Appendix 7-4-17

Monitoring Results for Unit 4 at Esfahan P/P	(1998/6/7, 10:30-18:00)
Fuel Type : Heavy Oil (70tons/h)	Output : 320MW(Max.)

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	842	Pitot coef.		0.85	Density	0.78			
mmHg	631.7	Ethanol Temperature		31	γ0=1.3kgf/m3N	1.3			
Rep. Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
D-3	67	135	175	0.3	17.7	1.125	193.1	0.634	19.9

2. Water Content

	1	C-2	2	C-2
Temp. Average (℃)		31.25		31.5
Gas Manometer (mm)	6	0.441	6	0.441
Pre.Weight (g)	125.467	123.384	124.983	124.658
Post.Weight (g)	126.639	123.408	126.168	124.688
Balance Weight (g)	1.172	0.024	1.185	0.030
Total Weight (g)	1.196		1.215	
Sucked Volume (L)	20		20	
Pv. (mmHg)	34.01		34.50	
Xw (%)	9.53%		9.68%	
Average Xw (%)	9.61%			

3. Soot Concentration

	1	D-3	2	D-3
Temp. Average (℃)	35-36	35.5	36-38	37
Gas Manometer (mm)	4	0.294	4	0.294
Nozzle Diameter	6 mm		6 mm	
Qm (Equal Velocity A)	21.2 L/min		21.2 L/min	
Collected Soot Amount	0.0924 g		0.0358 g	
Sucked Stack Gas V(L)	300	206	300	203
Pv. (mmHg)	43.20		46.92	
Soot Concentration	0.449 g/m3N		0.176 g/m3N	
Ave. Soot Concentration	0.313 g/m3N			
O2 Conversion Value	0.787 g/m3N		Ave.O2	12.66

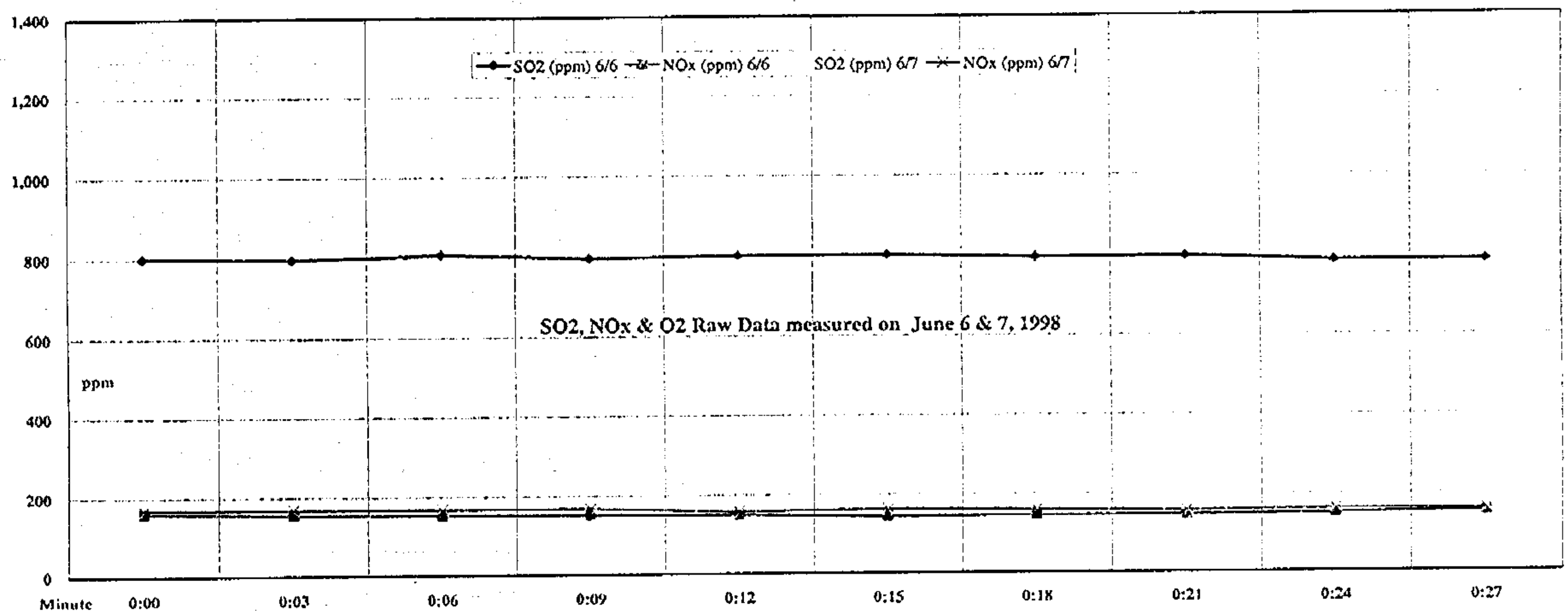
SO2, NOx, & O2 Raw Data measured on June 6, 1998

	16:35	16:38	16:41	16:44	16:47	16:50	16:53	16:56	16:59	17:02	Avg.
SO2 (ppm)	802	798	809	797	802	803	796	798	785	786	798
NOx (ppm)	160	156	155	153	151	146	148	147	151	154	152
O2 %	12.50	12.53	12.61	12.61	12.59	12.50	12.52	12.72	12.68	12.59	12.59
SO2(O2)	1,415	1,413	1,446	1,425	1,430	1,417	1,408	1,446	1,415	1,402	1,422
NOx(O2)	283	277	276	274	269	257	262	266	271	275	271

SO2, NOx, & O2 Raw Data measured on June 7, 1998

	15:57	16:00	16:03	16:06	16:09	16:12	16:15	16:18	16:21	16:24	Avg.
SO2 (ppm)	760	760	770	768	774	757	759	768	755	760	763
NOx (ppm)	169	170	170	169	160	163	161	158	162	162	164
O2 %	12.57	12.66	12.58	12.63	12.63	12.65	12.75	12.68	12.73	12.70	12.66
SO2(O2)	1,352	1,367	1,372	1,376	1,387	1,360	1,380	1,385	1,369	1,373	1,372
NOx(O2)	301	306	302	303	286	294	293	285	293	292	296

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%



Monitoring Results for Unit 4 at Esfahan P/P (1998/8/20, 4:30-8:30)
Fuel Type : Heavy Oil (23tons/h) & Natural Gas (20,000m3N/h) Output : 160MW

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	840	Pitot coef.	0.85	Density	0.78
mmH	630	Ethanol Temperature	31	γ0=1.3kgf/m3N	1.3

Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
A-1	5	270		0.1	20.7		174.3	0.658	21.1
A-2	5	200		0.1	15.2		178.9	0.651	18.2
A-3	5	135	70	0.1	10.1	-0.166	176.2	0.655	14.8
A-4	3	120		0.1	9.1		180.6	0.649	14.1
A-5	3	180		0.1	13.8		183.2	0.645	17.4
A-6	3	190		0.1	14.6		179.4	0.650	17.8
B-1	5	230		0.1	17.6		169.5	0.665	19.3
B-2	5	170		0.1	12.9		174.3	0.658	16.6
B-3	5	125	50	0.1	9.4	-0.239	180.6	0.649	14.3
B-4	3	130		0.1	9.9		185.6	0.641	14.8
B-5	3	205		0.1	15.8		187.0	0.640	18.7
B-6	3	280		0.1	21.6		181.2	0.648	21.7
C-1	5	250		0.1	19.1		175.6	0.656	20.3
C-2	5	200		0.1	15.2		182.3	0.646	18.3
C-3	5	270	120	0.1	20.7	-0.439	185.6	0.641	21.4
C-4	2	160		0.1	12.3		184.6	0.643	16.5
C-5	2	200		0.1	15.4		188.3	0.638	18.5
C-6	2	90		0.1	6.9		183.5	0.644	12.3
D-1	10	290		0.1	21.8		180.6	0.648	21.8
D-2	5	155		0.2	23.4		187.2	0.639	22.8
D-3	5	190	90	0.2	28.9	-0.558	180.0	0.649	25.1
D-4	2	285		0.1	22.1		190.0	0.635	22.2
D-5	2	295		0.1	22.9		182.3	0.646	22.4
D-6	2	185		0.1	14.3		184.3	0.643	17.7
E-1	5	165		0.2	25.0		185.4	0.642	23.5
E-2	5	190		0.2	28.9		186.3	0.640	25.3
E-3	5	165	85	0.2	25.0	-0.408	186.2	0.640	23.5
E-4	0	150		0.2	23.4		180.9	0.648	22.6
E-5	0	185		0.2	28.9		178.9	0.651	25.1
E-6	0	85		0.2	13.3		173.7	0.658	16.9
Average					17.9	-0.362	181.6	0.647	19.5

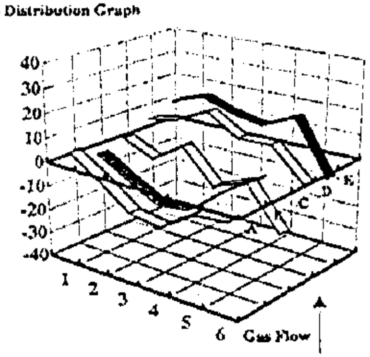
☐ = The Representative Point

4. Velocity (m/s) / Deviation

Velocity (m/s) / Deviation

	1	2	3	4	5	6	Average
A	21.1	18.2	14.8	14.1	17.4	17.8	17.2
	4.5	-3.7	-13.1	-15.0	-5.8	-4.7	
B	19.3	16.6	14.3	14.8	18.7	21.7	17.6
	-0.5	-8.0	-14.5	-13.2	-2.3	6.2	
C	20.3	18.3	21.4	16.5	18.5	12.3	17.9
	2.3	-3.5	5.2	-8.4	-2.7	-20.1	
D	21.8	22.8	25.1	22.2	22.4	17.7	22.0
	6.5	9.1	15.6	7.5	8.1	-4.9	
E	23.5	25.3	23.5	22.6	25.1	16.9	22.8
	11.1	16.1	11.2	8.7	15.5	-7.3	
Average	21.2	20.2	19.8	18.0	20.4	17.3	19.5
						Standard Deviation =	3.6

Velocity Deviation Distribution Graph

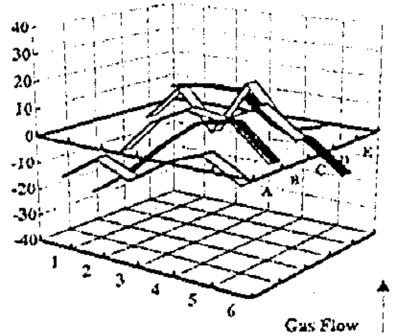


5. Temperature (℃) / Deviation

Temperature (℃) / Deviation

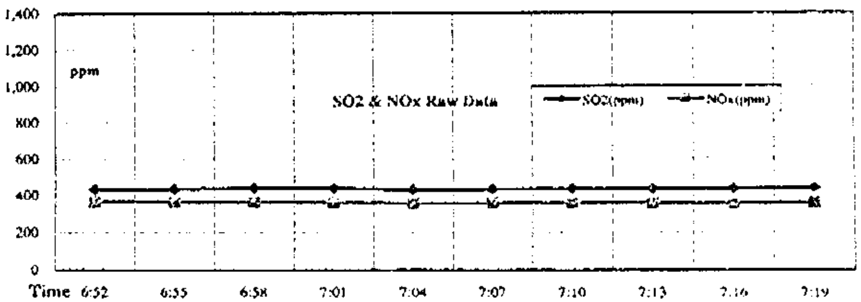
	1	2	3	4	5	6	Average
A	174.3	178.9	176.2	180.6	183.2	179.4	178.8
	-14.8	-5.4	-10.9	-1.9	3.4	-4.4	
B	169.5	174.3	180.6	185.6	187.0	181.2	179.7
	-24.6	-14.8	-1.9	8.3	11.1	-0.2	
C	175.6	182.3	185.6	184.6	188.3	183.5	183.3
	-12.2	1.5	8.3	6.2	13.8	4.0	
D	180.6	187.2	180.0	190.0	182.3	184.3	184.1
	-1.9	11.5	-2.2	17.3	1.5	5.6	
E	185.4	186.3	186.2	180.9	178.9	173.7	181.9
	7.9	9.7	9.5	-1.3	-5.4	-16.0	
Average	177.1	181.8	181.7	184.3	183.9	180.4	181.6
						Standard Deviation =	4.9

Temperature Deviation Distribution Graph



Calculation Formula

Deviation = (Velocity-Average Velocity) ×10 / Standard Deviation



2. Water Content

	1	B-5	2	B-5
Temp. Average (℃)		29.5		29
Gas Manometer (mm)	4	0.294	4	0.294
Pre. Weight (g)	125.352	126.605	125.916	122.826
Post. Weight (g)	126.594	126.746	126.849	122.866
Balance Weight (g)	1.24	0.14	0.93	0.04
Total Weight (g)	1.38		0.97	
Sucked Volume (L)	20		20	
Pv. (mmHg)	30.75		29.87	
Xw (%)	10.8%		7.8%	
Average Xw (%)	9.30%			

3. Soot Concentration

	1	D-5	2	D-5
Temp. Average (℃)		30		29
Gas Manometer (mm)	6	0.441	6	0.441
Nozzle Diameter	4 mm		4 mm	
Qm (Equal Velocity A)	23.7 L/min		23.7 L/min	
Collected Soot Amount	0.022 g		0.012 g	
Sucked Stack Gas V(L)	400	284	400	286
Pv. (mmHg)	31.65		29.87	
Soot Concentration	0.077 g/m3N		0.041 g/m3N	
Ave. Soot Concentration	0.059 g/m3N			
O2 Conversion Value	0.123 g/m3N		Ave.O2	10.94

6. SO_2, NO_x, & O_2 Raw Data monitored on August 20, 1998

	6:52	6:55	6:58	7:01	7:04	7:07	7:10	7:13	7:16	7:19	7:22	Avg.
SO2(ppm)	436	437	441	440	431	433	434	435	434	436		436
NOx(ppm)	368	365	366	363	357	357	360	358	355	357		360
O2(%)	10.88	10.87	10.70	11.03	11.07	10.98	10.95	10.94	11.00	10.96		10.94
SO2(O2)	646	647	642	662	651	648	648	649	651	651		650
NOx(O2)	546	540	533	546	539	534	537	534	533	533		537

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

Monitoring Results for Unit 4 at Esfahan P/P (1998/10/14, 9:10-12:00)
Fuel Type : Heavy Oil (36tons/h) & Natural Gas (32,700m3N/h) Output : 160MW

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	850	Pitot coef.	0.85	Density	0.784					
mmHg	638	Ethanol Temperature	26	γ0=1.3kgf/m3N	1.3					
Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kg/m3)	Velocity (m/s)	
A-1	0	90		0.2	14.1		145.0	0.712	16.7	
A-2	0	90		0.2	14.1		152.0	0.701	16.9	
A-3	0	75	45	0.2	11.8	-0.106	155.5	0.695	15.5	
A-4	0	70		0.2	11.0		157.0	0.692	15.0	
A-5	0	110		0.2	17.2		151.5	0.701	18.7	
A-6	0	115		0.2	18.0		145.6	0.711	18.9	
B-1	0	125		0.2	19.6		156.1	0.694	20.0	
B-2	0	70		0.2	11.0		161.1	0.686	15.1	
B-3	0	50	0	0.2	7.8	-0.417	160.2	0.687	12.7	
B-4	0	55		0.2	8.6		158.5	0.690	13.3	
B-5	0	100		0.2	15.7		156.2	0.693	17.9	
B-6	0	155		0.2	24.3		151.6	0.701	22.2	
C-1	0	90		0.2	14.1		161.1	0.685	17.1	
C-2	0	80		0.2	12.5		163.4	0.681	16.1	
C-3	0	105	0	0.2	16.5	-0.875	162.0	0.684	18.5	
C-4	0	85		0.2	13.3		161.5	0.684	16.6	
C-5	0	45		0.2	7.1		159.5	0.688	12.1	
C-6	0	75		0.2	11.8		163.5	0.681	15.6	
D-1	0	155		0.2	24.3		153.6	0.697	22.2	
D-2	0	140		0.2	22.0		160.0	0.687	21.3	
D-3	0	165	45	0.2	25.9	-0.856	164.0	0.681	23.2	
D-4	0	185		0.2	29.0		163.5	0.681	24.6	
D-5	0	145		0.2	22.7		159.5	0.688	21.6	
D-6	0	140		0.2	22.0		156.3	0.693	21.2	
E-1	0	140		0.2	22.0		155.7	0.694	21.2	
E-2	0	190		0.2	29.8		164.1	0.680	24.9	
E-3	0	170	55	0.2	26.7	-0.782	162.0	0.684	23.5	
E-4	0	160		0.2	25.1		163.3	0.682	22.8	
E-5	0	180		0.2	28.2		161.0	0.685	24.1	
E-6	0	120		0.2	18.8		159.6	0.688	19.7	
Average					18.2	-0.607	158.1	0.690	19.0	

☐ = The Representative Point

4. Velocity (m/s) / Deviation

Velocity (m/s) / Deviation

	1	2	3	4	5	6	Average
A	16.7	16.9	15.5	15.0	18.7	18.9	17.0
	-6.0	-5.7	-9.5	-10.8	-0.8	-0.1	
B	20.0	15.1	12.7	13.3	17.9	22.2	16.9
	2.8	-10.6	-17.0	-15.4	-2.9	8.7	
C	17.1	16.1	18.5	16.6	12.1	15.6	16.0
	-5.1	-7.7	-1.4	-6.4	-18.8	-9.1	
D	22.2	21.3	23.2	24.6	21.6	21.2	22.3
	8.8	6.3	11.5	15.2	7.3	6.0	
E	21.2	24.9	23.5	22.8	24.1	19.7	22.7
	6.0	16.1	12.3	10.5	14.1	1.9	
Average	19.4	18.9	18.7	18.5	18.9	19.5	19.0
					Standard Deviation =		3.7

5. Temperature (℃) / Deviation

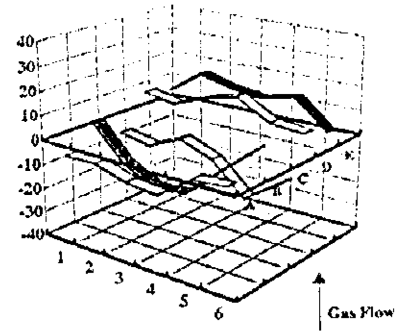
Temperature (℃) / Deviation

	1	2	3	4	5	6	Average
A	145.0	152.0	155.5	157.0	151.5	145.6	151.1
	-25.6	-12.0	-5.1	-2.2	-12.9	-24.4	
B	156.1	161.1	160.2	158.5	156.2	151.6	157.3
	-4.0	5.8	4.0	0.7	-3.8	-4.1	
C	161.1	163.4	162.0	161.5	159.5	163.5	161.8
	5.8	10.3	7.5	6.6	2.7	10.5	
D	153.6	160.0	164.0	163.5	159.5	156.3	159.5
	-8.8	3.6	11.4	10.5	2.7	-3.6	
E	155.7	164.1	162.0	163.3	161.0	159.6	161.0
	-4.7	11.6	7.5	10.1	5.6	2.9	
Average	154.3	160.1	160.7	160.8	157.5	155.3	158.1
					Standard Deviation =		5.1

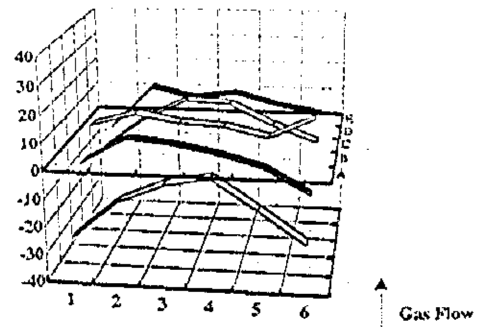
Calculation Formula

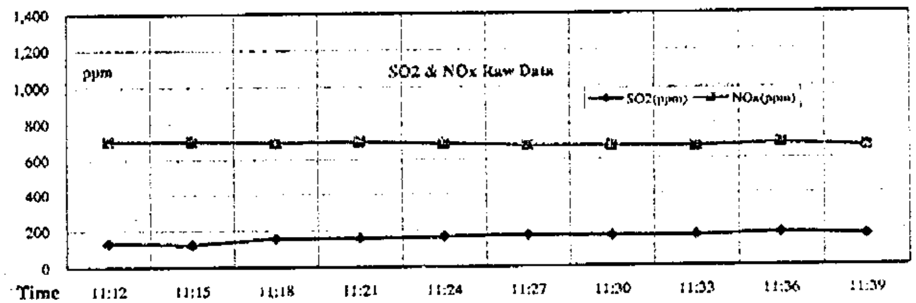
Deviation = (Velocity-Average Velocity) / Standard Deviation ×10

Velocity Deviation Distribution Graph



Temperature Deviation Distribution Graph





2. Water Content

	1	B-3	2	B-3
Temp. Average (℃)		29		30
Gas Manometer (mm)	4	0.294	4	0.294
Pre.Weight (g)	132.087	125.514	126.928	122.936
Post.Weight (g)	133.872	125.553	128.796	122.973
Balance Weight (g)	1.79	0.04	1.87	0.04
Total Weight (g)	1.82		1.90	
Sucked Volume (L)	20		20	
Pv. (mmHg)	29.87		31.65	
Xw (%)	13.6%		14.2%	
Average Xw (%)	13.86%			

3. Soot Concentration

Suspected Value

	1	C-3	2	C-3
Temp. Average (℃)		30		30
Gas Manometer (mm)	6	0.441	6	0.441
Nozzle Diameter	4 mm		4 mm	
Qm (Equal Velocity A)	31.6 L/min		15.3 L/min	
Collected Soot Amount	0.008 g		0.009 g	
Sucked Stack Gas V(L)	400	288	400	288
Pv. (mmHg)	31.65		31.65	
Soot Concentration	0.028 g/m3N		0.031 g/m3N	
Ave. Soot Concentration	0.030 g/m3N			
O2 Conversion Value	0.053 g/m3N		Ave.O2	9.22

6. SO2, NOx, & O2 Raw Data

	11:12	11:15	11:18	11:21	11:24	11:27	11:30	11:33	11:36	11:39	11:42	Avg.
SO2(ppm)	133	125	158	158	165	170	168	167	178	168		159.0
NOx(ppm)	708	708	700	704	692	680	676	673	691	672		690
O2(%)	8.86	8.79	9.28	9.31	9.29	9.13	9.24	9.35	9.13	9.77		9.22
SO2(O2)	164	154	202	203	211	215	214	215	225	224		203
NOx(O2)	875	870	896	903	886	859	862	867	873	898		879

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

Monitoring Results for Unit 4 at Esfahan P/P (1999/1/26, 9:00-13:50)
Fuel Type : Heavy Oil (36tons/h) Output : 160MW (Half-Output)

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	841	Pitot coef.		0.85	Density		0.799		
mmHg	631	Ethanol Temperature		8	γ0=1.3kgf/m3N		1.3		

Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
A-1	0	120		0.2	19.2		130.3	0.730	19.3
A-2	0	125		0.2	20.0		135.5	0.721	19.8
A-3	0	85	40	0.2	13.6	-0.252	143.0	0.708	16.5
A-4	0	110		0.2	17.6		153.2	0.691	19.0
A-5	0	95		0.2	15.2		150.4	0.696	17.6
A-6	0	120		0.2	19.2		148.6	0.699	19.7
B-1	0	90		0.2	14.4		126.5	0.738	16.6
B-2	0	70		0.2	11.2		135.0	0.722	14.8
B-3	0	50	40	0.2	8.0	0.046	140.3	0.713	12.6
B-4	0	70		0.2	11.2		154.5	0.689	15.2
B-5	0	110		0.2	17.6		155.1	0.688	19.0
B-6	0	130		0.2	20.8		154.9	0.689	20.7
C-1	0	120		0.2	19.2		136.0	0.720	19.4
C-2	0	100		0.2	16.0		143.9	0.706	17.9
C-3	0	90	35	0.2	14.4	-0.353	145.9	0.703	17.0
C-4	0	55		0.2	8.8		155.9	0.687	13.5
C-5	0	50		0.2	8.0		155.3	0.688	12.8
C-6	0	70		0.2	11.2		153.2	0.691	15.1
D-1	0	170		0.2	27.2		130.9	0.729	23.0
D-2	0	175		0.2	28.0		137.0	0.718	23.5
D-3	0	160	45	0.2	25.6	-0.830	144.0	0.706	22.7
D-4	0	170		0.2	27.2		158.1	0.683	23.7
D-5	0	125		0.2	20.0		157.2	0.684	20.3
D-6	0	130		0.2	20.8		152.0	0.692	20.6
E-1	0	210		0.2	33.6		140.0	0.712	25.8
E-2	0	230		0.2	36.8		142.9	0.707	27.1
E-3	0	200	70	0.2	32.0	-0.875	146.9	0.701	25.4
E-4	0	180		0.2	28.8		159.3	0.681	24.5
E-5	0	190		0.2	30.4		160.6	0.679	25.2
E-6	0	150		0.2	24.0		160.9	0.678	22.4
Average					20.0	-0.453	146.9	0.702	19.7

[ ] = The Representative Point

4. Velocity (m/s) / Deviation

Velocity (m/s) / Deviation

	1	2	3	4	5	6	Average
A	19.3	19.8	16.5	19.0	17.6	19.7	18.6
	-1.0	0.3	-7.9	-1.8	-5.2	0.1	
B	16.6	14.8	12.6	15.2	19.0	20.7	16.5
	-7.6	-12.1	-17.5	-11.2	-1.7	2.4	
C	19.4	17.9	17.0	13.5	12.8	15.1	16.0
	-0.7	-4.4	-6.6	-15.4	-16.9	-11.2	
D	23.0	23.5	22.7	23.7	20.3	20.6	22.3
	8.1	9.4	7.3	10.0	1.6	2.3	
E	25.8	27.1	25.4	24.5	25.2	22.4	25.1
	15.2	18.4	14.1	11.8	13.5	6.6	
Average	20.8	20.0	18.8	19.2	19.0	19.7	19.7
				Standard Deviation =			4.0

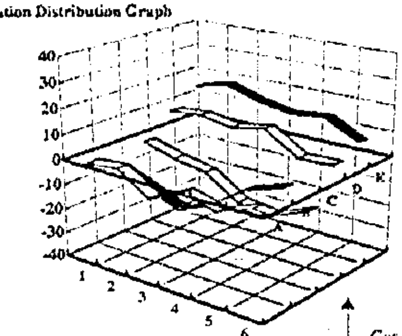
5. Temperature (℃) / Deviation

Temperature (℃) / Deviation

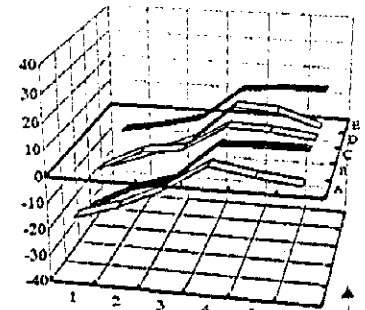
	1	2	3	4	5	6	Average
A	130.3	135.5	143.0	153.2	150.4	148.6	143.5
	-16.9	-11.6	-4.0	6.4	3.5	1.7	
B	126.5	135.0	140.3	154.5	155.1	154.9	144.4
	-20.7	-12.1	-6.7	7.7	8.3	5.4	
C	136.0	143.9	145.9	155.9	155.3	153.2	148.4
	-11.1	-3.1	-1.0	9.1	8.5	6.4	
D	130.9	137.0	144.0	158.1	157.2	152.0	146.5
	-16.3	-10.1	-3.0	11.4	10.5	5.2	
E	140.0	142.9	146.9	159.3	160.6	160.9	151.8
	-7.0	-4.1	0.0	12.6	13.9	14.2	
Average	132.7	138.9	144.0	156.2	155.7	153.9	146.9
				Standard Deviation =			9.8

