2.6 Impact of SIDEX around Galati

2.6.1 Present status of environmental pollution around SIDEX

The meteorological data measured for six years from 1985 to 1990 in Galati city were obtained from NIM(National Institute of Meteorology and Hydrology), and the data were expressed with appearance frequency classified by atmosphere stability, wind velocity and directions.

The Environmental Control Agency of Galati, located in the center of Galati, is in charge of enforcing the environmental protection laws and regulations and of supervising and monitoring the environmental pollution, and consists of 8 regulators, 11 inspectors, 6 monitors, and 25 analysists. The measurements of atmosphere and river water were obtained from the agency. The outline of those are as follows:

1) Weather around Galati city

The distribution chart of wind direction is shown at Fig. III.2-8.

This figure represents the appearance frequency of wind direction (—) divided into sixteen bearings and calm(wind velocity is 0.0 to 0.4m/second), and most outer circle is 12%(unit is 2%). It also represents the average wind velocity (---) in each direction, and most outer circle is 6m/s(unit is 1m/s).

It is found from the figure that the frequencies of two directions, N and NNE are bigger than the other, which are 22% in total and considered to affect hardly the atmosphere of Galati city. On the other hand, the three directions of W, WNW and WSW supposed to strongly affect it and their frequencies are 11% in total.

Judging from these results, it is concluded that SIDEX is well situated from the relation of wind direction and its influence.

The average wind velocity in each direction is found to be 4 ~5m/s from the figure, the classification of wind velocity indicates as shown in Fig. III.2-9. that the appearance frequency of more than 5m/s is about 40%, the highest than the other.

2) Atmosphere

Of the environmental control items, the measurement items are SOx, NOx, suspended particulate, ammonia, phenol, and sedimented dust. The 1993 measurement data of SOx was not available because of malfunction of the analyzer for nearly one year.

The measuring points and the measurements are shown in Fig. III.2-11 and Table III.2-12, respectively.

(1) Except for the sedimented dust, each item has no big problem, and only the yearly average of suspended particulate slightly exceeds the standard value.

(2) The standard stipulates 17 g/m^2 a month for the sedimented dust, while the yearly average of measurements at nine points is 25 g/m^2 a month and at No.3 measuring point, it was as much as 98.42 g/m^2 a month in July 1993. This value is quite high considering that the yearly average in the areas around works is 10 g/m^2 a month and mostly 5 g/m^2 a month in spite of no standard in Japan.

(3) Fig. III.2-12 shows the monthly transition of sedimented dust per the measuring point in Galati. The worst condition for dispersion of sedimentable dust is considered when the wind blows more than 5m/s and the appearance frequency in this velocity is indicated in Fig. III.2-10. The frequencies of NW and SW are about 10%, quite higher than others and SIDEX is supposed to affect the atmosphere of Galati town in these wind

conditions. Early execution of measures against soot and dust is required in SIDEX.

(4) The Environmental Control Agency of Galati does not perform investigations by analysis to identify the generation source such as survey of chemical composition of soot and dust. Therefore, accumulation of data through analyses of chemical composition and periodic measurement of wind directions and velocities may be required of the Agency to assess the impact of environmental pollution due to generation sources including SIDEX on Galati.

3) River water quality

The monthly transitions of concentrations of nitrate ion, ammonium ion, phenol, and COD-Mn at two measuring points around the confluence of the Siret and the waste water from SIDEX and at one measuring point around the confluence of the Donau and the Siret are shown in Fig. III.2-13. Measurement at the downstream of the Siret in 1993 was not available due to analyzer trouble. The similar transitions around the confluence of the Donau and the Siret are shown in Fig. III.2-14 (measuring points are indicated in Fig. III.2-11).

The pollution of the river water by comparison of the measurements with the standard values in terms of the impact of SIDEX is as summarized below:

(1) The measurements of the water quality of the Siret, though exceeding the standard values in two items in a few months, are largely within the standard values. With the Donau, however, the value of nitrate ion in the upstream and that of phenol in the downstream clearly exceed the standard values and require urgent measures. (The standard value for phenol greatly differs between class 1 and class 2. Class 1 is applied

to the Donau and class 2 to the Siret.)

(2) Direct impact of SIDEX on nitrate ion, ammonium ion, and COD-Mn cannot be seen. But the impact of SIDEX on phenol is mostly decisive and measures are required as soon as possible.

Note: The concentration of ammonium ion greatly lowers in the downstream of the Siret and its cause is not known.

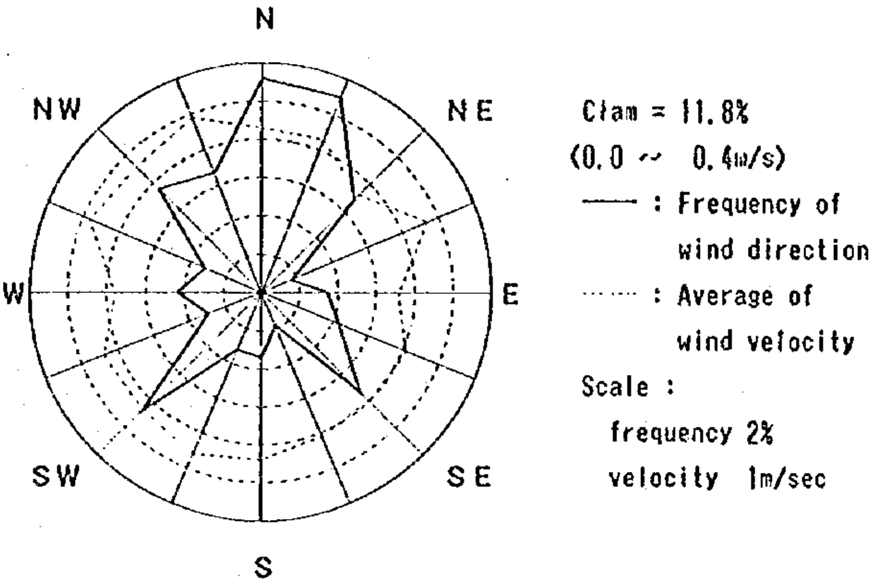


Fig. III.2-8. Frequency and Average Velocity of Wind in Galati City

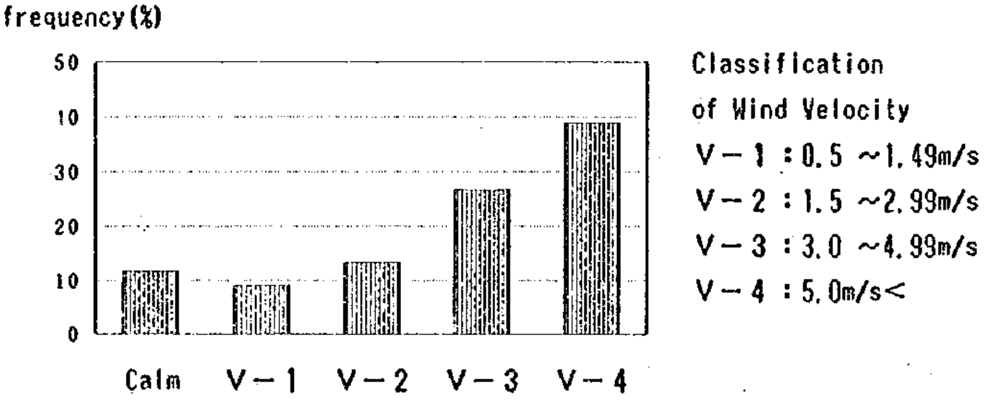


Fig. III.2-9. Frequency of Wind Velocity in Galati City

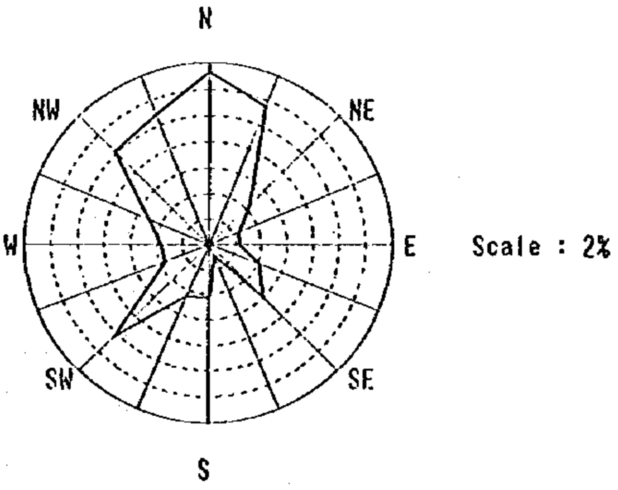


Fig. III.2-10. Fequency of Wind Direction in over 5m/sec of Velocity

8 and 9 - are in Galati County
↳ Tecuci Town
↳ Târgu Bujor Town

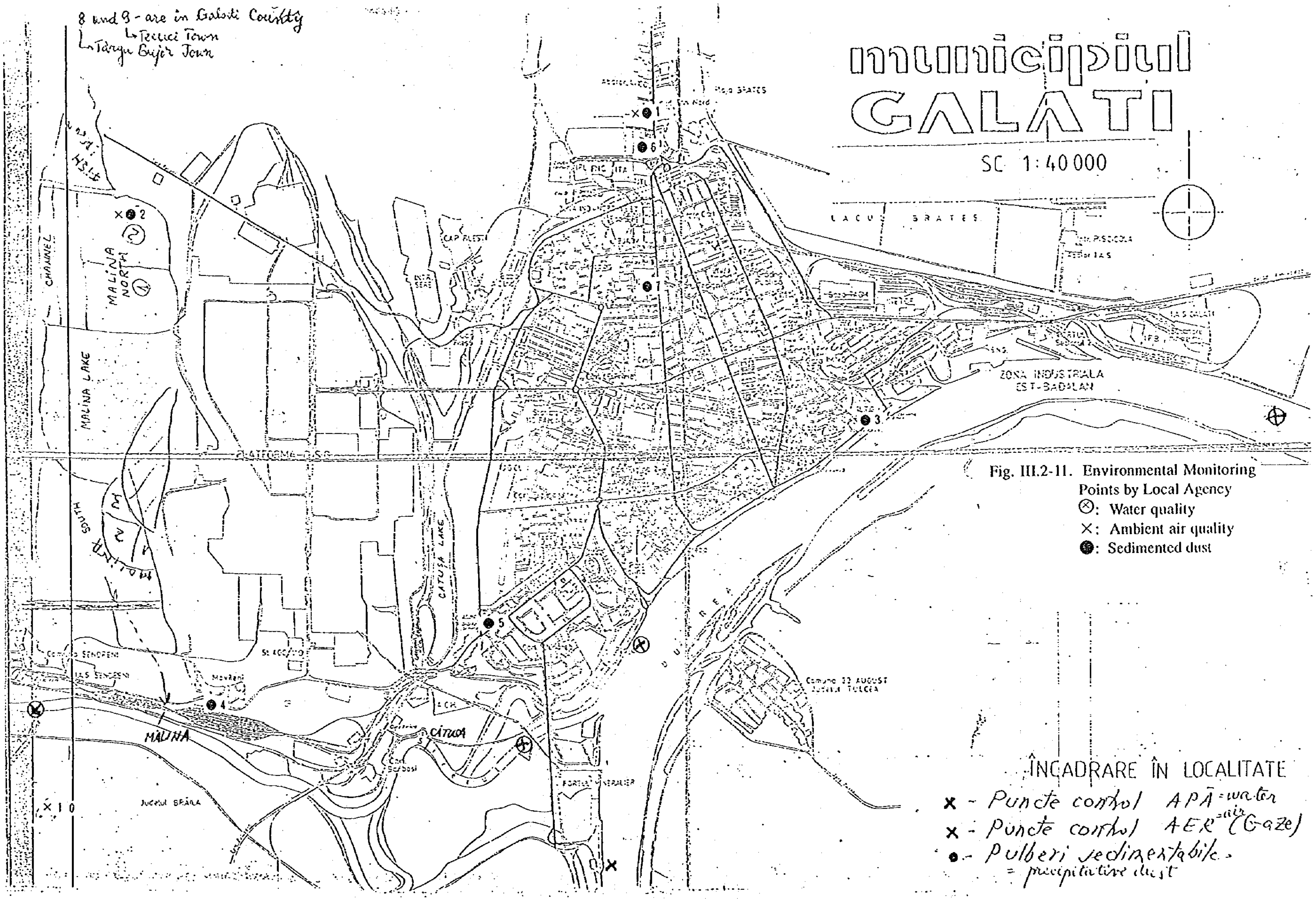


Fig. III.2-11. Environmental Monitoring Points by Local Agency
⊗: Water quality
×: Ambient air quality
●: Sedimented dust

× - Puncte control APĂ = water
× - Puncte control AER = air (Gaze)
● - Pulberi sedimentabile = precipitative dust

Table III.2-12. Monitoring Data of Ambient Air in Galati(1993)

Substances	Measurement Points	Data(mg/m³):Annual Average of Daily Data	Air Quality Standard (mg/m³) 24hours	Yearly
NO_2	No.1	0.020	0.1	0.04
	No.2	0.007		
	No.10	0.0084		
Suspended particulates	No.1	0.087	0.15	0.075
Ammonia	No.1	0.050	0.10	–
Phenol	No.1	0.004	0.03	–
Sedimentable powders	No.1	21.13	Data of Sedimented dust are annual average of monthly measurements. 17 g/m²/ month	
	No.2	16.27		
	No.3	33.29		
	No.4	24.66		
	No.5	32.59		
	No.6	29.05		
	No.7	28.88		
	No.8	20.24		
	No.9	26.14		

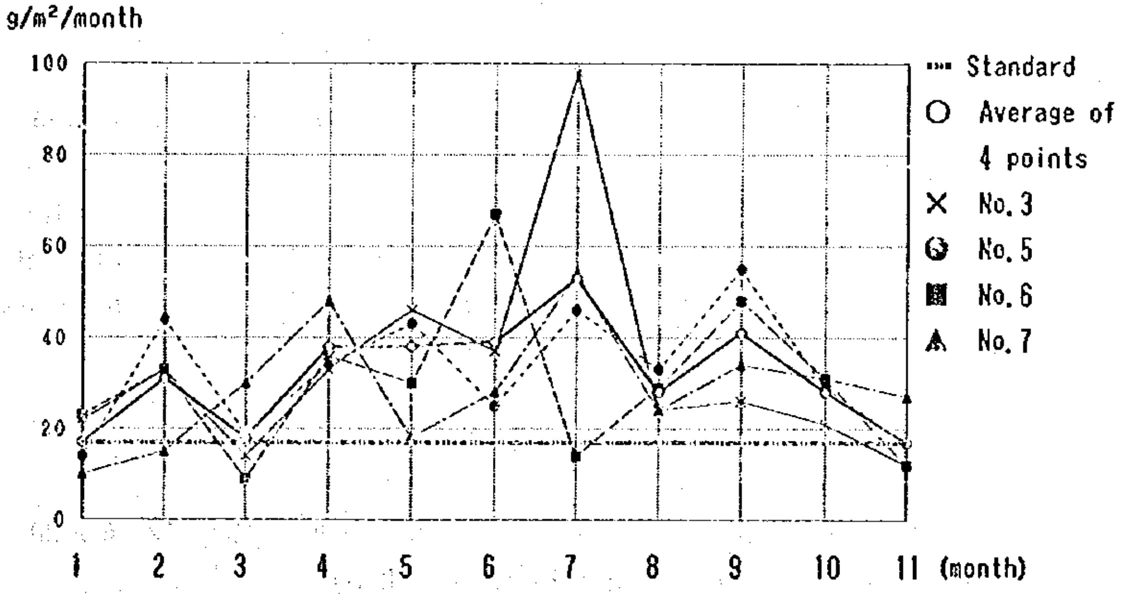


Fig. III.2-12. Monthly Data of Sedimented Dust in Galati(1993)

