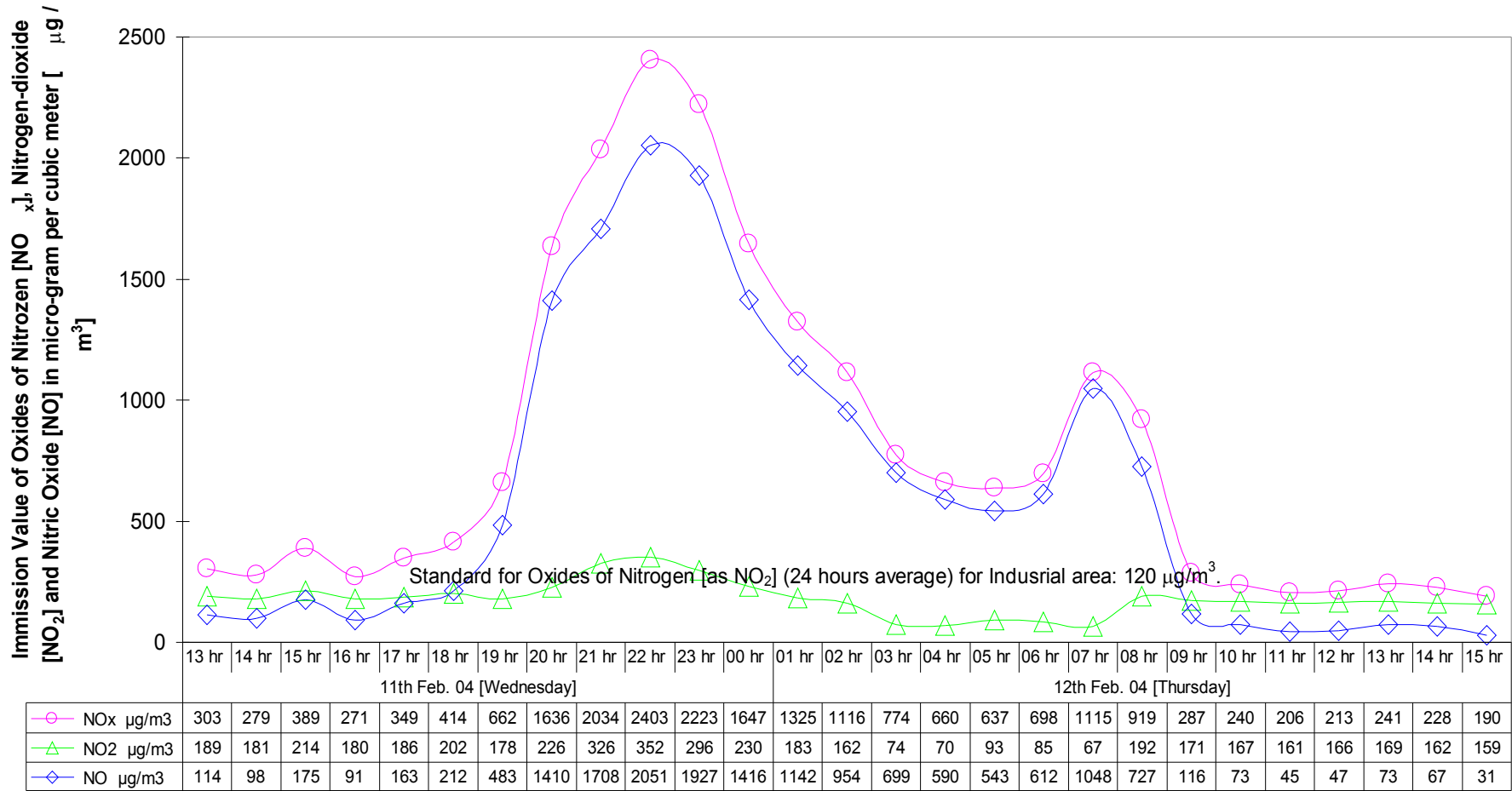


Traffic Ambient Air Quality / Immission Monitoring at Esplanade, Kolkata, West Bengal



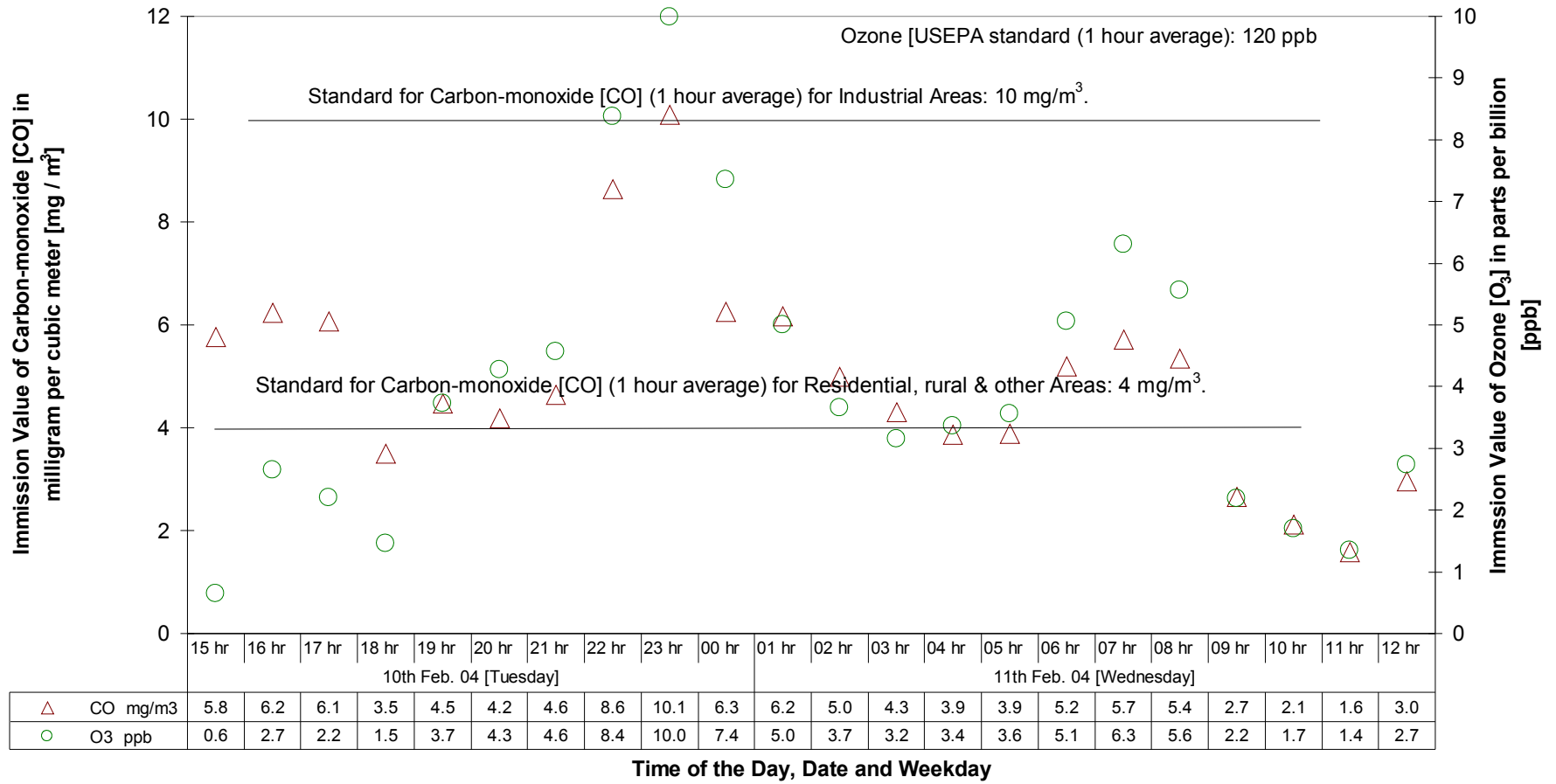
Time of the Day, Date and Weekday

Traffic Ambient Air Quality / Immission Monitoring at Esplanade, Kolkata, West Bengal