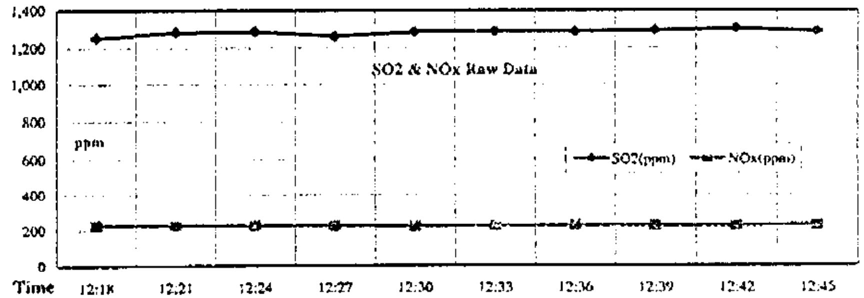
Calculation Formula
Deviation = (Velocity-Average Velocity) / Standard Deviation ×10

Velocity Deviation Distribution Graph



Temperature Deviation Distribution Graph





2. Water Content

	1	D-5	2	D-5
Temp. Average (℃)		5		5
Gas Manometer (mm)	4	0.294	4	0.294
Pre.Weight (g)	125.933	132.548	125.039	129.377
Post.Weight (g)	127.178	132.600	126.275	129.401
Balance Weight (g)	1.24	0.05	1.24	0.02
Total Weight (g)	1.30		1.26	
Sucked Volume (L)	20		20	
Pv. (mmHg)	6.39		6.39	
Xw (%)	9.1%		8.9%	
Average Xw (%)	8.97%			

3. Soot Concentration

	1	B-6	2	B-6
Temp. Average (℃)		4		4
Gas Manometer (mm)	6	0.441	6	0.441
Nozzle Diameter	4 mm		4 mm	
Qm (Equal Velocity A)	20.8 L/min		20.8 L/min	
Collected Soot Amount	0.043 g		0.041 g	
Sucked Stack Gas V(L)	600	487	600	487
Pv. (mmHg)	5.95		5.95	
Soot Concentration	0.088 g/m3N		0.084 g/m3N	
Ave. Soot Concentration	0.086 g/m3N			
O2 Conversion Value	0.127 g/m3N		Ave.O2	6.75

6. SO2, NOx, & O2 Raw Data

	12:18	12:21	12:24	12:27	12:30	12:33	12:36	12:39	12:42	12:45	Avg.
SO2(ppm)	1,253	1,284	1,289	1,262	1,287	1,288	1,287	1,291	1,303	1,287	1,283
NOx(ppm)	229	230	230	228	225	226	229	227	225	231	228
O2(%)	6.83	6.67	6.75	6.71	6.68	6.87	6.74	6.68	6.68	6.88	6.75
SO2(O2)	1,326	1,344	1,357	1,325	1,348	1,367	1,354	1,352	1,365	1,367	1,351
NOx(O2)	242	241	242	239	235	240	241	238	236	245	240

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

Monitoring Results for Unit 5 at Esfahan P/P	(1998/6/8, 10:20-17:00)
Fuel Type : Heavy Oil (3tons/h) &Natural Gas(45,000m3N/h)	Output : 220MW

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	840.8	Pitot coef.	0.85	Density	0.782
mmHg	630.8	Ethanol Temperature	28	γ0=1.3kgf/m3N	1.3

Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
A-1	19	155		0.2	21.3		151.4	0.694	20.8
A-2	19	210		0.2	29.9		152.5	0.692	24.7
A-3	19	205	160	0.2	29.1	0.076	148.6	0.699	24.3
A-4	20	195		0.2	27.4		146.0	0.703	23.5
A-5	20	175		0.2	24.2		145.0	0.705	22.1
A-6	20	155		0.2	21.1		134.3	0.723	20.3
B-1	19	190		0.2	26.7		145.1	0.705	23.2
B-2	19	195		0.2	27.5		148.1	0.700	23.6
B-3	19	175	140	0.2	24.4	0.095	149.1	0.698	22.2
B-4	19	150		0.2	20.5		148.8	0.698	20.4
B-5	19	190		0.2	26.7		148.0	0.700	23.3
B-6	19	160		0.2	22.1		146.6	0.702	21.1
C-1	19	110		0.2	14.2		144.4	0.706	16.9
C-2	19	120		0.2	15.8		148.6	0.699	17.9
C-3	19	200	145	0.2	28.3	-0.055	147.5	0.700	23.9
C-4	19	120		0.2	15.8		149.4	0.697	17.9
C-5	19	130		0.2	17.4		150.3	0.696	18.8
C-6	19	160		0.2	22.1		147.0	0.701	21.1
D-1	19	160		0.2	22.1		141.4	0.711	21.0
D-2	19	165		0.2	22.8		144.3	0.706	21.4
D-3	19	185	160	0.2	26.0	0.242	145.2	0.705	22.8
D-4	19	200		0.2	28.3		148.0	0.700	23.9
D-5	19	150		0.2	20.5		146.0	0.703	20.3
D-6	19	170		0.2	23.6		143.9	0.707	21.8
E-1	19	160		0.2	22.1		141.3	0.711	21.0
E-2	19	170		0.2	23.6		142.7	0.709	21.7
E-3	19	170	145	0.2	23.6	0.194	144.2	0.706	21.8
E-4	19	160		0.2	22.1		148.4	0.699	21.1
E-5	19	190		0.2	26.7		149.6	0.697	23.3
E-6	19	165		0.2	22.8		146.0	0.703	21.4
Average					23.3	0.111	146.4	0.703	21.6

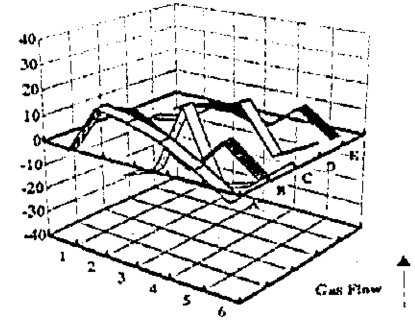
□ = The Representative Point

4. Velocity (m/s) / Deviation

Velocity (m/s) / Deviation

	1	2	3	4	5	6	Average
A	20.8	24.7	24.3	23.5	22.1	20.3	22.6
	-3.9	16.1	13.8	9.7	2.5	-6.4	
B	23.2	23.6	22.2	20.4	23.3	21.1	22.3
	8.2	10.4	3.4	-6.2	8.6	-2.5	
C	16.9	17.9	23.9	17.9	18.8	21.1	19.4
	-24.1	-18.9	12.0	-18.9	-14.3	-2.5	
D	21.0	21.4	22.8	23.9	20.3	21.8	21.9
	-3.2	-1.0	6.5	12.1	-6.5	0.9	
E	21.0	21.7	21.8	21.1	23.3	21.4	21.7
	-3.2	0.7	0.9	-2.3	8.8	-0.7	
Average	20.6	21.9	23.0	21.4	21.5	21.1	21.6
						Standard Deviation =	1.9

Velocity Deviation Distribution Graph

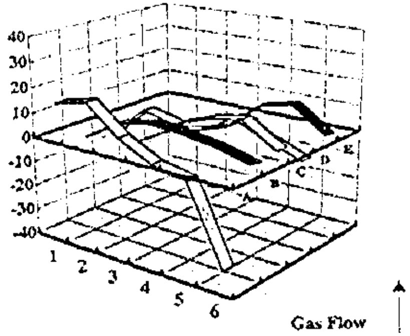


5. Temperature (℃) / Deviation

Temperature (℃) / Deviation

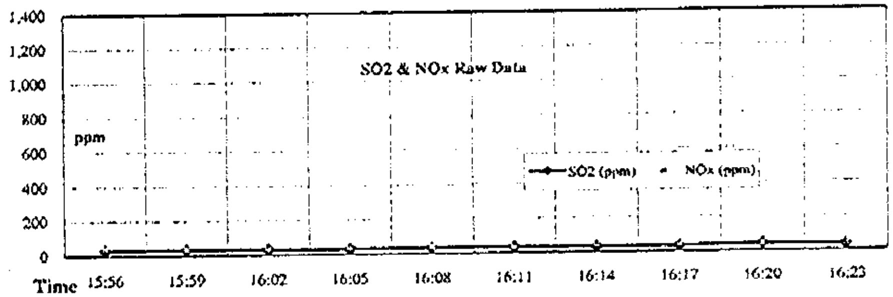
	1	2	3	4	5	6	Average
A	151.4	152.5	148.6	146.0	145.0	134.3	146.3
	14.0	17.1	6.2	-1.1	-3.9	-33.9	
B	145.1	148.1	149.1	148.8	148.0	146.6	147.6
	-3.6	4.8	7.6	6.8	4.5	0.1	
C	144.4	148.6	147.5	149.4	150.3	147.0	147.9
	-5.6	6.2	3.1	8.4	11.0	1.7	
D	141.4	144.3	145.2	148.0	146.0	143.9	144.8
	-14.0	-5.9	-3.3	4.5	-1.1	-7.0	
E	141.3	142.7	144.2	148.4	149.6	146.0	145.4
	-14.3	-10.3	-6.1	5.6	9.0	-1.1	
Average	144.7	147.2	146.9	148.1	147.8	143.6	146.4
						Standard Deviation =	3.6

Temperature Deviation Distribution Graph



Calculation Formula

Deviation = (Velocity-Average Velocity) / Standard Deviation ×10



2. Water Content

	1	C-2	2	C-2
Temp. Average (℃)	33-34	33.5	34-34	34
Gas Manometer (mm)	2mm	0.147	2mm	0.147
Pre.Weight (g)	122.799	124.593	126.639	123.408
Post.Weight (g)	124.692	124.650	126.692	125.198
Balance Weight (g)	1.89	0.06	0.05	1.79
Total Weight (g)	1.95		1.84	
Sucked Volume (L)	20		20	
Pv. (mmHg)	38.64		39.74	
Xw (%)	14.88%		14.22%	
Average Xw (%)	14.55%			

3. Soot Concentration

	1	D-2	2	D-2
Temp. Average (℃)	35-35	35	36-36	36
Gas Manometer (mm)	16	1.176	16	1.1765
Nozzle Diameter	6 mm		6 mm	
Qm (Equal Velocity A)	25.3 L/min		25.3 L/min	
Collected Soot Amount	0.0055 g		0.0073 g	
Sucked Stack Gas V(L)	500	344	500	342
Pv. (mmHg)	42.02		44.41	
Soot Concentration	0.016 g/m3N		0.021 g/m3N	
Ave. Soot Concentration	0.019 g/m3N			
O2 Conversion Value	0.071 g/m3N		Ave.O2	15.49

6. SO2, NOx, & O2 Raw Data

	15:56	15:59	16:02	16:05	16:08	16:11	16:14	16:17	16:20	16:23	Avg.
SO2 (ppm)	32.0	34.8	34.1	32.7	33.8	34.8	32.9	34.0	39.7	35.2	34
NOx (ppm)	42	41	38	41	43	41	42	44	41	40	41
O2 (%)	15.48	15.30	15.92	15.41	15.49	15.45	15.42	15.45	15.50	15.43	15.49
SO2(O2)	87	92	101	88	92	94	88	92	108	95	94
NOx(O2)	113	108	113	111	117	111	112	118	112	107	112

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

Monitoring Results for Unit 5 at Esfahan P/P (1998/6/10, 10:15-16:00)
Fuel Type:Heavy Oil (4tons/h) & Natural Gas (47,000m3N)Output : 220MW(Max

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	841	Pitot coef.		0.85	Density		0.783		
mmHg	631.0	Ethanol Temperatu		27	γ0=1.3kgf/m3N		1.3		
Rep. Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
D-2	17	150	135	0.2	20.8	0.252	148.1	0.700	20.5

2. Water Content

	1	C-2	2	C-2
Temp. Average (℃)		36		37
Gas Manometer (mm)	4	0.294	4	0.294
Pre.Weight (g)	127.758	124.078	124.693	124.655
Post.Weight (g)	129.664	124.120	126.599	124.690
Balance Weight (g)	1.906	0.042	1.906	0.035
Total Weight (g)	1.948		1.941	
Sucked Volume (L)	20		20	
Pv. (mmHg)	44.41		46.92	
Xw (%)	15.09%		15.14%	
Average Xw (%)	15.11%			

3. Soot Concentration

	1	D-3	2	D-3
Temp. Average (℃)		34.75		35.25
Gas Manometer (mm)	18	1.324	22	1.618
Nozzle Diameter	6 mm		6 mm	
Qm (Equal Velocity A)	22.85 L/min		22.85 L/min	
Collected Soot Amount	0.0072 g		0.0104 g	
Sucked Stack Gas V(L)	500	345	500	344
Pv. (mmHg)	41.44		42.61	
Soot Concentration	0.021 g/m3N		0.030 g/m3N	
Ave. Soot Concentration	0.026 g/m3N			
O2 Conversion Value	0.087 g/m3N		Ave.O2	14.82

SO2, NOx, & O2 Raw Data measured on June 8, 1998

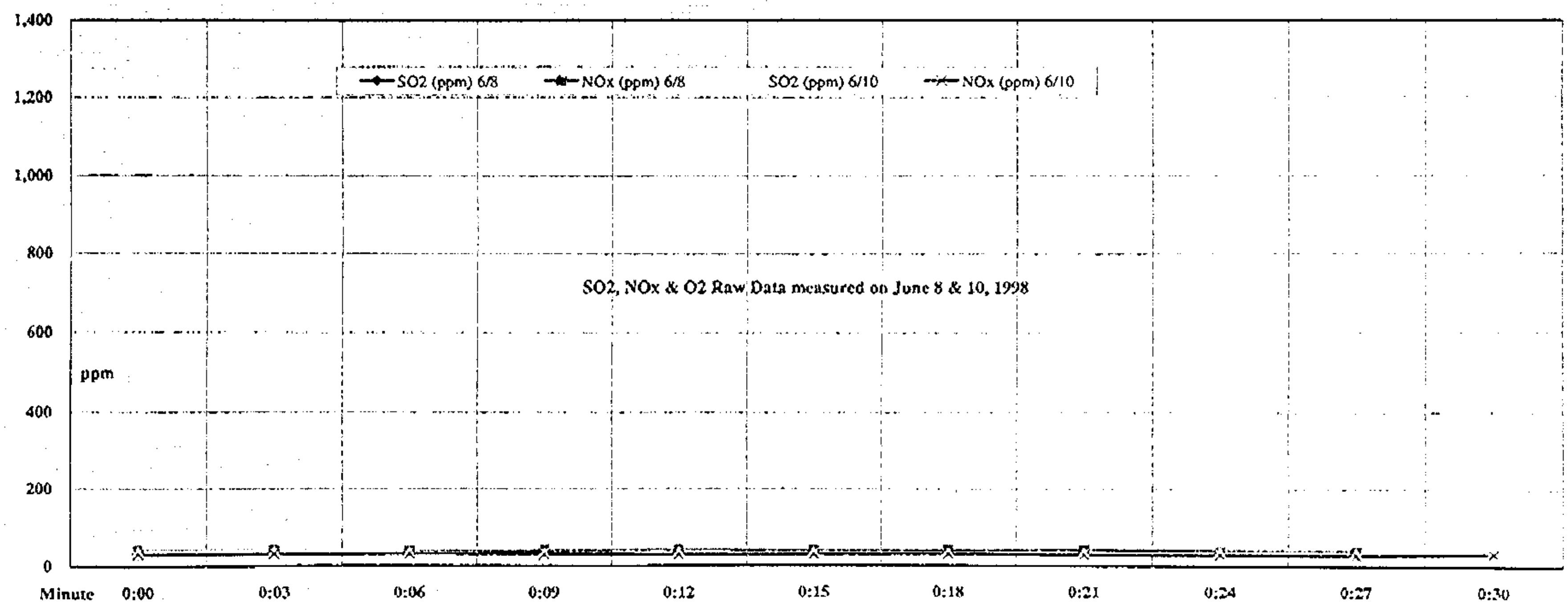
	15:56	15:59	16:02	16:05	16:08	16:11	16:14	16:17	16:20	16:23		Avg.
SO2 (ppm	32	35	34	33	34	35	33	34	40	35		34
NOx (ppm	42	41	38	41	43	41	42	44	41	40		41
O2 %	15.48	15.30	15.92	15.41	15.49	15.45	15.42	15.45	15.50	15.43		15.49
SO2(O2)	87	92	101	88	92	94	88	92	108	95		94
NOx(O2)	113	108	113	111	117	111	112	118	112	107		112

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

SO2, NOx, & O2 Raw Data measured on June 10, 1998

	11:53	11:56	11:59	12:02	12:05	12:08	12:11	12:14	12:17	12:20	12:23	Avg.
SO2 (ppm	37	38	35	31	33	35	35	34	36	35	39	35
NOx (ppm	33	34	34	32	32	31	33	31	31	30	34	32
O2 %	14.73	14.75	14.77	14.84	14.73	14.83	14.81	14.92	14.90	15.10	14.66	14.82
SO2(O2)	88	92	84	76	78	84	85	84	88	88	92	85
NOx(O2)	79	81	81	77	76	76	79	75	76	75	80	78

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%



Monitoring Results for Unit 5 at Esfahan P/P	(1999/1/27, 8:50-12:30)
Fuel Type : Heavy Oil (39tons/h)	Output : 170MW

1. Dynamic, Real & Static Pressure, and Temperature & Velocity Raw Data

Pa	845	Pitot coef.	0.85	Density	0.804
mmHg	634	Ethanol Temperature	3	γ0=1.3kgf/m3N	1.3

Point	Zero (mm)	D.ps. (mm)	T.ps. (mm)	Mano. Incl.	Real ps. (mm)	S.ps. (mm)	Temp. ℃	γ (kgf/m3)	Velocity (m/s)
A-1	0	85		0.2	13.7		118.9	0.754	16.0
A-2	0	110		0.2	17.7		122.0	0.748	18.3
A-3	0	100	-45	0.2	16.1	-1.386	122.7	0.747	17.5
A-4	0	105		0.2	16.9		123.0	0.746	17.9
A-5	0	115		0.2	18.5		120.0	0.752	18.7
A-6	0	105		0.2	16.9		115.3	0.761	17.7
B-1	0	90		0.2	14.5		118.7	0.755	16.5
B-2	0	120		0.2	19.3		122.5	0.748	19.1
B-3	0	115	20	0.2	18.5	-0.746	123.6	0.746	18.7
B-4	0	120		0.2	19.3		131.2	0.732	19.3
B-5	0	120		0.2	19.3		131.5	0.731	19.3
B-6	0	90		0.2	14.5		130.6	0.733	16.7
C-1	0	85		0.2	13.7		118.4	0.756	16.0
C-2	0	100		0.2	16.1		122.0	0.749	17.4
C-3	0	115	65	0.2	18.5	-0.214	124.2	0.745	18.7
C-4	0	120		0.2	19.3		129.3	0.736	19.3
C-5	0	70		0.2	11.3		127.2	0.739	14.7
C-6	0	70		0.2	11.3		124.7	0.744	14.6
D-1	0	85		0.2	13.7		115.7	0.761	15.9
D-2	0	135		0.2	21.7		120.5	0.752	20.2
D-3	0	115	54	0.2	18.5	-0.344	125.0	0.743	18.8
D-4	0	245		0.1	19.7		128.5	0.737	19.5
D-5	0	200		0.1	16.1		127.7	0.738	17.6
D-6	0	210		0.1	16.9		127.4	0.739	18.0
E-1	0	90		0.2	14.5		122.9	0.747	16.6
E-2	0	120		0.2	19.3		123.4	0.746	19.1
E-3	0	140	56	0.2	22.5	-0.534	125.7	0.742	20.7
E-4	0	245		0.1	19.7		128.1	0.737	19.4
E-5	0	220		0.1	17.7		127.9	0.738	18.4
E-6	0	180		0.1	14.5		126.9	0.740	16.6
Average					17.0	-0.645	124.2	0.745	17.9

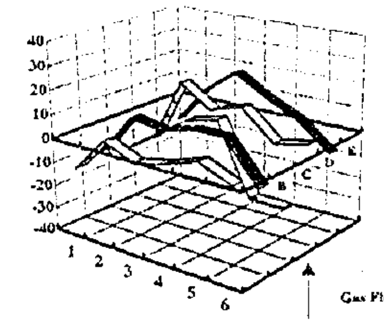
☐ = The Representative Point

4. Velocity (m/s) / Deviation

Velocity (m/s) / Deviation

	1	2	3	4	5	6	Average
A	16.0	18.3	17.5	17.9	18.7	17.7	17.7
	-12.2	2.5	-2.9	-0.1	4.8	-1.2	
B	16.5	19.1	18.7	19.3	19.3	16.7	18.3
	-9.3	7.8	5.3	9.1	9.2	-7.7	
C	16.0	17.4	18.7	19.3	14.7	14.6	16.8
	-12.4	-3.1	5.4	8.8	-20.9	-21.2	
D	15.9	20.2	18.8	19.5	17.6	18.0	18.3
	-12.7	14.9	5.5	9.9	-2.3	0.5	
E	16.6	19.1	20.7	19.4	18.4	16.6	18.5
	-8.7	7.9	18.2	9.9	3.3	-8.2	
Average	16.2	18.8	18.9	19.1	17.7	16.7	17.9
						Standard Deviation =	1.6

Velocity Deviation Distribution Graph

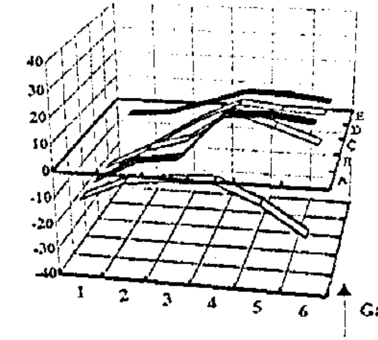


5. Temperature (℃) / Deviation

Temperature (℃) / Deviation

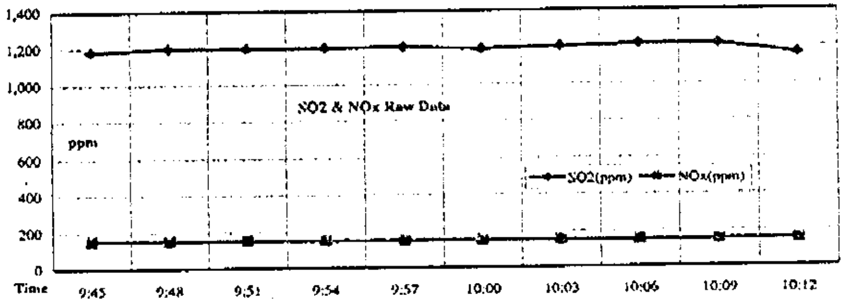
	1	2	3	4	5	6	Average
A	118.9	122.0	122.7	123.0	120.0	115.3	120.3
	-12.1	-5.0	-3.4	-2.7	-9.6	-20.4	
B	118.7	122.5	123.6	131.2	131.5	130.6	126.4
	-12.6	-3.9	-1.3	16.1	16.8	5.2	
C	118.4	122.0	124.2	129.3	127.2	124.7	124.3
	-13.3	-5.0	0.0	11.7	6.9	1.2	
D	115.7	120.5	125.0	128.5	127.7	127.4	124.1
	-19.4	-8.4	1.9	9.9	8.1	7.4	
E	122.9	123.4	125.7	128.1	127.9	126.9	125.8
	-2.9	-1.8	3.5	9.0	8.5	6.2	
Average	118.9	122.1	124.2	128.0	126.9	125.0	124.2
						Standard Deviation =	4.4

Temperature Deviation Distribution Graph



Calculation Formula

Deviation = (Velocity-Average Velocity) / Standard Deviation ×10



2. Water Content

	1	C-4	2	C-4
Temp. Average (℃)		6.5		6.5
Gas Manometer (mm)	4	0.294	4	0.294
Pre. Weight (g)	124.143	124.524	125.258	128.813
Post. Weight (g)	125.364	124.562	128.071	128.830
Balance Weight (g)	1.22	0.04	2.81	0.02
Total Weight (g)	1.26		2.83	
Sucked Volume (L)	20		20	
Pv. (mmHg)	7.10		7.10	
Xw (%)	8.86%		17.9%	
Average Xw (%)	8.86%			

Extra-ordinary Value

3. Soot Concentration

	1	D-6	2	D-6
Temp. Average (℃)		5		5
Gas Manometer (mm)	16	1.176	16	1.176
Nozzle Diameter	6 mm		6 mm	
Qm (Equal Velocity A)	19.0 L/min		19.0 L/min	
Collected Soot Amount	0.061 g		0.053 g	
Sucked Stack Gas V(L)	600	487	600	487
Pv. (mmHg)	6.39		6.39	
Soot Concentration	0.125 g/m3N		0.109 g/m3N	
Ave. Soot Concentration	0.117 g/m3N			
O2 Conversion Value	0.117 g/m3N		Ave.O2	0.00

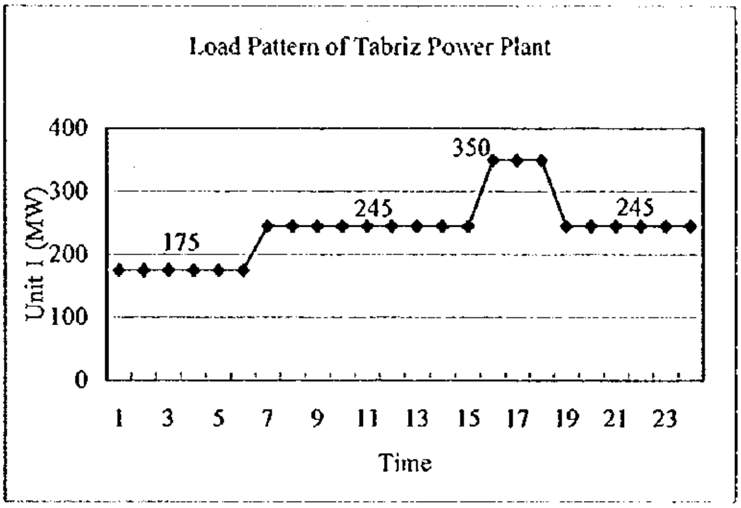
6. SO2, NOx, & O2 Raw Data

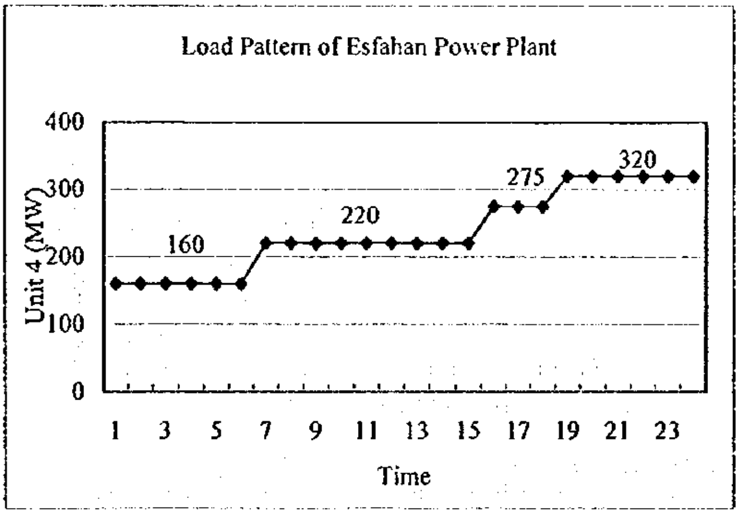
	9:45	9:48	9:51	9:54	9:57	10:00	10:03	10:06	10:09	10:12	Avg.
SO2(ppm)	1,183	1,201	1,199	1,201	1,205	1,192	1,203	1,215	1,214	1,162	1,198
NOx(ppm)	158	155	157	156	154	156	153	153	154	155	155
O2(%)	8.10	8.05	8.15	8.14	8.13	8.14	8.07	8.02	8.17	8.08	8.11
SO2(O2)	1,376	1,391	1,400	1,401	1,404	1,390	1,396	1,404	1,419	1,349	1,393
NOx(O2)	184	180	183	182	180	182	177	177	180	180	180

Note: SO2(O2) & NOx(O2) = SO2 & NOx values based on O2=6%

Appendix 8-1 Monthly Fuel Consumption and Generated Electricity from Each Power Plant

Power Plant		Tabriz				Esfahan		
Facility		Boiler		Gas Turbine		Boiler		
Year	Month	Generated Electricity MWh	Fuel Heavy Oil 10^3Litter	Generated Electricity MWh	Fuel Natural Gas 10^3m^3	Generated Electricity MWh	Fuel Heavy Oil 10^3Litter	Fuel Natural Gas 10^3m^3
1998	June	217,560	54,997	-	-	417,656	55,369	46,833
	July	325,670	82,501	29,315	16,069	467,038	45,097	71,841
	August	336,510	86,206	28,930	15,993	471,811	46,891	69,250
	September	213,880	56,254	29,425	16,279	469,154	43,242	73,175
	October	209,110	52,658	27,555	14,459	368,705	32,922	61,396
	November	325,440	81,881	22,825	13,145	344,270	26,567	61,260
	December	415,520	102,838	17,050	10,057	369,172	29,505	60,286
1999	January	414,520	103,843	12,320	8,485	409,046	54,591	49,993
	February	447,590	111,184	15,894	10,528	381,463	54,660	43,370
	March	325,705	83,568	15,290	8,332	360,100	54,129	39,015





Appendix 8-2 Large Factories

Data of facility types, fuel consumption, and stack information of large factories within target area were collected by Counterpart. Pollutant emission was estimated from existing emission factors from Japan, whereas, wet gas volume was estimated from fuel composition data from Iran and Japan.