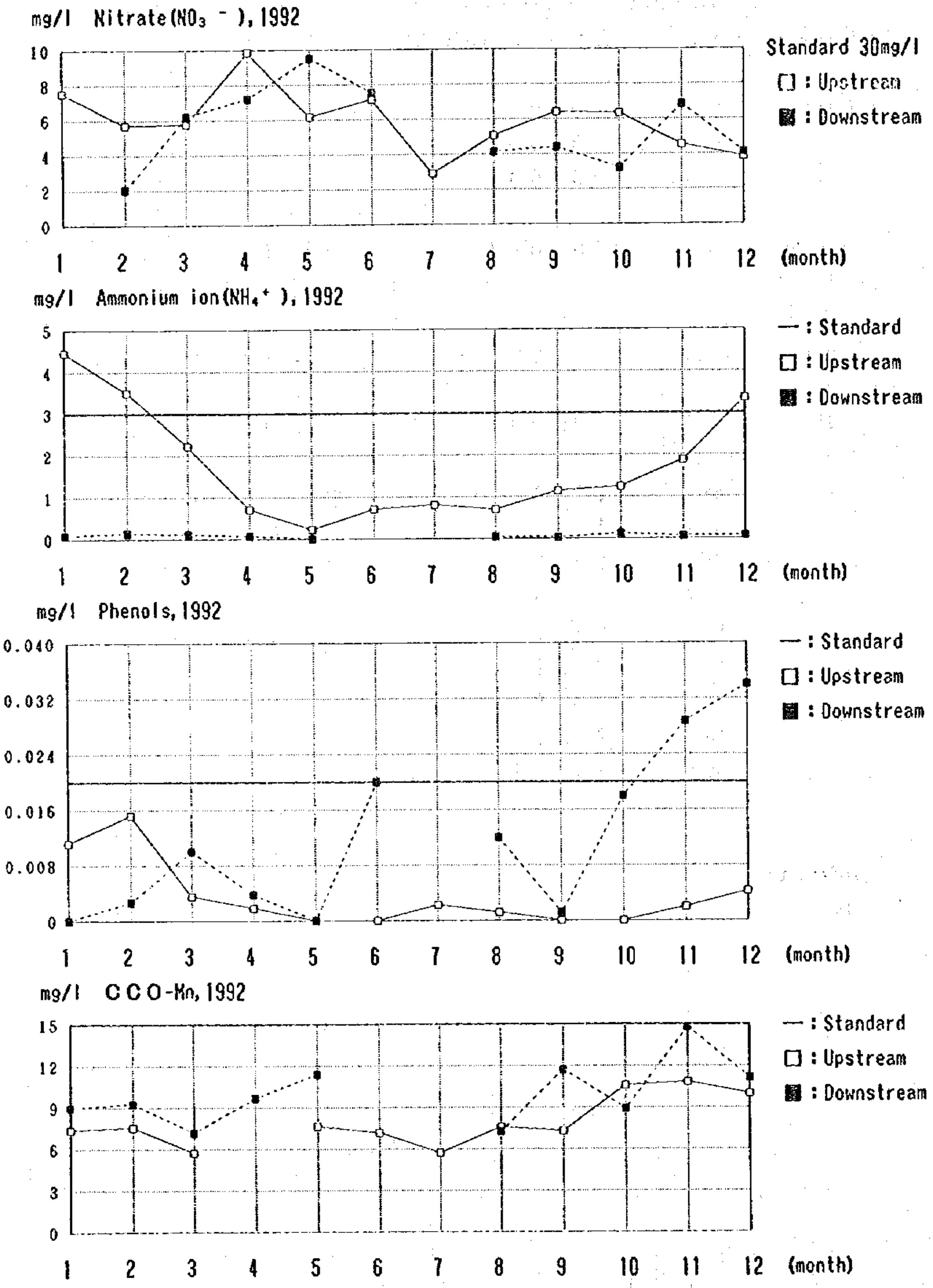


Fig. III. 2-13. Water Quality Data of Siret River

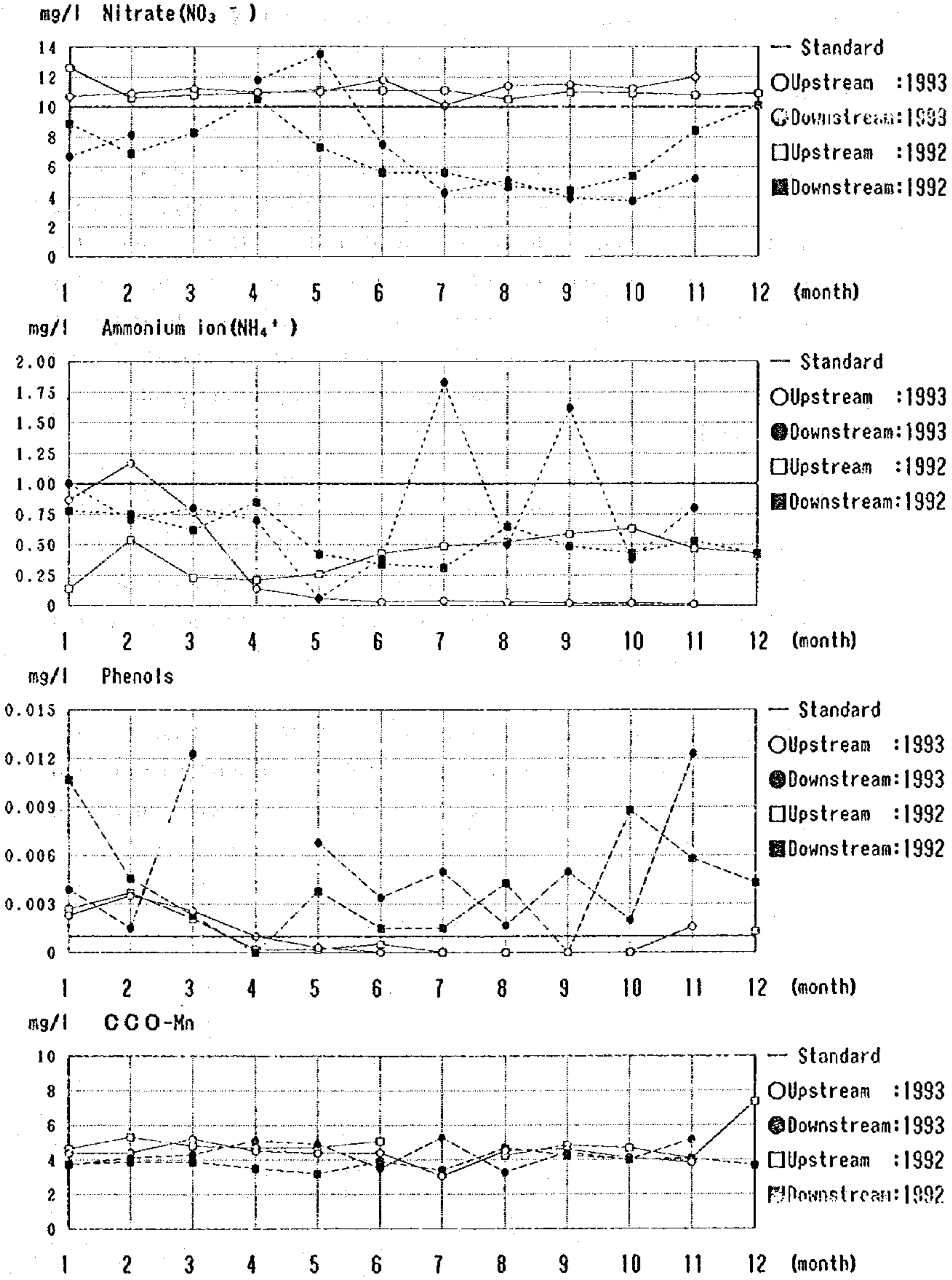


Fig. III. 2-14. Water Quality Data of Donau River

2.6.2 Estimated effects of measures on the areas around SIDEX

1) Atmosphere

The measures recommended so far will eventually meet the values of the standard in 2002 and emission rate and loads of SOx and NOx will be considerably reduced as shown in Fig. III.2-15 and 2-16. (The emission of SOx and NOx is calculated as in Section III.2.1 and the effects of energy-saving measures such as integration of coke oven batteries, intensified control of combustion, and decreased consumption of coke breeze at the sintering plants are reflected in these values.)

After the measures are taken, the emission will be decreased by 66% for SOx and about 20% for NOx compared with the previous measures in the production plan in 2002. Installation of dust collectors will decrease the volume of sedimented dust and suspended particulate.

The contribution concentration of SOx and NOx by SIDEX in the atmosphere was calculated by means of diffusion model before and after execution of all measures proposed in the model and related plants in this study.

The procedure and results are as follows:

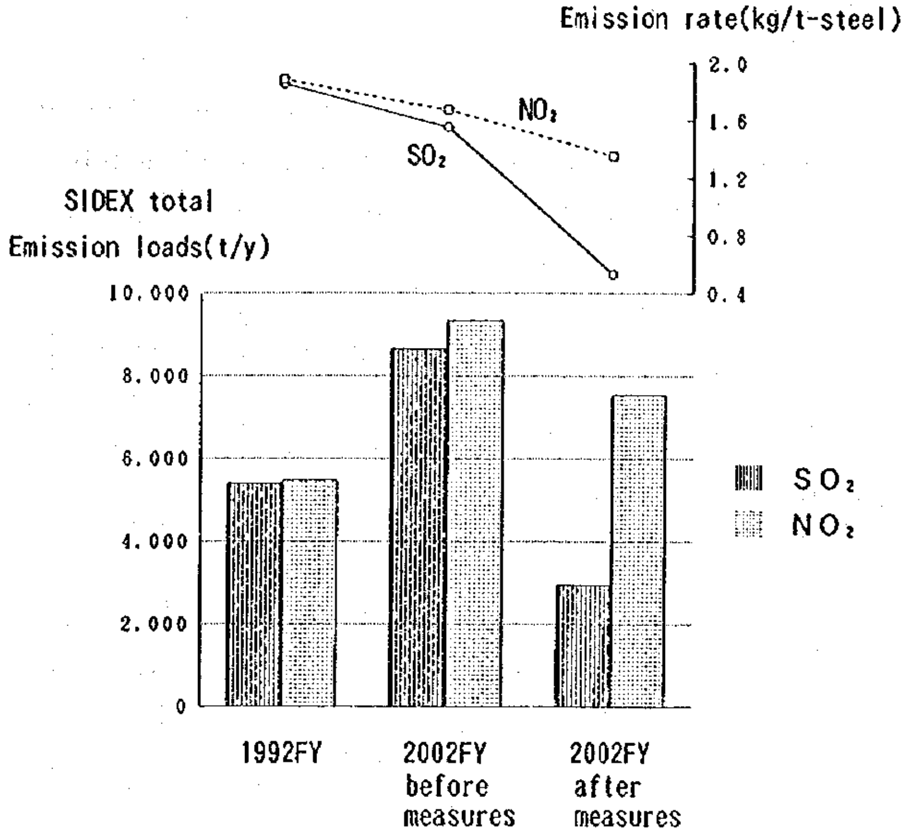


Fig. III.2-15. Emission Rate of SOx and NOx after Measures in SIDEX 2002

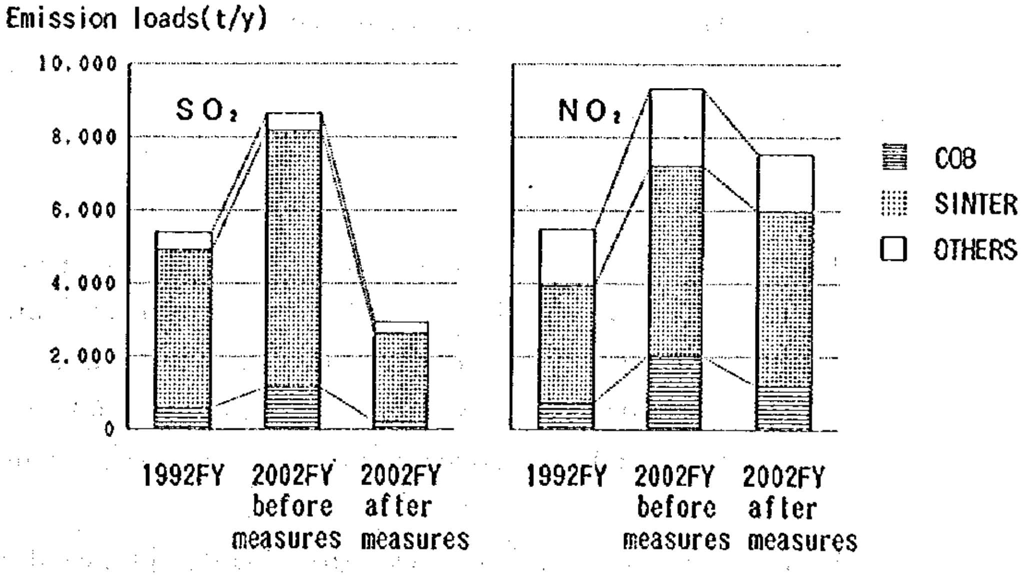


Fig. III.2-16. Emission of SOx and NOx in Each Source in SIDEX

(1) Procedure of simulation

As mentioned previously, the meteorological data for six years in Galati city supplied by NIM were used in this simulation. Procedure in calculation is shown in Fig. III.2-17.