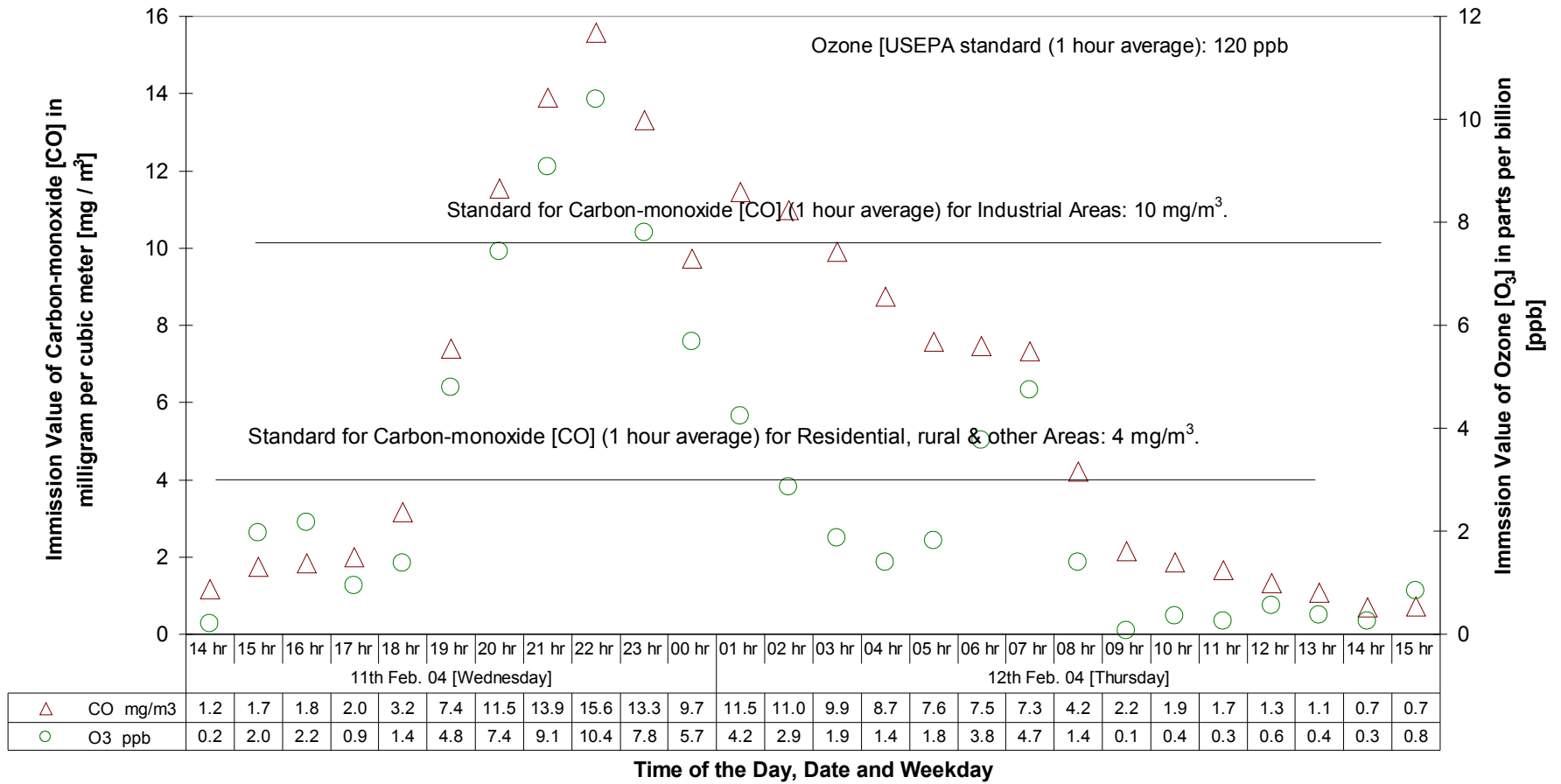


Time of the Day, Date and Weekday

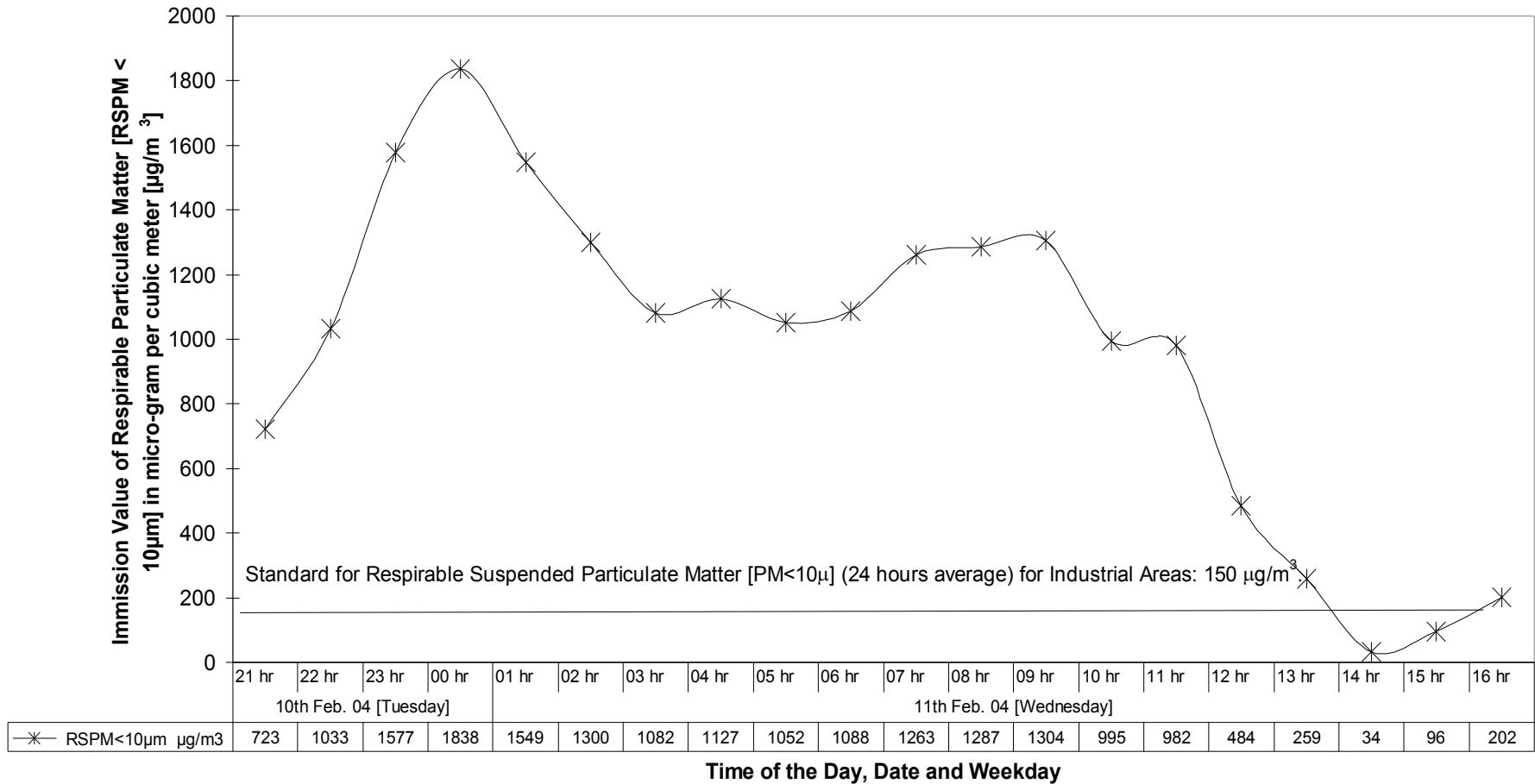
Traffic Ambient Air Quality / Immission Monitoring at Esplanade, West Bengal