Large factories within target area of Tabriz were Tabriz Oil Refinery and Soofian Cement Factory. Stack gas monitoring was not conducted at target power plant due to its small scale of gas turbines. But instead, monthly fuel consumption was obtainable, and using the existing emission factors and combustion calculations, pollutant emissions were estimated, and the result was included in the simulation model. Within target area of Esfahan, pollutant emissions were estimated for Montazeri Power Plant, Esfahan Oil Refinery, Esfahan Polyacryl Factory, Esfahan Steel Industry, Esfahan Cement Factory, and Sepahan Cement Factory. Emission conditions of large factories other than the target power plants are listed in the table below.

Tabriz

Factory Name	Unit	Tabriz Oil Refinery			Soofian Cement
Facility		Heating Furnace			Kiln
Fuel Type		Light Gas	Gas Oil	Heavy Oil	Heavy Oil
Fuel Consumption	m^3_N/y	62,192 x10³	63,000	268,000	140,378.54
Wet Gas Volume	m^3_N/h	106,777.1	131,458.0	598,857.6	292,662.0
SO_X Emission	m^3_N/h	0	33.3710	405.1	197.9602
NO_x Emission	m^3_N/h	6.4251	7.1397	42.5	91.6752
PM Emission	kg/h	0.2211	1.5203	47.6	1459.1736
Flue Gas Temperature	°C	200.0			140.0
Stack height	m	53.5			40.0
Stack Diameter	m	2.50			2.00
Sulfur Content	%	0	0.8	1.95	1.95
NO_x Emission Factor	kg/10⁶kcal	20.65	22.47	29.36	122.22
PM Emission Factor	kg/10⁶kcal	0.346	2.33	16	9473
Reference	Sulfur Content	Ref:Esfahan Power Plant	Ref:111	Ref:Tabriz Power Plant	Ref:Tabriz Power Plant
Information	NOx Emission Factor	Ref:87 Fac:Heating Furnace Fuel:OFG	Ref:87 Fac:Heating Furnace Fuel:Gas Oil	Ref:87 Fac:Heating Furnace Fuel:Heavy Oil	Ref:87 Fac:Heating Furnace Fuel:Heavy Oil
	PM Emission Factor	Ref:110 Fac:Heating Furnace Fuel:Accessory Gas	Ref:110 Fac:Heating Furnace Fuel:Accessory Oil	Ref:110 Fac:Heating Furnace Fuel:Heavy Oil	Ref:110 Fac:Cement Kiln Fuel:Heavy Oil

Esfahan 1

Factory Name	Unit	Montazeri Power Plant	Esfahan-Polyacryl Factory		Esfahan Cement		Sepahan Cement	
Facility		Generation Boiler	Generation Boiler		Blast Furnace	Kiln	Kiln	Kiln
Fuel Type		Heavy Oil	Natural Gas	Gas Oil	Natural Gas	Heavy Oil	Heavy Oil	Natural Gas
Fuel Consumption	m^3_N/y	1,752,000	58800x10³	42,000	57,024,00x10³	14256	96679.78	65711.427x10³
Wet Gas Volume	m^3_N/h	3,200,000.0	136,780.0	91,394.6	140,688.0	33,054.8	174,067.0	174,067.0
SO_X Emission	m^3_N/h	4263.6860	0	22.2473	0	32.4472	109.4189	109.4189
NO_x Emission	m^3_N/h	371.6684	4.2529	5.2830	9.6622	9.5626	39.4861	39.4861
PM Emission	kg/h	92.8726	0	2.0532	500.9692	158.6967	899.6507	899.6507
Flue Gas Temperature	°C	150.0	145.0		140.0		140.0	140.0
Stack height	m	200.0	10.0		40.0		40.0	40.0
Stack Diameter	m	4.20	1.60		2.00		2.00	2.00
Sulfur Content	%	3.13	0	0.8	0	3.13	3.13	0
NO_x Emission Factor	kg/10⁶kcal	38.79	14.99	24.94	37.52	122.22	122.22	37.52
PM Emission Factor	kg/10⁶kcal	4.72	0	4.72	9473	9877	9473	9473
Reference	Sulfur Content	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:111	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant
Information	NOx Emission Factor	Ref:87 Fac:Generation Boiler Fuel:Heavy Oil	Ref:87 Fac:Generation Boiler Fuel:LNG	Ref:87 Fac:Generation Boiler Fuel:Gas Oil	Ref:87 Fac:Cement Kiln Fuel:LNG	Ref:87 Fac:Cement Kiln Fuel:LNG	Ref:87 Fac:Cement Kiln Fuel:Heavy Oil	Ref:87 Fac:Cement Kiln Fuel:LNG
	PM Emission Factor	Ref:111 Fac:Generation Boiler Fuel:Heavy Oil	EF not available → Set by SUR	Ref:111 Fac:Generation Boiler Fuel:Heavy Oil	Ref:111 Fac:Cement Kiln Fuel:Heavy Oil(No Gas)	Ref:111 Ref:Cement Kiln Fuel:Heavy Oil(No Gas)	Ref:111 Fac:Dry type Cement Kiln Fuel:Heavy Oil	Ref:111 Fac:Dry type Cement Kiln Fuel:Heavy Oi(No Gas)

Esfahan 2

Factory Name	Unit	Esfahan Oil Refinery					Esfahan Steel		
Facility		Generation Boiler	Heating Furnace	Heating Furnace	Heating Furnace	Heating Furnace	Furnaces	Converter	Furnaces
Fuel Type		Heavy Oil	Heavy Oil	Refinary Off Gas	Natural Gas	Gas Oil	Natural Gas	Natural Gas	Natural Gas
Fuel Consumption	m^3_N/y	410,400	340,560	296,356x10^3	37,979x10^3	76,000	190,080.00x10^3	169,251.20x10^3	159,803.50x10^3
Wet Gas Volume	m^3_N/h	903,912.7	815,675.6	508,812.1	84,715.7	158,584.2	468,960.0	377,530.6	356,456.7
SO_X Emission	m^3_N/h	967.9598	800.6814	0	0	40.2571	0	0	0
NO_x Emission	m^3_N/h	84.8267	53.1094	30.6170	3.5954	8.6130	1.5321	13.3788	19.4277
PM Emission	kg/h	21.1965	59.4353	1.0535	0.1302	1.8341	2.1026	566.8900	2.6634
Flue Gas Temperature	℃	140.0	200.0	200.0	200.0	200.0	140.0	500.0	150.0
Stack height	m	76.0	53.5	53.5	53.5	53.5	64.0	50.0	50.0
Stack Diameter	m	2.95	2.50	2.50	2.50	2.50	3.04	3.55	2.55
Sulfur Content	%	3.13	3.13	0	0	0.8	0	0	0
NO_x Emission Factor	kg/10^{6}kcal	38.79	29.36	20.65	19.62	22.47	1.45	14.22	21.87
PM Emission Factor	kg/10^{6}kcal	4.72	16	0.346	0.346	2.33	0.969	6190.5	1.46
Reference Information	Sulfur Content	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:111	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant	Ref:Esfahan Power Plant
	NOx Emission Factor	Ref:87 Fac:Generation Boiler Fuel:Heavy Oil	Ref:87 Fac:Heating Furnace Fuel:Heavy Oil	Ref:87 Fac:Heating Furnace Fuel:OFG	Ref:87 Fac:Heating Furnace Fuel:LNG	Ref:87 Fac:Heating Furnace Fuel:Gas Oil	Ref:110 Fac:Blast Furnace Fuel:BFG(No Natural Gas)	Ref:87 Fac:Converter Fuel:LNG	Ref:87 Fac:Heating Furnace for rolling Fuel:LNG
	PM Emission Factor	Ref:110 Fac:Generation Boiler Fuel:Heavy Oil	Ref:110 Fac:Heating Furnace Fuel:Heavy Oil	Ref:110 Fac:Heating Furnace Fuel:Accessory Gas	Ref:110 Fac:Heating Furnace Fuel:Accessory Gas	Ref:110 Fac:Heating Furnace Fuel:Accessory Oil	Ref:110 Fac:Blast Furnace Fuel:BFG(No Natural Gas)	Ref:110 Fac:Converter & ideal energy usage & calculation	Ref:110 Fac:Heating Furnace for rolling Fuel:LP(No Natural Gas)

Esfahan 3

Factory Name	Unit	Esfahan Steel			Esfahan Steel		
Facility		Generation Boiler No.1			Generation Boiler No.2		
Fuel Type		Natural Gas	Furnace Gas	Coke Gas	Natural Gas	Furnace Gas	Coke Gas
Fuel Consumption	m^3_N/y	8,401.54x10^3	61,763.04x10^3	3,275.42x10^3	2,491.63x10^3	18,316.98x10^3	971.39x10^3
Wet Gas Volume	m^3_N/h	22,800.8	20,244.6	4,444.6	6,147.3	5,458.1	1,198.3
SO_X Emission	m^3_N/h	0	0	0	0	0	0
NO_x Emission	m^3_N/h	0.7001	0.1033	0.1492	0.2076	0.0306	0.0442
PM Emission	kg/h	0	0	0	0	0	0
Flue Gas Temperature	℃	140.0			140.0		
Stack height	m	80.0			64.0		
Stack Diameter	m	4.00			1.50		
Sulfur Content	%	0	0	0	0	0	0
NO_x Emission Factor	kg/10^{6}kcal	14.99	3.01	20.48	14.99	3.01	20.48
PM Emission Factor	kg/10^{6}kcal	0	0	0	0	0	0
Reference Information	Sulfur Content	Ref:Esfahan Power Plant	Ref:110 Fuel:Furnace Gas	Ref:110 Fuel:Coke Gas	Ref:Esfahan Power Plant	Ref:110 Fuel:Furnace Gas	Ref:110 Fuel:Coke Gas
	NOx Emission Factor	Ref:87 Fac:Generation Boiler Fuel:LNG	Ref:87 Fac:Generation Boiler Fuel:BFG	Ref:87 Fac:Generation Boiler Fuel:COG	Ref:87 Fac:Generation Boiler Fuel:LNG	Ref:87 Fac:Generation Boiler Fuel:BFG	Ref:87 Fac:Generation Boiler Fuel:COG
	PM Emission Factor	EF not available → Set by SUR	EF not available → Set by SUR	EF not available → Set by SUR	EF not available → Set by SUR	EF not available → Set by SUR	EF not available → Set by SUR

Appendix 8-3 Traffic Volume

For Esfahan area, traffic volumes from 7 roads (8 vehicle types, and 18 hours' total traffic volumes) were obtained from Esfahan municipal authority. Also, since some roads were located near the 3 monitoring stations, the traffic volumes were counted for such roads for a short time. Traffic volumes obtained from Esfahan municipal authority were not hourly data, so 24-hour traffic volume patterns of other JICA project in Greater Teheran Area (#81) were applied. For information such as emission factors, vehicle weight, and fuel consumption that are necessary to estimate pollution emission from vehicles, the data from the other JICA project (#81) were applied similarly. The utilized data are listed in the below.

Fuel Specifications

Vehicle Group	Vehicle Type	Fuel	Specific Weight (kg/Litter)	Sulfur Content (%)	Equivalent Inertia (t)
Car		Gasoline	0.730	0.0086	1.0
Bus	Minibus	Gas Oil	0.845	0.8000	3.0
	Bus		0.845	0.8000	10.0
Truck		Gas Oil	0.845	0.8000	8.0
2 Wheeler		Gasoline	-	-	-

Fuel Consumption Equation by Exhaust Control Groups

Vehicle Group	Fuel	Engine Type	Vehicle Age(Years)	Vehicle Age Percentage(%)	Fuel Consumption Equation ($EF=A+B \cdot V+C \cdot V^2$)		
					A	B	C
car	Gasoline	4 Cycle	0~10	44	0.17590	-0.004264	0.000037100
			10 and Older	56	0.25640	-0.007639	0.000072500
Bus/ Truck	Gas Oil	Direct Injection	0~10	38	0.05673	-0.001377	0.000012390
			10 and Older	62	0.04427	-0.0007469	0.000005939
2 Wheeler	Gasoline	-		-	-		

Note 1) EF:Fuel Consumption (Litter/km; Litter/t・km for bus and truck) (#87)
Note 2) V :Travel Speed=30km/h

NOx Emission Factor Equation by Exhaust Control Groups

Vehicle Group	Fuel	Engine Type	Vehicle Age(Years)	Vehicle Age Percentage(%)	EF Equation ($EF=A+B \cdot V+C \cdot V^2$)		
					A	B	C
Car	Gasoline	4 Cycle	0~10	44	2.3000	-0.01410	0.0007337
			10~20	36	1.3740	-0.01275	0.0003499
			20 and Older	20	0.5045	-0.01367	0.0003211
Bus/ Truck	Gas Oil	Direct Injection	0~10	38	1.4980	-0.04530	0.0004537
			10~20	31	1.4510	-0.03877	0.0003738
			20 and Older	31	1.1670	-0.01536	0.0000962
2 Wheeler	Gasoline	-		-	0.4g/km		

Note 1) Emission Factor of 2 wheeler is from EPA (#87)
Note 2) EF : NOx Emission Factor (g/km; g/t・km for bus and truck)
Note 3) V :Travel Speed=30km/h

SPM Emission Factor Equation by Exhaust Control Groups

Vehicle Group	Fuel	Engine Type	Exhaust Pipe ($EF=A+B \cdot V+C \cdot V^2$)			EF of Tire Abrasion	EF of Upflung Dust
			A	B	C		
Car	Gasoline	4 Cycle	0.01			0.02	0.05
Bus	Gas Oil	Direct Injection	0.2245	-0.004336	0.00003172	0.10	0.10
Truck	Gas Oil	Direct Injection	1.4510	-0.038770	0.00037380	0.20	0.10
2 Wheeler	Gasoline	-	-			-	-

Note 1) EF : SPM Emission Factor (g/km; g/t・km for exhaust pipe of bus and truck) (#109)
Note 2) V :Travel Speed=30km/h

Appendix 8-4 Areal Emission Source

The total fuel consumption by fuel types and industrial types of East-Azarbayejan province and Esfahan province were obtained and used in the simulation model as area source. To calculate fuel consumption of the remaining area, first, fuel consumed in the target power plants, large facilities, and road traffic were subtracted from the total fuel consumption. Then, assumption of combustion facility types for each industry was made, and Japanese emission factors of each industry and facility type were applied. To differentiate urban/rural areas of both provinces, the population ratio of urban and rural area was used to distribute the emission. Finally, the emissions were summarized into 3 categories, small and medium facilities and establishments, households, and transportation. The following tables show the details of areal emission.

Fuel Consumption (Tabriz)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	t	120,112	1,376	648	108	1	1	0	0	152	467	0	1,589	4,453	0	111,318	0
Gasoline	m^3	528,391	209	9	8	1	0	0	0	2	189	0	521,531	4,390	2,052	0	0
Gas Oil	m^3	1,395,165	138,275	58,692	35,643	2,856	2,620	0	0	12,247	26,216	84,546	512,887	18,073	367,650	135,459	0
Kerosene	m^3	1,002,731	928	216	488	3	3	0	0	37	179	0	0	6,090	1,149	993,636	0
Heavy Oil	m^3	425,819	0	0	0	0	0	0	0	0	0	82,412	0	228,330	0	0	115,077
Natural Gas	10^3m^3	603,000	27,000	915	115	5,135	0	0	0	36	20,799	0	0	45,000	0	504,000	0

Fuel Consumption (Esfahan)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	t	129,533	1,520	441	756	5	5	0	0	0	314	0	2,802	4,993	0	118,698	0
Gasoline	m^3	786,671	6,882	1,150	4,156	87	59	0	0	0	1,430	0	763,296	0	9,611	0	0
Gas Oil	m^3	1,790,085	127,494	17,827	77,631	133	837	0	0	0	31,065	5,490	1,133,859	5,764	325,728	64,256	0
Kerosene	m^3	526,423	6,818	390	5,746	24	56	0	0	0	602	2,666	0	2,762	0	507,359	0
Heavy Oil	m^3	486,536	0	0	0	0	0	0	0	0	0	19,104	0	314,968	0	0	152,464
Natural Gas	10^3m^3	6,915,606	2,583,803	846,904	1,409,788	50	478	0	0	0	326,583	0	0	246,000	0	1,502,000	0

SOx Emission (Tabriz)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas		0.0673	0.0008	0.0004	0.0001	0	0	0	0	0.0001	0.0003	0	0.0009	0.0025	0	0.0631	0
Gasoline		0.9649	0	0	0	0	0	0	0	0	0	0	0.9531	0	0	0	0
Gas Oil	$m^3{}_N/h$	236.2172	25.9692	11.0229	6.6941	0.5364	0.4920	0	0	2.3002	4.9236	15.8784	96.4872	3.3943	69.0477	25.4403	0
Kerosene		7.5150	0.0070	0.0016	0.0037	0	0	0	0	0.0003	0.0013	0	0	0.0457	0.0086	7.4537	0
Heavy Oil		228.1977	0	0	0	0	0	0	0	0	0	44.1648	0	122.3628	0	0	61.6701
Natural Gas		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		472.9621	25.9773	11.0249	6.6979	0.5364	0.4921	0	0	2.3005	4.9256	60.0433	97.4412	125.8131	69.0600	32.9571	61.6701

SOx Emission (Esfahan)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas		0.0184	0.0002	0.0001	0.0001	0	0	0	0	0	0	0	0.0004	0.0007	0	0.0171	0
Gasoline		0.3616	0	0	0	0	0	0	0	0	0	0	0.3541	0	0	0	0
Gas Oil	$m^3{}_N/h$	79.3567	6.0784	0.8499	3.7011	0.0064	0.0399	0	0	0	1.4811	0.2617	54.1490	0.2748	15.5294	3.0635	0
Kerosene		0.9895	0.0130	0.0007	0.0109	0	0.0001	0	0	0	0.0011	0.0051	0	0.0053	0	0.9662	0
Heavy Oil		106.4058	0	0	0	0	0	0	0	0	0	4.1781	0	68.8838	0	0	33.3440
Natural Gas		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total		187.1320	6.0947	0.8513	3.7140	0.0064	0.0401	0	0	0	1.4829	4.4449	54.5035	69.1646	15.5337	4.0467	33.3440

NOx Emission (Tabriz)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	m^3_N/h	4.9292	0.0827	0.0344	0.0071	0	0	0	0	0.0102	0.0310	0	0.8799	0.3454	0	3.6212	0
Gasoline		234.1813	0.0138	0.0003	0.0004	0	0	0	0	0.0002	0.0129	0	233.9680	0.1359	0.0635	0	0
Gas Oil		56.9679	7.3024	2.3248	1.7401	0.1736	0.1593	0	0	0.9722	1.9324	3.7706	28.3964	0.6044	12.2942	4.6000	0
Kerosene		33.1250	0.0406	0.0086	0.0232	0.0001	0.0001	0	0	0.0014	0.0071	0	0	0.2193	0.0414	32.8258	0
Heavy Oil		43.2838	0	0	0	0	0	0	0	0	0	6.1134	0	24.7145	0	0	12.4559
Natural Gas		11.0521	0.9702	0.0347	0.0054	0.2987	0	0	0	0.0010	0.6305	0	0	1.8476	0	8.2343	0
Total		383.5393	8.4096	2.4027	1.7761	0.4725	0.1594	0	0	0.9849	2.6140	9.8840	263.2444	27.8670	12.3991	49.2792	12.4559

NOx Emission (Esfahan)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	m^3_N/h	1.4963	0.0239	0.0059	0.0125	0.0001	0.0001	0	0	0	0.0053	0	0.3939	0.0983	0	0.9802	0
Gasoline		87.0874	0.0853	0.0107	0.0477	0.0013	0.0008	0	0	0	0.0248	0	86.9266	0	0.0755	0	0
Gas Oil		21.1038	1.7376	0.1793	0.9621	0.0021	0.0129	0	0	0	0.5813	0.0622	15.9362	0.0489	2.7651	0.5539	0
Kerosene		4.3862	0.0800	0.0039	0.0693	0.0002	0.0005	0	0	0	0.0061	0.0264	0	0.0252	0	4.2546	0
Heavy Oil		13.8195	0	0	0	0	0	0	0	0	0	0.3765	0	9.0582	0	0	4.3847
Natural Gas		36.1756	27.3822	8.1467	16.7144	0.0007	0.0071	0	0	0	2.5132	0	0	2.5640	0	6.2294	0
Total		164.0689	29.3089	8.3465	17.8060	0.0043	0.0214	0	0	0	3.1307	0.4651	103.2567	11.7947	2.8406	12.0182	4.3847

PM Emission (Tabriz)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	m^3_N/h	0.2039	0.0723	0.0678	0	0	0	0	0	0.0011	0.0034	0	0.0830	0	0	0.0486	0
Gasoline		18.3840	0.0015	0.0011	0.0001	0	0	0	0	0	0.0003	0	18.2601	0.0834	0.0390	0	0
Gas Oil		67.7163	8.1764	7.7656	0.2958	0.0237	0.0217	0	0	0.0221	0.0474	1.4654	48.7253	0.3710	7.5471	1.4311	0
Kerosene		10.3624	0.0061	0.0017	0.0039	0	0	0	0	0.0001	0.0003	0	0	0.1216	0.0229	10.2117	0
Heavy Oil		17.9808	0	0	0	0	0	0	0	0	0	1.5276	0	10.9397	0	0	5.5135
Natural Gas		0.2895	0.1753	0.0685	0	0	0	0	0	0.0002	0.1067	0	0	0	0	0.1142	0
Total		114.9370	8.4316	7.9047	0.2998	0.0237	0.0218	0	0	0.0235	0.1580	2.9931	67.0684	11.5157	7.6090	11.8056	5.5135

PM Emission (Esfahan)

Fuel Type	Unit	Grand Total	Total of Industry	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transpor-tation	Commercial	Agriculture	Household	Others
Liquid Gas	m^3_N/h	0.0626	0.0123	0.0117	0	0	0	0	0	0	0.0006	0	0.0371	0	0	0.0132	0
Gasoline		6.8753	0.0448	0.0358	0.0081	0.0002	0.0001	0	0	0	0.0006	0	6.7842	0	0.0464	0	0
Gas Oil		30.0474	0.7786	0.5988	0.1636	0.0003	0.0018	0	0	0	0.0142	0.0242	27.3448	0.0300	1.6974	0.1723	0
Kerosene		1.3621	0.0130	0.0008	0.0118	0	0.0001	0	0	0	0.0003	0.0114	0	0.0140	0	1.3236	0
Heavy Oil		6.0445	0	0	0	0	0	0	0	0	0	0.0941	0	4.0096	0	0	1.9409
Natural Gas		16.5995	16.5131	16.0879	0	0	0	0	0	0	0.4252	0	0	0	0	0.0864	0
Total		60.9914	17.3618	16.7349	0.1834	0.0005	0.0020	0	0	0	0.4409	0.1297	34.1662	4.0536	1.7438	1.5955	1.9409

Specific Weight, Caloric Value, and Sulfur Content

Fuel Type	Specific Weight			Caloric Value			Sulfur Content		
	Unit	Tabriz	Esfhan	Unit	Tabriz	Esfahan	Unit	Tabriz	Esfhan
Liquid Gas	kg/kg	-	-	kcal/kg	12,145	12,145	%	0.002	0.002
Gasoline	kg/L	0.7315	0.7315	kcal/L	8,400	8,400		0.0086	0.0086
Gas Oil	kg/L	0.8286	0.8286	kcal/L	9,073	9,073		0.8	0.8
Kerosene	kg/L	0.7951	0.7951	kcal/L	8,826	8,826		0.0333	0.0333
Heavy Oil	kg/L	0.9700	0.9715	kcal/L	9,703	10,156		1.95	3.13
Natural Gas	kg/m^3_N	0.7970	0.7970	kg/m^3_N	8,680	8,680		0	0

NOx Emission Factor

Fuel Type	Unit	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transportation	Commercial	Agriculture	Household	Others
Liquid Gas	$kg/10^6kcal$	22.15	27.3	22.1	22.1	22.74	61.8	27.97	27.74	26.17	0.001742	32.4	32.4	13.59	32.4
Gasoline		22.15	27.3	34	34	22.47	63.15	44.39	41.22	24.94	0.002105	18.7	18.7	0	18.7
Gas Oil		22.15	27.3	34	34	22.47	63.15	44.39	41.22	24.94	0.000182	18.7	18.7	18.99	18.7
Kerosene		22.80	27.3	20.1	20.1	16.12	50.56	21.8	22.88	22.40	-	20.7	20.7	18.99	20.7
Heavy Oil		21.50	27.3	59.8	59.8	29.36	122.22	42.81	41.77	38.79	-	56.6	56.6	0	56.6
Natural Gas		22.15	27.3	34	34	19.62	37.52	15.86	17.72	14.99	-	24.0	24.0	9.55	24

PM Emission Factor

Fuel Type	Unit	Food & Drink	Textile & Leather	Wood	Paper & Print	Coal, Oil & Chemical	Non-Metal	Metal	Machinery	Power Plants	Transportation	Commercial	Agriculture	Household	Others
Liquid Gas	$kg/10^6kcal$	21.30	0	0	0	1.346	9877	1.460	1.460	0	0.0000800	0	0	0.0889	0
Gasoline		36.03	2.26	2.26	2.26	2.330	9877	0.492	0.492	4.72	0.0000800	5.59	5.59	0	5.59
Gas Oil		36.03	2.26	2.26	2.26	2.330	9877	0.492	0.492	4.72	0.0001521	5.59	5.59	2.8769	5.59
Kerosene		2.26	2.26	2.26	2.26	2.330	9877	0.492	0.492	4.72	-	5.59	5.59	2.8769	5.59
Heavy Oil		69.80	2.26	2.26	2.26	16.000	9877	7.670	7.670	4.72	-	12.20	12.20	0	12.20
Natural Gas		21.30	0	0	0	0.346	9877	1.460	1.460	0	-	0	0	0.0645	0

NOx Emission Factors in Detail — Unit : kg/10^6kcal

Fuel Type	Food & Drink			Textile & Leather			Wood			Paper & Print			Coal, Oil & Chemical			Non-Metal			Metal		
Liquid Gas	22.15		(A)	27.3		(A)	22.1	Wood,dry	(A)	22.1	Wood,dry	(A)	22.74	Oil drying furnace	(B)	61.8		(B)	27.97		(B)
Gasoline	22.15	Average Value	(A)	27.3		(A)	34	Average Value	(A)	34	Average Value	(A)	22.47	Oil heating	(B)	63.15	Cement	(B)	44.39	Metal	(B)
Gas Oil	22.15		(A)	27.3	Textile,dry,	(A)	34	Average Value	(A)	34	Average Value	(A)	22.47	furnace, Gasoil	(B)	63.15	Calcination	(B)	44.39	Heat-treatment	(B)
Kerosene	22.8	Food,broil	(A)	27.3	gas oil	(A)	20.1	Wood,dry	(A)	20.1	Wood,dry	(A)	16.12	Oil drying	(B)	50.56	Furnace	(B)	21.8	Furnace	(B)
Heavy Oil	21.5	Food,broil	(A)	27.3		(A)	59.8	Wood,dry,class-B	(A)	59.8	Wood,dry,class-B	(A)	29.36	furnace	(B)	122.22		(B)	42.81		(B)
Natural Gas	22.15	Average Value	(A)	27.3		(A)	34	Average Value	(A)	34	Average Value	(A)	19.62	Oil heating furnace	(B)	37.52		(B)	15.86		(B)