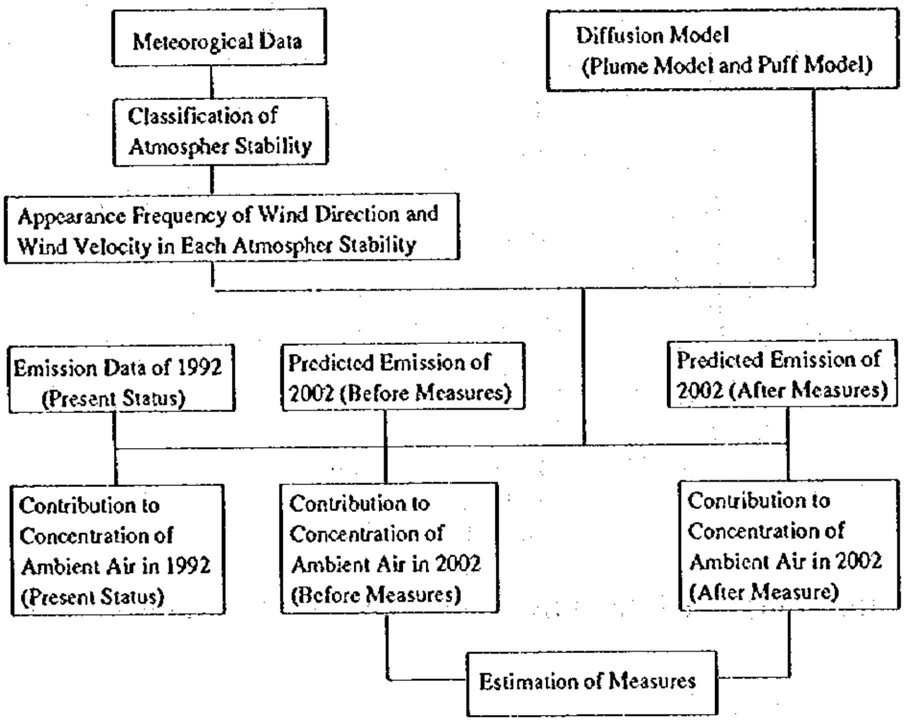


Fig. III.2-17. Procedure of Simulation

(2) Emission condition

1 Emission of SOx and NOx

The emission loads of SOx and NOx in each source is calculated as in Section III.2.1 using sulfur and nitrogen balance of sintering process, quantity of fuel and its sulfur contents, waste gas volume calculated by fuel and O_2 concentration and NOx concentration measured or estimated.

In addition, the RENEL's emission loads, supposed a big source next to SIDEX, were calculated from the data supplied by RENEL.

The contribution concentration of SOx and NOx were calculated on the case not only SIDEX but also containing RENEL.

Emission loads of RENEL in 2002 were fixed as in 1992.

Emission conditions in main plants are listed in Table III.2-13.

2 Effective stack height

Waste gas emitted from outlet of a stack rises up in the atmosphere due to the effects of exhaust velocity and buoyancy caused by high stack gas temperature and diffuses.

This overall rise of the stack gas is called the effective stack height He, which is the sum of the real stack height(Ho) and rising height(ΔH) as shown the following formula:

$$He = Ho + \Delta H$$

ΔH is calculated on the cases of calm and windy condition.
(Windy condition)
The following two equations were used depending on the heat emission of stack gas (Q_H : cal/s).

$$Q_H = \rho \cdot Cp \cdot Q \cdot \Delta T$$

ρ : density of stack gas at 0℃ (1.293×10^3 g/m^3)
Cp : specific heat at constant pressure (0.24cal/ K/g)
Q : stack gas emission rate corrected for standard condition (Nm^3/s)
ΔT : temperature difference between air and stack gas (T-15℃)

When $Q_H < 2.0 \times 10^6$ cal/s, the following Moses&Carson's equation was used.

$$\Delta H = (C_1 \cdot Vs \cdot D + C_2 \cdot Q_H^{1/2}) \cdot u^{-1}$$

Where C_1 : 0.35 (experimental constant)
C_2 : 0.171 (experimental constant)
Vs : emission speed of stack gas (m/s)
D : outlet diameter of a stack (m)
u : wind speed at the top of a stack (m/s)

When $Q_H \geqq 2.0 \times 10^6$ cal/s, the following CONCAWE's equation was used.

$$\Delta H = 0.175 \cdot Q_H^{1/2} \cdot u^{-3/4}$$

CONCAWE stands for Conservation of Clean Air and Water in Western Europe and the equation was obtained with many observances by investing group of a oil refinery company in western Europe.

(Calm condition)
The following Briggs's equation was used.

$$\Delta H = 1.4\, Q_H^{1/4}\, (d\theta/dZ)^{-3/8}$$

Where, $d\theta/dZ$: vertical gradient of potential temperature (℃/m). In this study fixed figure, 0.0033 was used as the value of $d\theta/dZ$.

(3) Diffusion model

1 Diffusion formula

(Windy condition : Plume model)
The ground level concentration of smoke emitted continuously from a point source in windy condition can be estimated by the following equation:

$$C(x, y) = \frac{Q}{\pi \cdot \sigma y \cdot \sigma z \cdot u} \exp\left(-\frac{y2}{2\sigma y^2}\right) \exp\left(-\frac{He^2}{2\sigma z^2}\right)$$

Where, $C(x,y)$:ground level concentration at arbitrary position (x, y)(m^3 pollutant/m^3 air)

x :downwind distance from a point source along wind direction(m)

y :horizontal distance with a right angle along x axis(m)

u :wind velocity(m/s)

Q :emission rate(Nm3/s)

He :effective stack height(m)

σy :plume width along y axis(m)

σz :plume width along z axis(m)

In this simulation, the calculation is carried out with dividing wind direction into 16 bearings and it can be considered that the pollutant concentration in a plume is distributed equally in the same wind direction when the emission continues for the long term.
Therefore, the parameter σy indicated plume width along y axis can be ignored and then the following Holland's equation is obtained. We used this equation this study.

$$C(R, Z) = \sqrt{1/(2\pi)} \cdot \frac{2Q}{(\pi/8) \cdot R \cdot \sigma z \cdot u} \cdot \exp\left(-\frac{He^2}{2\sigma z^2}\right)$$

R :horizontal distance between point source and calculation point (m)

σz was determined by Pasquill-Gifford chart shown in Fig.III.2-18.

(Calm condition :Puff model)

The ground level concentration of smoke emitted continuously from a point source in calm condition can be estimated by the following equation:

$$C(x, y, T) = \frac{2Q}{(2\pi)^{3/2} \cdot \gamma} \cdot \frac{1}{(R^2 + \alpha^2 \cdot He^2 / \gamma^2)}$$

Where, $C(x,y,T)$:ground level concentration at arbitrary position (x, y) after T hours (m^3 air)

Q :emission rate (Nm^3/S)

He :effective stack height (m)

σy :standard deviation of concentration distribution along y axis (it is a function of T in this case)

σz :standard deviation of concentration distribution along z axis (it is a function of T in this case)

T :time of continuous calm condition (s)

$R^2 = x^2 + y^2$, $\alpha = \sigma y/T$, $\gamma = \sigma z/T$

α and γ are diffusion parameters when T is 1 hour and they are given by Table III.2-17 according to atmosphere stability.

2 Estimation area

The area of 52km square(52km×52km) was the object for the calculation, which ranges 26km along four directions from the arbitrary point in SIDEX set as a center of the coordinate system, and the ground level concentration was calculated at the center point of each mesh divided by 2km.

3 Conversion of NO to NO_2

The NO_2 concentration was determined by conversion from NO using the fixed figure, which is the average in

$(NO_2)/(NO+NO_2)$ measured by Local Agency at Galco S.A. and Atlas S.A.

(4) Meteorological model

1 Wind direction and velocity

As mentioned previously, the data of wind direction and velocity measured in Galati city for 52,584hours of six years(1985 to 1990) were used. Wind directions were divided into 16 bearings and the classifications of wind velocity were set as shown in Table III.2-14, and the appearance frequency of each direction and velocity was shown in Table III.2-15.

2 Stability classification

The Pasquill's stability classification shown in Table III.2-16. was used in this calculation.

(5) The results

The contour lines for the annual average concentration of contribution by SIDEX before or after execution of the measures for SO_2 and NO2 are shown from Fig. III.2-19 to 2-30, and the results of joined contribution by SIDEX and RENEL are shown from Fig. III.2-31 to 2-42. The procedure of the calculation is shown in Fig.III.2-43.

The maximum concentration of the ground level appeared around southern part in SIDEX's site in every cases, and its value is 0.012ppm(0.034mg/Nm^3, 0.025mg/Nm^3) in both SO2 and NO_2.

For SO_2, the contribution concentration by only SIDEX in Galati town vary from 0.002ppm to 0.008ppm(0.006 ~ 0.023mg/Nm3) before measures as shown in Fig. III.2-21, but

after measures(Fig. III.2-23.), which decrease to around 0.002ppm and it is recognized that the sphere of the contribution also considerably reduce.
For NO_2, the contribution concentration by only SIDEX also reduce to 0.002 ~ 0.006ppm (0.004~ 0.012mg/Nm^3) after measures(Fig. III.2-29) from 0.002 ~ 0.008ppm(0.004 ~ 0.016mg/Nm^3) before measures(Fig. III.2-27).

The reason that the contribution sphere in 1992 and 2002 before measures are almost the same is as follows:

Hourly emission load in operation of each stack is used in the calculation, so the sum of these loads is nearly the same in both cases of 1992 and 2002 before measures, because operating plants are assumed to be common in both cases. The annual loads in 2002 are bigger than in 1992, of course. Therefore, the result of the calculation in 1992 represents the worst condition for the atmosphere in Galati town, which is the case when all smoke are emitted for one hour from all plants operated at the same time.

The results of the joint contribution concentration by SIDEX and RENEL represented the tendency as the case of only SIDEX, but these should be considered as a reference, because the emission loads were fixed as same as in 1992. As SIDEX and RENEL are obviously very big sources around Galati district, the implementation of simulation is desired, taking into consideration the status of emission in 2002 in order to estimate the joint contribution concentration by SIDEX and RENEL more precisely.

(6) Estimated effects of measures

It is impossible to predict the concentration of ambient air for

SO_2, due to lack of measurement data, so urgent instrumentation and implementation of measurement are necessary.

For NO_2 concentration, the present quality in Galati town is 0.007~0.020 mg/Nm^3 and the joint contribution concentration will be 0.002 ~0.006ppm (0.004~0.012mg/Nm^3).

Therefore, if the emission loads can be assumed to be as same as one in 1992 and the level of the background concentration will be maintained as the present in the future, it will be able to estimate after execution of the measures in 2002 that the air quality in Galati will meet the Ambient Air Quality Standard of NO_2 in Romania.

TableⅢ. 2-13. Emission Data of SIDEX and RENEL for Simulation

Data of Stacks and Waste Gas			SIDEX				RENEL
			Coke Oven	Sintering	Others	Total SIDEX	
1992 Present Status	Stacks	Height(m), Nm	90[5], 120	80[3], 70[2]	21~80[63]	21~120[74]	100[3]
		Diameter(m)	3.0	6.5, 7.0, 8.7	0.4~8.5	0.4 ~8.7	6.07
	Waste Gas	Temp. (℃)	140	150	80 ~500	80 ~500	av. 129
		dry(Nm^3/hr)	400, 514	4, 231, 000	2, 902, 298	7, 533, 812	867, 8343
		wet(Nm^3/hr)	471, 852	4, 654, 100	3, 154, 533	7, 857, 385	1, 002, 603
		SOx(ppm)	av. 71	av. 96	av. 11	av. 55	av. 118
		NOx(ppm)	av. 125	av. 98	av. 48	av. 78	av. 130
2002 Before Measures	Stacks	Height(m), Nm	90[5], 120	80[2], 70[2]	21~80[68]	21~120[78]	assumed the same as loads of 1992
		Diameter(m)	3.0	6.5, 7.0, 8.7	0.4~8.5	0.4 ~8.7	
	Waste Gas	Temp. (℃)	140	150	80 ~500	80 ~500	
		dry(Nm^3/hr)	445, 148	4, 105, 500	2, 847, 495	7, 398, 143	
		wet(Nm^3/hr)	525, 034	4, 516, 050	3, 062, 083	7, 692, 617	
		SOx(ppm)	av. 104	av. 100	av. 7	av. 57	
		NOx(ppm)	av. 253	av. 103	av. 42	av. 86	
2002 After Measures	Stacks	Height(m), Nm	90[3], 120	80[1], 70[2]	21~80[67]	21~120[74]	assumed the same as loads of 1992
		Diameter(m)	3.0	7.0, 8.7	0.4~8.5	0.4 ~8.7	
	Waste Gas	Temp. (℃)	140	150	80 ~500	80 ~500	
		dry(Nm^3/hr)	466, 215	1, 915, 000	2, 201, 510	4, 582, 725	
		wet(Nm^3/hr)	519, 817	2, 106, 500	2, 333, 872	4, 768, 689	
		SOx(ppm)	av. 18	av. 60	av. 6	av. 28	
		NOx(ppm)	av. 142	av. 166	av. 42	av. 101	

TableIII.2-14. Wind Classification and Representative Value

Wind Velocity (m/sec)	Representative Value(m/sec)
0.0 ～ 0.4	0
0.5 ～ 1.4	1
1.5 ～ 2.9	2
3.0 ～ 4.9	4
5.0<	6

TableIII.2-15. Appearance Frequency(%) in Each Wind Velocity and Direction

Wind Direction	Wind Velocity(m/sec)				Total (%)
	0.5 ～ 1.4	1.5 ～ 2.9	3.0 ～ 4.9	5.0 <	
N	1.43	1.81	3.51	5.89	12.64
NNE	1.10	1.78	4.49	5.10	12.47
NE	1.00	1.86	2.98	1.95	7.79
ENE	0.16	0.26	0.37	1.12	1.91
E	0.66	0.90	1.40	1.05	4.01
ESE	0.46	0.89	1.81	1.86	5.02
SE	0.85	1.42	3.47	2.65	8.38
SSE	0.26	0.39	0.66	0.87	2.18
S	0.36	0.64	0.86	1.95	3.81
SSW	0.32	0.47	0.87	2.03	3.70
SW	0.99	1.36	2.91	4.70	9.96
WSW	0.24	0.59	0.95	1.62	3.40
W	0.90	0.75	1.66	1.65	4.96
WNW	0.30	0.32	0.75	2.28	3.64
NW	0.76	1.00	2.16	4.64	8.57
NNW	0.47	0.73	1.43	4.93	7.56
Total(%)	10.26	15.17	30.28	44.29	100.00

TableIII.2-16 Classification Table of Stability

Wind Velocities (U) m/s	Solar Radiation(T) kw/m²				Balance of Radiant Quantity(Q)		
	T ≧0.6	0.6 >T ≧0.3	0.3 >T ≧0.15	0.15>T	Q≧-0.02	-0.02> Q≧-0.04	-0.04>Q
U<2	A	A-B	B	D	D	G	G
2 ≦U <3	A-B	B	C	D	D	E	F
3 ≦U <4	B	B-C	C	D	D	D	E
4 ≦U <6	C	C-D	D	D	D	D	D
6 ≦U	C	D	D	D	D	D	D