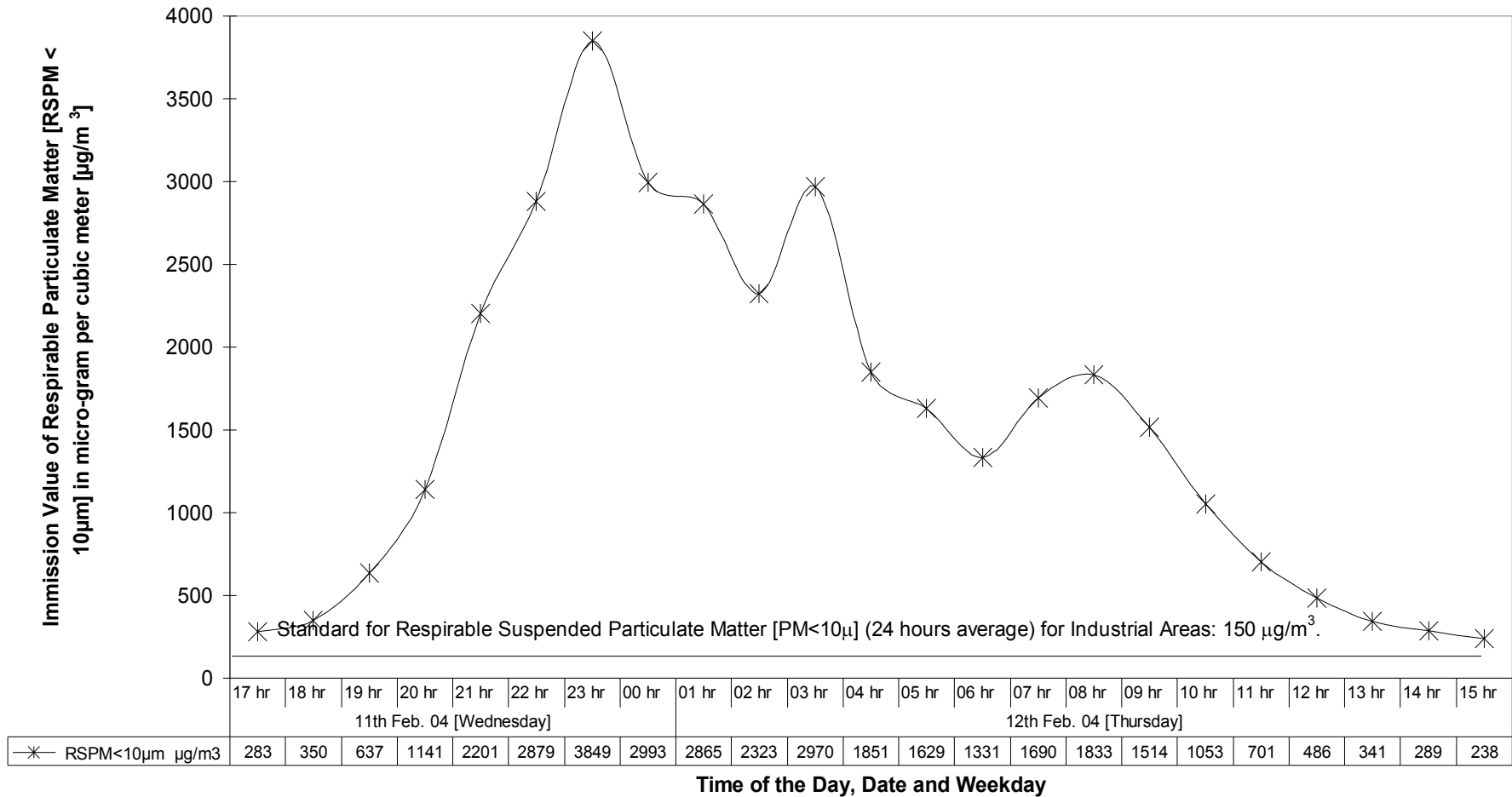
Traffic Ambient Air Quality / Immission Monitoring at Esplanade, West Bengal



Traffic Ambient Air Quality / Immission Monitoring of Respirable Particulate matter [RSPM<10µm] at Esplanade, Kolkata, West Bengal



Traffic Ambient Air Quality / Immission Monitoring of Respirable Particulate matter [RSPM<10µm] at Esplanade, Kolkata, West Bengal



B] B.B.D. Bag (Dalhousie)(Administrative office area and business district):

The immission monitoring was done by placing the continuous monitoring mobile van at the south west corner of the pond surrounded by tram track and government vehicle parking area with road around the parking area followed by moderately high rising building. The heavy goods vehicle traffic restriction from 8 hr (am) to 20 hr (8 pm). The general traffic flow was more a clockwise forming a very low speed whirl pool of air with moisture from the pond. The immission values so observed were directly contributed from vehicle emission.

2.1 Graph – BBD-1 & 2 and Table – BBD-1:

Real time hourly variation of the meteorological parameters at B.B.D.Bag during 12th , 13th & 14th February, 2004 viz., wind speed (WS) in meter per second (m/sec), relative humidity (RH) in percentage (%) and ambient temperature (TEMP) in centigrade (°C).

Observation – BBD-1:

During the immission monitoring programme at the B.B.B. Bag surrounded by high rising office complex and busy traffic roads, it was observed that the ambient temperature shows that there was no much change in the temperature; it was due to heat island formed during post winter season.