Fuel Type	Machinery			Power Plants			Transportation			Commercial			Agricultural			Household			Others		
Liquid Gas	27.74		(B)	26.17		(A)	0.001742		(D)	32.4	Boiler,LPG	(A)	32.4	Boiler,LPG	(A)	13.59	Home,LPG	(B)	32.4	Boiler	(A)
Gasoline	41.22	Metal heating	(B)	24.94		(A)	0.002105	kg/km/vehicle	(D)	18.7	Boiler,gasoil	(A)	18.7	Boiler,gasoil	(A)	-		-	18.7	Boiler,gasoil	(A)
Gas Oil	41.22	furnace, heat	(B)	24.94	Generation	(A)	0.000182		(D)	18.7	Boiler	(A)	18.7	Boiler	(A)	18.99	Home,Kerosene	(B)	18.7	Boiler	(A)
Kerosene	22.88	treatment,	(B)	22.40	Boiler, class-C	(A)	-		-	20.7	Boiler	(A)	20.7	Boiler	(A)	18.99	Home	(B)	20.7	Boiler	(A)
Heavy Oil	41.77	forging furnace	(B)	38.79		(A)	-		-	56.6	Boiler	(A)	56.6	Boiler	(A)	-		-	56.6	Boiler	(A)
Natural Gas	17.72		(B)	14.99		(A)	-		-	24.0	Boiler,town gas	(A)	24.0	Boiler,town gas	(A)	9.55	Home,NG	(B)	24	Boiler,town gas	(A)

PM Emission Factors in Details — Unit : kg/10^6kcal

Fuel Type	Food & Drink			Textile & Leather			Wood			Paper & Print			Coal, Oil & Chemical			Non-Metal			Metal		
Liquid Gas	21.3	Dry,C-eletrolode	(A)	0	Set by SUR	-	0	Set by SUR	-	0	Set by SUR	-	1.346	Secondary Gas	(A)	9877		(A)	1.460	Steel, LPG	(A)
Gasoline	36.03	Av. of kerosene	(A)	2.26		(A)	2.26		(A)	2.26		(A)	2.33	Oil Secon-	(A)	9877	Cement	(A)	0.492	heating Kero-	(A)
Gas Oil	36.03	& heavy oil	(A)	2.26	Dry, paper,	(A)	2.26	Dry, paper,	(A)	2.26	Dry, paper,	(A)	2.33	heating dary	(A)	9877	Calcination	(A)	0.492	furnace sene	(A)
Kerosene	2.26	Dry, paper	(A)	2.26	Kerosene	(A)	2.26	Kerosene	(A)	2.26	Kerosene	(A)	2.33	furnace Oil	(A)	9877	Furnace, class-C	(A)	0.492	for	(A)
Heavy Oil	69.8	Dry, fertilizer	(A)	2.26		(A)	2.26		(A)	2.26		(A)	16		(A)	9877		(A)	7.670	rolling	(A)
Natural Gas	21.3	Dry,C-eletrolode	(A)	0	Set by SUR	-	0	Set by SUR	-	0	Set by SUR	-	0.346	Secondary Gas	(A)	9877		(A)	1.460	LPG	(A)

Fuel Type	Machinery			Power Plants			Transportation			Commercial			Agricultural			Household			Others		
Liquid Gas	1.460	Heat- LPG	(A)	0	Set by SUR	-	0.0000800		(D)	0	Set by SUR	-	0	Set by SUR	-	0.0889	Home,LPG	(D)	0	Set by SUR	-
Gasoline	0.492	Steel, manage-	(A)	4.72		(A)	0.0000800	kg/km/vehicle	(D)	5.59		(A)	5.59		(A)	-		-	5.59		(A)
Gas Oil	0.492	Pres- ment kero-	(A)	4.72	Generation	(A)	0.0001521		(D)	5.59	Boiler,Kerosene	(A)	5.59	Boiler,Kerosene	(A)	2.8769	Home,Kerosene	(D)	5.59	Boiler,Kerosene	(A)
Kerosene	0.492	sure- sene	(A)	4.72	boiler, class-C	(A)	-		-	5.59		(A)	5.59		(A)	2.8769	Home	(D)	5.59		(A)
Heavy Oil	7.670	heating class-C	(A)	4.72		(A)	-		-	12.20	Boiler,class-C	(A)	12.20	Boiler,class-C	(A)	-		-	12.20	Boiler,class-C	(A)
Natural Gas	1.460	LPG	(A)	0	Set by SUR	-	-		-	0	Set by SUR	-	0	Set by SUR	-	0.0645	Home,NG	(D)	0	Set by SUR	-

Note 1) Class-C is used for heavy oil unless mensioned
Note 2) Assumed that 90% of PM is deleted by scrubber

(A) #110
(B) # 87
(C) #111
(D) #109

Table 8-5-1 Pasquill's Stability Index ("Safety guides for Water cooled nuclear power plants" Safety Guide, 1982)

Wind Speed(U) m/s	Daytime				Nighttime		
	Solar Radiation (T) kW/m²				Net Radiation (Q) kW/m²		
	T=>0.60	0.60>T =>0.30	0.30>T =>0.15	0.15>T	Q=>-0.02	-0.02>Q =>-0.04	-0.04>Q
U<2	A	A-B	B	dD	nD	G	G
2<=U<3	A-B	B	C	dD	nD	E	F
3<=U<4	B	B-C	C	dD	nD	nD	E
4<=U<5	C	C-D	dD	dD	nD	nD	nD
6<=	C	dD	dD	dD	nD	nD	nD

Table 8-5-2 Lid Height by Seasons

Area		Morning	Noon	Afternoon	Night	Midnight
Tabriz	Summer	1,113.6	1,500.0	1,500.0	1,383.3	1,275.0
	Winter	1,250.0	1,250.0	1,233.3	1,200.0	1,300.0
Esfahan	Summer	1,338.9	1,438.9	1,486.1	1,447.2	1,377.8
	Winter	316.7	1,500.0	1,500.0	1,266.7	1,066.7

Unit : m

Definition of lid is "within upper inversion layer, and be the lowest layer", whereas definition of inversion layer is "layer with temperature increase of more than 0.1 degrees Celsius per increasing altitude of 50m, and with its thickness 100m and above".

Table 8-5-3 Potential Temperature Gradients by Seasons

		Daytime	Nighttime
Tabriz	Summer	0.0018	0.0023
	Winter	0.0048	0.0053
Esfahan	Summer	0.0021	0.0027
	Winter	0.0037	0.0052

Unit : ℃/m

Table 8-5-4 O_3 Background Concentration

Area	Season	Morning	Noon	Afternoon	Night	Midnight
Tabriz	Summer	12.6	47.9	56.0	19.1	13.6
	Winter	14.1	32.7	25.2	12.0	12.5
Esfahan	Summer	11.4	38.1	54.3	22.0	15.7
	Winter	11.0	29.7	35.4	12.2	10.8

Unit : ppb

Table 8-5-5 Upper Wind Speed Correction Factors by Atmospheric Stability Classes

Stability	A-CD	dD-nD	E-G
Tabriz	0.05	0.07	-0.10
Esfahan	0.18	0.20	0.35

Table 8-5-6a Dispersion Parameters Set for Tabriz Area

	Vertical Layers	Atmospheric Stability Classes				
		A-B	BC-CD	dD	nD	E-G
Summer Morning	1(<=10m)	AB	C	D	D	F
	2(10-40m)	B	CD	D	D	E
	3(40-70m)	B	CD	D	D	E
	4(100m<)	C	D	D	D	D
Summer Noon	1	AB	C	D	-	-
	2,3	B	CD	D	-	-
	4	C	CD	D	-	-
Summer Afternoon	1	B	C	D	D	F
	2,3	BC	CD	D	D	E
	4	CD	D	D	D	D
Summer Night	1	-	-	-	D	F
	2,3	-	-	-	D	E
	4	-	-	-	D	DE
Summer Midnight	1	-	-	-	D	FG
	2,3	-	-	-	D	EF
	4	-	-	-	D	DE
Winter Morning	1	B	C	D	D	FG
	2,3	C	CD	D	D	F
	4	CD	D	D	D	E
Winter Noon	1	AB	C	D	-	-
	2,3	B	CD	D	-	-
	4	C	CD	D	-	-
Winter Afternoon	1	B	C	D	D	FG
	2,3	BC	CD	D	D	F
	4	CD	CD	D	D	E
Winter Night	1	-	-	-	D	F
	2,3	-	-	-	D	EF
	4	-	-	-	D	DE
Winter Midnight	1	-	-	-	D	F
	2,3	-	-	-	D	EF
	4	-	-	-	D	DE

Table 8-5-6b Dispersion Parameters Set for Esfahan Area

	Vertical Layers	Atmospheric Stability Classes				
		A-B	BC-CD	dD	nD	E-G
Summer Morning	1(<=10m)	AB	C	D	D	FG
	2(10-40m)	B	CD	D	D	F
	3(40-70m)	B	CD	D	D	F
	4(<=100m)	C	D	D	D	E
	5 (100m<)	C	D	D	D	E
Summer Noon	1	A	C	D	-	-
	2,3	AB	CD	D	-	-
	4,5	BC	CD	D	-	-
Summer Afternoon	1	AB	C	D	D	FG
	2,3	B	CD	D	D	F
	4,5	C	CD	D	D	E
Summer Night	1	-	-	-	D	FG
	2,3	-	-	-	D	F
	4,5	-	-	-	D	E
Summer Midnight	1	-	-	-	D	G
	2,3	-	-	-	D	FG
	4,5	-	-	-	D	EF
Winter Morning	1	AB	C	D	D	FG
	2,3	B	CD	D	D	F
	4,5	C	D	D	D	E
Winter Noon	1	A	C	D	-	-
	2,3	AB	CD	D	-	-
	4,5	BC	CD	D	-	-
Winter Afternoon	1	AB	C	D	D	FG
	2,3	B	CD	D	D	F
	4,5	C	CD	D	D	E
Winter Night	1	-	-	-	D	FG
	2,3	-	-	-	D	F
	4,5	-	-	-	D	E
Winter Midnight	1	-	-	-	D	G
	2,3	-	-	-	D	FG
	4,5	-	-	-	D	EF

Table 8-5-7 Initial Dispersion Width

Area	Line	Areal		
	Transportation	Industry	Household	Transportation
Tabriz	5.0	20.0	5.0	1.0
Esfahan	5.0	20.0	5.0	1.0

Unit : m

Appendix 8-6 Parameters for Simulation Model

Table 8-6-1 Constant for σ_y and σ_z for Plume Equation

Stability	α_y	γ_y	x	α_z	γ_z	x (m)
A	0.901	0.426	0 ~ 1,000	1.122	0.0800	0 ~ 300
	0.851	0.602	1,000 ~	1.514	0.00855	300 ~ 500
				2.109	0.000212	500 ~
B	0.914	0.282	0 ~ 1,000	0.964	0.1272	0 ~ 500
	0.865	0.396	1,000 ~	1.094	0.0570	500 ~
C	0.924	0.1772	0 ~ 1,000	0.918	0.1068	0 ~
	0.855	0.232	1,000			
D	0.929	0.1107	0 ~ 1,000	0.826	0.1046	0 ~ 1,000
	0.889	0.1467	1,000 ~	0.632	0.400	1,000 ~ 10,000
				0.555	0.811	10,000 ~
E	0.921	0.0864	0 ~ 1,000	0.788	0.0928	0 ~ 1,000
	0.897	0.1019	1,000 ~	0.565	0.433	1,000 ~ 10,000
				0.415	1.732	10,000 ~
F	0.929	0.0554	0 ~ 1,000	0.784	0.0621	0 ~ 1,000
	0.889	0.0733	1,000 ~	0.526	0.370	1,000 ~ 10,000
				0.323	2.41	10,000 ~
G	0.921	0.0380	0 ~ 1,000	0.794	0.0373	0 ~ 1,000
	0.896	0.0452	1,000 ~	0.637	0.1105	1,000 ~ 2,000
				0.431	0.529	2,000 ~ 10,000
				0.222	3.62	10,000 ~

(#87)

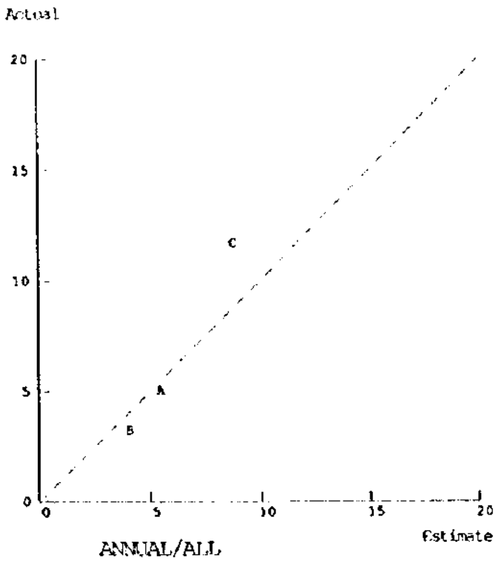
Table 8-6-2 α and γ for Puff Equation

Stability	α	γ
A	0.948	1.569
B	0.781	0.474
C	0.635	0.208
D	0.470	0.113
E	0.439	0.067
F	0.439	0.048
G	0.439	0.029

(#87)

Appendix 8-7 Conformity of Measured and Calculated Concentrations

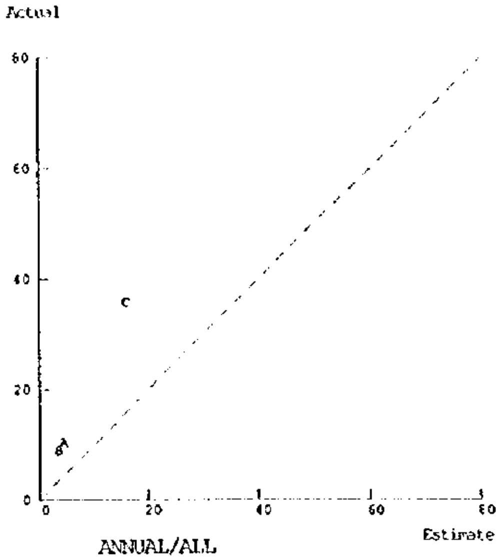
Tabriz



	Actual	Estimate
A 98 Baranloo	5.1	5.5
B 98 Mayan	3.3	4.1
C 98 Qaramalek	11.7	8.8

N= 3 R= 1.00
ACT = 1.83 x EST + -4.60

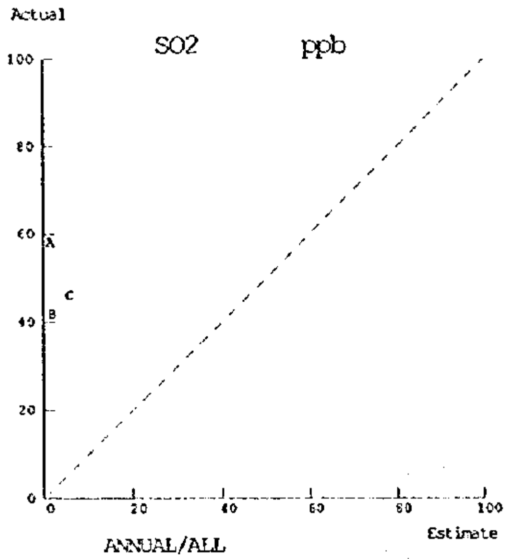
SO2 ppb



	Actual	Estimate
A 98 Baranloo	10.5	4.6
B 98 Mayan	9.0	3.8
C 98 Qaramalek	35.9	16.1

N= 3 R= 1.00
ACT = 2.21 x EST + .46

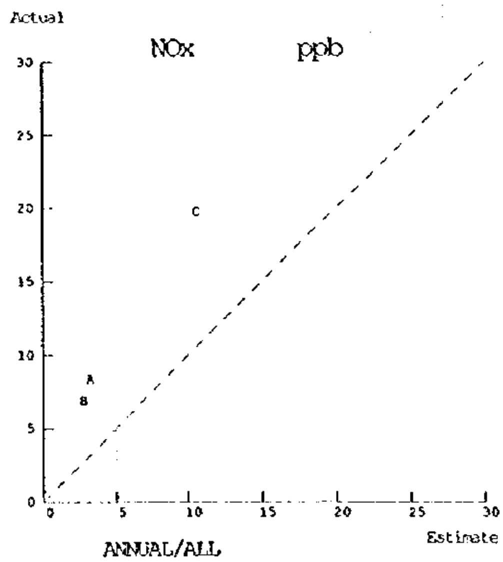
NOx ppb



	Actual	Estimate
A 98 Baranloo	58.1	1.7
B 98 Mayan	41.9	2.0
C 98 Qaramalek	46.2	6.0

N= 3 R= -.32
ACT = -1.12 x EST + 52.36

SPM ug/m3



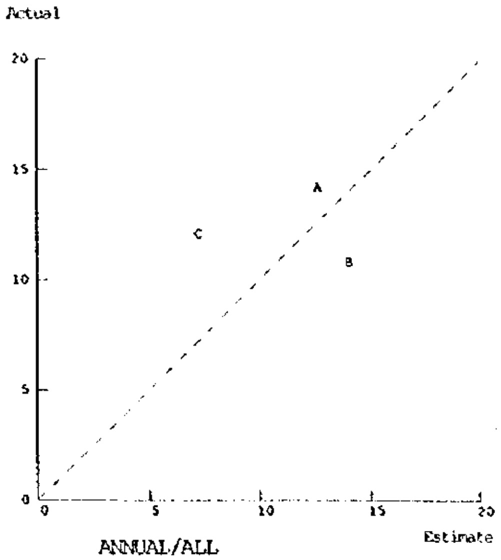
	Actual	Estimate
A 98 Baranloo	8.4	3.3
B 98 Mayan	6.9	2.8
C 98 Qaramalek	19.8	10.7

N= 3 R= 1.00
ACT = 1.59 x EST + 2.79

NO2 ppb

PARAM\DIF
EXISTING(1998), TABRIZ, IRAN
+Large Plants, Tab City:Present
+Medium Plants, Tab City:Presen
+Industries
+Residences
+Transportation
+Traffic in Tabriz City

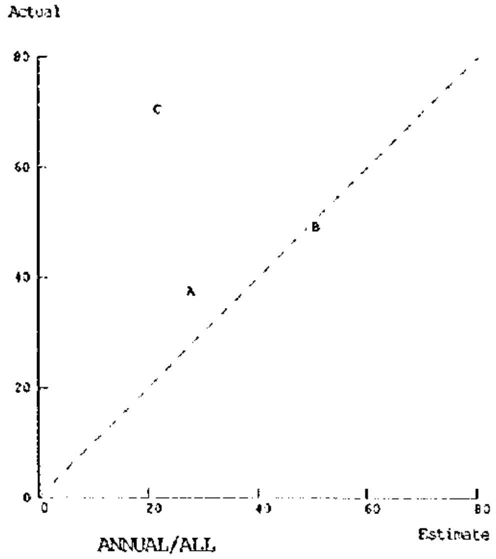
Esfahan



	Actual	Estimate
A 98 Kaveh	14.2	12.7
B 98 Golshahr	10.8	14.1
C 98 Shariati	12.1	7.3

N= 3 R= -.06
ACT = -.03 x EST + 12.70

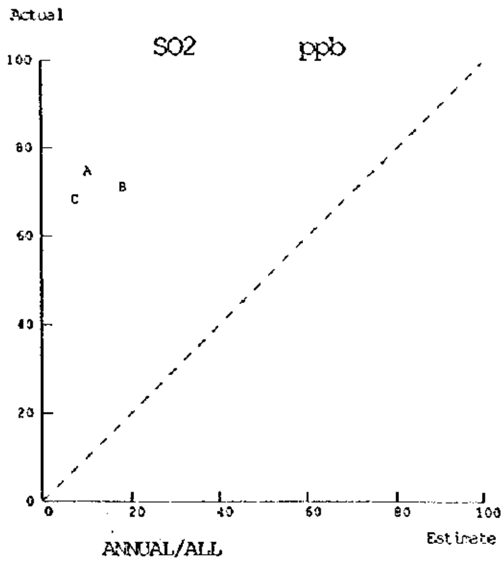
SO2 ppb



	Actual	Estimate
A 98 Kaveh	37.5	28.0
B 98 Golshahr	49.2	50.8
C 98 Shariati	70.5	21.8

N= 3 R= -.36
ACT = -.40 x EST + 65.65

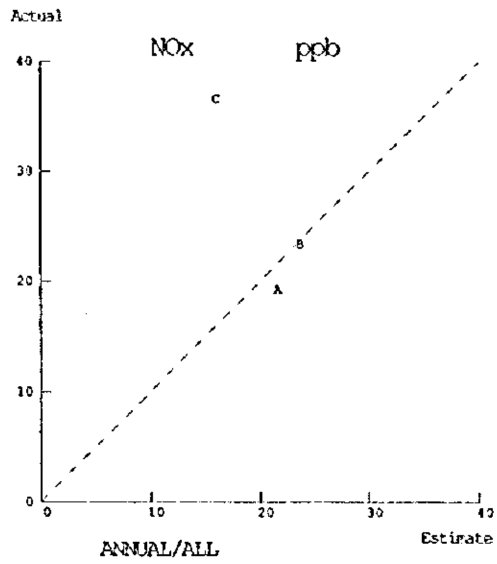
NOx ppb



	Actual	Estimate
A 98 Kaveh	74.8	10.5
B 98 Golshahr	72.2	18.3
C 98 Shariati	68.4	7.7

N= 3 R= .19
ACT = .11 x EST + 70.17

SPM ug/m3

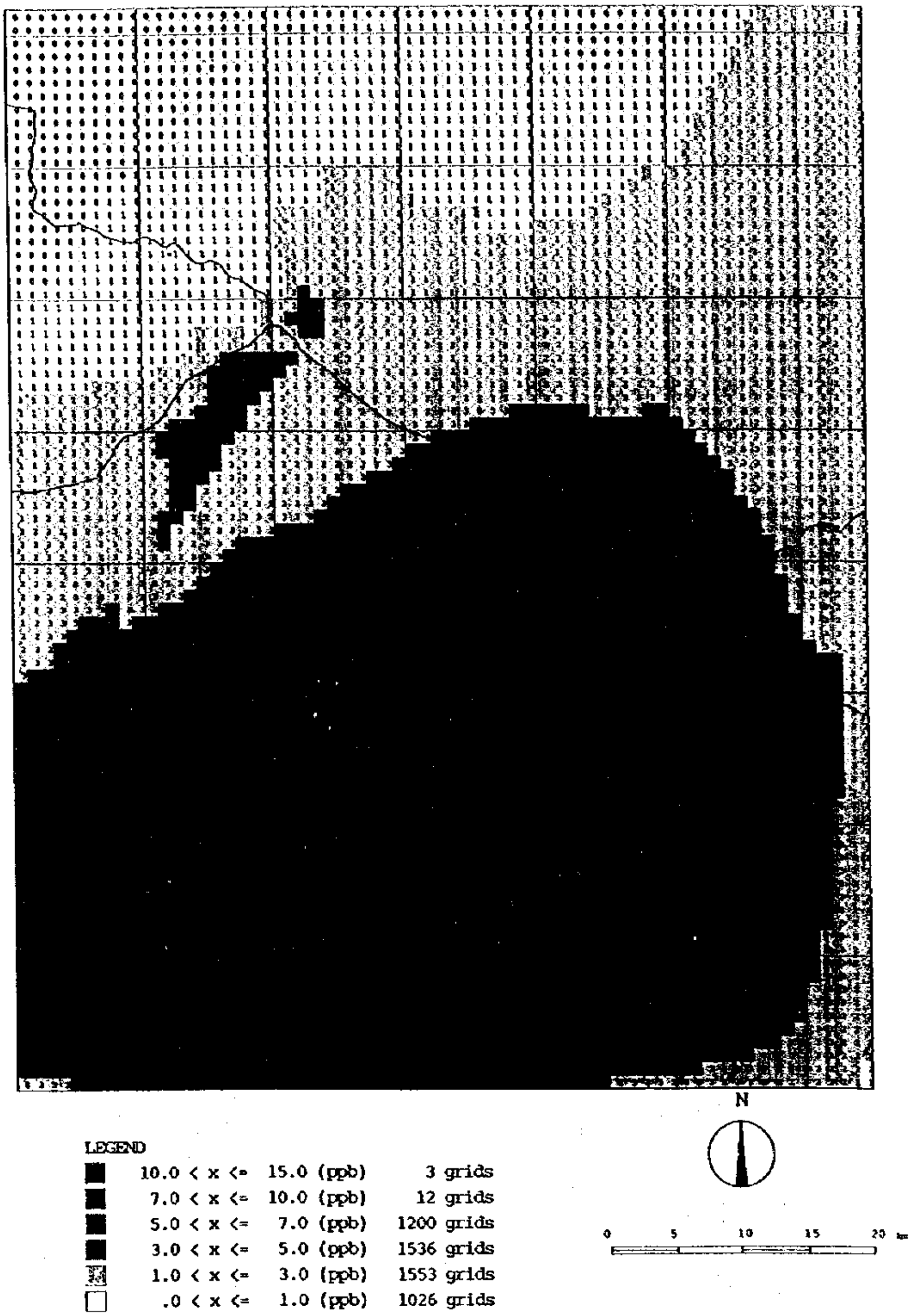


	Actual	Estimate
A 98 Kaveh	19.3	21.7
B 98 Golshahr	23.4	23.8
C 98 Shariati	36.6	15.2

N= 3 R= -.88
ACT = -2.02 x EST + 67.88

NO2 ppb

PARAM\DIF
EXISTING(1998), ESFAHAN, IRAN
+Large Plants, Esf City:Present
+Medium Plants, Esf City:Presen
+Industries
+Residences
+Transportaion
+Traffic in Esfahan City