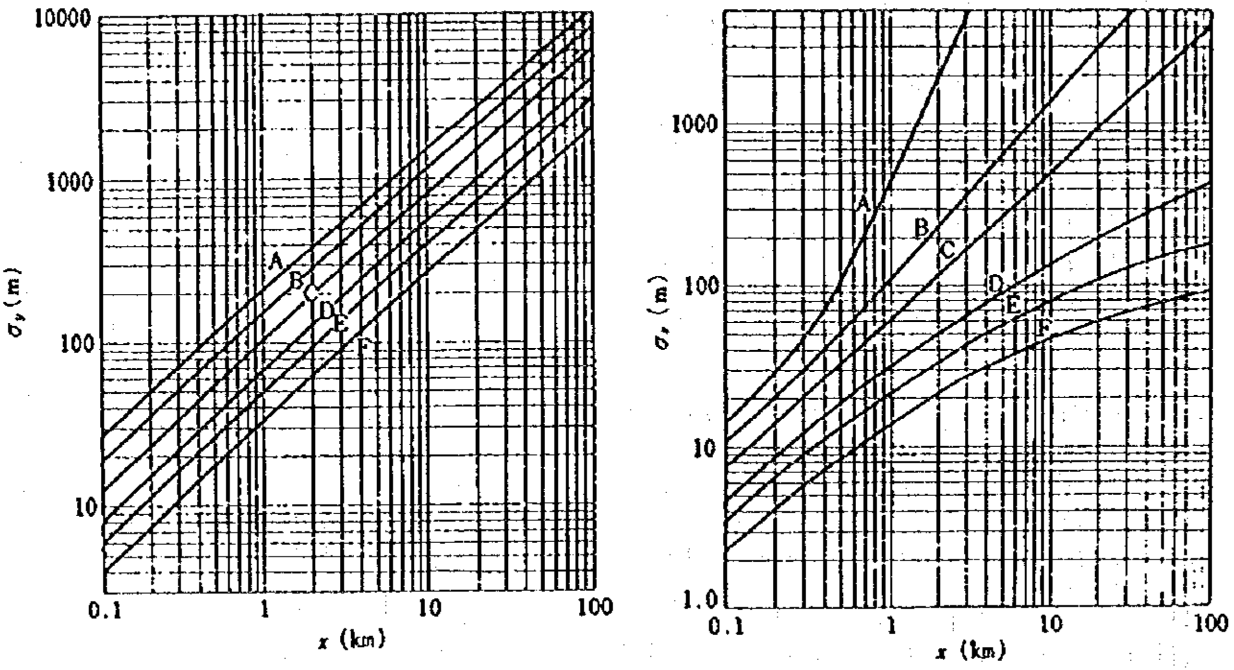


Fig.III.2-18. σ_y and σ_z by Pasquill-Gifford
(A-F means stability classification)

TableⅢ.2-17 Diffusion parameter in calm condition (≦0.4m/s)

Classification by Pasquill	α	γ
A	0.948	1.569
A～B	0.859	0.862
B	0.781	0.474
B～C	0.702	0.314
C	0.635	0.208
C～D	0.542	0.153
D	0.470	0.113
E	0.439	0.067
F	0.439	0.048
G	0.439	0.029

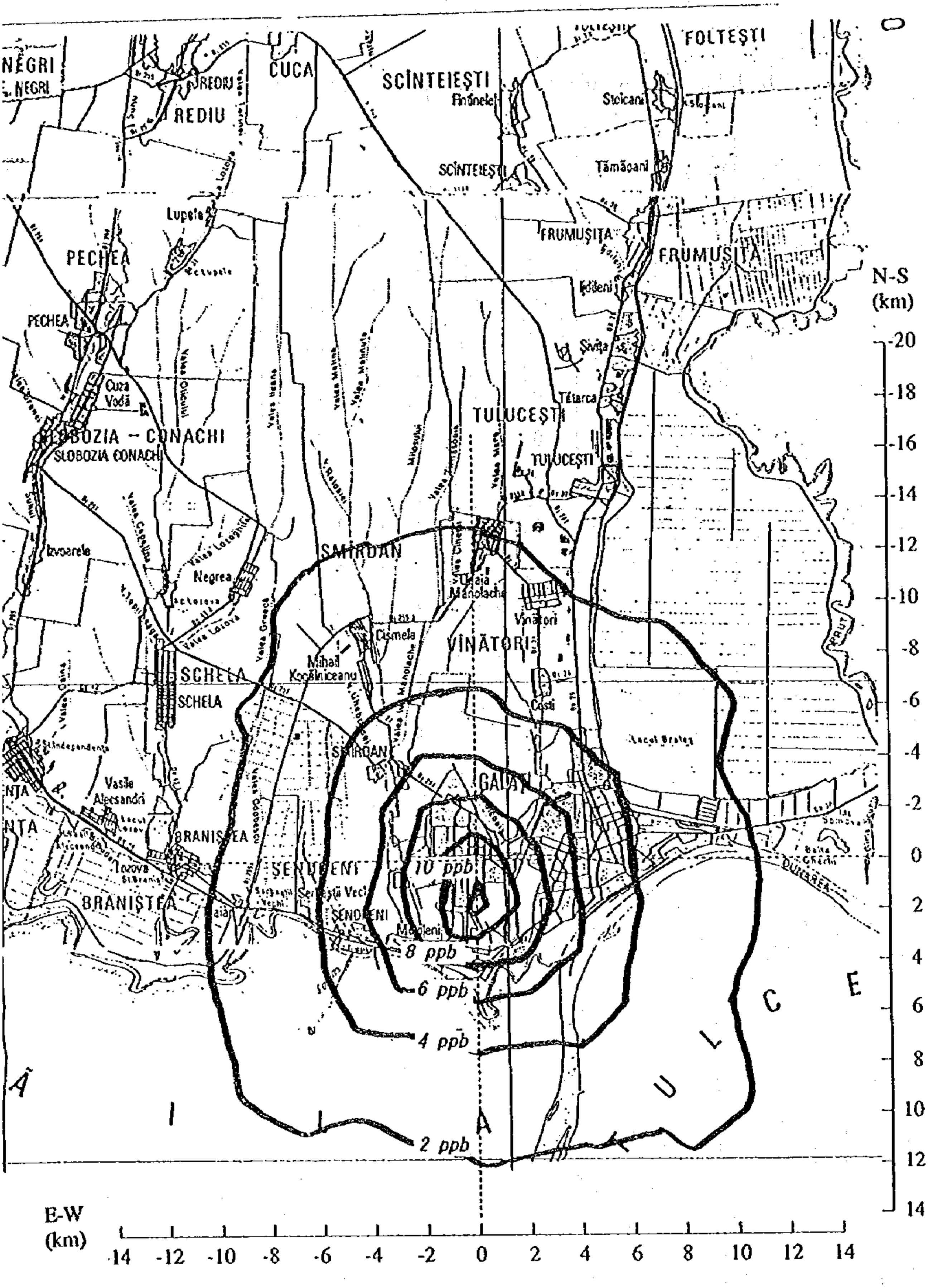


Fig.III.2-19. Contribution concentration (SO_2) by SIDEX
(1992 : equal concentration drawings : Plane)

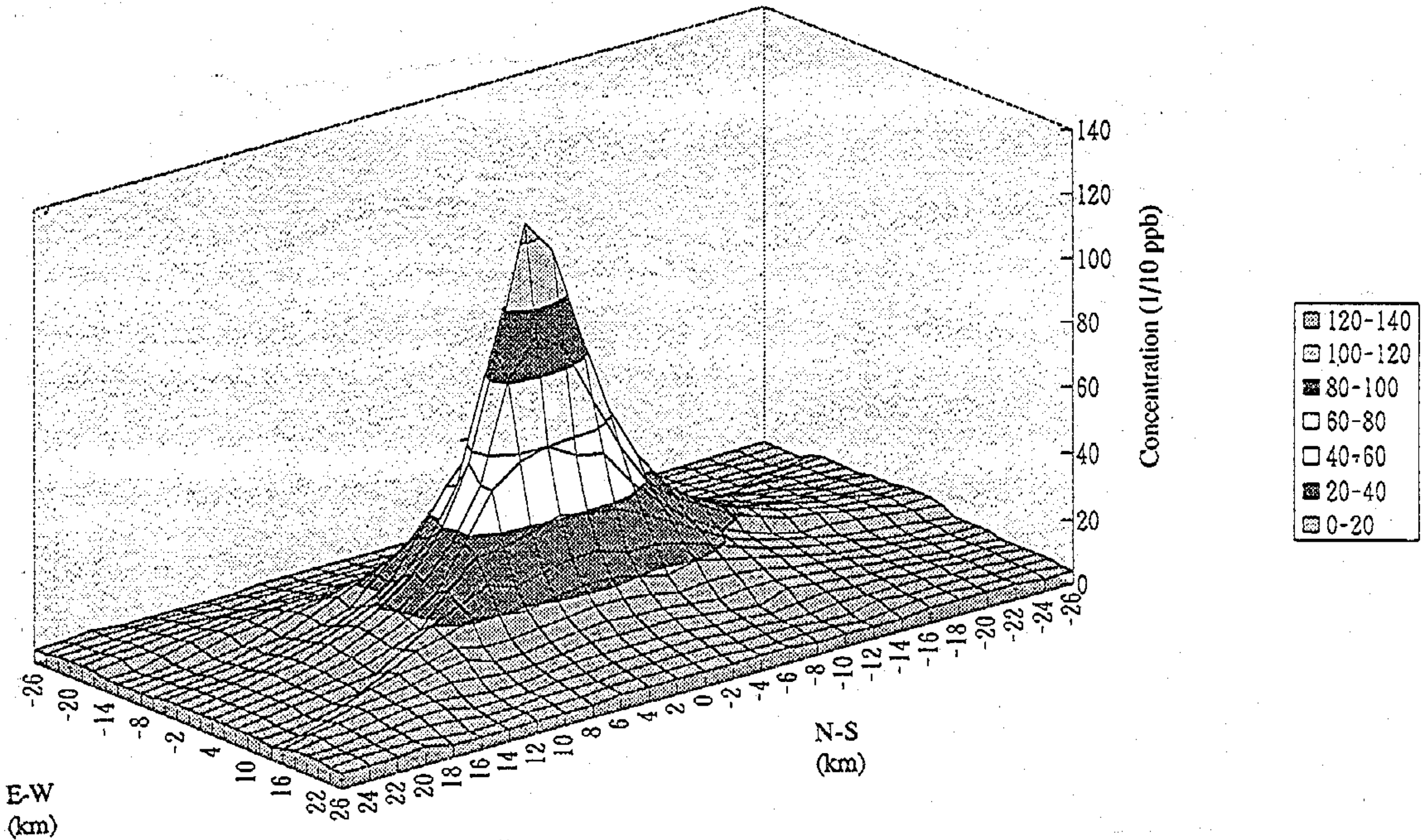


Fig.III.2-20. Contribution concentration (SO_2) by SIDEX
(1992 : equal concentration drawings : Solid)

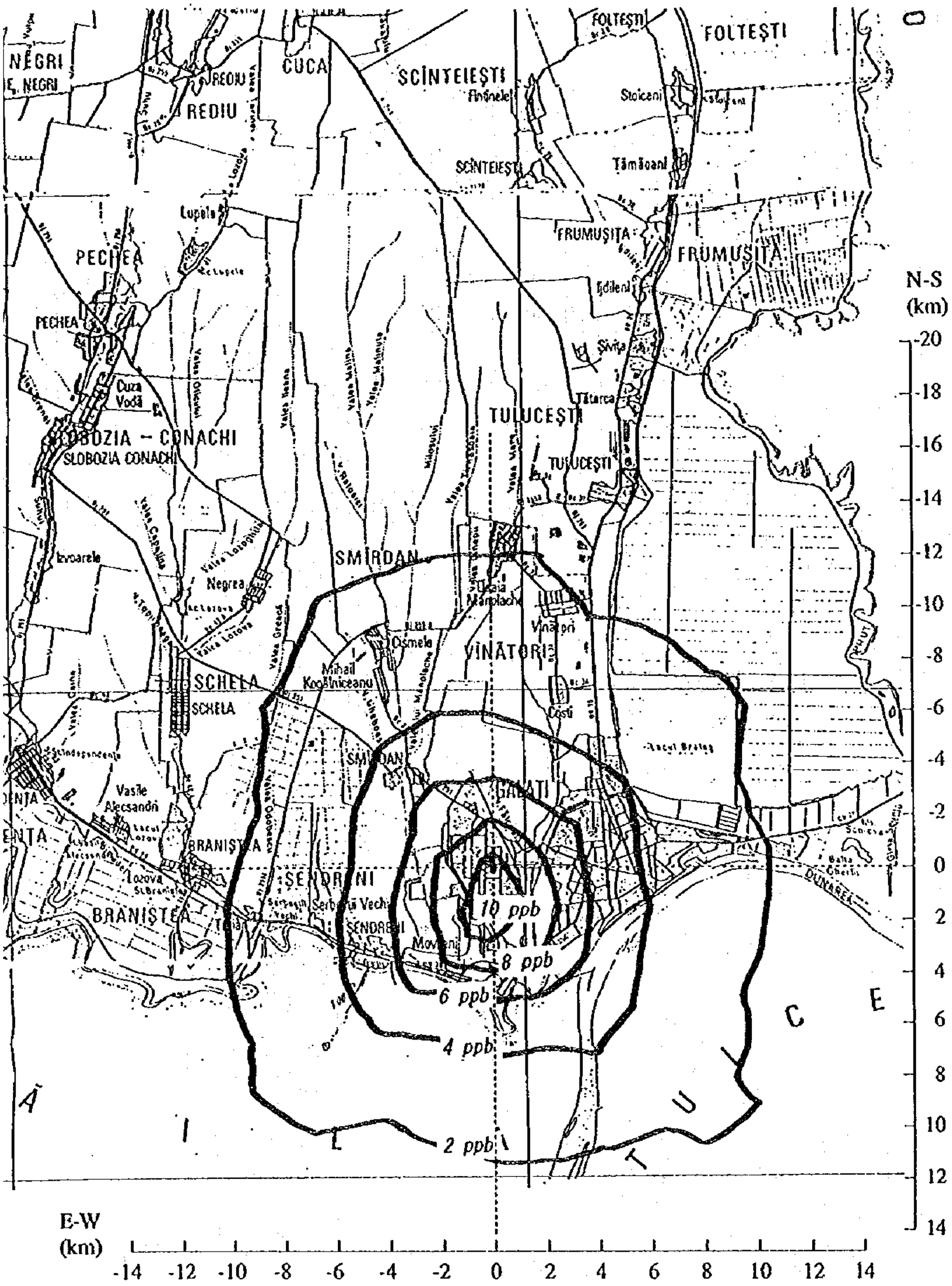


Fig.III.2-21. Contribution concentration (SO_2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Plane)