		TEMP °C	WS m/sec	RH %
13 th Feb. 04 [Friday]	Maximum at 17 hr	25		
13 th Feb. 04 [Friday]	Maximum at 17 hr		7.83	
13 th Feb. 04 [Friday]	Maximum at 04 hr			70
13 th Feb. 04 [Friday]	Minimum at 22 hr	9		
14 th Feb. 04 [Saturday]	Minimum at 06 hr		0.23	
13 th Feb. 04 [Friday]	Minimum at 13 & 14 hr			29
Average		21	4	51

2.2 Graph – BBD-3 & 4:

Real time hourly variation of the Sulphur-dioxide [SO₂] at B.B.D. Bag during 12th, 13th & 14th February, 2004.

Observation – BBD-2:

The measured immission values of the Sulphur-dioxide [SO₂] were within the standard specified for residential, rural and other areas for 24 hours average of 80 µg/m³. The maximum value of SO₂ was 48.5 µg/m³ at 3 am (hr) on 13th February, 2004. At night-time the concentration of SO₂ were higher due to the heavy goods vehicles traffic in the business district.

		SO ₂ µg/m ³
13th Feb. 04 [Friday]	Maximum at 3 am	48.50
	Minimum	0.00
	Average	16.70
	98 Percentile	47.42
	50 Percentile	11.2

2.2 Graph – BBD-5 & 6:

Real time hourly variation of the Oxides of Nitrogen [NO_x], Nitrogen-dioxide [NO₂] and Nitric oxide [NO] at B.B.D. Bag during 12th, 13th & 14th February, 2004.

Observation – BBD-3:

The measured immission values of the Oxides of Nitrogen [NO_x], Nitrogen-dioxide [NO₂] and Nitric oxide [NO] (1 hour average) shows the values high during night time and during peak traffic flow from 20 hr (8 pm) to 22 hr (10 pm). The NO₂ values was observed to be above the standard value for industrial area (24 hours average) of 120 µg/m³ during 21 hr (11 pm) to 00 hr (midnight) on 12th February 2004 and during 08 hr (am) to 10 hr (am) and 18 hr (6 pm) to 00 hr (midnight) on 13th February 2004, 01 hr (am) to 04 hr (am) on 14th February 2004.

		NO _x µg/m ³	NO ₂ µg/m ³	NO µg/m ³
13th Feb. 04 [Friday]	Maximum at 11 pm	503		
12th Feb. 04 [Thursday]	Maximum at 9 pm		239	
13th Feb. 04 [Friday]	Maximum at 11 pm			384
13th Feb. 04 [Friday]	Minimum at 5 pm	27		
13th Feb. 04 [Friday]	Minimum at 5 pm		26	
	Minimum			0
	Average	191	115	76
	98 Percentile	480	198	358
	50 Percentile	154	121	26

2.2 Graph – BBD-7 & 8:

Real time hourly variation of the carbon-monoxide [CO] and ozone [O₃] at B.B.D. Bag during 12th, 13th & 14th February, 2004.

Observation – BBD-4:

The measured immission values of the carbon-monoxide [CO] (1 hour average) on Friday, 13th February, 2004 were observed that the value decreases with the increase in the solar radiation whereas the ozone [O₃] values increases. After the sunset the CO values increases from 17 hr (5 pm) and reaches maximum at 23 hr (11 pm) on Friday due to the use of petrol driven vehicles prior to the weekday holiday and reaches maximum at 02 hr (2 am) on Saturday 14th February, 2004 and then decreases rapidly.

The measured CO values between 22 hr (10 pm) on 13th February 2004 (Friday) to 15 hr (3 pm) on 14th February 2004 (Saturday – offices closes after 2 pm) were observed to be more than the standard value for residential, rural and other areas as 4 mg/m³ (1 hour average). All the CO values were less than the standard specified for industrial areas as 10 mg/m³ (1 hour average).

The reasons for such variation in the CO values may be that the petrol driven vehicles were in use during the Friday night before the weekend holiday.

		CO mg/m ³	O ₃ ppb
14 th Feb. 04 [Saturday] [1 am & 2 am]	Maximum	6.9	
13 th Feb. 04 [Friday] [2 pm]	Maximum		7.3
13 th Feb. 04 [Friday] [2 pm]	Minimum	0.5	
14 th Feb. 04 [Saturday] [4 am to 7 am]	Minimum		0.1
Average		3.0	1.9
98 Percentile		6.9	6.6
50 Percentile		2.6	1.4

2.3 Graph – BBD-9 & 10:

Real time hourly variation of the respirable suspended particulate matter [RSPM] alias [RPM] alias [PM<10µ] at B.B.D. Bag during 12th, 13th & 14th February, 2004.

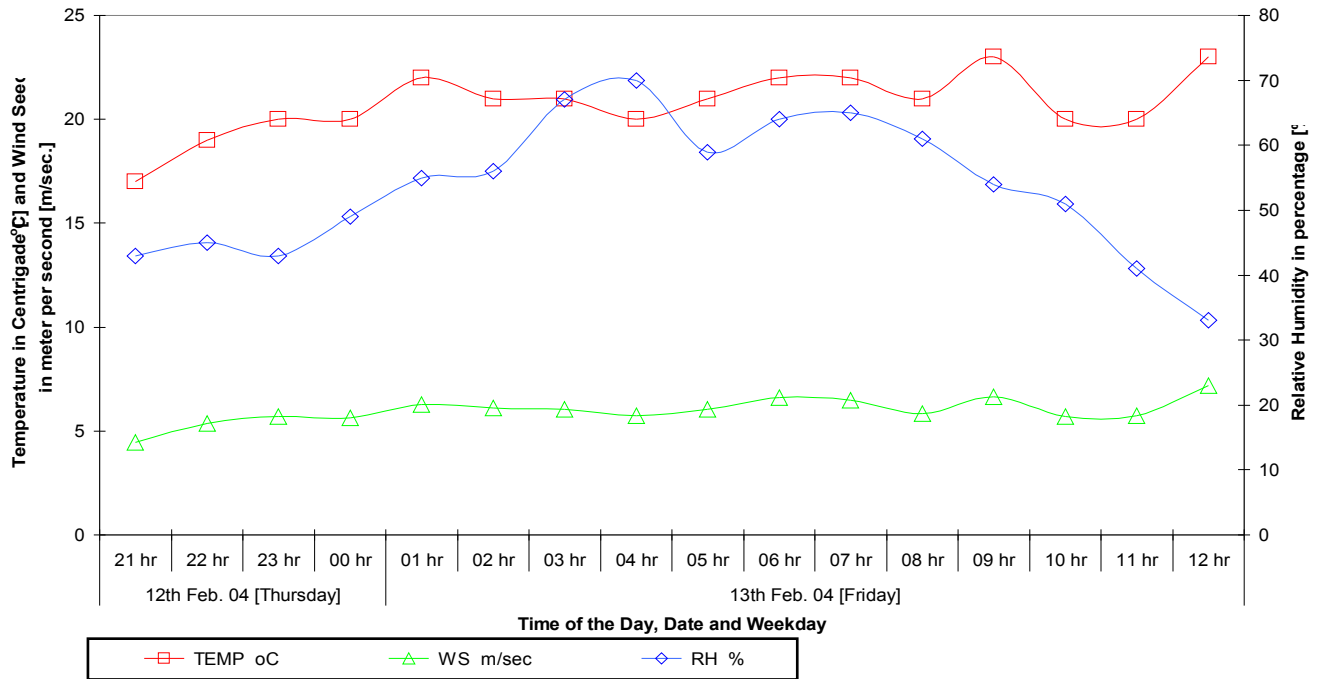
Observation – BBD-5:

The measured immission values of the respirable suspended particulate matter [RSPM] alias [RPM] alias [PM<10µ] at BBD Bag were much above the standard as specified for the industrial area (24 hours average) 150 µg/m³. This was due to the temperature inversion in the post winter season and formation of a smog cloud over the city.