Monitoring Stations

103 Baranloo
104 Mayan
105 Qaramalek

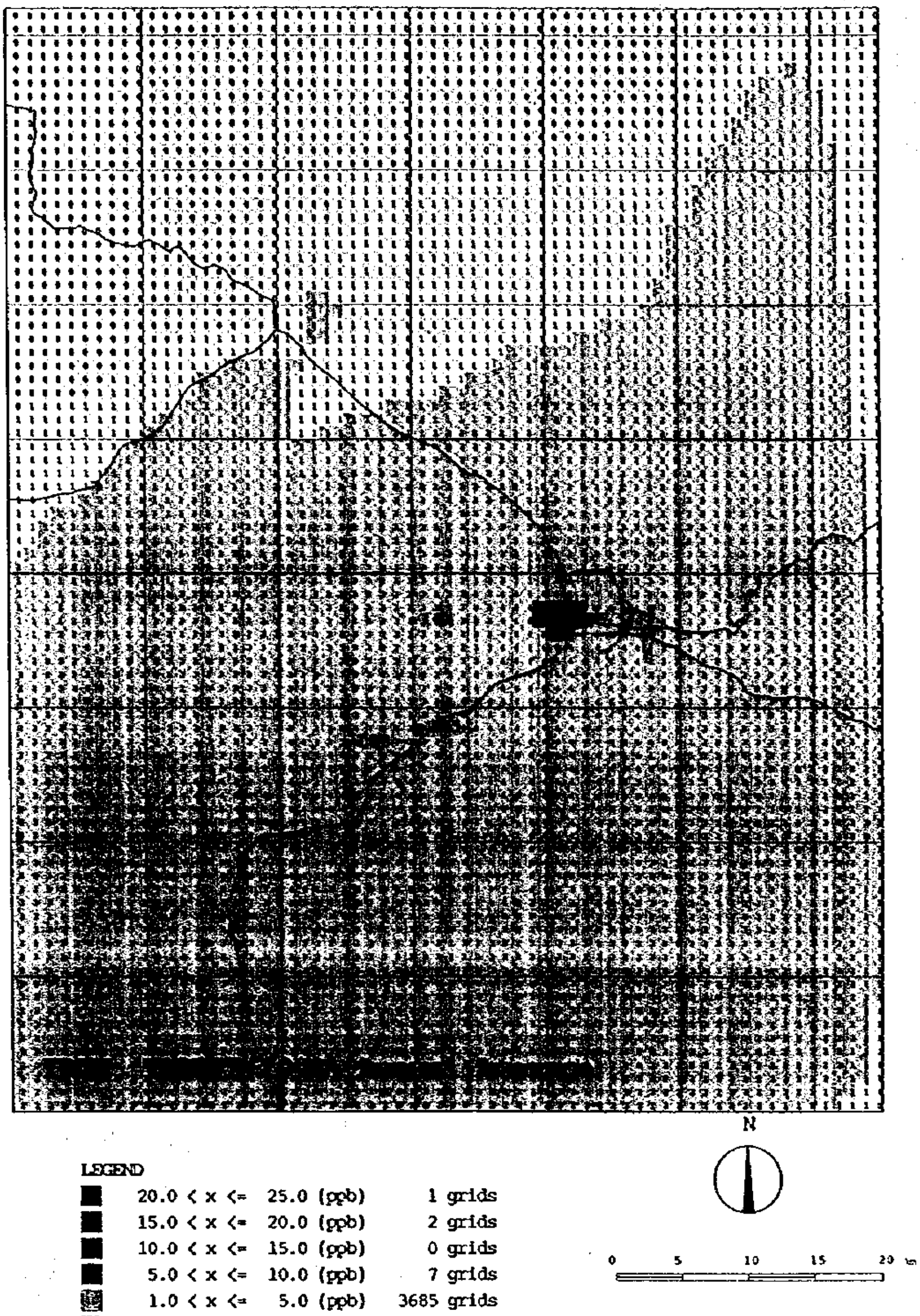
Power Plant

101 Tabriz Power Plant

DATE

SO2 ppb C MAX= 13.7ppb

Figure Distribution of Annual Average Concentration (SO_2, All Sources, Tabriz)



LEGEND

■	20.0 < x <= 25.0 (ppb)	1 grids
■	15.0 < x <= 20.0 (ppb)	2 grids
■	10.0 < x <= 15.0 (ppb)	0 grids
■	5.0 < x <= 10.0 (ppb)	7 grids
▩	1.0 < x <= 5.0 (ppb)	3685 grids
□	.0 < x <= 1.0 (ppb)	1635 grids

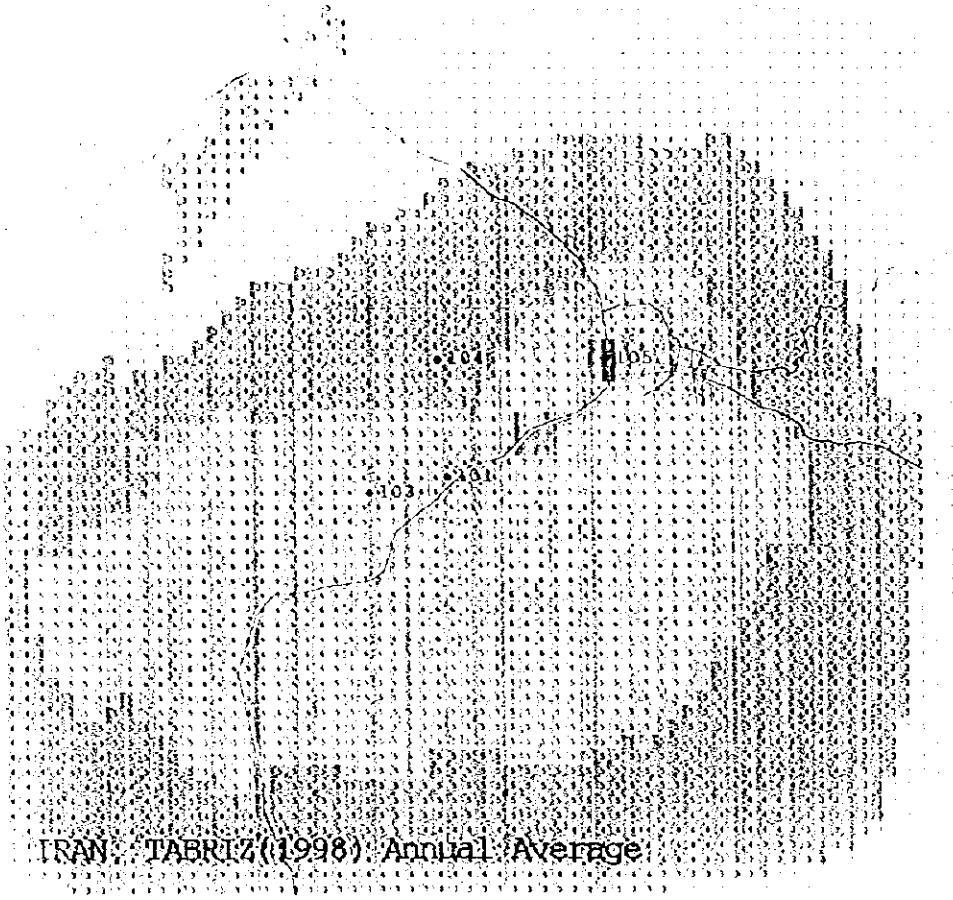
Monitoring Stations
103 Baranloo
104 Mayan
105 Qaramalek

Power Plant
101 Tabriz Power Plant

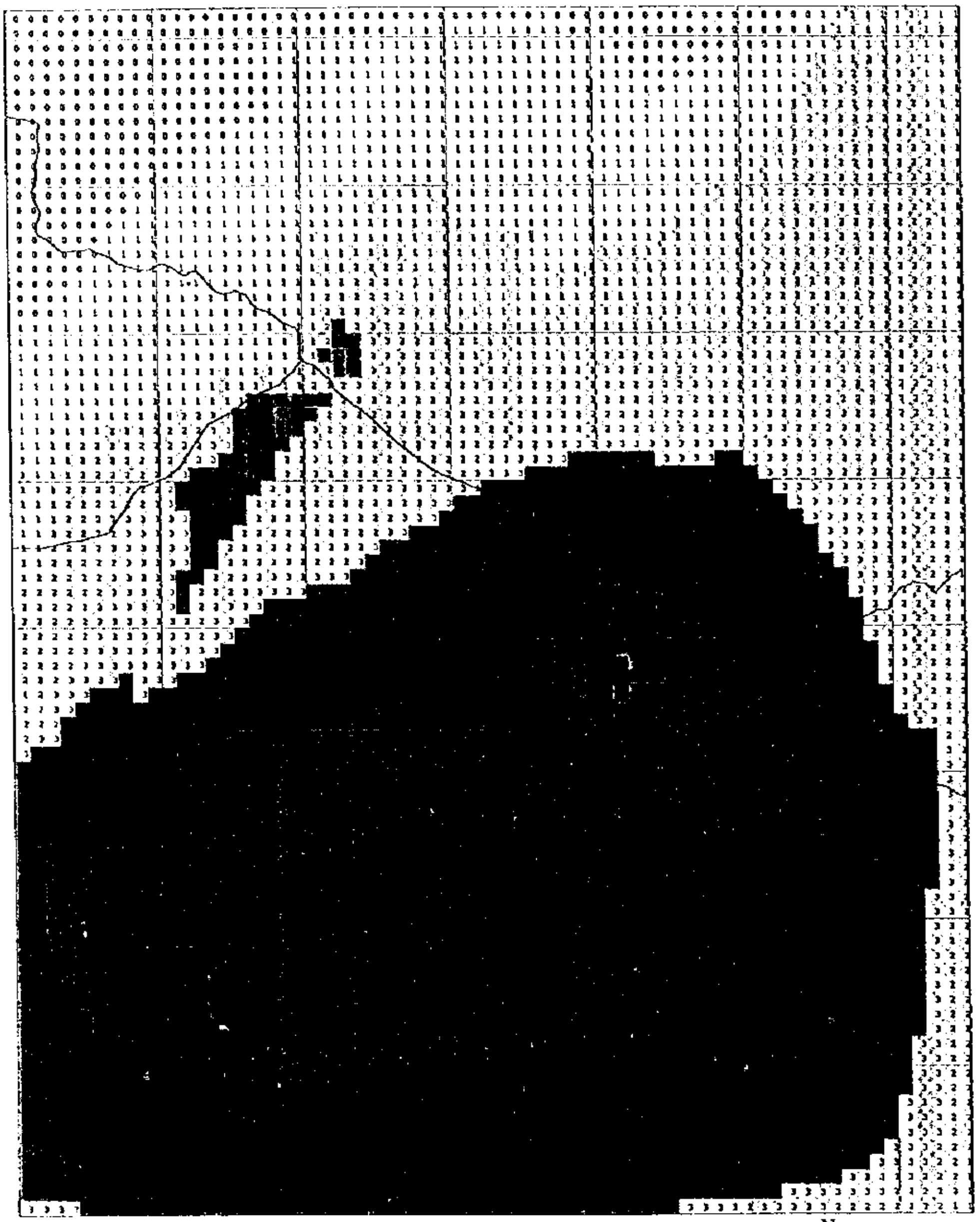
DATE

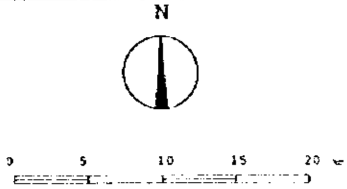
NO2 ppb □C MAX= 20.6ppb

Figure Distribution of Annual Average Concentration (NO_2, All Sources, Tabriz)



104
105
101
103
IRAN, TABRIZ(1998) Annual Average





LEGEND

■	10.0 < x <=	15.0 (ppb)	3 grids
■	7.0 < x <=	10.0 (ppb)	12 grids
■	5.0 < x <=	7.0 (ppb)	1200 grids
■	3.0 < x <=	5.0 (ppb)	1536 grids
	1.0 < x <=	3.0 (ppb)	1553 grids
□	.0 < x <=	1.0 (ppb)	1026 grids

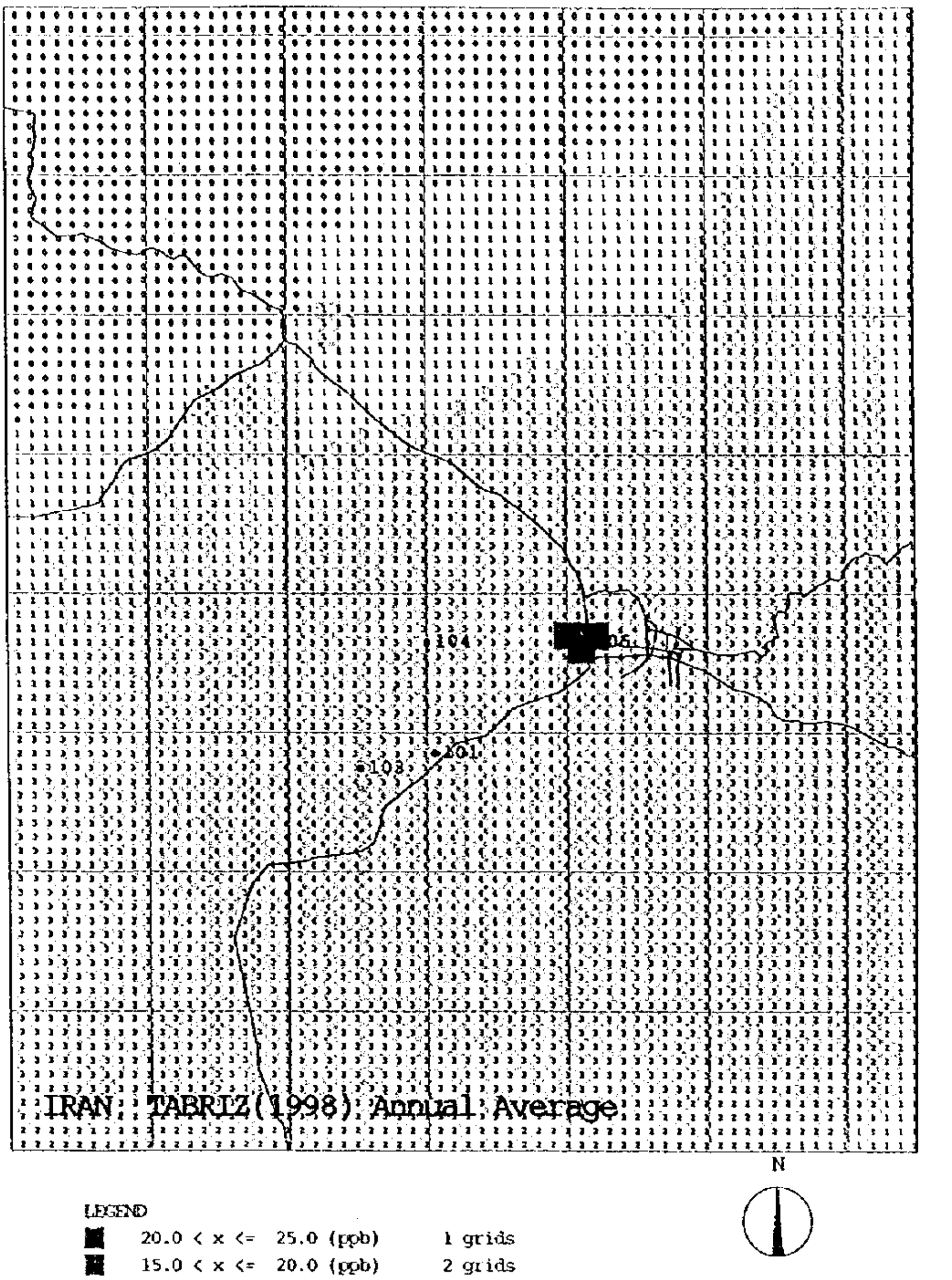
Monitoring Stations
103 Baranloo
104 Mayan
105 Qaramalek

Power Plant
101 Tabriz Power Plant

DATE

SO2 ppb □C MAX= 13.7ppb

Figure Distribution of Annual Average Concentration (SO_2, All Sources, Tabriz)



LEGEND

■	20.0 < x <= 25.0 (ppb)	1 grids
■	15.0 < x <= 20.0 (ppb)	2 grids
■	10.0 < x <= 15.0 (ppb)	0 grids
■	5.0 < x <= 10.0 (ppb)	7 grids
	1.0 < x <= 5.0 (ppb)	3685 grids
	.0 < x <= 1.0 (ppb)	1635 grids

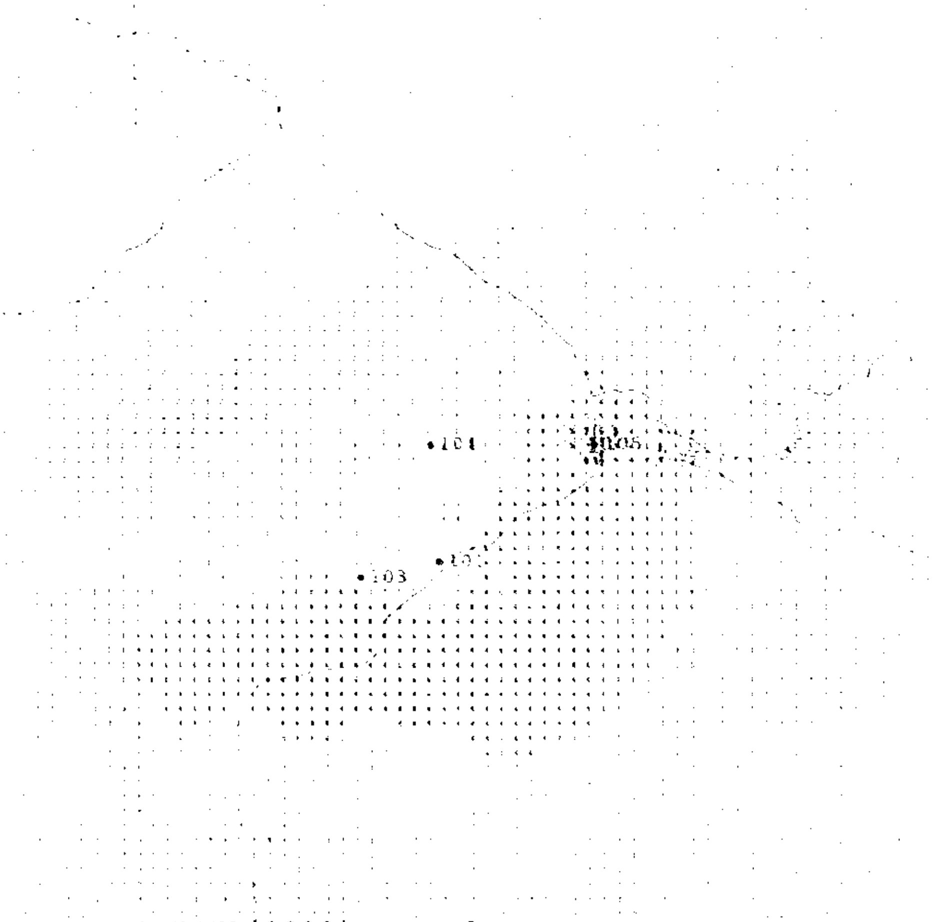
Monitoring Stations
- 103 Baranloo
- 104 Mayan
- 105 Qaramalek

Power Plant
- 101 Tabriz Power Plant

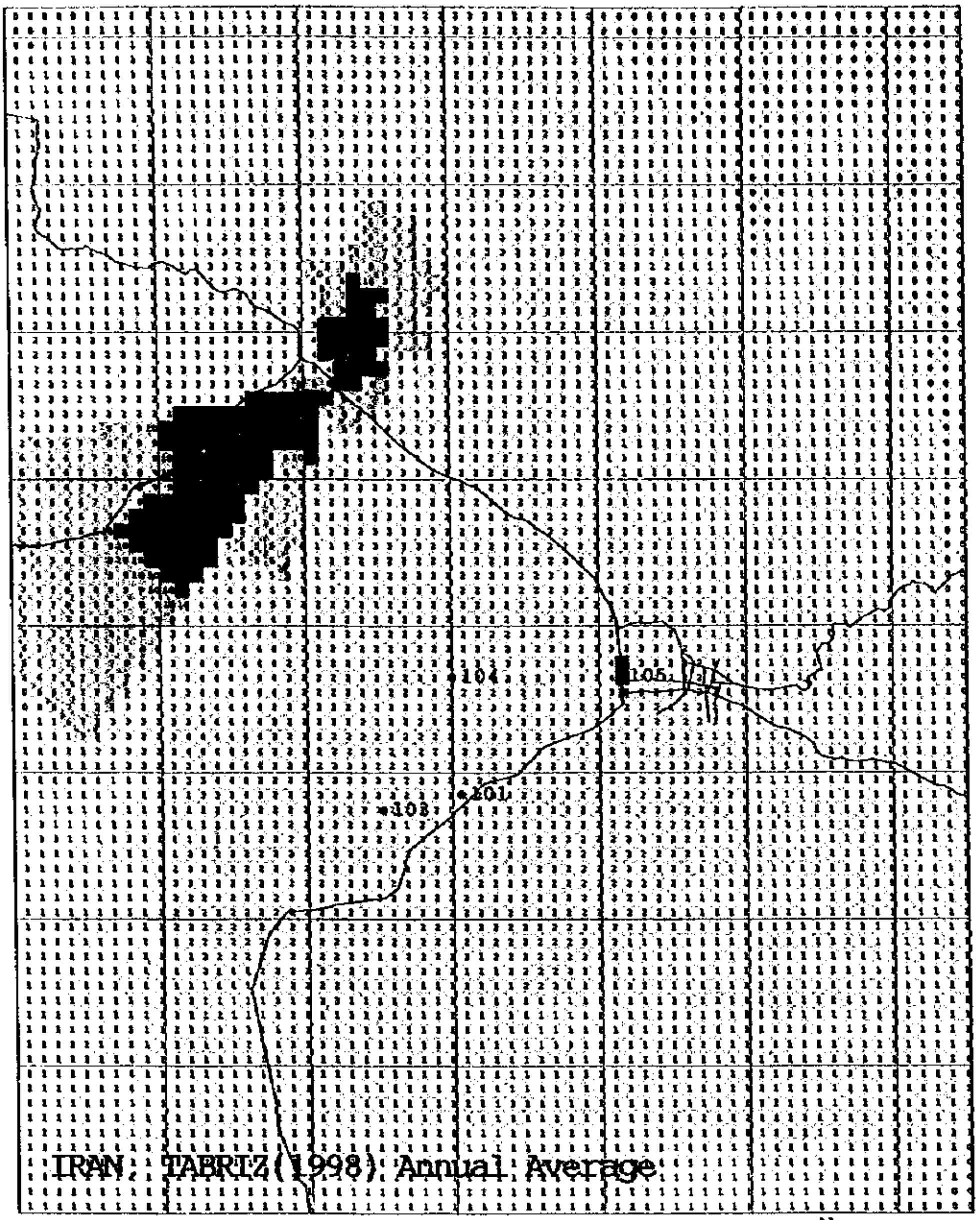
DATE

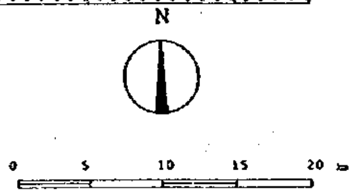
NO2 ppb □C MAX= 20.6ppb

Figure Distribution of Annual Average Concentration (NO_2, All Sources, Tabriz)



IRAN, TABRIZ(1998) Annual Average





LEGEND

■	40.0 < x <= 50.0 (ug/m3)	2 grids
■	30.0 < x <= 40.0 (ug/m3)	6 grids
■	20.0 < x <= 30.0 (ug/m3)	18 grids
■	10.0 < x <= 20.0 (ug/m3)	99 grids
▒	5.0 < x <= 10.0 (ug/m3)	283 grids
□	.0 < x <= 5.0 (ug/m3)	4922 grids

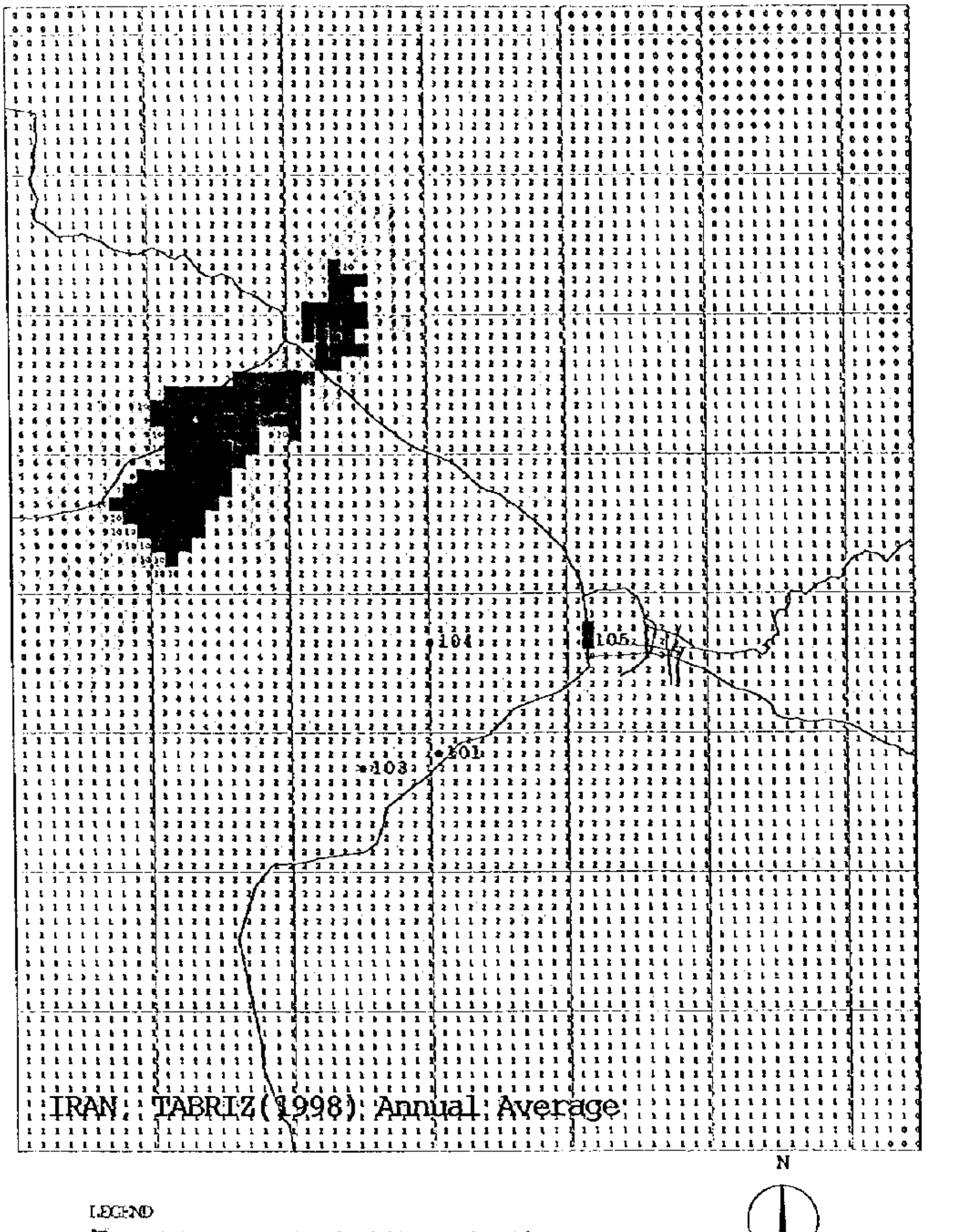
Monitoring Stations
103 Baranloo
104 Mayan
105 Qaramalek

Power Plant
101 Tabriz Power Plant

DATE

SPM ug/m3 □C MAX= 47.8ug/m3

Figure Distribution of Annual Average Concentration (SPM, All Sources, Tabriz)



LEGEND

■	40.0 < x <= 50.0 (ug/m3)	2 grids
■	30.0 < x <= 40.0 (ug/m3)	6 grids
■	20.0 < x <= 30.0 (ug/m3)	18 grids
■	10.0 < x <= 20.0 (ug/m3)	99 grids
	5.0 < x <= 10.0 (ug/m3)	283 grids
	.0 < x <= 5.0 (ug/m3)	4922 grids