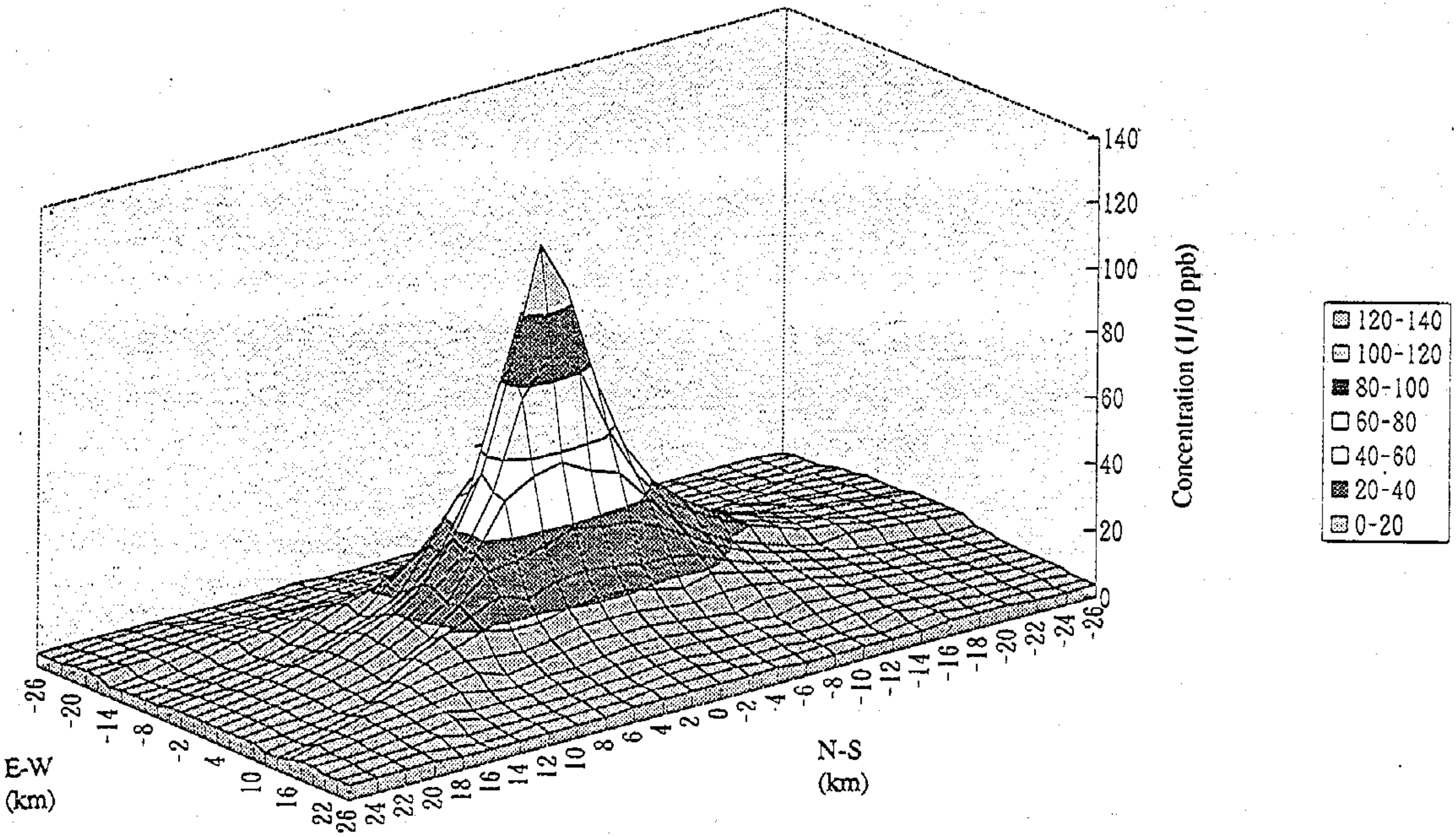


Fig.III.2-22. Contribution concentration (SO_2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Solid)

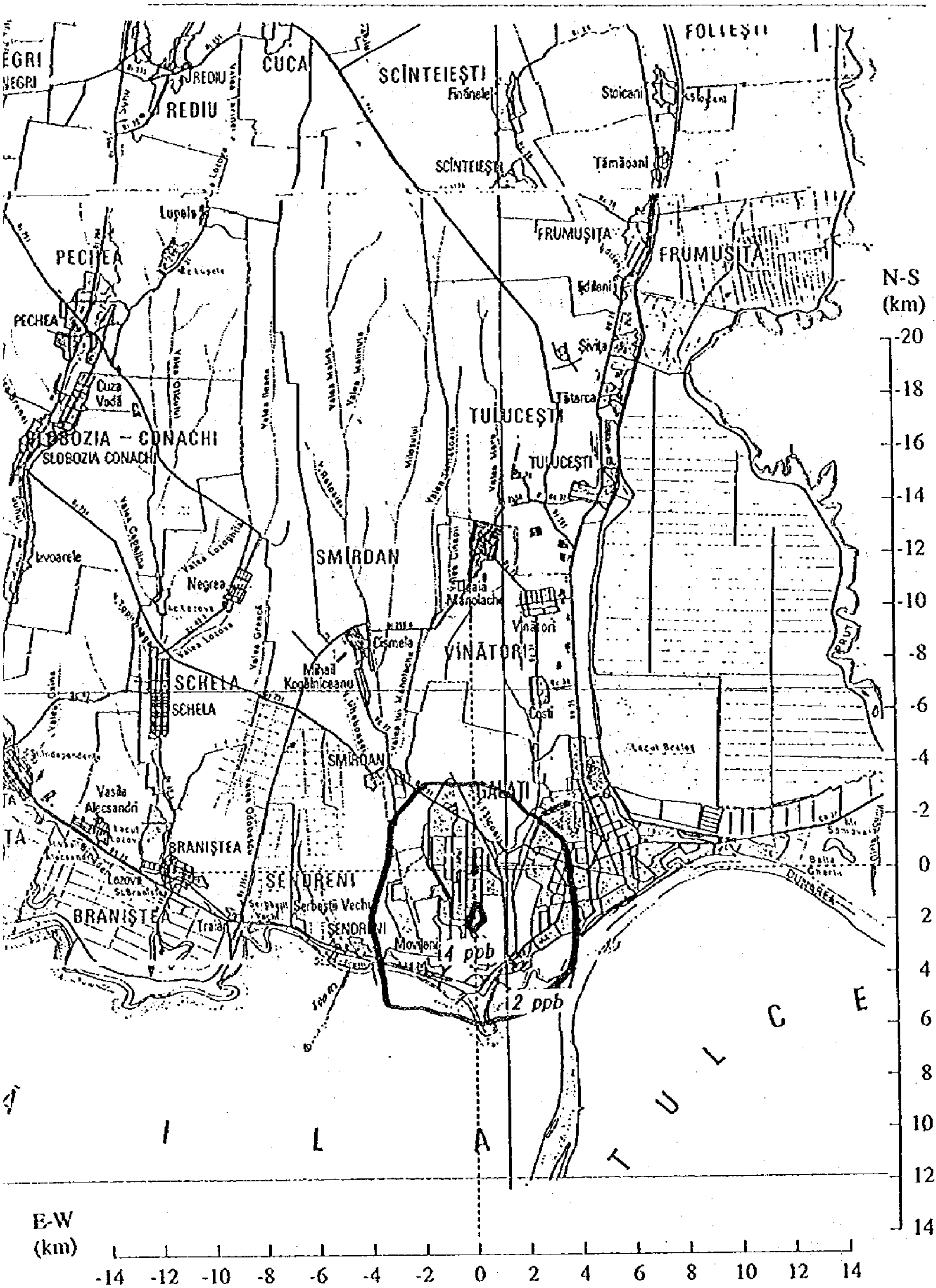


Fig.III.2-23. Contribution concentration (SO2) by SIDEX
(2002 after taking measures
: equal concentration drawings : Plane)

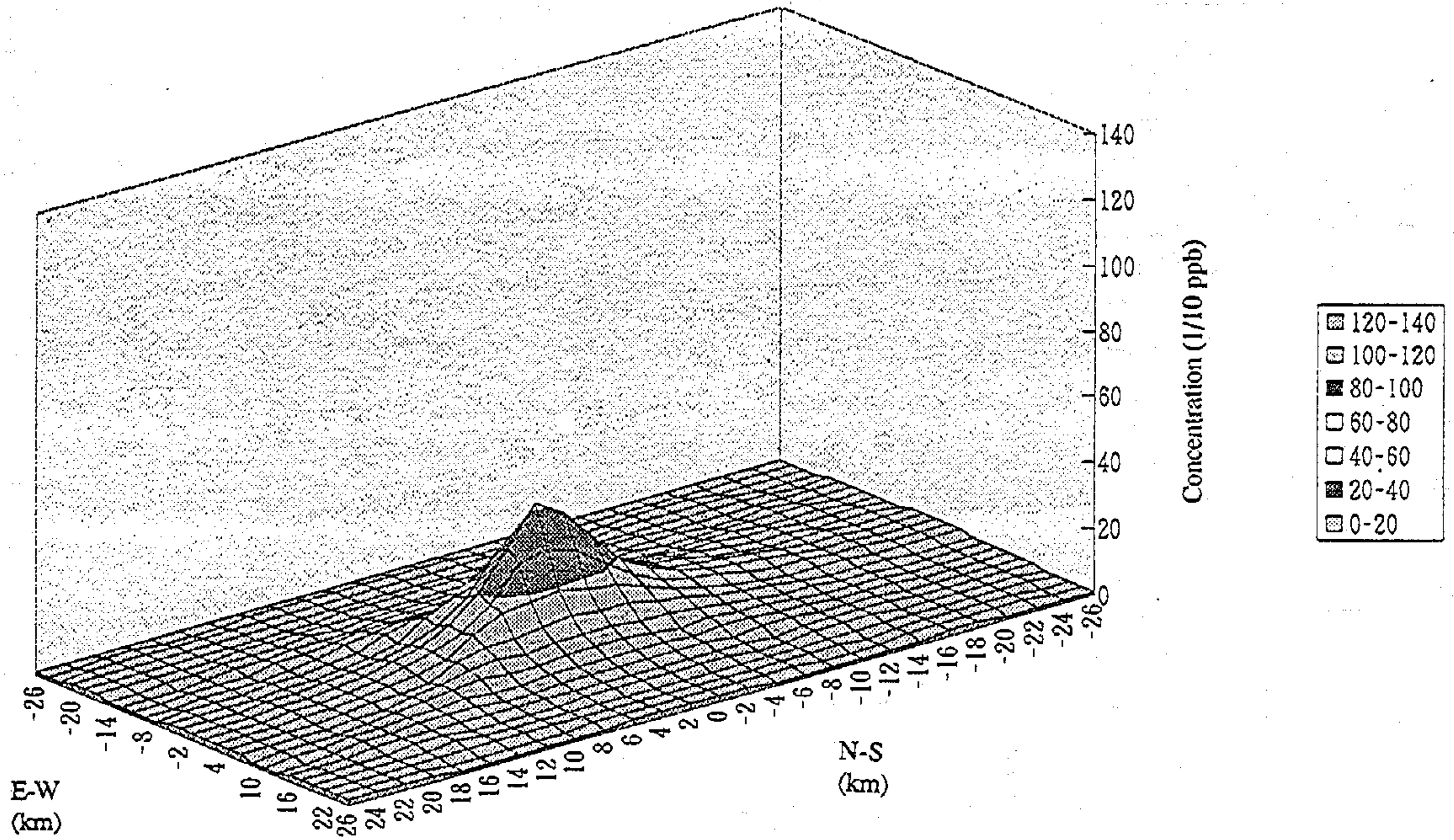


Fig.III.2-24. Contribution concentration (SO_2) by SIDEX
(2002 after taking measures
: equal concentration drawings : Solid)

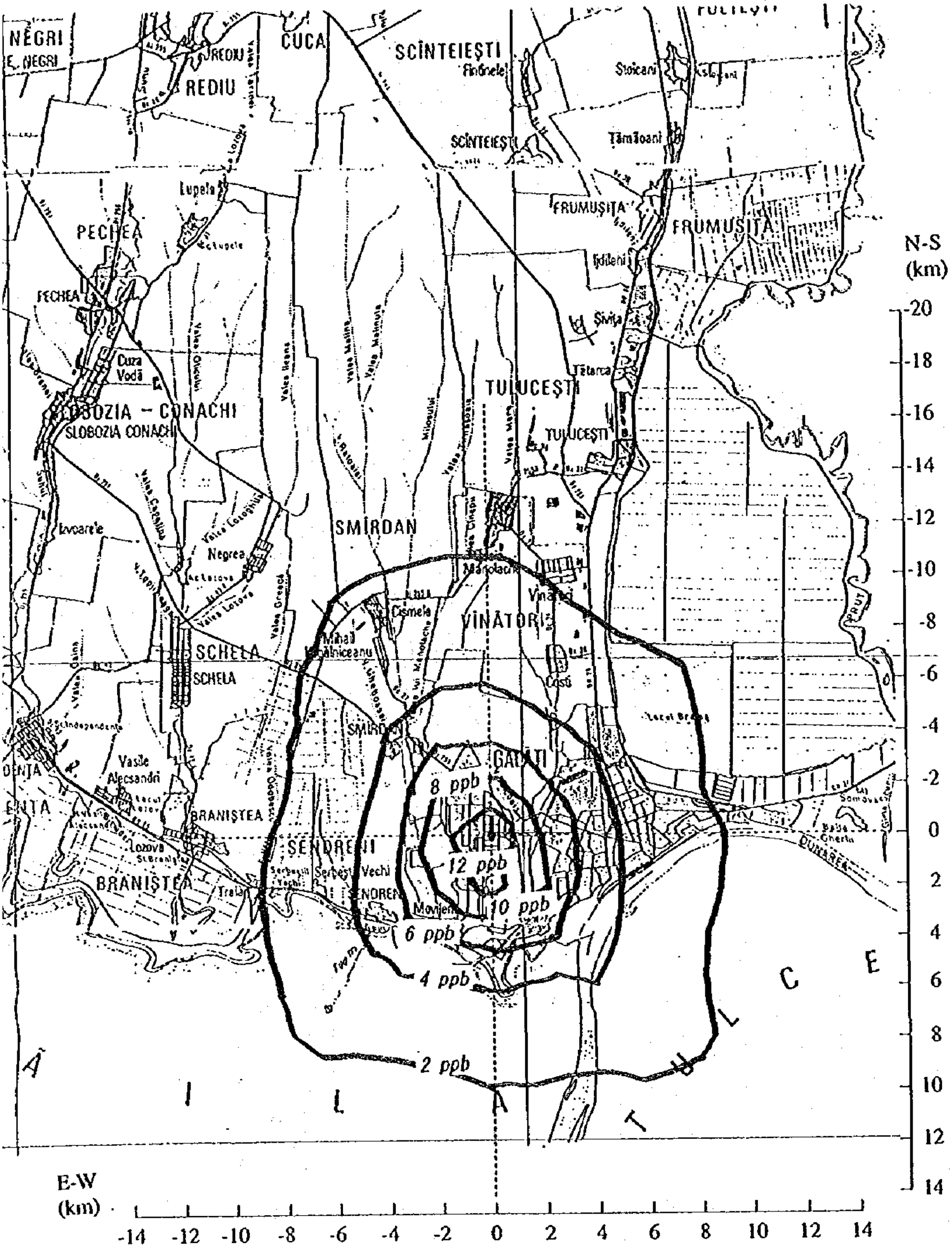


Fig.III.2-25. Contribution concentration (NO_2) by SIDEX (1992 : equal concentration drawings : Plane)