The value of the RSPM varies with weekday flow of traffic, Thursday being non-payment day for business community (Lakshmi bar), the incoming traffic flow for goods and outgoing goods vehicle during evening is comparatively less, the flow of goods traffic increases from 04 hr (4 am) on Friday up to 08 hr (8 am), the complete restriction of goods vehicle into the business district starts at 08 hr (8 am) the RSPM value decreases up to 19 hr (7 pm) then rapidly increases from 20 hr (8 pm) when the restriction on the movement of heavy goods vehicles were withdrawn and the RSPM value reaches maximum at around 02 (2 am) to 03 hr (3 am) on Saturday and falls after 04 hr (4 am) these were due to the early morning sleeping phenomena effecting the drivers of vehicles when all heavy vehicles generally comes to a halt. The RSPM values again increases from 07 to 08 hr (am), which were due to the movement of heavy vehicles prior to the restriction on the movement time from 08 hr (8 am). The Saturday being state government holiday there were no flow of government vehicles into BBD Bag zone and half day holiday for business houses after 14 hr (2 pm).

		RSPM<10µm µg/m ³
14 th Feb. 04 [Saturday] [02 hr]	Maximum	1,088
13 th Feb. 04 [Friday] [16 hr]	Minimum	119
Average		548
98 Percentile		1,072
50 Percentile		531

Meteorological Parameters during Immission Monitoring at B.B.D. Bag, Kolkata, West Bengal



Graph – BBD-2

Meteorological Parameters during Immission Monitoring at B.B.D. Bag, Kolkata, West Bengal

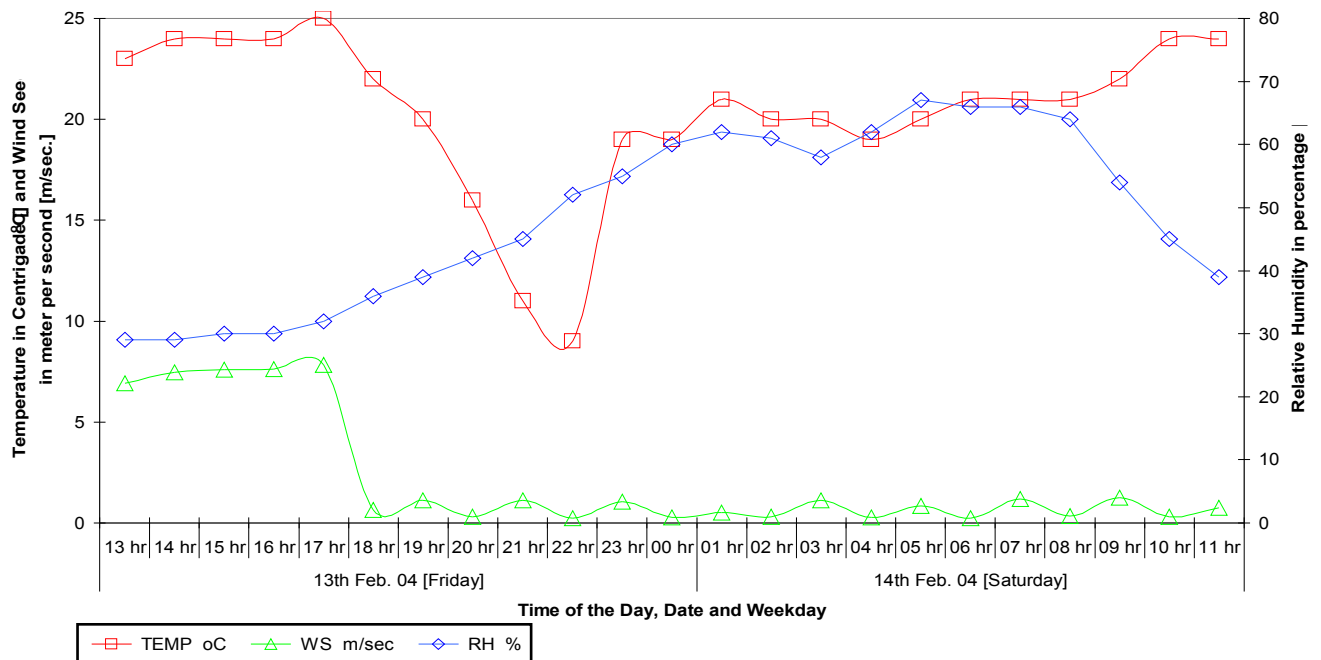


Table – BBD-1

Immission Monitoring at B.B.D. Bag, Kolkata, West Bengal

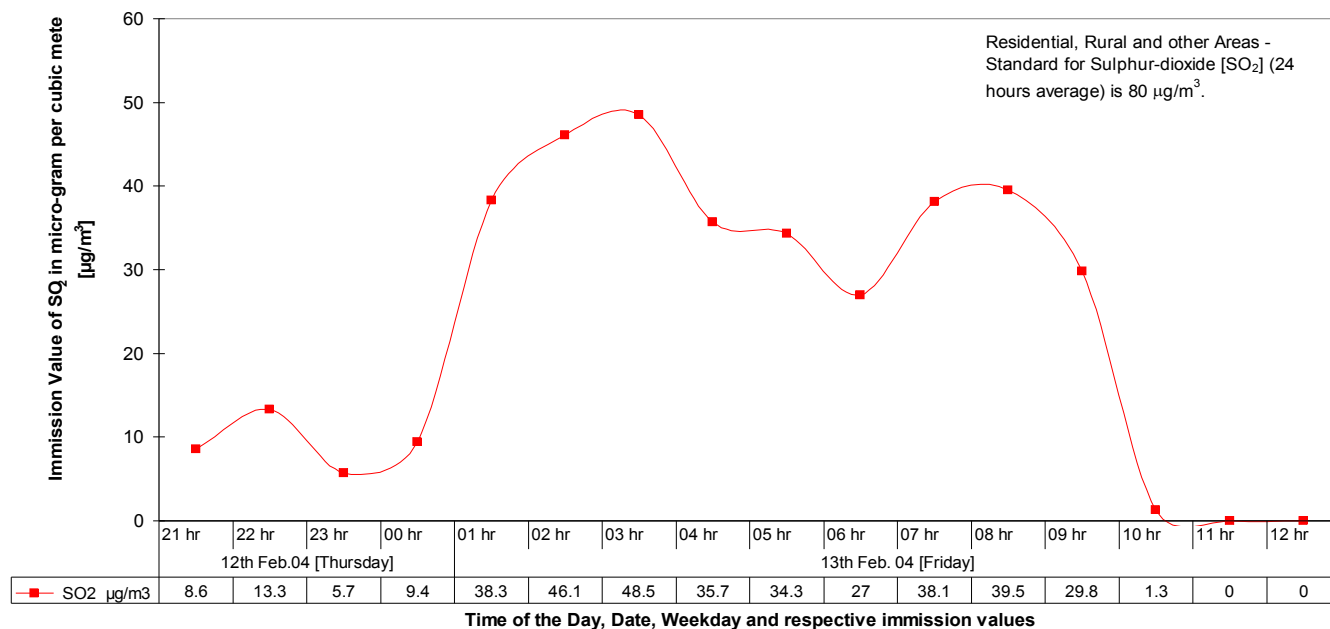
		TEMP	WS	RH			TEMP	WS	RH
		°C	m/sec	%			°C	m/sec	%
12 th February 2004 [Thursday]	9 pm	17	4.46	43	1 3 t h F e b r u a r y 2 0 0 4 [F r i d a y]	1 pm	23	6.92	29
	10 pm	19	5.36	45		2 pm	24	7.47	29
	11 pm	20	5.7	43		3 pm	24	7.59	30
	12 pm	20	5.64	49		4 pm	24	7.62	30
	1 am	22	6.27	55		5 pm	25	7.83	32
	2 am	21	6.09	56		6 pm	22	0.64	36
	3 am	21	6.03	67		7 pm	20	1.13	39
	4 am	20	5.74	70		8 pm	16	0.32	42
	5 am	21	6.05	59		9 pm	11	1.13	45
	6 am	22	6.62	64		10 pm	9	0.24	52
	7 am	22	6.47	65		11 pm	19	1.05	55
	8 am	21	5.84	61		12 pm	19	0.26	60