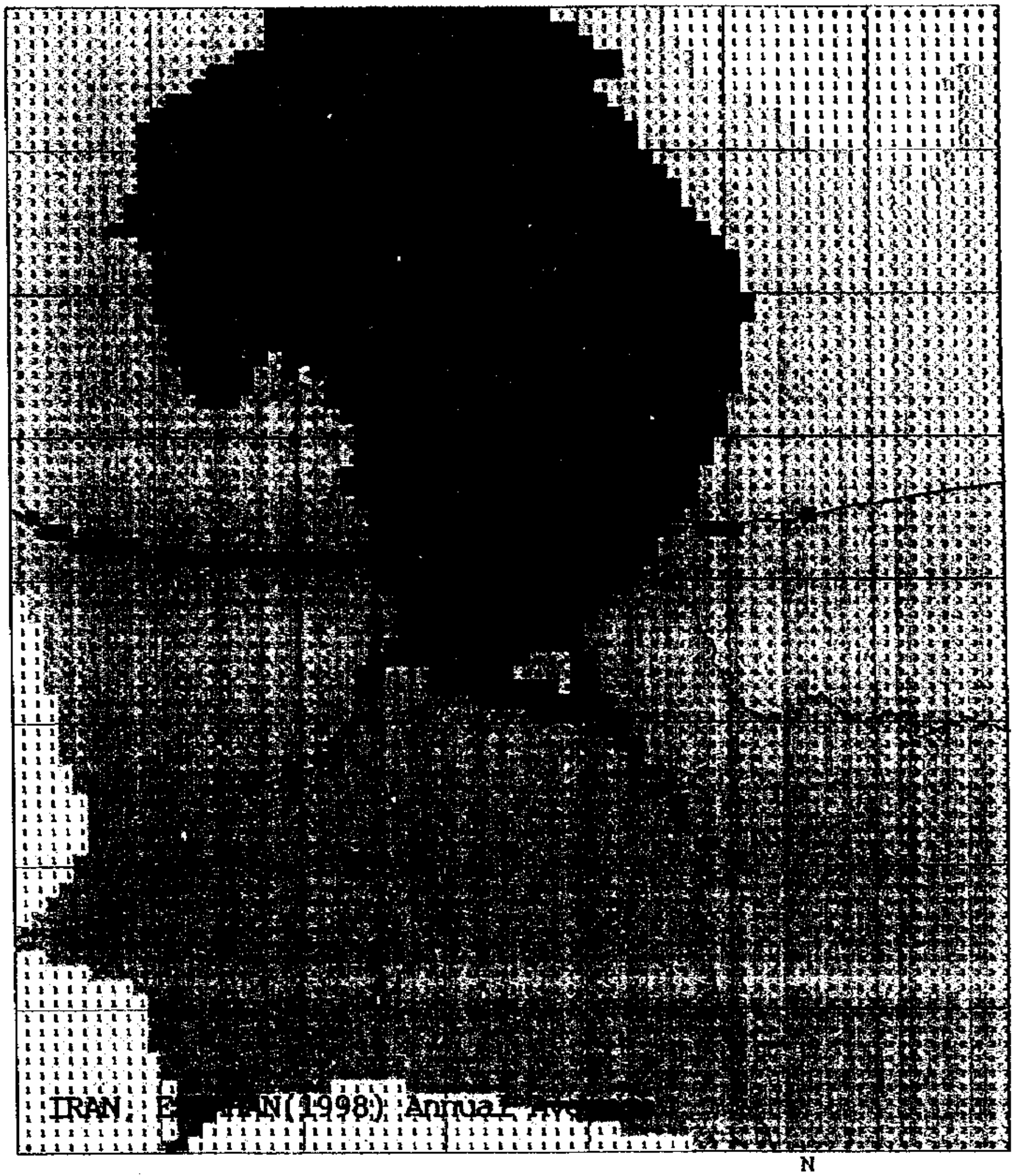
Monitoring Stations
103 Baranloo
104 Mayan
105 Qaramalek

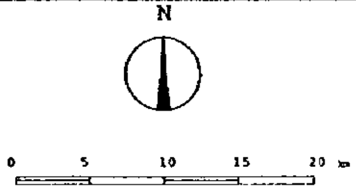
Power Plant
101 Tabriz Power Plant

DATE

SPM ug/m3 C MAX= 47.8ug/m3

Figure Distribution of Annual Average Concentration (SPM, All Sources, Tabriz)





LEGEND

■	20.0 < x <= 30.0 (ppb)	2 grids
■	10.0 < x <= 20.0 (ppb)	212 grids
■	8.0 < x <= 10.0 (ppb)	248 grids
■	5.0 < x <= 8.0 (ppb)	974 grids
▩	1.0 < x <= 5.0 (ppb)	3603 grids
□	.0 < x <= 1.0 (ppb)	481 grids

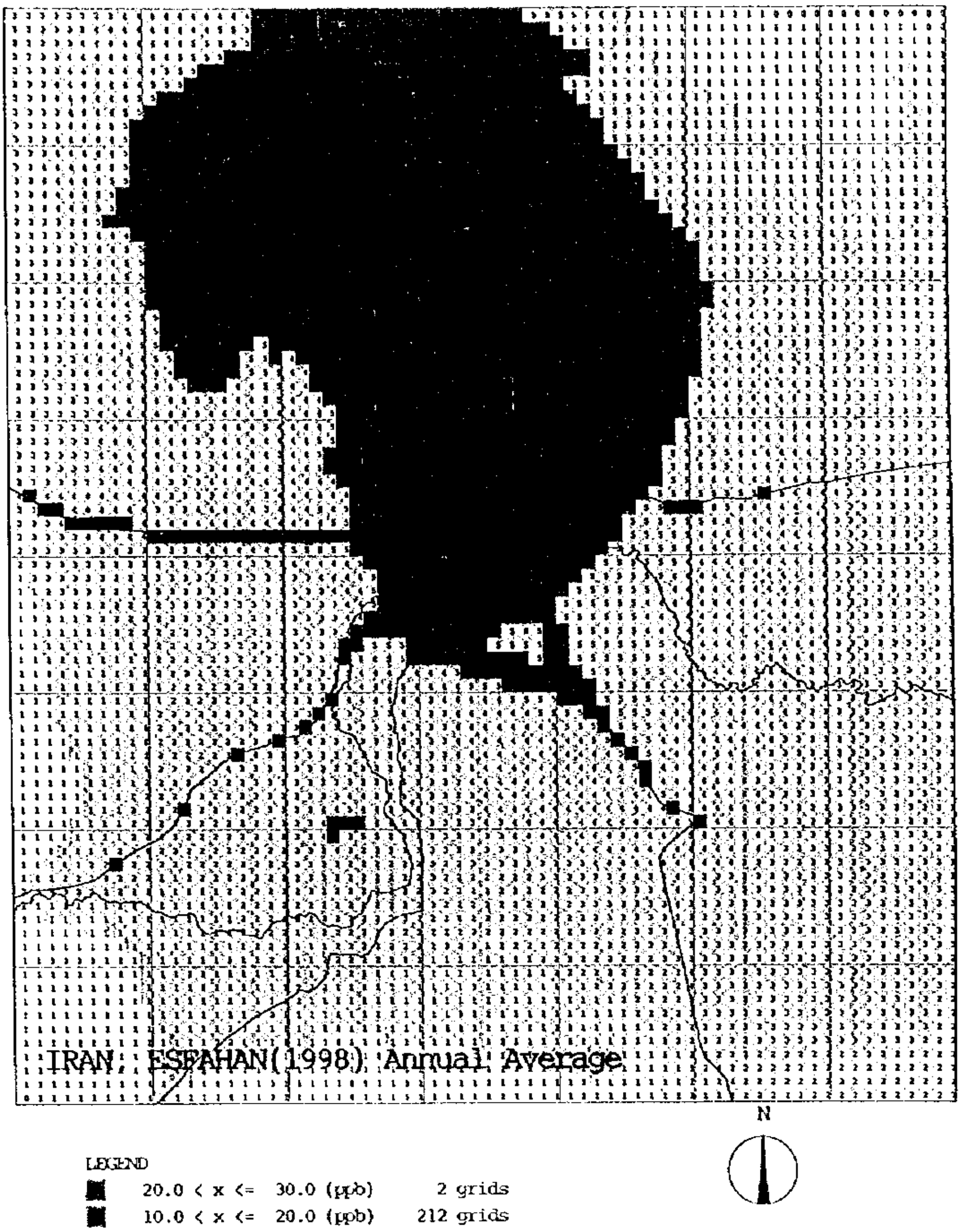
Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

DATE

SO2 ppb □C MAX= 21.0ppb

Figure Distribution of Annual Average Concentration (SO_2, All Sources, Esfahan)



LEGEND

■	20.0 < x <= 30.0 (ppb)	2 grids
■	10.0 < x <= 20.0 (ppb)	212 grids
■	8.0 < x <= 10.0 (ppb)	248 grids
■	5.0 < x <= 8.0 (ppb)	974 grids
▢	1.0 < x <= 5.0 (ppb)	3603 grids
▢	.0 < x <= 1.0 (ppb)	481 grids

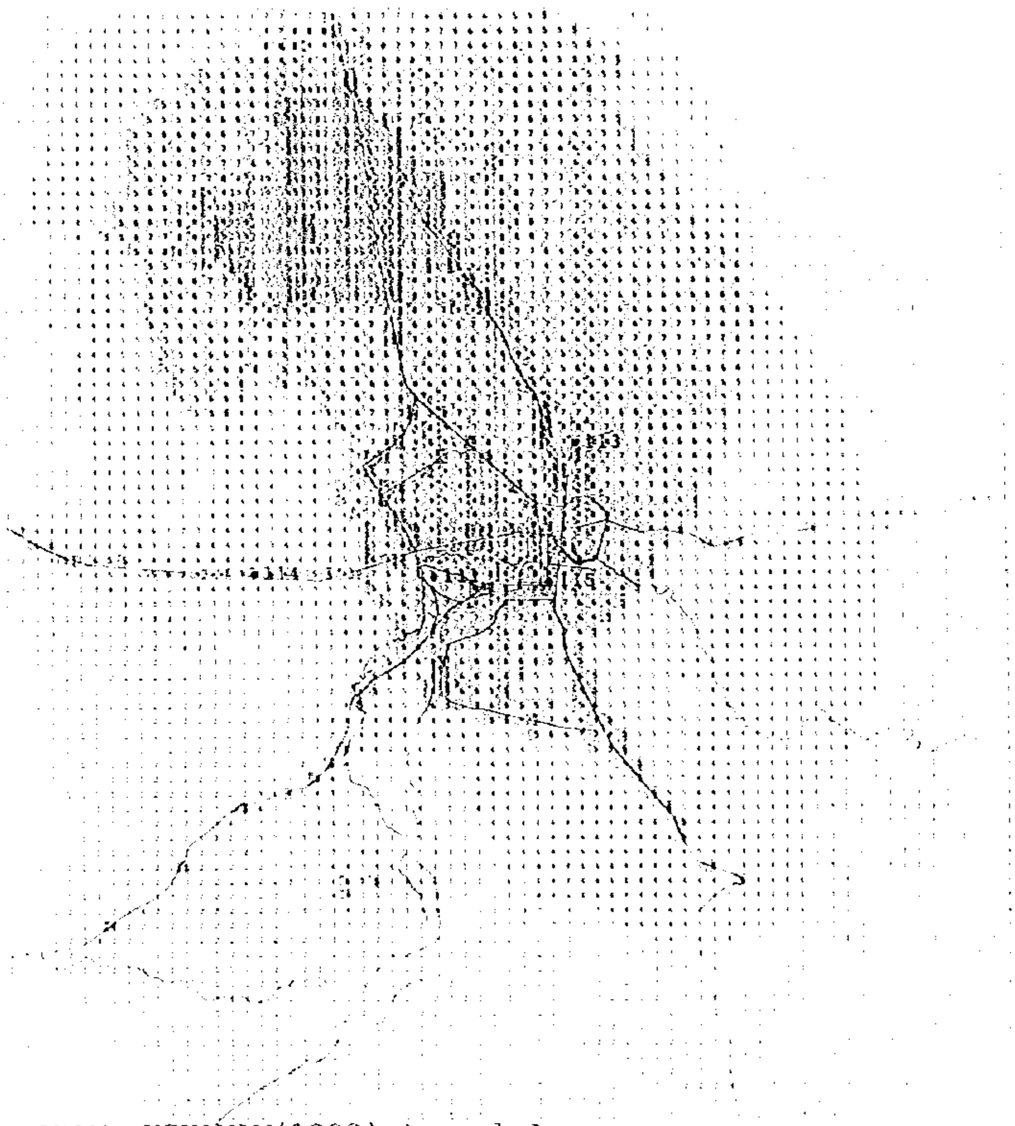
Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

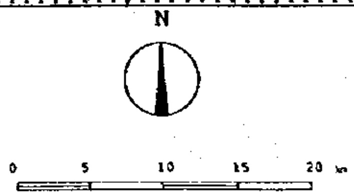
DATE

SO_2 ppb □C MAX= 21.0ppb

Figure Distribution of Annual Average Concentration (SO_2, All Sources, Esfahan)



IRAN, ESFAHAN(1998) Annual Average



LEGEND

■	40.0 < x <= 50.0 (ppb)	0 grids
■	30.0 < x <= 40.0 (ppb)	0 grids
■	20.0 < x <= 30.0 (ppb)	19 grids
■	10.0 < x <= 20.0 (ppb)	177 grids
▒	5.0 < x <= 10.0 (ppb)	740 grids
□	.0 < x <= 5.0 (ppb)	4584 grids

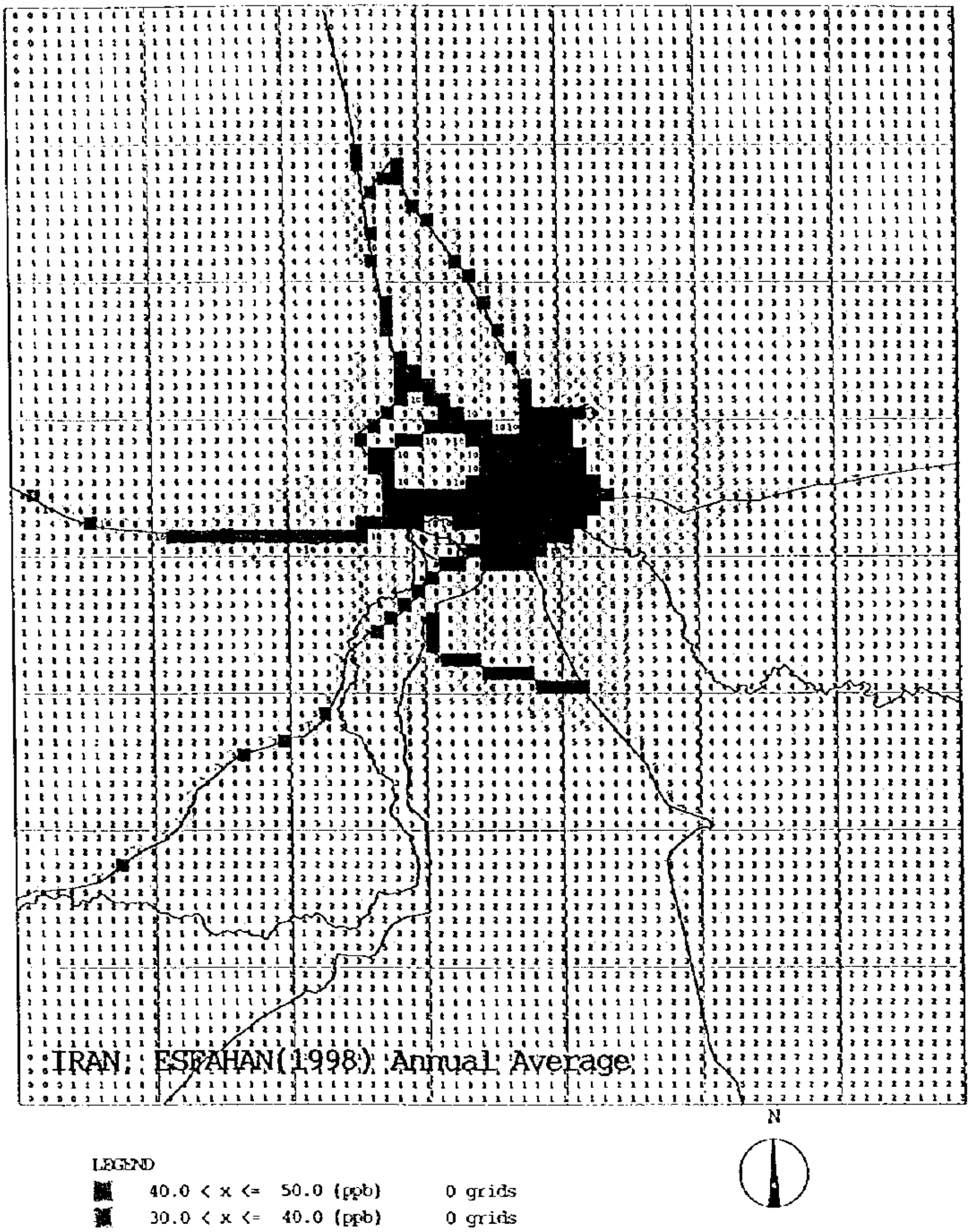
Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

DATE

NO2 ppb □C MAX= 28.6ppb

Figure Distribution of Annual Average Concentration (NO_2, All Sources, Esfahan)



LEGEND

40.0 < x <= 50.0 (ppb)	0 grids
30.0 < x <= 40.0 (ppb)	0 grids
20.0 < x <= 30.0 (ppb)	19 grids
10.0 < x <= 20.0 (ppb)	177 grids
5.0 < x <= 10.0 (ppb)	740 grids
.0 < x <= 5.0 (ppb)	4584 grids

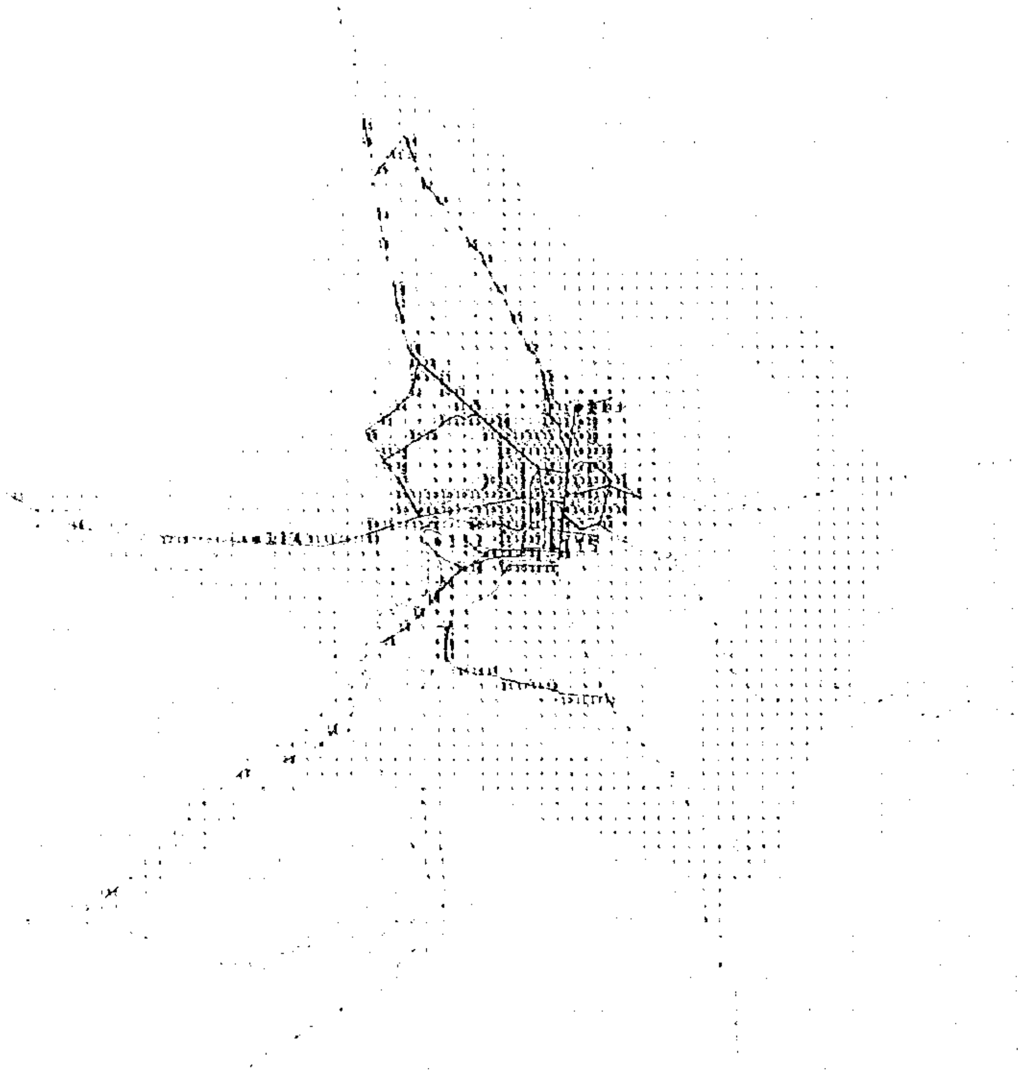
Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

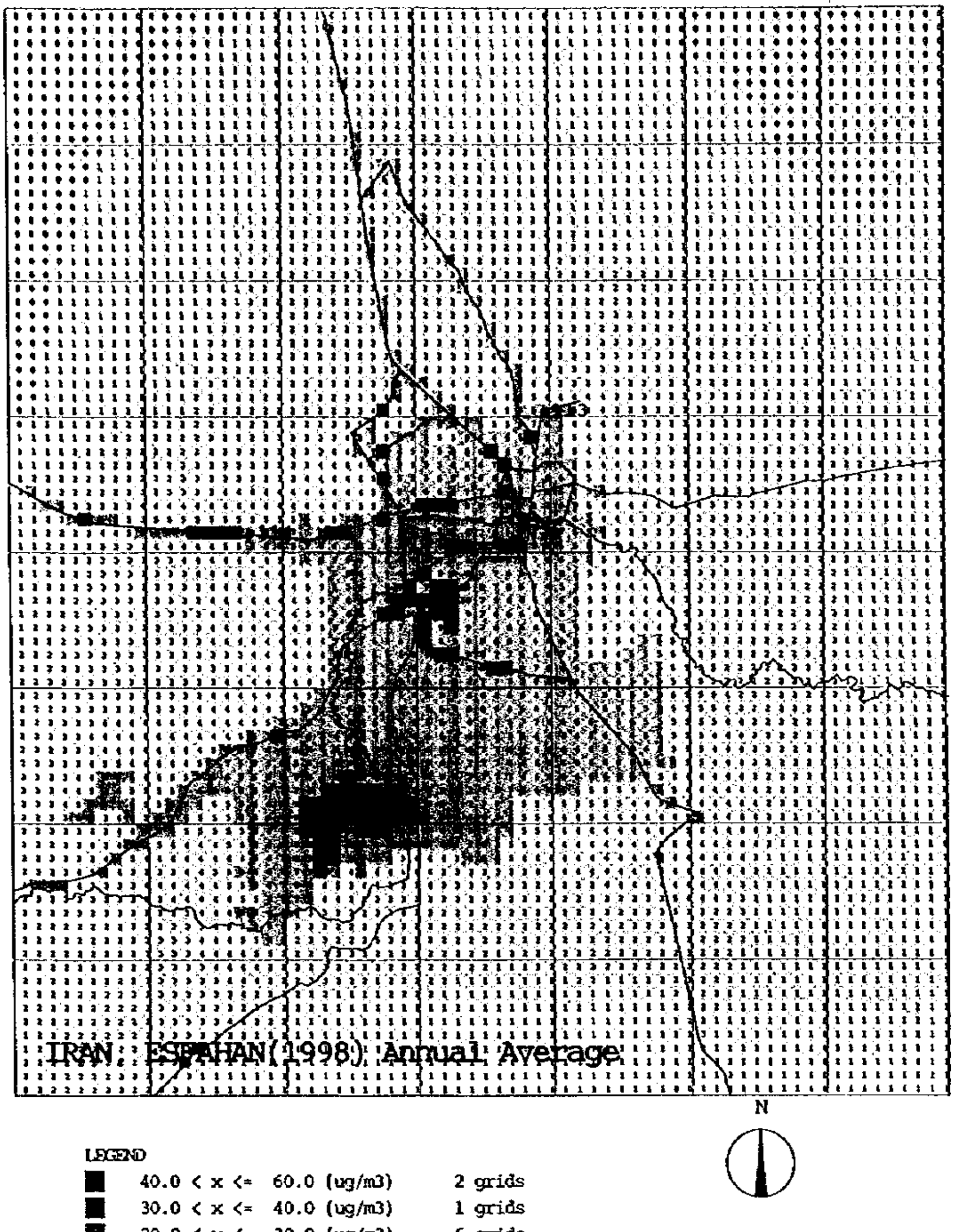
DATE

NO2 ppb □C MAX= 28.6ppb

Figure Distribution of Annual Average Concentration (NO_2, All Sources, Esfahan)



IRAN, ESFAHAN(1998) Annual Average



LEGEND

■	40.0 < x <= 60.0 (ug/m3)	2 grids
■	30.0 < x <= 40.0 (ug/m3)	1 grids
■	20.0 < x <= 30.0 (ug/m3)	6 grids
■	10.0 < x <= 20.0 (ug/m3)	70 grids
▨	5.0 < x <= 10.0 (ug/m3)	763 grids
□	.0 < x <= 5.0 (ug/m3)	4678 grids

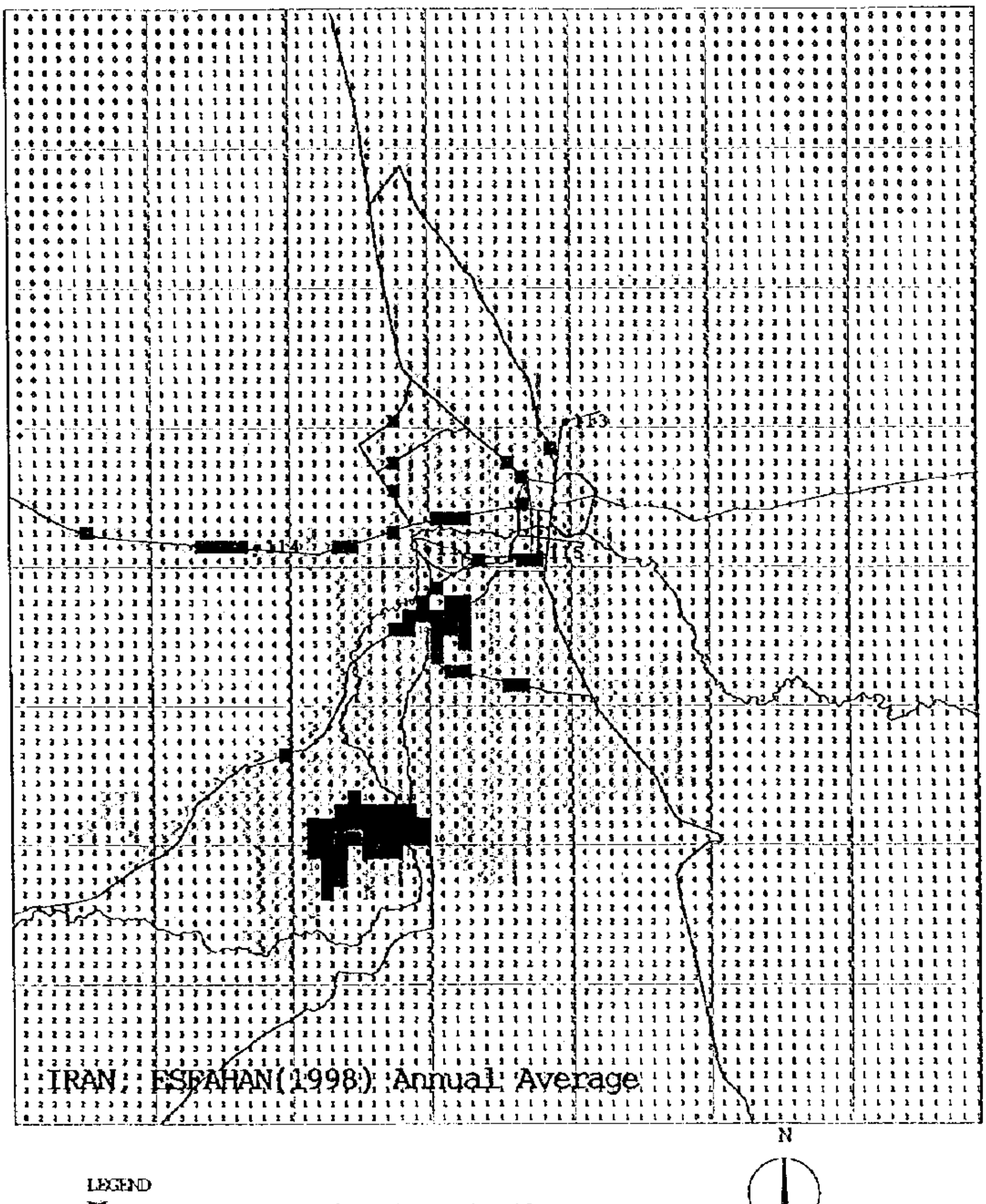
Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

DATE

SPM ug/m3 □C MAX= 51.4ug/m3

Figure Distribution of Annual Average Concentration (SPM, All Sources, Esfahan)



LEGEND

■	40.0 < x <= 60.0 (ug/m3)	2 grids
■	30.0 < x <= 40.0 (ug/m3)	1 grids
■	20.0 < x <= 30.0 (ug/m3)	6 grids
■	10.0 < x <= 20.0 (ug/m3)	70 grids
	5.0 < x <= 10.0 (ug/m3)	763 grids
	.0 < x <= 5.0 (ug/m3)	4678 grids

Monitoring Stations
113 Kaveh
114 Golshahr
115 Shariati

Power Plant
111 Esfahan Power Plant

DATE

SPM ug/m3 C MAX= 51.4ug/m3

Figure Distribution of Annual Average Concentration (SPM, All Sources, Esfahan)

IRAN, ESFAHAN(1998) Annual Average

Appendix 9-1

Method for determination of heavy metals in ambient air

This method is valid for heavy metals on collecting filter paper used by Low Volume Air Sampler and insoluble components in settled dust.