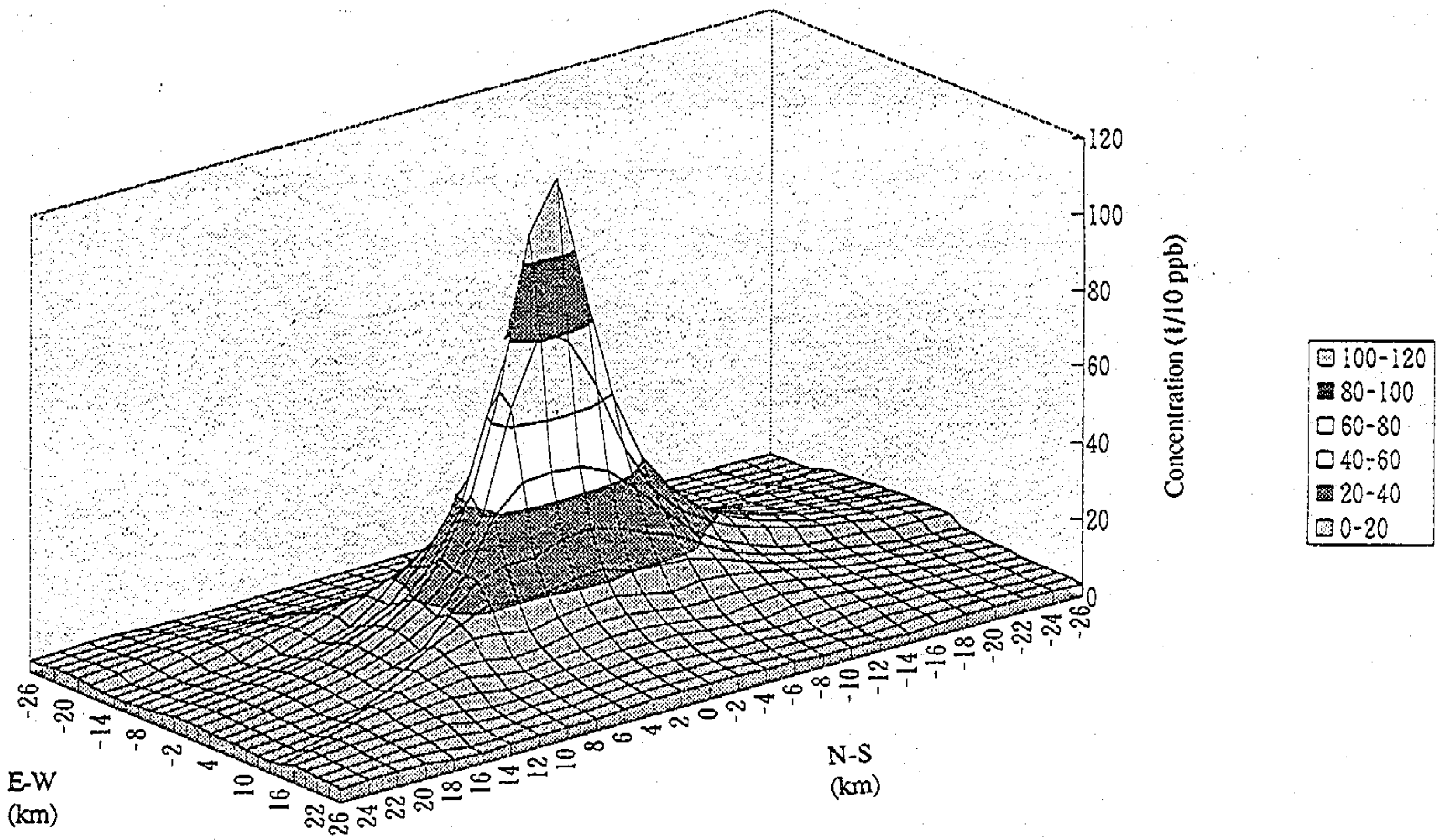


Fig.III.2-26. Contribution concentration (NO_2) by SIDEX
(1992 : equal concentration drawings : Solid)

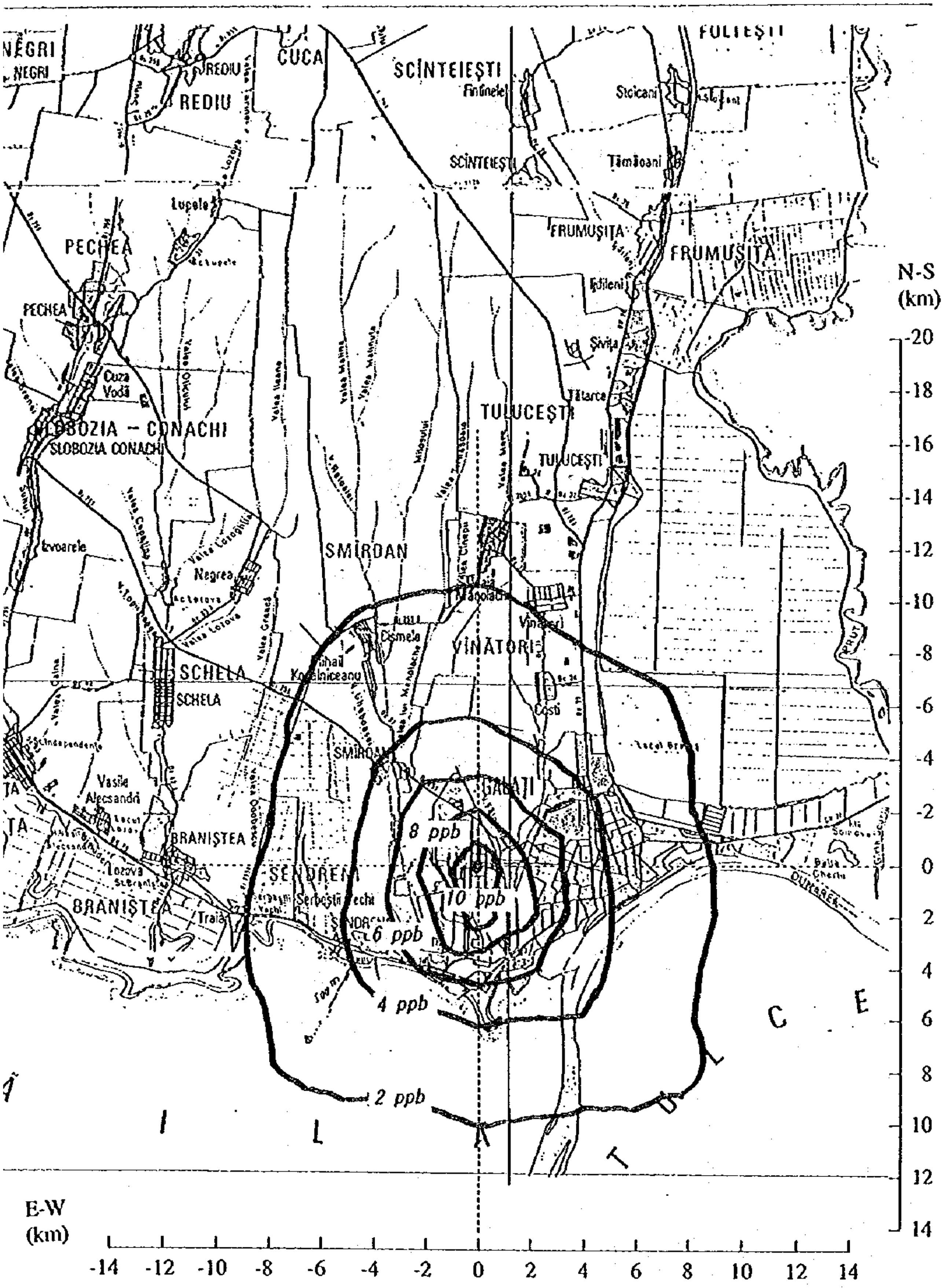


Fig.III.2-27. Contribution concentration (NO2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Plane)

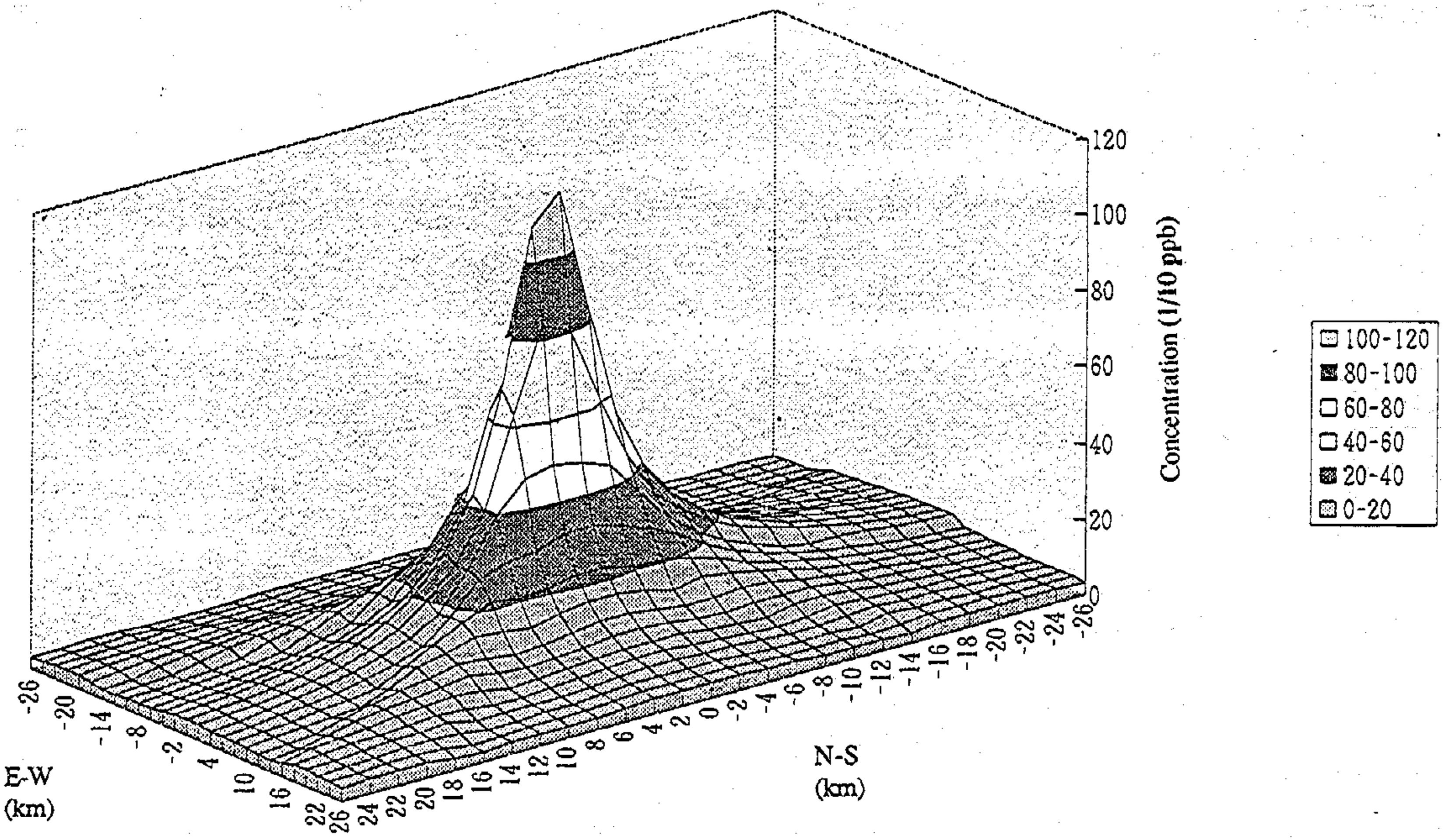


Fig.III.2-28. Contribution concentration (NO_2) by SIDEX
(2002 before taking measures
: equal concentration drawings : Solid)

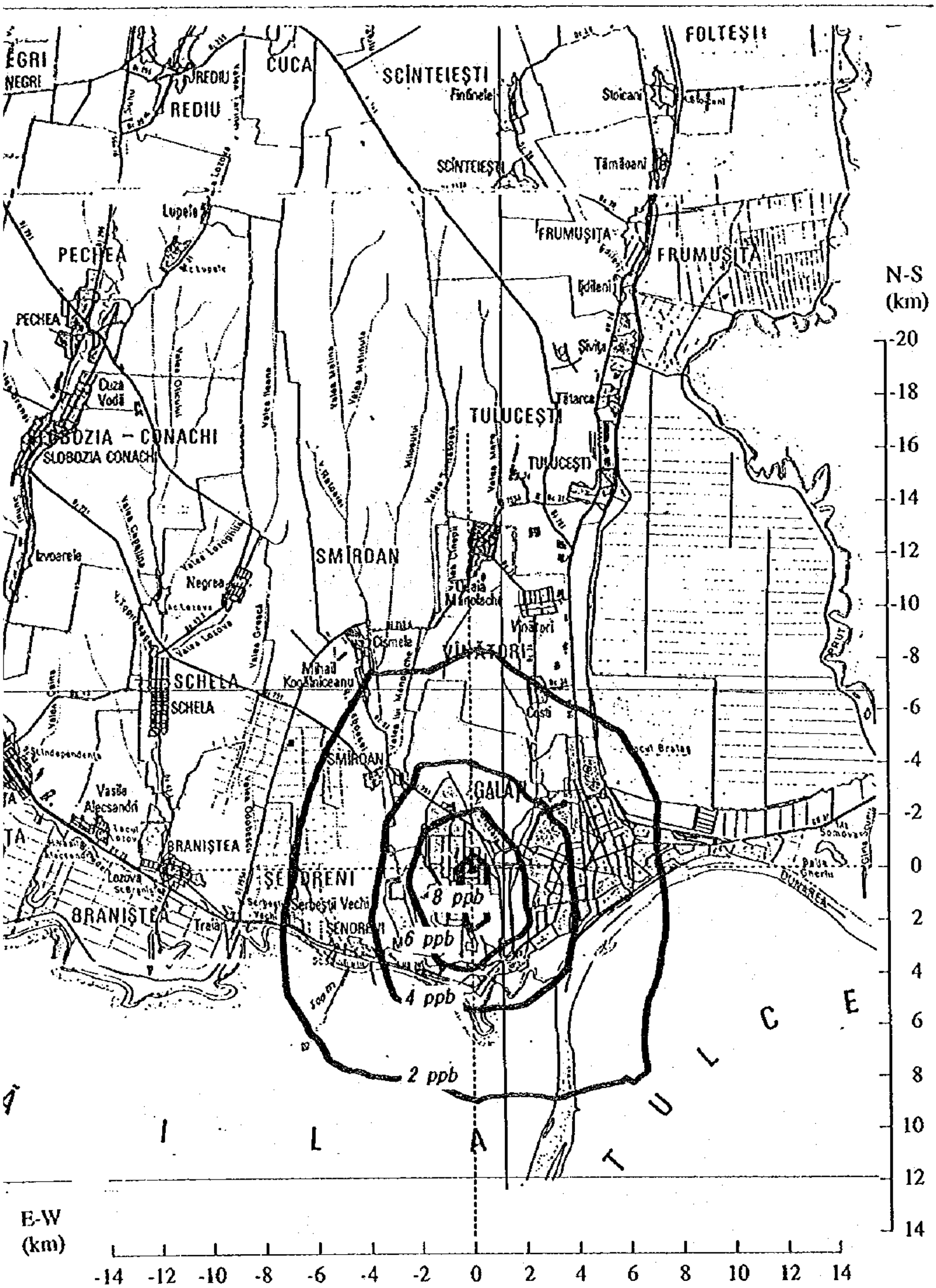


Fig.III.2-29. Contribution concentration (NO2) by SIDEX (2002 after taking measures : equal concentration drawings : Plane)