9 am	23	6.65	54	1 4 t h F e b r u a r y 2 0 0 4 [S a t u r d a y]	1 am	21	0.5	62
10 am	20	5.69	51		2 am	20	0.29	61
11 am	20	5.74	41		3 am	20	1.13	58
12 am	23	7.2	33		4 am	19	0.28	62
					5 am	20	0.86	67
					6 am	21	0.23	66
					7 am	21	1.19	66
					8 am	21	0.33	64
					9 am	22	1.26	54
					10 am	24	0.32	45
					11 am			
						24	0.75	39

		TEMP °C	WS m/sec	RH %
13 th February 2004 [Friday] [5 pm]	Maximum	25		
13 th February 2004 [Friday] [5 pm]	Maximum		7.83	
13 th February 2004 [Friday] [4 am]	Maximum			70
13 th February 2004 [Friday] [10 pm]	Minimum	9		
14 th February 2004 [Saturday] [6 am]	Minimum		0.23	
13 th Feb. 04 [Friday] [1pm & 2 pm]	Minimum			29
Average		21	4	51

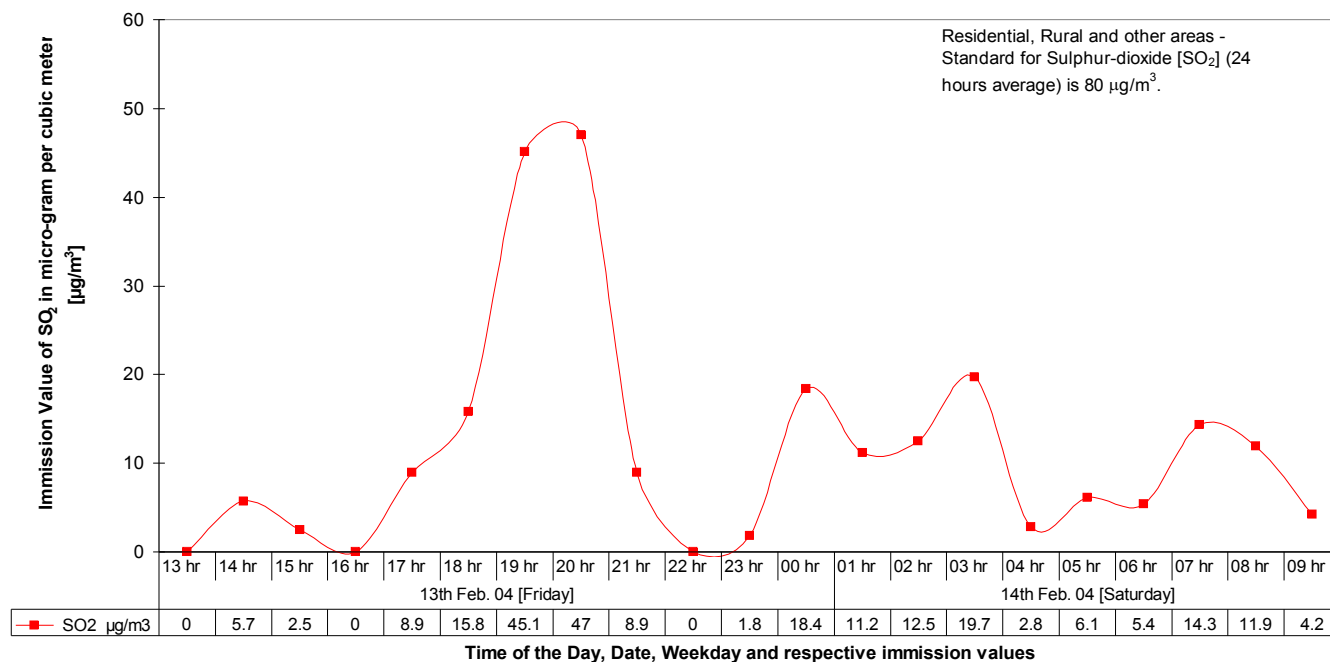
Graph – BBD-3

Ambient Air Quality / Immission monitoring of Sulphur-dioxide [SO₂ in µg/m³] at B.B.D. Bag, Kolkata, West Bengal