1. Preparation of Analysis Sample Solution

(1) Reagents

(a) Hydrochloric acid (1+2)

Note: (1+2) means a mixture of 1 part of 100% HCl and 2 parts of pure water.

(b) Hydrochloric acid (1+10)

(c) Nitric acid 100%

(d) Nitric acid (1+10)

(e) Perchloric acid 100%

(2) Operation

a) Chop the filter paper with sample solid into a 100 ml beaker made of fluororesin. Pour into the beaker 20 ml of nitric acid (c) and 5 ml of hydrochloric acid (a). Heat the beaker on a hot plate (130℃) for one hour, while covering with a watch glass made of fluororesin.

b) After one hour, remove the watch glass, and keep heating until the contents being reduced to 5 ml. Cool down. Add 5 ml of nitric acid (c) and heat again until the contents to 5 ml.

c) Cool down and add 10 ml of nitric acid (c), 3 ml of perchloric acid (e) and 3 ml of hydrochloric acid (b). Partially cover with the watch glass and heat on the hot plate of 200℃.

d) Stop heating when the white fume of perchloric acid ceased. After cool down, add 5 ml of nitric acid (c) and heat it again on the heat plate at 130℃. Cover tightly with the watch glass when the perchloric acid white fume ceased.

e) Keep heating until the contents turns to white or light-yellow. Remove the watch glass when it is white or light-yellow.

f) When it is approximately dry, stop heating and cool down. [If it is still black or brown, add 2 ml of nitric acid (c) and 3 ml of perchloric acid and heat again. Organic matter should be decomposed completely in this manner.]

g) Add 50 ml of warm pure water and 10 ml of nitric acid (d), heat on the hot plate (130℃) for 10 minutes to dissolve the white remains.

h) Filtrate the contents by a filter paper of Class 5B after cool down. Wash the beaker and the filter with warm nitric acid (d). Filtrate the washing in the same manner as before.

i) Combine all the filtrates and washing into a beaker of 100 ml made of fluororesin and heat it gradually on the hot plate (130℃) until approximately evaporate to dryness.

j) After cooling the dry material, add 10 ml of nitric acid (d) and heat on the water bath to dissolve it.

k) After cooling, transfer the contents into a measuring flask of 25 ml. Add pure water to the marked line of 25 ml. This is the sample solution to the atomic absorption spectro-chemical analysis.

2. Calculation Method for Heavy Metal Concentration in Air

V, Ni, Pb, and Zn concentration in ambient air sampled by Low Volume Air Samplers shall be calculated according the the following formula.

$$C = (Cs - Cb) \times 25 \times 1000/(V \times 298/(273 + t))$$

where C: metal concentration, micrograms/m^3 of air

Cs: Result of Atomic Absorption Analysis, microgram

Cb: Blank test results of Atomic Absorption Analysis, microgram

V: Air volume sacked into the Low Volume Air Sampler, m^3

t: Average ambient air temperature while sacking air to the Sampler

Appendix 9-2

Analytical Procedure for Soluble Metals in Settled Dust

Sample : 2 liter solution in a capped plastic bottle

Preparation :

1. Reduce the sample of 2 liter to 25 ml using a 100 ml beaker (repeatedly supplying the sample for the evaporation loss) by evaporation and by avoiding violent boiling.
2. Wash the plastic bottle and pour the wash water to the beaker for evaporation.
3. Stop heating when the remained solution is approximately 20 ml.
4. After cool, filtrate the solution and put the filtrate to 25 ml measuring flask.
5. Wash the evaporation beaker with 5 ml pure water and filtrate the wash water and put the filtrate to the measuring flask.
6. Make the filtrate total 25 ml with pure water and bring it to the Atomic Absorption Analysis.

Appendix 9-3

Method for Determination of Heavy Metals in Stack Gas

This method is valid for heavy metals on cylindrical filter paper used for sampling of soot in stack gases.

1. Preparation of Analysis Sample Solution

(1) Reagents

- (a) Hydrochloric acid (1 + 2)
- (b) Hydrofluoric acid (100%)
- (c) Hydrogen peroxide in water (30%)

(2) Apparatus - 100 ml Beaker made of fluororesin

(3) Operation

a) Chop the sampled filter to a suitable size to put into a beaker of 100 ml made of fluororesin. Add 30 ml of hydrochloric acid (a) and 5 ml of hydrogen peroxide solution.

b) Heat the beaker covered with a watch glass of fluororesin for 60 minutes on a water bath. After cooling it, wash the watch glass with warm pure water of 10 - 15 ml. Filtrate this washing solution and the contents in the beaker by using a filter paper of Class 5B.

c) Add 20 ml of hydrochloric acid (a) into the beaker and heat it on the water bath for 10 minutes. After cool it, filtrate the contents by using the previous filter paper.

d) Wash the beaker with 30 ml of warm pure water and filtrate the washings with the same filter paper.

e) Combine all the filtrate and washings into a beaker of 100 ml made of fluororesin. Vaporize the contents to approximate dryness on the water bath.

f) Add 10 ml of hydrochloric acid (a) into the beaker, heat it on the water bath to dissolve the contents. After cooling, move the contents in the beaker into a measuring flask of 25 ml. Add pure water up to the marked line of 25 ml. This is the sample solution to the Atomic Absorption Spectro-chemical Analysis.

g) Separately operate in the similar manner on the filter paper and take it as the blank test solution to the Analysis.

2. Analysis Method

(1) The atomic absorption spectro-chemical analysis shall be applied.

(2) Reagents

(a) Nickel Standard Stock Solution (1 ml = 100 micrograms of Ni)

Add 20 ml of nitric acid (1+2) to 0.100 gram of metallic nickel (not less than 99.5% as nickel) in a graduated cylinder of 1000 ml. Gently heat it in warm water to dissolve completely and then dilute it with pure water exactly to 1 liter.

Nickel Standard Solution (1 ml = 2 micrograms of Ni)

Dilute the Standard Stock Solution with hydrochloric solution of (1+25) to exactly 50 times. This solution shall be freshly prepared at each time when required.

(b) Vanadium Standard Stock Solution (1 ml = 100 micrograms of V)

Dissolve 0.230 grams of ammonium metavanadate in approximately 200 mo of warm pure water. Add 10 ml of hydrochloric acid (1+2). After cooling, dilute the contents with pure water exactly to 1 liter.

Vanadium Standard Solution (1 ml = 10 micrograms of V)

Dilute the vanadium standard stock solution with hydrochloric acid (1+25) exactly to 10 times. This solution shall be freshly prepared at each time when required.

(c) Lead Standard Stock Solution (1 ml = 100 micrograms of Pb)

Add 20 ml of nitric acid (1+4) to 0.100 g of metallic lead (nmot less than 99.9% as lead). Gently heat to dissolve it. Subsequently, boil it to release NOx gas. After cooling, dilute with pure water correctly to 1 liter.

Lead Standard Solution (1 ml = 10 microgram of Pb)

Dilute the Lead Standard Stock Solution with hydrochloric acid (1+25) correctly to 10 times. This solution shall be freshly prepared at each time when required.

(d) Zinc Standard Stock Solution (1 ml = 100 microgram of Zn)

Add 80 ml of hydrochloric acid (1+2) to 0.100 g of metallic zinc (not less than 99.9% as zinc), dissolve it, and dilute the contents with pure water correctly to 1 liter.

Zinc Standard Solution (1 ml = 1 microgram of Zn)

Dilute the Zinc Standard Stock Solution with hydrochloric acid (1+25) correctly to 100 times. This solution shall be freshly prepared at each time when required.

(3) Gas to be Used

Metal	Combustible Gas	Combustion Support Gas
Nickel	Acetylene	Air
Vanadium	Acetylene	Nitrous oxide
Lead	Acetylene	Air
Zinc	Acetylene	Air

(4) Apparatus

Atomic Absorption Spectro-chemical Analyzer

Lamp and Wave Length

Hollow-cathode Lamp	Wave Length
Nickel	232.0 nm
Vanadium	318.4 nm
Lead	283.3 nm
Zinc	213.9 nm

(5) Preparation of Working Curve

The working curve shall be prepared in accordance with Article 7.1 (1) of JIS K0121.

(6) Operation

Burn the correspondent hollow-cathode lamp. After the flame having stabilized, measure the absorbance or absorption percentage by using a filter having the corresponding wave length of the sample solution and obtain the heavy metal amount from the working curve.

Separately operate a blank test by using a blank solution and correct the results.

3. Heavy Metal Concentration in Stack Gas

The metal concentration in stack gas is expressed by the milligram of metal in 1 m^3 of the dried stack gas at 25℃ and 760 mmHg.

$C = m / Q$

where C: metal concentration (mg/m^3S)

m: weight of metal in the sample (mg)

Q: volume of dried sample gas (m^3S)= $V \times (298/(273+tm)) \times ((Pa + Pm - Pv)/760)$

where V: volume of gas sucked by a gas meter (m^3)

tm: temperature of the gas sucked (℃)

Pa: barometric pressure (mmHg)

Pm: gauge pressure at the gas meter (mmHg)

Pv: saturated water vapor pressure at tm (mmHg)

Appendix 9-4

Method for Determining of Gaseous Pollutants in Air by Passive Samplers

1. Introduction

Passive samplers are to collect gaseous pollutants in ambient air based on a molecular diffusion and selective chemical bondage. It is convenient for air sampling without electric power supply and its small size.

The sampler consists of a diffusion plate with 45 pinholes, a stainless mesh, an o-ring made of TFE (Poly-tetra-fluoro-ethylene), a filter paper (impregnated with TEA, glycerin, and other required chemicals), and a casing body.

When the sampler is exposed in ambient air avoiding a rain fall and direct sun shine, gas molecules diffuse into pinholes and reach the filter. Only acidic gases are trapped there by TEA. Sampling period is usually one day to several days. Starting and ending times of the sampling should be recorded. After exposure, the sampler is removed and put into a package bag. Review to Chapter 6 and its Appendix for kinds of samplers used for the Study and setting up of the samplers.

2. Sampler Chemical Analyses

2.1 Ion Chromatography for NO_2 and SO_2

Step	Remarks
Sampled Filter Paper	Put into a 50 ml polyethylene bottle or a test tube with a stopper. Add 10 ml of 0.3% H_2O_2.
Ultra sonic or Mechanical Shaker	For 10 min
Standing Over One Night	To decompose remaining H_2O_2 which will damage an Ion Chromatograph column.
Washing of Syringe and Disposable Filter Unit	Three times with the sample solution
Sample (1 ml) Injection	Use one disposable filter for 10 samples.
Ion Chromatography Analysis	

For references:

The following are used with an eluent of 1.8 mM of Na_2CO_3 and 1.7 mM of $NaHCO_3$ at the flow rate of 2.0 ml/min.

Guard Column	- Dionex, Ion Pac., AG4A-SC
Analytical Column	- Dionex, Ion Pac., AS4A-SC
Auto-suppresser	- Dionex, ASRS-14 mm

2.2 Absorptiometry for NOx

a) Put a sampled filter into a 50 ml polyethylene bottle or a stopper test tube.
b) Add 10 ml of pure water to the bottle.
c) Keep it for 30 minutes.
d) Shake it for a few minutes.
e) Cool it to 2 to 6 ℃ in a refrigerator.
f) Add 2 ml of a color reagent solution (see below)
g) Keep it for 30 minutes in the refrigerator
h) Take it out of the refrigerator and keep it to reach the room temperature.
i) Colormity at 545 nm.

References:

(1) Color Reagent

Sulfuric Acid Solution - Dissolve 80 grams of sulfanilamide in 200 ml of phosphoric acid and add pure water to make it correctly 1 liter. Keep it in a cool and dark place.

NEDA Solution - Dissolve 0.56 grams of N-1-naphthyl-ethylene diamine dihydrochloride in 100 ml of pure water.

Color Reagent is a mixture of the Sulfuric Acid Solution and the NEDA Solution (10 + 1).

(2) Sodium Nitrite Stock Solution (1 microgram NO_2/ml) - 1.5 grams of sodium nitrite that has been dried at 105 to 110℃ for over than 4 hours is weighed out and dissolved in pure water to a volume of 1 liter.

(3) Sodium Nitrite Solution - Dilute the Stock Solution with pure water correctly to 100 times, and take 0, 2, 5, 10, and 20 ml of the diluted solution and again dilute it with pure water up to 100 ml (0 to 2.0 micrograms NO_2/ml).

3. Ambient Concentration

Ambient air concentration of each gaseous pollutant has to be calculated from the results of the chemical analyses using the following equation.

$C = W \times a / H$

where C: ambient air concentration (ppb)

W: result of the chemical analysis (micrograms) adjusted after the blank test

H: minutes exposed (min)

a : coefficient - see the table below.

	10℃	20℃	30℃
SO_2	120.3×10^{-6}	123.8×10^{-6}	127.3×10^{-6}
NO_2	104.4×10^{-6}	107.5×10^{-6}	110.5×10^{-6}

Appendix 9-5

Impregnated Filter Paper for Passive Sampler

1. Preparation of Impregnated Filter Paper (SO_2 + NO_2)

Mixed Reagent

Pour glycerin 10 ml into a capped measuring cylinder, add TEA 30 ml and finally make the contents to total 100 ml by addition of pure water. Shake it for a few minutes.

Impregnation

Put 100 round filter papers (ADVANTEC No. 51A or equivalent, 47 mm in diameter) on a vat (30 x 20 x 5 cm) with a pair of tweezers. Pour the mixed reagent into the vat.

Drying

Dispose excess reagent by decantation. And put a square filter on the vat to absorb excess reagent.

Put a square filter (ADVANTEC No. 51A) on a plate of a silica gel desiccator and put impregnated filters, one layer and without touching each other. Place two pillars (triangle shaped, cardboard made) on the first square filter and place the second square filter on top of the pillar. Accordingly make tiers of square filter papers to make space for 100 wet round filters for drying without touching each other. Cover the desiccator and keep it for 2 to 4 hours. Complete dryness is not necessary. As glycerin has water holding property, it can keep the filters in a slightly moistened condition.

Storage

Put 5 dried round filter papers in a small polyethylene bag. Seal the bag and store in a cool dark place. The effectiveness of the paper remains for 3 months before use.

2. Preparation of Impregnated Filter Paper (NOx)

Mixed Reagent

Pour glycerin 10 ml into a capped measuring cylinder, add TEA 30 ml and finally make the contents to total 100 ml by addition of pure water. Shake it for a few minutes.

Impregnation

Dissolve PTIO 0.3 g with acetone into the mixed reagent of 15 ml which is named as NOx Reagent

Put round filter papers (ADVANTEC No. 51A or equivalent, 47 mm in diameter) in a desiccator (see Note 1) with a pair of tweezers, not to touch each other.

Pour the mixed reagent of 200 micro-liter with a micro-dispenser on one filter, one by one.

Desiccation

Introduce clean air into the desiccator with the flow rate of about 2 liter /minute. Blow air for approximately one hour (see Note 2).

Storage

Put each 5 filters in a small polyethylene bag (sealed type), seal the bag tightly, and store it in a cool and dark place. The effectiveness of the loaded filter paper remains for 3 months before use.

Note 1: Box type, 30 x 25 x 40 cm, with gas inlet nozzles, silica bed

Note 2: As glycerin has water holding property, filters are slighly moist.

Appendix 9-6

Tabriz (1)

Results and Location of Passive Sampling

Location No.	Sampling start time is on the Field	Sampling finish time is on the Field	average temp	period (min)	NO2- (ug/ml)	NO2 ppb	SO42- (ug/ml)	SO2 ppb	NOx (ug/ml)	NOx ppb
1	1998/2/1 11:05	1998/2/8 11:45	5	10120	0.1800	2	43.57	242	0.668	11
	1998/6/3 10:00	1998/6/13 9:20	20	12920	0.6900	5	ND	0	0.283	8
	1998/8/22 10:20	1998/8/29 9:10	25	8570	ND	0	ND	0	0.780	12
	1998/11/7 13:50	1998/11/14 10:42	10	8452	1.2200	14	4.20	27	1.600	39
2	1998/2/1 11:12	1998/2/8 11:40	5	10108	ND	0	116.85	649	1.492	20
	1998/6/3 10:20	1998/6/13 9:30	20	12910	1.2000	9	23.20	97	1.460	23
	1998/8/22 10:25	1998/8/29 9:10	25	8565	ND	0	ND	0	1.140	17
	1998/11/7 14:00	1998/11/14 10:43	10	8443	2.4000	27	ND	0	1.820	56
3	1998/2/1 11:20	1998/2/8 11:53	5	10113	ND	0	174.50	969	0.703	9
	1998/6/3 10:25	1998/6/13 9:35	20	12910	1.0500	8	2.28	9	0.898	16
	1998/8/22 10:35	1998/8/29 9:15	25	8560	ND	0	5.50	34	0.830	12
	1998/11/7 14:05	1998/11/14 10:45	10	8440	1.8400	21	12.00	79	1.990	52
4	1998/2/1 11:35	1998/2/8 15:40	5	10325	ND	0	128.02	696	0.765	10
	1998/6/3 10:30	1998/6/13 9:45	20	12815	0.9900	7	23.10	96	1.258	20
	1998/8/22 10:45	1998/8/29 9:20	25	8555	0.5000	5	14.50	90	0.740	16
	1998/11/7 14:10	1998/11/14 10:50	10	8440	1.0100	12	14.00	92	1.940	42
5	1998/2/1 13:25	1998/2/8 11:50	5	8545	ND	0	266.45	1751	0.987	15
	1998/6/3 10:40	1998/6/13 10:00	20	12920	1.1500	8	1.21	5	0.843	17
	1998/8/22 10:50	1998/8/29 9:25	25	8555	0.6500	7	0.53	3	0.850	19
	1998/11/7 14:25	1998/11/14 10:40	10	8415	1.2300	14	0.83	5	1.790	42
6	1998/2/2 14:50	1998/2/8 12:54	5	7084	ND	0	224.13	1776	0.240	5
	1998/6/8 11:00	1998/6/15 11:45	20	10125	ND	0	ND	0	0.418	5
	1998/8/31 11:25	1998/9/7 12:25	25	10140	0.4500	4	1.34	7	0.430	9
	1998/11/8 10:35	1998/11/15 12:35	10	10200	ND	0	ND	0	4.200	55
7	1998/2/2 15:25	1998/2/9 15:20	5	8635	1.7600	20	7.24	47	0.391	26
	1998/6/15 11:00	1998/6/26 9:30	20	14310	1.0400	7	1.45	5	0.801	14
	1998/8/31 10:30	1998/9/7 10:45	25	10095	ND	0	0.49	3	0.610	8
	1998/11/8 10:00	1998/11/15 10:40	10	10120	0.9800	9	1.72	9	5.320	79
8	1998/2/3 8:33	1998/2/10 8:50	5	10097	1.7600	17	ND	0	1.149	32
	1998/6/14 18:00	1998/6/23 10:10	20	11170	ND	0	ND	0	0.541	6
	1998/8/22 11:45	1998/8/29 10:10	25	8545	0.3700	4	2.24	14	1.150	21
	1998/11/9 10:45	1998/11/19 15:25	10	14680	1.7100	11	1.91	7	2.480	34
9	1998/2/3 23:00	1998/2/9 23:00	5	8640	ND	0	256.20	1665	1.108	17
	1998/6/13 16:00	1998/6/23 22:00	20	14760	0.9100	6	ND	0	0.808	13
10	1998/2/8 12:15	1998/2/17 12:20	5	12965	ND	0	1.28	6	0.810	6
	1998/6/8 10:30	1998/6/15 11:25	20	10135	0.8700	8	1.02	5	0.811	18
	1998/8/31 11:00	1998/9/7 11:45	25	10125	ND	0	1.33	7	0.460	6
	1998/11/8 10:15	1998/11/15 11:50	10	10175	0.9900	9	ND	0	1.820	33
11	1998/2/8 12:40	1998/2/17 12:35	5	11515	ND	0	0.23	1	0.350	4
	1998/6/8 10:50	1998/6/15 11:35	20	10125	ND	0	5.01	27	0.572	7
	1998/8/31 11:20	1998/9/7 11:55	25	10115	ND	0	2.80	15	0.720	9
	1998/11/10 9:30	1998/11/19 9:00	10	11490	1.3600	11	ND	0	2.710	43
12	1998/2/8 13:12	1998/2/17 13:08	5	11516	ND	0	3.10	15	0.740	9
	1998/6/8 11:40	1998/6/15 12:00	20	10100	ND	0	ND	0	0.293	4
	1998/8/31 12:20	1998/9/7 0:00	25	7900	ND	0	ND	0	ND	0
	1998/11/8 11:35	1998/11/15 12:25	10	10130	1.0700	10	0.46	3	1.940	36
13	1998/2/9 11:22	1998/2/18 11:00	5	8618	ND	0	0.33	2	0.280	4
	1998/6/6 17:30	1998/6/15 18:15	20	13005	0.6300	4	0.54	2	0.208	7
	1998/9/8 12:15	1998/9/16 12:15	25	11520	ND	0	0.32	1	0.940	10
	1998/11/10 11:55	1998/11/19 11:20	10	11485	1.1800	10	0.77	4	4.100	57
14	1998/2/8 12:06	1998/2/16 14:58	5	11693	ND	0	0.24	1	0.170	2
	1998/6/6 16:10	1998/6/15 18:55	20	13125	ND	0	ND	0	0.005	13
	1998/9/8 11:45	1998/9/18 11:35	25	10070	0.3100	3	ND	0	0.390	6
	1998/11/10 11:10	1998/11/19 10:40	10	11490	0.8300	7	ND	0	2.210	32
15	1998/2/9 12:45	1998/2/17 14:45	5	11640	ND	0	ND	0	0.240	3
	1998/6/6 15:50	1998/6/15 17:50	20	13080	ND	0	1.05	4	0.130	1
	1998/9/8 13:05	1998/9/16 12:45	25	10060	0.4000	4	1.02	5	0.810	14
	1998/11/10 13:15	1998/11/19 13:15	10	12960	0.7000	5	1.02	4	2.330	29
16	1998/2/9 18:12	1998/2/17 12:10	5	9838	ND	0	0.50	3	0.360	5
	1998/6/6 10:25	1998/6/15 12:45	20	13100	0.8200	6	ND	0	0.388	10
	1998/9/8 11:30	1998/9/16 11:20	25	10070	0.5800	5	ND	0	1.140	19
	1998/11/10 11:00	1998/11/19 10:00	10	11460	1.1300	9	ND	0	2.450	38
17	1998/2/9 16:40	1998/2/18 10:40	5	11160	ND	0	ND	0	0.680	8
	1998/6/6 12:00	1998/6/15 13:05	20	13025	ND	0	1.10	5	0.554	5
	1998/9/8 12:30	1998/9/16 12:55	25	11545	9.6200	76	ND	0	0.260	79
	1998/11/10 9:45	1998/11/19 9:10	10	11485	0.6100	5	ND	0	4.250	54
18	1998/2/9 18:00	1998/2/17 7:00	5	9420	ND	0	ND	0	0.300	4
	1998/6/7 17:10	1998/6/14 12:00	20	8330	ND	0	ND	0	0.035	1
	1998/9/7 20:45	1998/9/14 23:00	25	10215	ND	0	ND	0	0.880	11
	1998/11/10 20:50	1998/11/17 20:50	10	10080	0.7000	7	0.32	2	4.510	66
19	1998/2/10 10:45	1998/2/17 12:00	5	10155	ND	0	0.70	4	0.470	6
	1998/6/6 10:00	1998/6/15 12:40	20	13120	0.9900	7	0.62	3	0.365	11

Tabriz (2)

Passive Sampler Data List

Location No.	Sampling start time is on the Field	Sampling finish time is on the Field	average temp	period (min)	NO2- (ug/ml)	NO2 ppb	SO42- (ug/ml)	SO2 ppb	NOx (ug/ml)	NOx ppb
20	1998/2/10 11:30	1998/2/18 11:15	5	10065	ND	0	0.37	2	0.420	1
	1998/6/8 11:00	1998/6/20 12:30	20	20250	0.6700	3	ND	0	0.198	4
	1998/9/8 11:00	1998/9/18 11:00	25	11520	0.5200	4	ND	0	1.140	19
	1998/11/10 10:35	1998/11/19 9:45	10	11470	1.0100	8	0.93	4	4.560	61
21	1998/2/10 12:00	1998/2/18 12:20	5	11540	ND	0	1.00	5	0.660	8
	1998/6/20 12:40	1998/6/27 10:50	20	8530	0.8300	9	ND	0	0.342	14
	1998/9/8 10:25	1998/9/16 10:45	25	11540	ND	0	ND	0	1.210	13
	1998/11/10 10:20	1998/11/19 9:35	10	11475	1.1700	10	ND	0	3.950	55
22	1998/2/10 12:45	1998/2/17 14:30	5	10185	ND	0	1.77	10	0.530	7
	1998/6/8 15:30	1998/6/15 17:45	20	13095	0.8100	6	2.01	8	0.398	10
	1998/9/8 13:20	1998/9/16 12:55	25	10055	0.3900	4	2.84	15	0.820	14
	1998/11/10 13:35	1998/11/19 13:25	10	11510	1.2100	10	1.42	7	4.160	58
23	1998/2/10 15:35	1998/2/18 13:05	5	9930	ND	0	0.50	3	0.700	10
	1998/6/3 11:15	1998/6/13 10:45	20	12930	0.8600	6	4.32	18	0.569	12
	1998/8/22 11:00	1998/8/29 0:00	25	7980	ND	0	ND	0	ND	0
	1998/11/7 14:35	1998/11/15 10:10	10	9815	1.2400	12	8.00	45	2.020	39
24	1998/2/10 15:50	1998/2/18 13:15	0	9925	ND	0	2.31	13	0.440	6
	1998/6/3 11:35	1998/6/13 11:00	0	12925	0.8700	7	1.93	9	1.095	18
	1998/8/22 11:30	1998/8/29 9:50	25	8540	0.5600	6	ND	0	1.050	21
	1998/11/7 14:40	1998/11/15 10:20	10	9820	0.7900	8	21.06	119	1.960	34
25	1998/2/10 16:15	1998/2/18 15:15	5	10020	ND	0	0.18	1	1.030	14
	1998/6/3 12:00	1998/6/13 11:15	20	12915	1.2300	9	1.92	8	1.283	22
	1998/8/22 11:50	1998/8/29 10:05	25	8535	0.5600	6	1.24	8	0.970	20
	1998/11/9 10:55	1998/11/19 15:35	10	14680	2.0100	13	1.90	7	4.580	55
26	1998/2/10 16:40	1998/2/19 15:05	5	11425	ND	0	ND	0	0.850	11
	1998/6/7 11:00	1998/6/17 10:45	20	12945	0.9900	7	ND	0	0.968	17
	1998/9/5 12:30	1998/9/13 10:00	25	8930	ND	0	9.68	52	1.020	13
	1998/11/9 12:20	1998/11/23 14:20	10	20280	3.4200	16	2.20	6	3.560	40
27	1998/2/11 10:38	1998/2/18 14:35	5	10317	ND	0	0.43	2	0.610	8
	1998/6/3 12:10	1998/6/13 11:30	20	12920	0.9100	7	2.55	11	0.651	13
	1998/8/22 12:10	1998/8/29 10:35	25	8545	ND	0	1.07	7	0.800	12
	1998/11/9 12:45	1998/11/19 15:40	10	14575	1.2800	8	1.74	7	3.370	39
28	1998/2/11 11:05	1998/2/18 14:45	5	10300	ND	0	ND	0	0.570	7
	1998/6/3 12:20	1998/6/13 11:40	20	12920	1.3900	10	9.27	39	1.602	26
	1998/8/22 12:00	1998/8/29 10:10	25	8530	0.8700	9	2.77	17	0.460	16
	1998/11/9 13:00	1998/11/19 15:50	10	14570	1.5700	10	2.70	10	1.950	28
29	1998/2/11 12:00	1998/2/20 15:25	5	13165	ND	0	ND	0	0.770	8
	1998/6/7 12:00	1998/6/17 12:20	20	14420	0.7700	5	0.60	2	0.414	9
	1998/9/5 13:30	1998/9/13 11:20	25	9950	0.5800	5	0.88	5	0.390	10
	1998/11/14 11:45	1998/11/23 12:15	10	12990	1.8000	13	1.01	4	4.450	59
30	1998/2/11 12:28	1998/2/21 15:00	5	14552	0.0200	0	ND	0	0.470	5
	1998/6/7 12:15	1998/6/17 12:50	20	14435	ND	0	ND	0	0.197	2
	1998/9/5 13:45	1998/9/13 11:40	25	9955	ND	0	ND	0	0.040	23
31	1998/2/11 13:20	1998/2/21 14:25	5	14465	ND	0	ND	0	0.320	3
	1998/6/20 17:50	1998/6/28 0:00	20	9010	ND	0	ND	0	0.180	3
	1998/9/5 15:00	1998/9/13 12:15	25	9915	ND	0	ND	0	ND	0
	1998/11/14 12:40	1998/11/23 12:50	10	12970	1.2000	9	0.25	1	6.270	73
32	1998/2/11 16:38	missig	5							
	1998/6/10 13:00	1998/6/20 11:20	20	12860	0.7400	5	1.87	8	0.667	12
33	1998/2/11 18:17	1998/2/18 16:30	5	8533	ND	0	0.41	3	0.800	13
34	1998/2/12 11:46	1998/2/18 16:20	0	8914	ND	0	ND	0	0.120	2
	1998/6/11 10:30	1998/6/20 16:00	0	13290	ND	0	ND	0	0.013	0
	1998/9/5 11:45	1998/9/13 10:45	25	10020	ND	0	ND	0	0.310	4
	1998/11/14 16:00	missing	10							
35	1998/2/12 14:55	1998/2/19 10:55	5	8400	ND	0	ND	0	0.150	2
	1998/6/6 9:30	1998/6/13 10:30	20	10140	ND	0	0.64	3	0.161	2
	1998/8/22 12:30	1998/8/29 9:35	25	8465	ND	0	1.02	6	0.800	12
	1998/11/8 9:40	1998/11/15 10:00	10	10100	0.8800	8	ND	0	1.490	28
36	1998/2/15 12:35	1998/2/21 17:00	5	8905	ND	0	0.27	2	0.760	12
	1998/6/7 11:30	1998/6/17 12:00	20	14430	1.9500	13	1.40	5	1.967	30
	1998/8/31 12:55	1998/9/7 16:00	25	10265	0.6500	6	0.94	5	1.020	18
	1998/11/9 11:20	1998/11/19 17:10	10	14750	2.7000	18	3.62	14	5.260	65
37	1998/6/3 11:50	1998/6/13 11:07	0	12917	0.8700	7	1.01	4	0.576	13
38	1998/6/6 17:50	1998/6/15 18:30	0	13000	ND	0	ND	0	0.008	0
39	1998/6/16 19:40	1998/6/26 14:50	0	12670	0.7700	6	ND	0	0.234	9
40	1998/6/20 10:40	1998/6/27 10:20	0	8620	ND	0	ND	0	0.305	5
41	1998/6/20 12:00	1998/6/27 10:40	5	8560	ND	0	ND	0	0.082	1
	1998/9/7 18:00	1998/9/16 18:00	25	12960	0.3800	3	0.48	2	1.290	15
	1998/11/1 20:00	missing	10					0		
42	1998/6/10 11:30	1998/6/20 12:40	0	14470	ND	0	0.55	2	0.703	7
43	1998/6/10 18:15	1998/6/20 21:00	0	14565	0.9800	7	ND	0	0.412	11