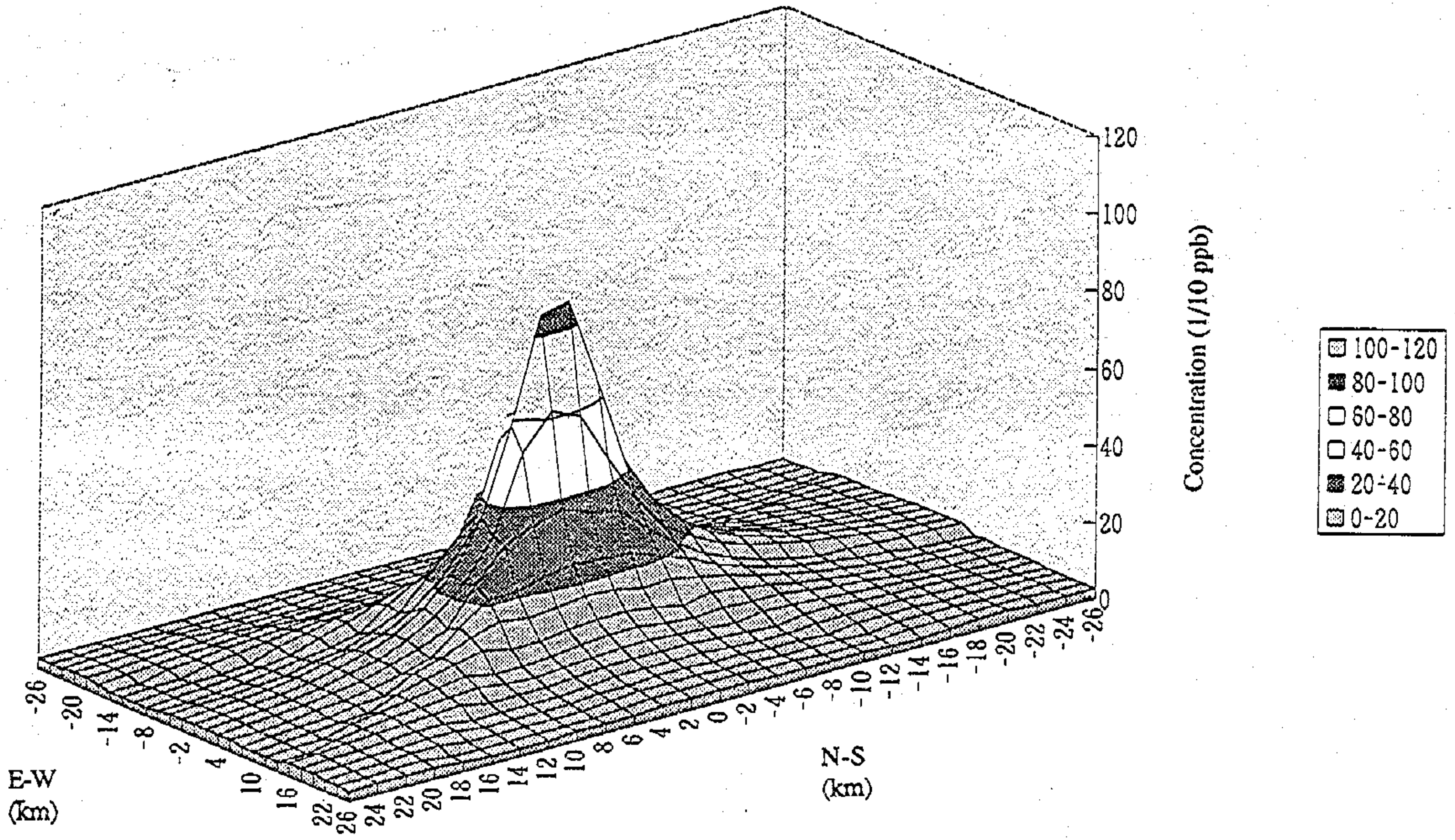


Fig.III.2-30. Contribution concentration (NO_2) by SIDEX (2002 after taking measures : equal concentration drawings : Solid)

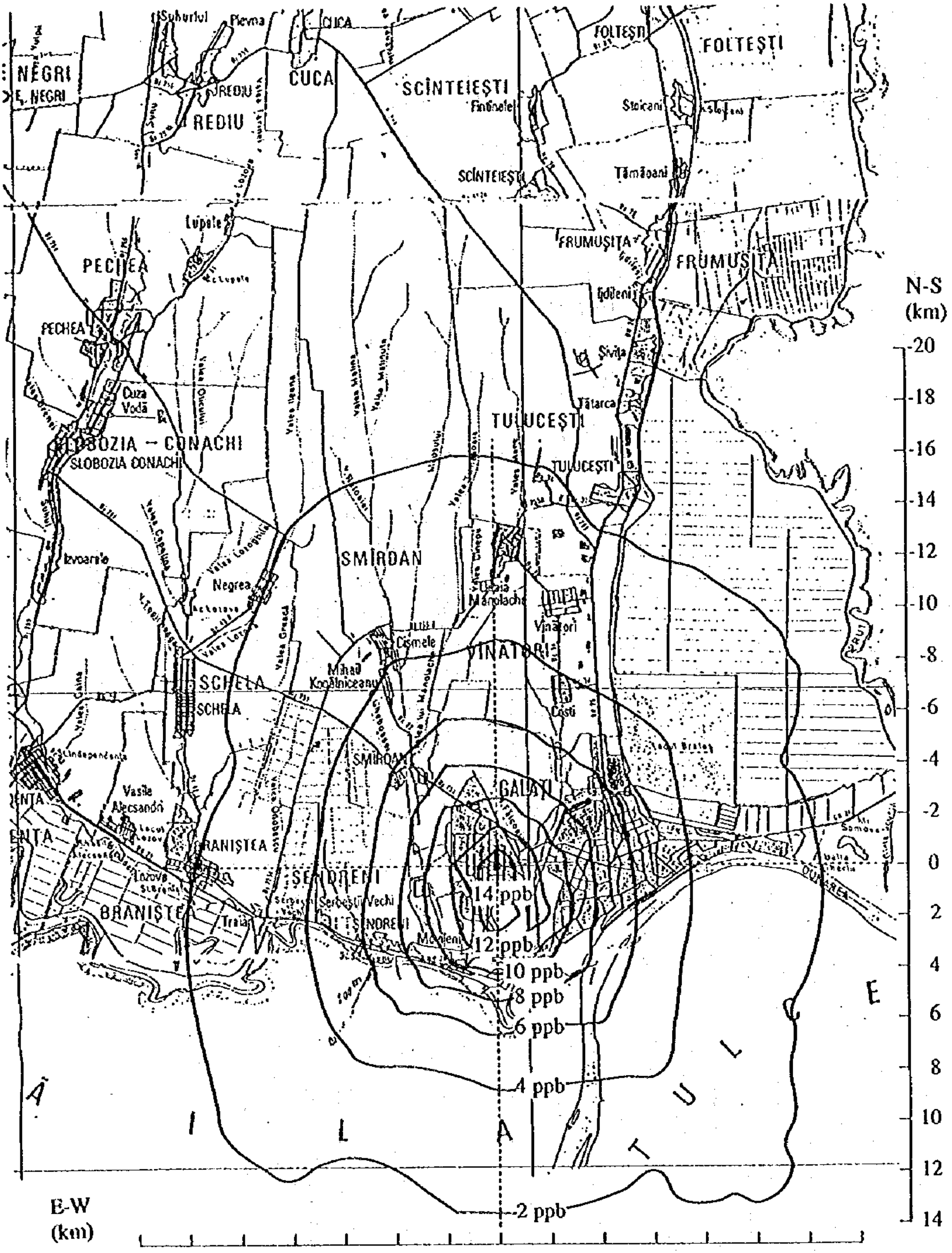


Fig.III.2-31. Contribution concentration (SO_2) by SIDEX + RENEL (1992 : equal concentration drawings : Plane)

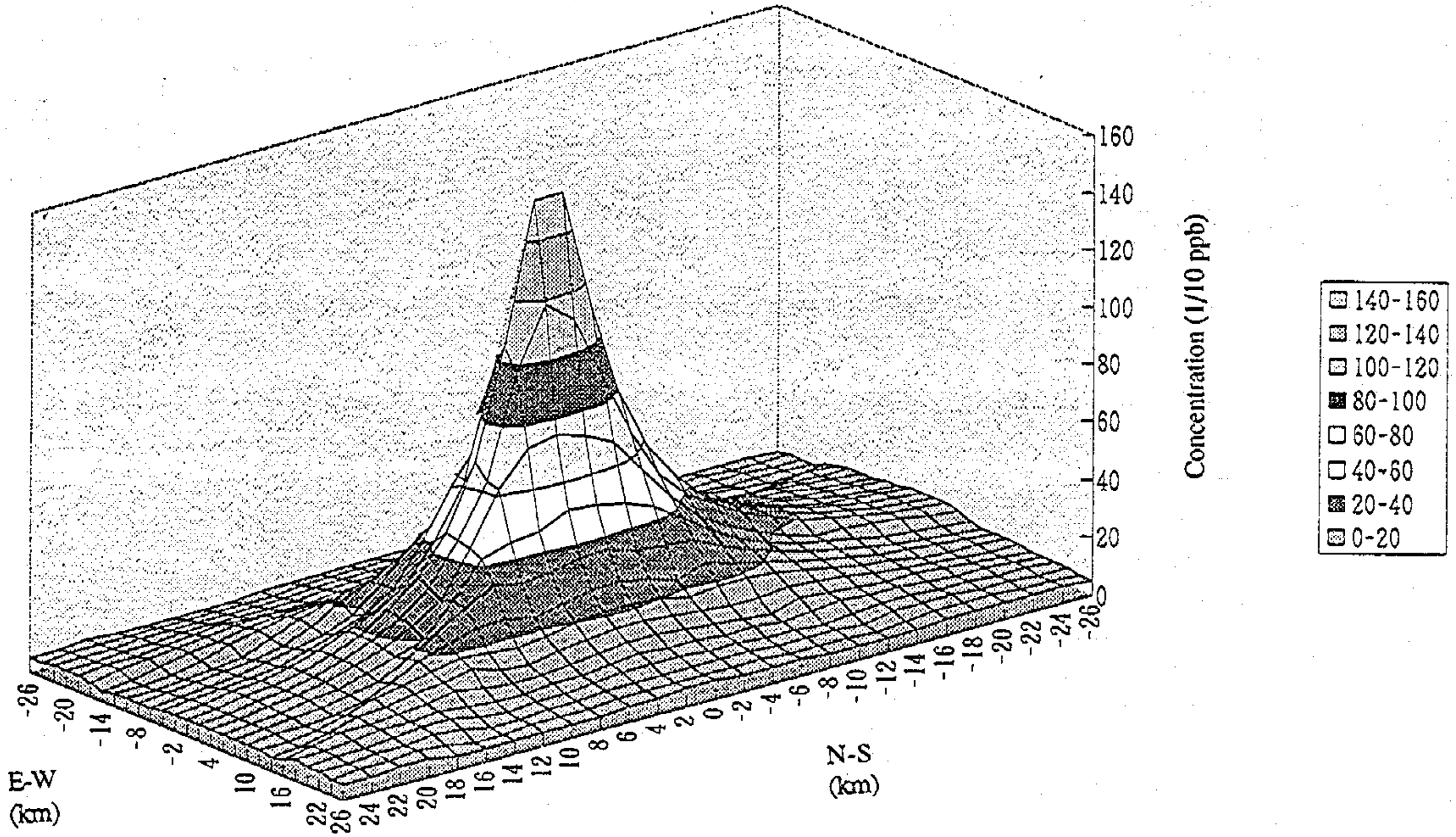


Fig.III.2-32. Contribution concentration (SO_2) by SIDEX + RENEL
(1992 : equal concentration drawings : Solid)