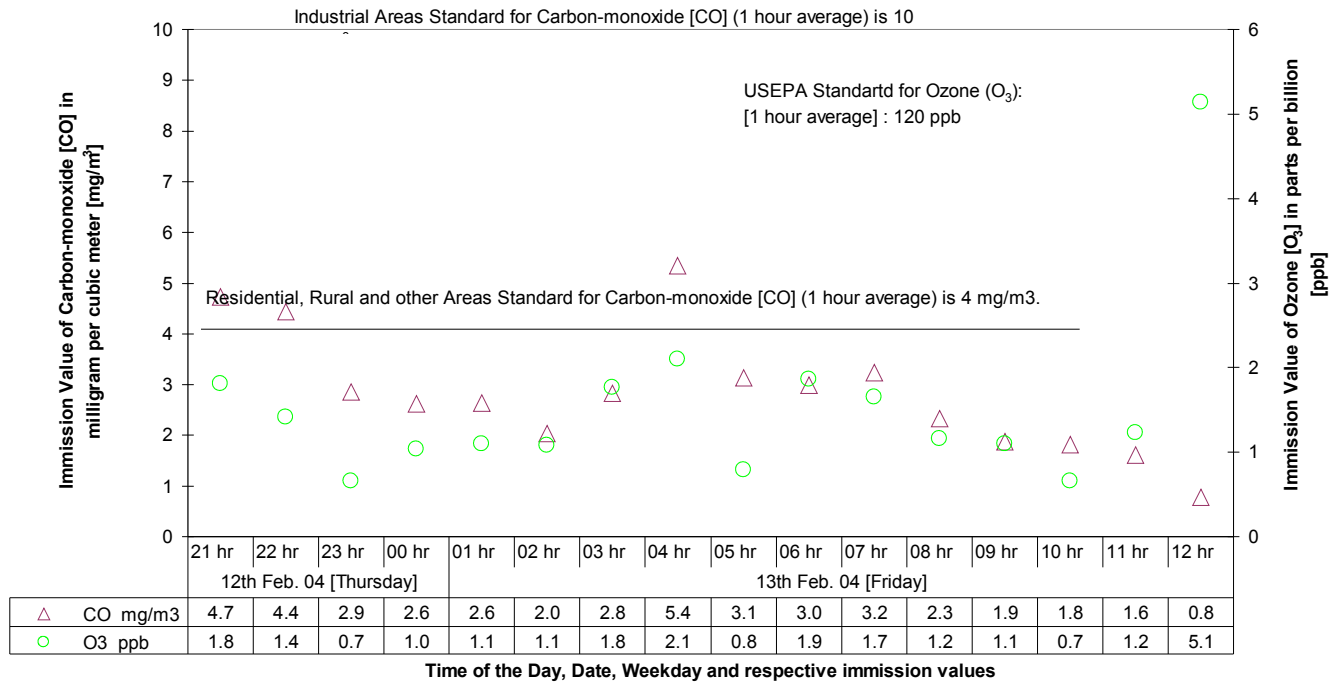
Graph – BBD-4

Ambient Air Quality / Immission monitoring of Sulphur-dioxide [SO₂ in µg/m³] at B.B.D. Bag, Kolkata, West Bengal