Esfahan (1)

Passive Sampler Data List

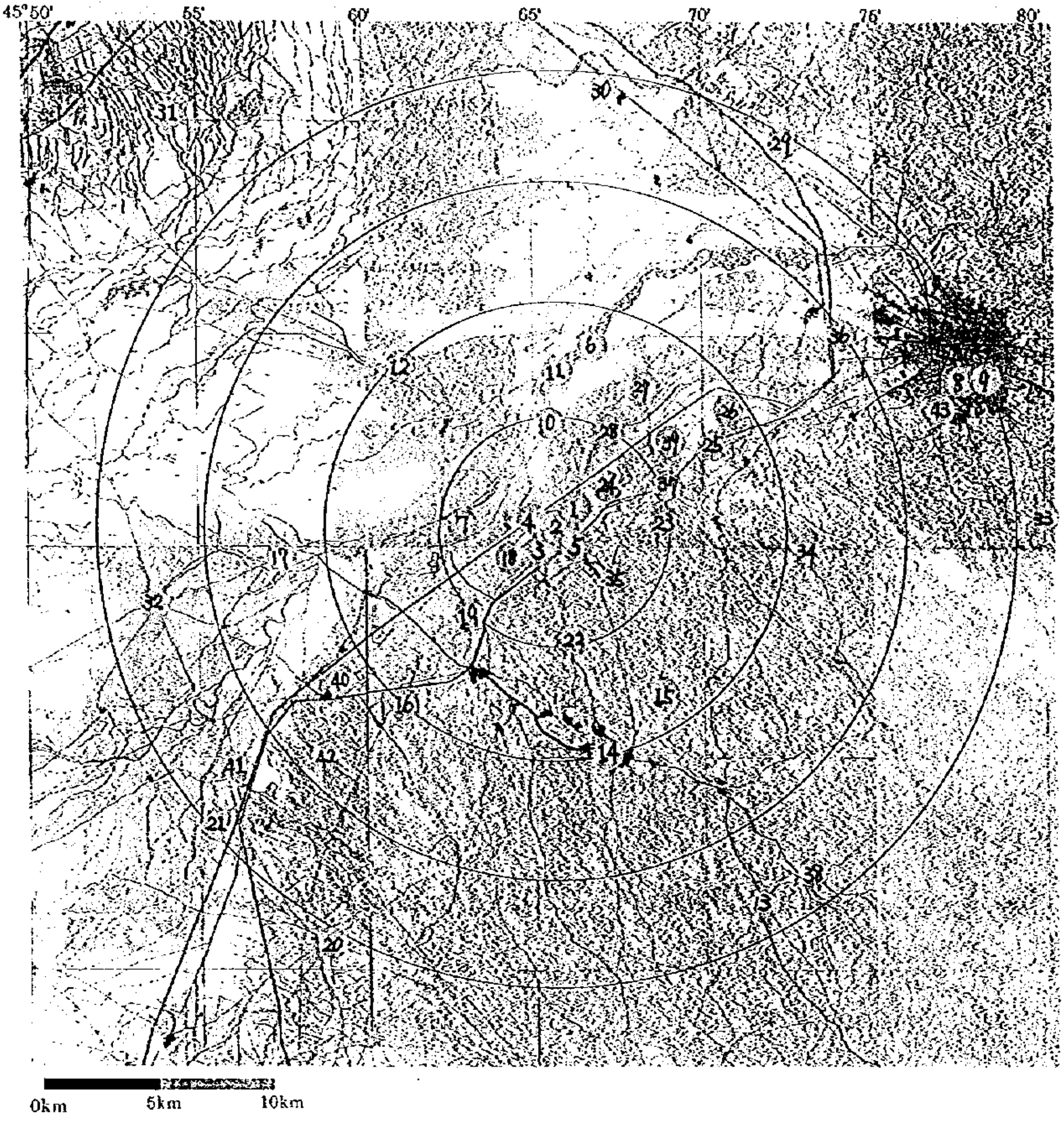
Location No.	Sampling start time is on the Field	Sampling finish time is on the Field	average temp	period (min)	NO2- (μg/ml)	NO2 ppb	SO42- (μg/ml)	SO2 ppb	NOX (μg/ml)	NOX ppb
1	1998/2/10 15:00	1998/2/17 14:00	5	8580	0.8300	9	35.00	229	1.310	30
	1998/6/17 11:00	1998/6/27 11:30	20	14430	1.4100	6	5.30	20	1.192	20
	1998/8/19 15:00	1998/8/29 14:00	25	12900	0.8700	6	0.34	1	1.230	18
	1999/10/24 8:42	1998/11/2 16:10	10	13408	1.2100	9	0.25	1	3.470	43
2	1998/2/10 15:00	1998/2/17 14:00	5	8580	ND	0	33.00	216	0.550	9
	1998/6/17 11:00	1998/6/27 11:30	20	14430	0.8800	6	0.85	3	0.362	9
	1998/8/19 15:10	1998/8/29 14:15	25	12905	0.7200	5	0.88	4	2.150	26
	1998/10/24 8:00	1998/11/1 11:35	10	11675	1.8200	15	1.13	5	3.260	52
3	1998/2/10 16:00	1998/2/17 14:00	5	8520	ND	0	5.00	33	0.300	5
	1998/6/17 11:30	1998/6/27 11:30	20	14400	1.0100	6	1.60	6	0.998	15
	1998/8/19 15:15	1998/8/28 14:17	25	11462	0.9200	7	1.16	5	1.520	24
	1998/10/24 9:50	1998/11/1 10:30	10	11560	2.1600	18	0.85	4	2.690	49
4	1998/2/10 16:00	1998/2/17 14:00	5	8520	0.7000	8	12.00	79	0.930	23
	1998/6/17 11:35	1998/6/27 11:15	20	12940	1.7400	12	1.89	8	1.421	26
	1998/8/19 15:20	1998/8/29 14:20	25	12900	1.1700	8	3.00	12	1.650	24
	1998/10/24 9:10	1998/11/1 17:20	10	12010	1.5200	12	0.84	4	4.210	59
5	1998/2/14 14:05	1998/2/21 9:10	5	8345	0.8100	10	6.00	40	1.050	27
	1998/6/17 11:45	1998/6/27 11:15	20	12930	2.0100	14	8.32	35	1.570	30
	1998/8/19 15:30	1998/8/29 14:30	25	12900	0.8500	6	3.94	16	1.760	23
	1998/10/24 8:35	1998/11/1 11:10	10	11675	1.9400	16	0.22	1	3.580	57
6	1998/2/12 16:30	1998/2/19 18:20	5	10190	ND	0	ND	0	0.570	8
	1998/6/17 18:00	1998/6/25 20:30	20	11670	1.0300	8	1.72	8	2.170	10
	1998/8/23 14:00	1998/8/30 18:00	25	10320	0.4600	4	0.70	4	1.090	17
	1998/10/24 15:00	1998/11/1 22:00	10	11940	0.7400	6	3.80	18	6.970	83
7	1998/2/12 18:00	1998/2/19 16:40	5	10120	ND	0	1.10	6	0.710	9
	1998/6/17 18:00	1998/6/25 20:15	20	11655	1.0300	8	2.23	10	0.969	19
	1998/8/23 16:00	1998/8/30 17:00	25	10140	0.2700	2	ND	0	0.670	11
	1998/10/24 18:00	1998/11/5 18:00	10	17280	1.7900	10	ND	0	6.520	60
8	1998/2/12 14:35	1998/2/19 17:45	5	10270	1.3700	13	19.00	104	3.190	55
	1998/8/23 15:00	1998/8/30 20:00	25	10360	0.5400	5	0.46	2	1.550	23
	1998/10/26 15:40	1998/11/2 21:15	10	10415	3.8300	35	1.46	8	4.820	97
9	1998/2/12 15:25	1998/2/19 14:30	5	8585	0.8700	10	9.00	59	1.900	40
	1998/6/1 12:35	1998/6/7 18:20	20	8865	1.7100	18	1.31	8	1.104	34
	1998/8/19 16:15	1998/8/28 10:20	25	12485	0.9600	7	2.19	9	2.340	31
	1998/10/25 10:10	1998/11/2 12:00	10	11630	2.2700	19	3.21	15	5.230	78
10	1958/2/12 15:45	1998/2/19 16:00	5	10095	1.1200	11	23.00	128	2.090	39
	1998/6/7 16:45	1998/6/27 19:30	20	28965	ND	0	3.95	7	0.596	9
	1998/8/19 18:00	1998/8/28 10:28	25	12508	1.2000	9	0.73	3	2.270	31
	1998/10/24 15:00	1998/11/2 16:00	10	13020	2.4000	18	ND	0	7.010	89
11	1998/2/12 16:40	1998/2/19 14:30	5	8510	0.7600	9	10.00	66	0.830	22
	1998/6/22 11:10	1998/7/2 15:30	20	14660	1.3800	9	0.67	2	0.855	21
	1998/8/22 10:40	1998/8/29 11:00	25	10100	ND	0	ND	0	0.500	6
	1998/10/25 11:20	1998/11/4 14:20	10	14580	1.6600	11	1.31	5	3.210	40
12	1998/2/14 10:30	1998/2/20 14:30	5	8880	0.6300	7	0.20	1	0.630	17
	1998/8/19 9:40	1998/8/29 13:20	25	14620	1.0800	7	0.42	2	1.070	16
	1998/10/24 9:35	1998/11/2 12:00	10	13105	1.8200	13	0.40	2	4.350	57
13	1998/2/14 11:10	1998/2/21 11:03	5	8633	0.7900	9	15.00	98	1.050	25
	1998/6/20 11:00	1998/6/27 14:30	20	10290	1.1700	11	0.57	3	0.881	20
	1998/8/19 10:30	1998/8/29 12:00	25	14490	1.9400	12	1.06	4	1.590	26
	1998/10/24 10:20	1998/11/2 9:10	10	11450	2.3000	19	1.90	9	5.230	80
14	1998/2/14 11:30	1998/2/21 11:20	5	8630	0.9800	11	6.00	39	1.360	32
	1998/6/1 9:10	1998/6/10 10:20	20	13030	1.8100	13	1.44	6	1.368	26
	1998/8/19 11:00	1998/8/29 12:15	25	14475	1.4300	9	0.36	1	1.480	22
	1998/10/24 10:40	1998/11/1 13:00	10	11660	0.8900	7	0.55	3	3.000	41
15	1998/2/14 11:50	1998/2/21 11:35	5	8625	0.6400	7	0.50	3	1.230	27
	1998/6/7 10:15	1998/6/20 12:20	20	18845	0.9600	5	0.94	3	0.361	13
	1998/8/19 11:45	1998/8/29 12:30	25	14445	0.9700	6	0.41	2	1.610	20
	1998/10/24 10:55	1998/11/1 13:50	10	11695	1.6100	13	2.37	11	3.080	48
16	1998/2/14 12:10	1998/2/21 11:55	5	8625	0.7300	8	0.30	2	0.640	18
	1998/6/20 12:40	1998/6/27 18:35	20	10315	1.1300	10	ND	0		
	1998/8/19 12:10	1998/8/29 13:00	25	14450	0.9600	6	0.83	3		
	1998/10/24 11:20	1998/11/1 14:00	10	11680	1.1000	9	0.72	3	2.350	36
17	1998/2/14 19:40	1998/2/20 18:45	5	7145	0.8600	12	0.12	1	1.960	49
	1998/8/19 16:00	1998/8/29 13:00	25	12780	1.5100	11	2.66	11	3.130	41
	1998/10/25 9:25	1998/11/2 11:00	10	11615	3.7700	31	2.15	10	4.590	84
18	1998/2/16 10:10	1998/2/22 14:45	5	8915	0.7000	8	0.80	5	1.170	25
	1998/8/23 10:00	1998/8/30 8:45	25	8565	1.8000	19	1.10	7	2.740	59
	1998/10/26 9:50	1998/11/5 8:25	10	12875	3.9200	29	1.90	8	5.540	86
19	1998/2/16 10:30	1998/2/22 14:00	5	8850	ND	0	1.80	11	2.510	38
	1998/6/20 13:00	1998/6/27 14:00	20	10140	0.9200	8	ND	0	0.529	15
	1998/8/23 12:00	1998/8/30 9:00	25	8460	1.2000	13	1.10	7	1.470	35
	1998/10/26 9:55	1998/11/5 8:30	10	12875	2.2900	17	0.87	4	6.110	80
20	1998/2/18 11:00	1998/2/22 14:30	5	8850	ND	0	0.60	4	0.760	12
	1998/8/23 10:10	1998/8/30 9:15	25	8585	1.3600	14	0.64	4	2.110	45
	1998/10/26 10:05	1998/11/5 8:45	10	12880	3.7100	28	0.43	2	2.570	54

Esfahan (2)

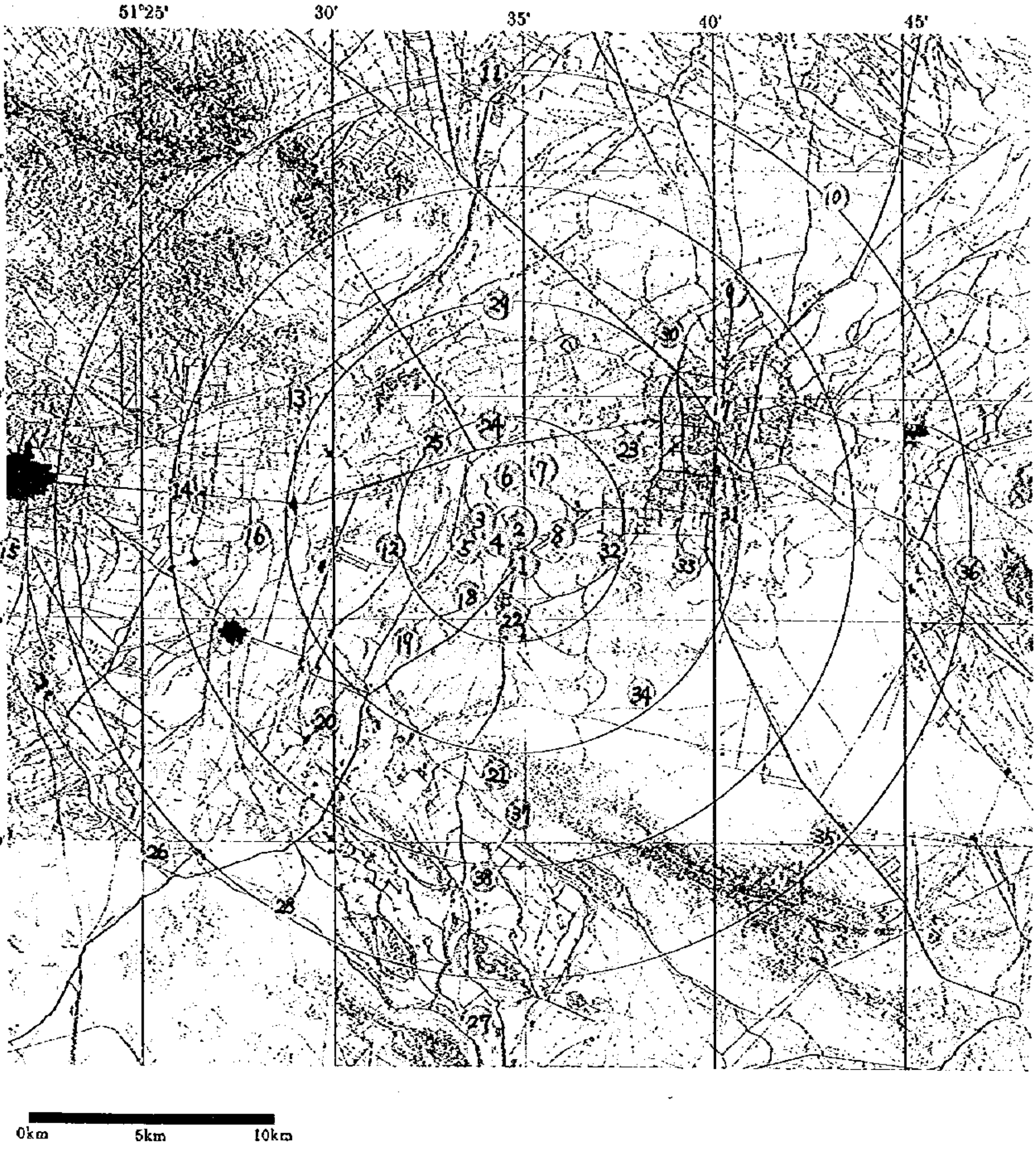
Passive Sampler Data List

Location No.	Sampling start time is on the Field	Sampling finish time is on the Field	average temp	period (min)	NO2- (ug/ml)	NO2 ppb	SO42- (ug/ml)	SO2 ppb	NOX (ug/ml)	NOX ppb
21	1998/2/18 11:35	1998/2/22 15:00	5	8845	ND	0	0.30	2	0.640	10
	1998/6/7 14:10	1998/6/20 10:15	20	17045	2.2100	12	0.84	3	3.058	35
	1998/8/23 11:30	1998/8/30 10:10	25	8560	0.3200	3	0.31	2	0.570	12
	1998/10/26 11:20	1998/11/5 10:00	10	12880	1.1000	8	0.47	2	2.250	31
22	1998/2/18 12:15	1998/2/22 15:30	5	8835	ND	0	0.20	1	0.780	12
	1998/8/23 11:45	1998/8/30 10:20	25	8555	0.5700	6	0.77	5	1.160	23
	1998/6/21 12:00	1998/6/28 11:20	0	8600	1.4100	18	ND	0	0.833	30
	1998/10/26 11:35	1998/11/5 10:20	10	12885	1.4500	11	3.46	15	4.500	57
23	1998/2/17 13:30	1998/2/23 11:40	5	7090	ND	0	0.25	2	0.860	16
24	1998/2/17 13:45	1998/2/23 11:55	5	7090	ND	0	2.10	17	1.700	32
	1998/8/22 11:30	1998/8/29 11:30	25	10080	0.5200	5	1.82	9	1.560	24
	1998/10/25 12:15	1998/11/4 13:40	10	14485	2.2400	15	1.90	7	6.110	71
25	1998/2/17 14:00	1998/2/23 12:10	5	7090	ND	0	0.34	3	1.000	19
	1998/6/20 10:30	1998/6/27 14:00	20	10290	0.9800	9	ND	0	1.435	21
	1998/8/19 10:00	1998/8/29 11:45	25	14505	1.8400	12	0.41	1	0.980	20
	1998/10/24 10:00	1998/11/2 8:45	10	11445	1.4100	12	ND	0		
26	1998/2/18 14:15	1998/2/24 14:45	5	8670	0.7700	9	ND	0	1.190	27
	1998/8/23 10:20	1998/8/30 9:30	25	8590	0.8400	9	ND	0	1.530	31
	1998/10/26 10:30	1998/11/5 9:10	10	12880	2.3600	18	0.92	4	4.300	62
27	1998/2/18 15:20	1998/2/24 16:00	5	8680	ND	0	0.30	2	0.750	12
	1998/6/7 11:40	1998/6/20 10:10	20	17190	0.9000	5	0.77	2	3.057	28
28	1998/2/18 16:00	1998/2/24 16:30	5	8870	0.5900	7	1.70	11	0.850	20
	1998/8/23 10:40	1998/8/30 9:40	25	8580	0.5000	5	0.51	3	0.840	18
	1998/10/26 10:55	1998/11/5 9:25	10	12870	1.1300	8	0.74	3	3.670	48
29	1998/2/19 19:30	1998/2/25 12:30	5	6780	0.5600	8	0.70	6	1.240	33
	1998/8/22 11:00	1998/8/29 11:15	25	10095	0.5100	5	0.77	4	1.170	19
	1998/10/25 11:35	1998/11/4 14:10	10	14555	2.2500	15	1.53	6	3.300	45
30	1998/2/20 10:00	1998/2/25 15:10	5	7510	0.6500	11	0.70	5	2.610	58
	1998/8/19 19:30	1998/8/27 6:30	25	9300	1.2900	13	2.50	14	1.940	39
	1998/10/25 10:50	1998/11/4 14:45	10	14635	2.7300	18	3.50	13	6.070	73
31	1998/2/19 19:00	1998/2/25 23:00	5	8880	ND	0	ND	0	1.220	19
	1998/6/1 10:10	1998/6/10 15:15	20	13265	2.2000	15	1.46	6	2.072	35
	1998/8/19 16:10	1998/8/30 13:00	25	14210	1.1700	7	2.82	11	2.020	25
	1998/10/25 10:00	1998/11/2 12:10	10	11650	1.5400	13	1.30	6	4.310	62
32	1998/2/20 12:00	1998/2/25 14:00	5	7320	0.7000	9	0.89	7	2.380	53
33	1998/2/20 12:30	1998/2/25 14:35	5	7325	0.7000	9	0.90	7	1.400	35
	1998/8/22 12:50	1998/8/30 10:45	25	9955	0.8400	6	2.51	13	1.460	24
	1998/10/26 9:00	1998/11/4 10:10	10	13030	2.2000	16	2.90	12	3.850	55
34	1998/2/20 13:00	1998/2/25 15:05	5	7325	ND	0	0.26	2	1.180	22
	1998/6/21 11:00	1998/6/28 11:40	20	10120	1.2000	11	0.64	3	0.967	19
	1998/8/22 12:45	1998/8/30 11:50	25	10025	0.9000	8	1.10	6	2.720	42
	1998/10/26 9:15	1998/11/4 10:15	10	13020	2.0100	15	0.45	2	4.920	65
35	1998/2/20 13:30	1998/2/25 15:20	5	7310	ND	0	0.40	3	1.340	25
36	1998/2/20 14:15	1998/2/25 15:45	5	7290	ND	0	ND	0	0.560	10
	1998/6/21 11:00	1998/6/28 11:30	20	10110	0.9400	9	ND	0	0.615	16

Location of Passive Sampler at Tabriz



Location of Passive Sampler at Esfahan



Appendix 9-7

Comparison of Data : Passive Sampler and Automatic Analyzer

unit : ppb

		Measuring point	Measuring month/day	SO_2		NO_2		NO_x	
				Passive	Auto.	Passive	Auto.	Passive	Auto.
Tabriz	Winter	Baranloo	2/2 ~2/9	47	–	20	–	26	–
		Mayan Pump	2/8 ~2/17	1	–	0	–	4	–
		Qaramalek	2/15~2/21	2	–	0	–	12	–
	Spring	Baranloo	6/15~6/26	5	6.3	7	7.4	14	8.9
		Mayan Pump	6/8 ~6/15	27	–	0	–	7	–
		Qaramalek	6/7 ~6/17	5	–	13	–	30	–
	Summer	Baranloo	8/31~9/7	3	4.2	0	6.4	8	8.7
		Mayan Pump	8/31~9/7	15	2.0	0	4.0	9	5.1
		Qaramalek	8/31~9/7	5	3.6	6	12.9	18	18.1
	Autumn	Baranloo	11/8~11/15	9	3.5	9	10.5	79	13.4
		Mayan Pump	11/10~11/19	0	2.2	11	9.8	43	14.4
		Qaramalek	11/9~11/19	14	15.3	18	25.2	65	52.9
Esfahan	Winter	Golshahr	2/14~2/21	39	–	11	–	32	–
		Kaveh	2/12~2/19	59	–	10	–	40	–
		Shariati	2/19~2/25	0	–	0	–	19	–
	Spring	Golshahr	6/1 ~6/10	6	–	13	–	26	–
		Kaveh	6/1 ~6/10	8	–	18	–	34	–
		Shariati	6/1 ~6/10	6	–	15	–	35	–
	Summer	Golshahr	8/19~8/29	1	13.2	9	20.4	22	43.2
		Kaveh	8/19~8/29	9	11.5	7	22.8	31	48.4
		Shariati	8/19~8/29	11	15.4	7	30.0	25	51.8
	Autumn	Golshahr	10/24~11/1	3	12.4	7	30.1	41	71.6
		Kaveh	10/25~11/2	15	24.5	19	–	78	–
		Shariati	10/25~11/2	6	21.2	13	55.1	62	128.5

– : no Data

Location of measuring points are shown in Appendix 9-6.

Tabriz	No. on A9-16	Esfahan	No. on A9-17
Baranloo	7	Golshahr	14
Mayan Pump	11	Kaveh	9
Qaramalek	36	Shariati	31