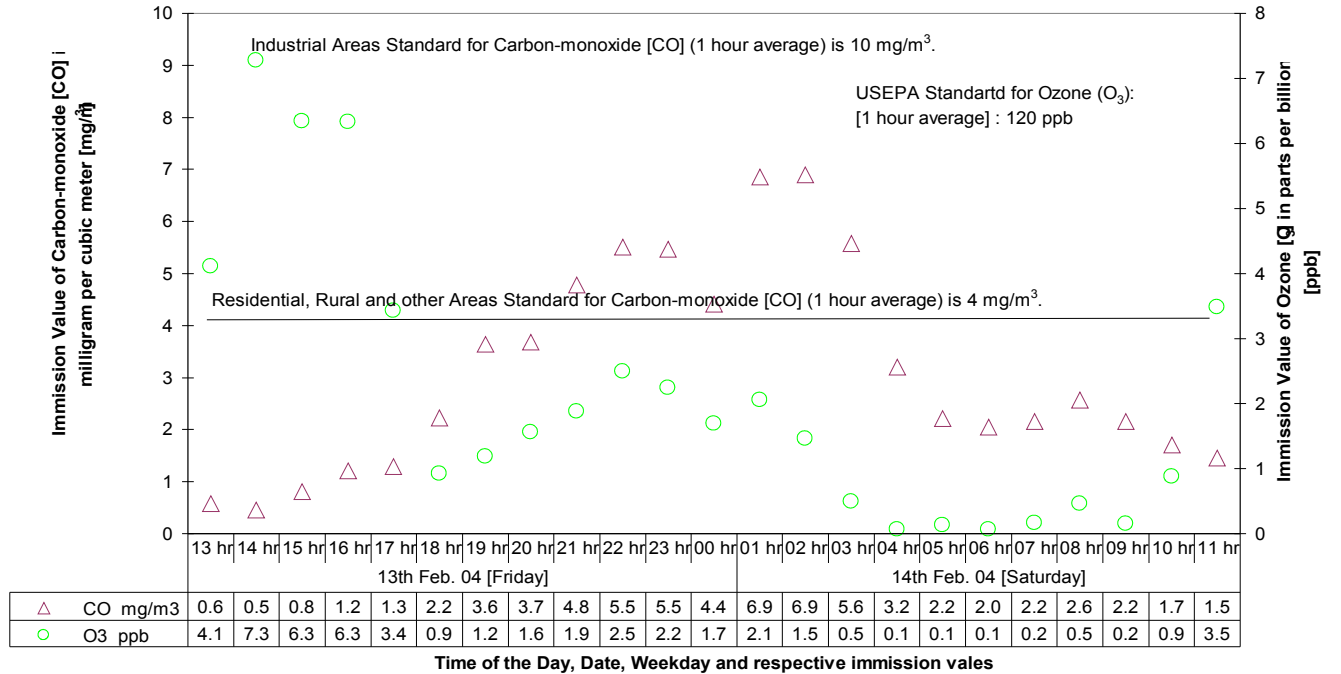
Graph – BBD-5

Ambient Air Quality / Immission Monitoring at B.B.D. Bag, Kolkata, West Bengal

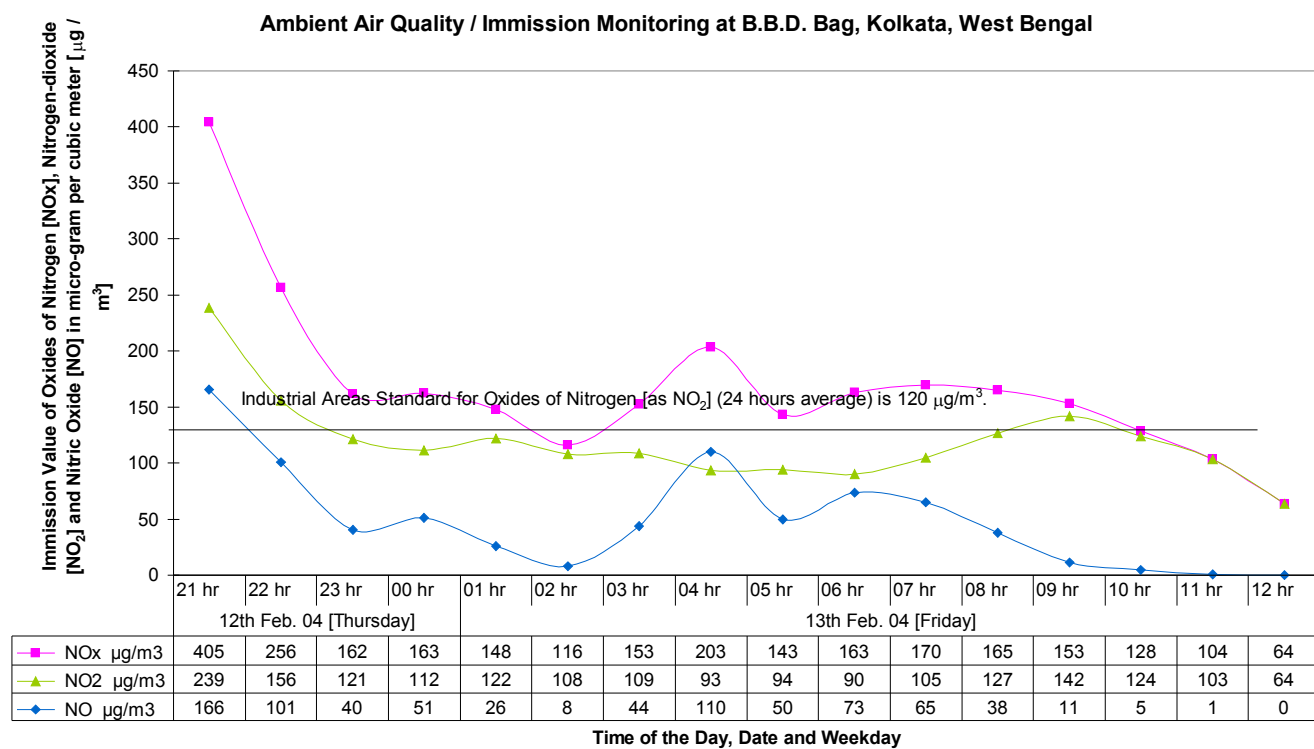


Graph – BBD-6

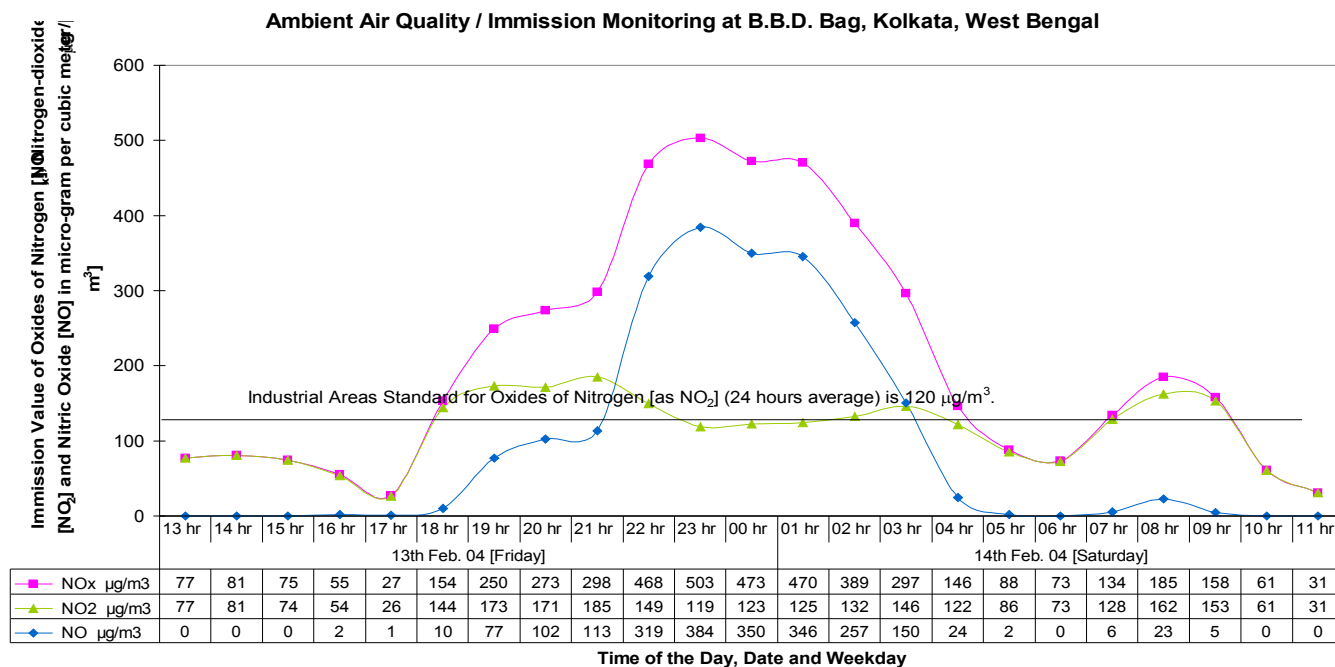
Ambient Air Quality / Immission Monitoring at B.B.D. Bag, Kolkata, West Bengal



Graph – BBD-7

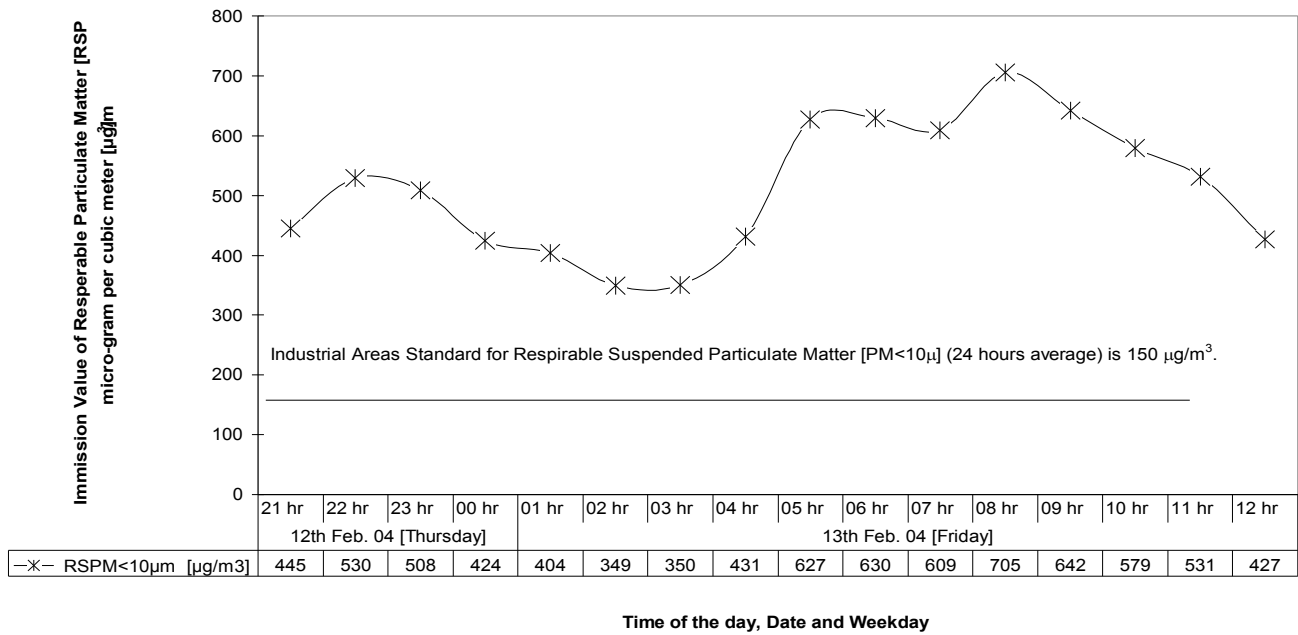


Graph – BBD-8



Graph – BBD-9

Ambient Air Quality / Immission Monitoring of Respirable Particulate Matter [RSPM<10µm] at B.B.D. Bag, Kolkata, West Bengal



Graph – BBD-10

Ambient Air Quality / Immission Monitoring of Respirable Particulate Matter [RSPM<10µm] at B.B.D. Bag, Kolkata, West Bengal