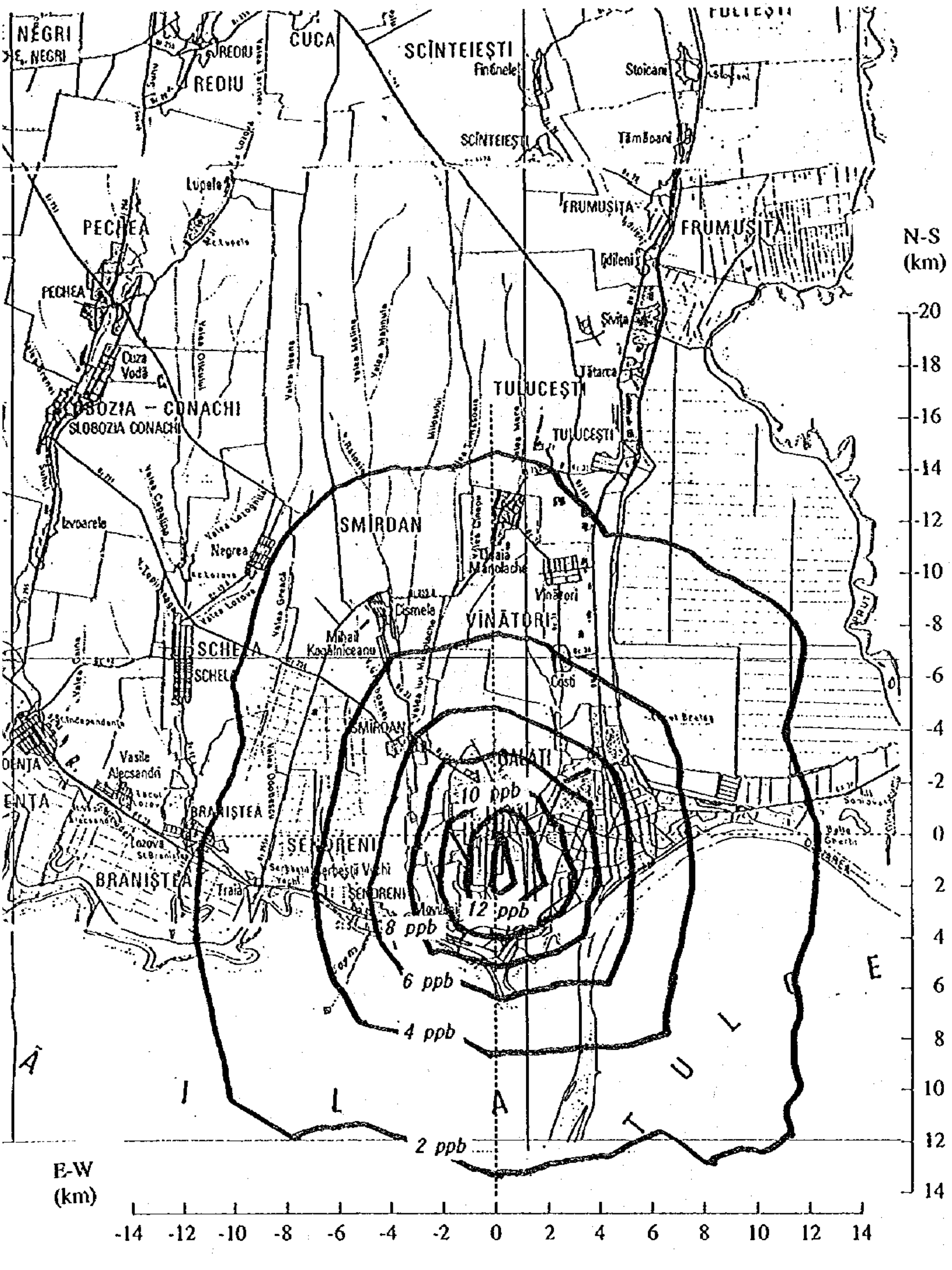


Fig.III.2-33. Contribution concentration (SO_2) by SIDEX + RENEL
(2002 before taking measures
: equal concentration drawings : Plane)

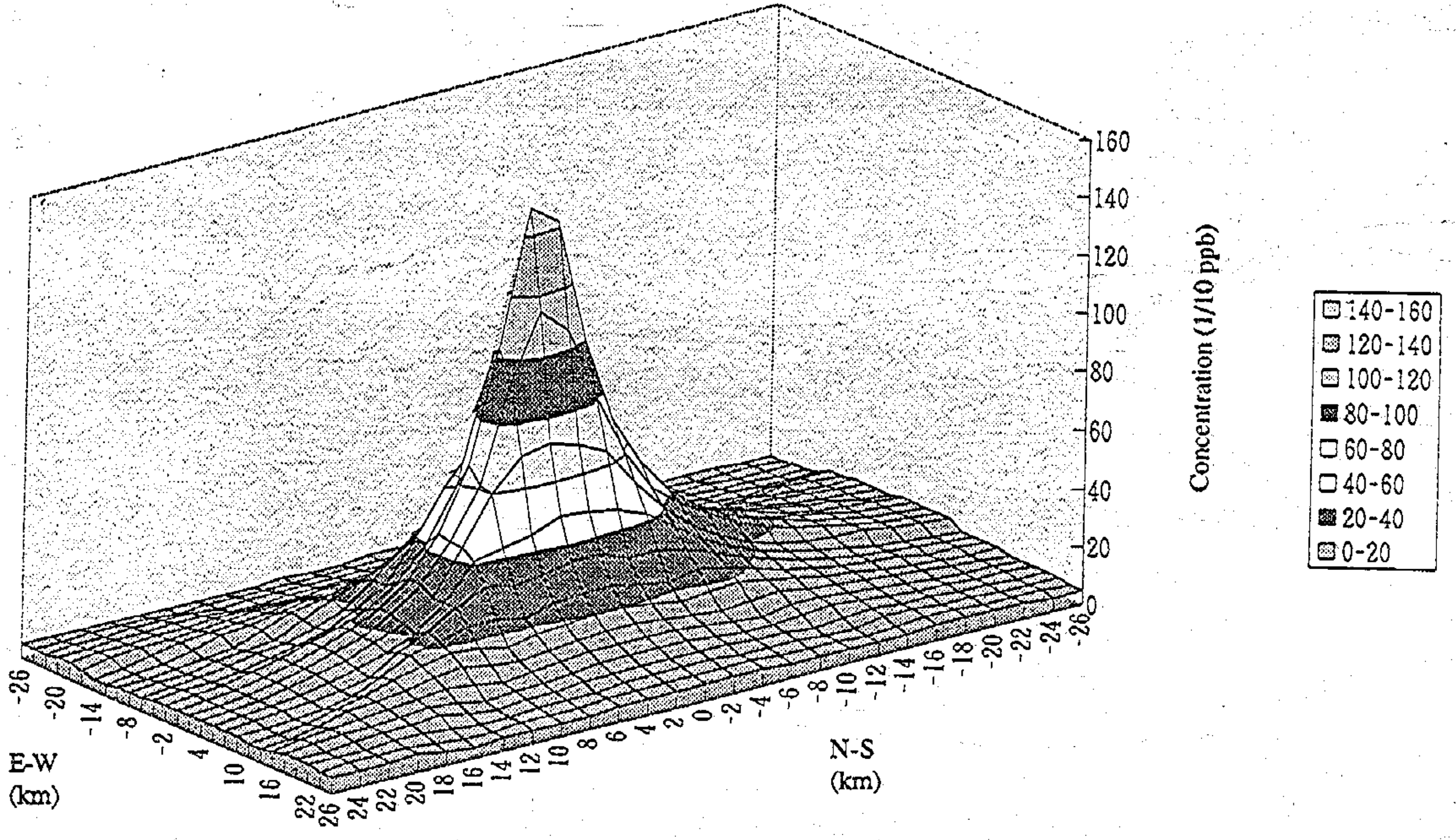


Fig.III.2-34. Contribution concentration (SO_2) by SIDEX + RENEL
(2002 before taking measures
: equal concentration drawings : Solid)

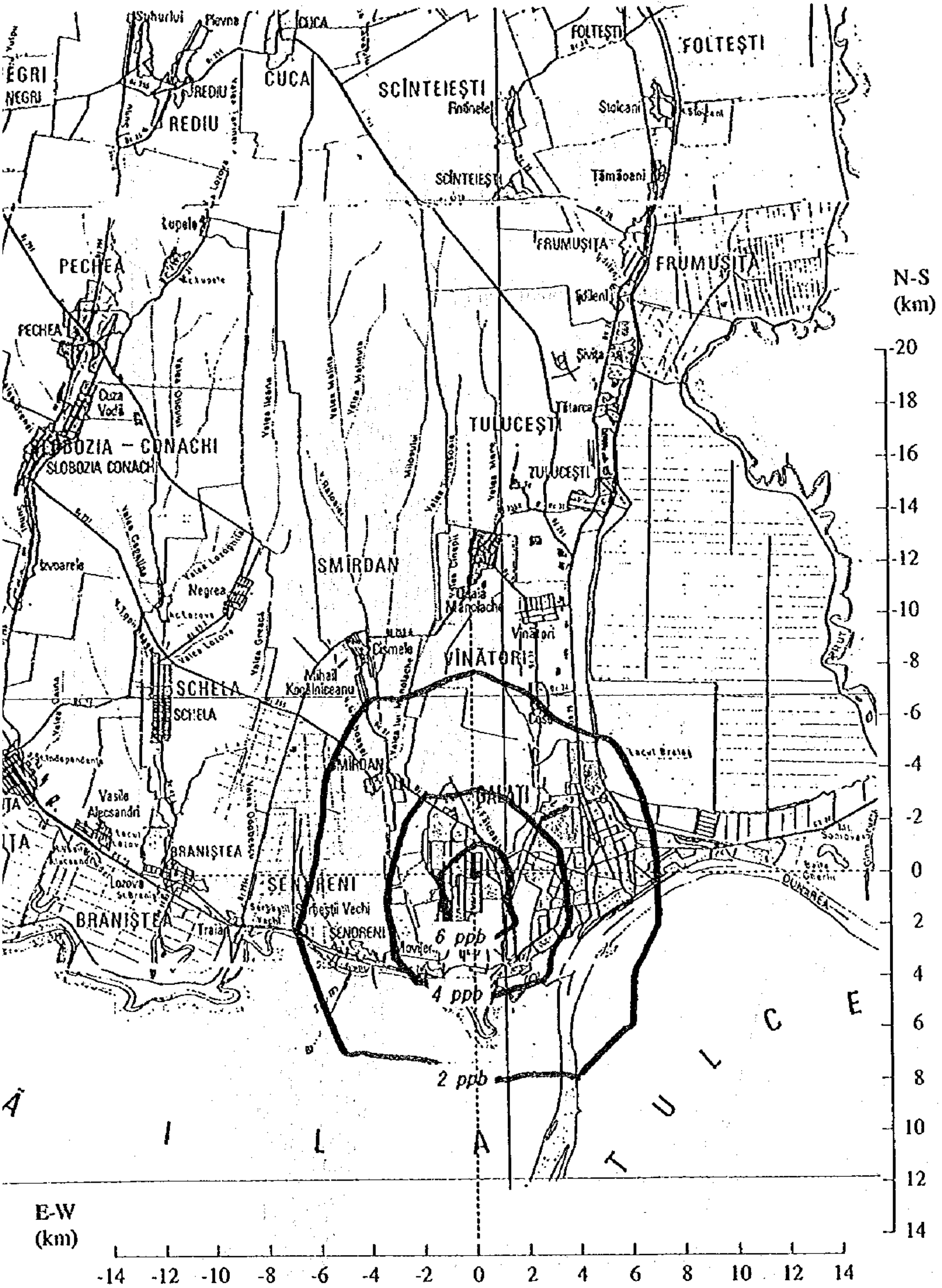


Fig.III.2-35. Contribution concentration (SO_2) by SIDEX + RENEL
(2002 after taking measures
: equal concentration drawings : Plane)

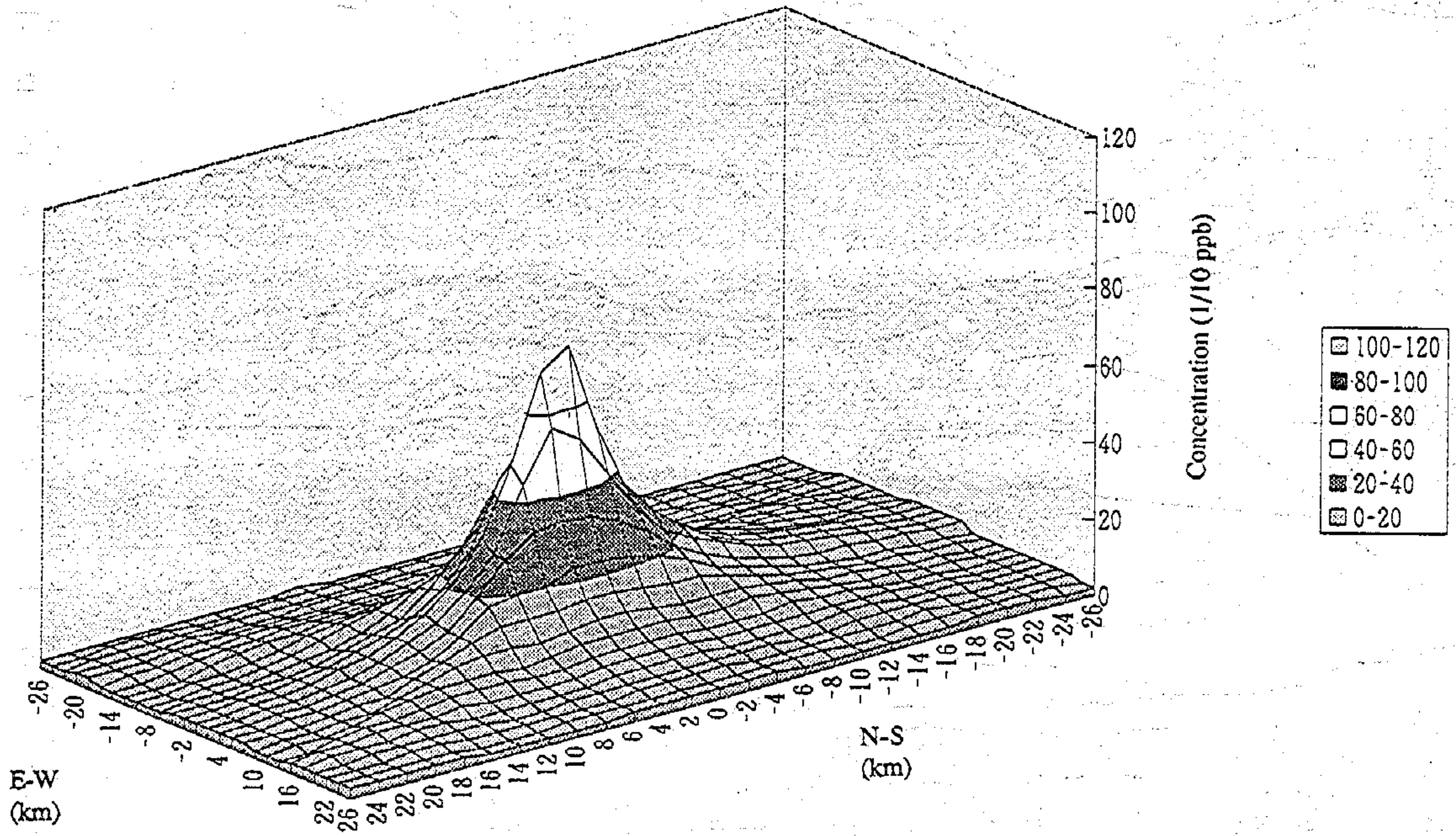


Fig.III.2-36. Contribution concentration (SO_2) by SIDEX + RENEL
(2002 after taking measures
: equal concentration drawings : Solid)

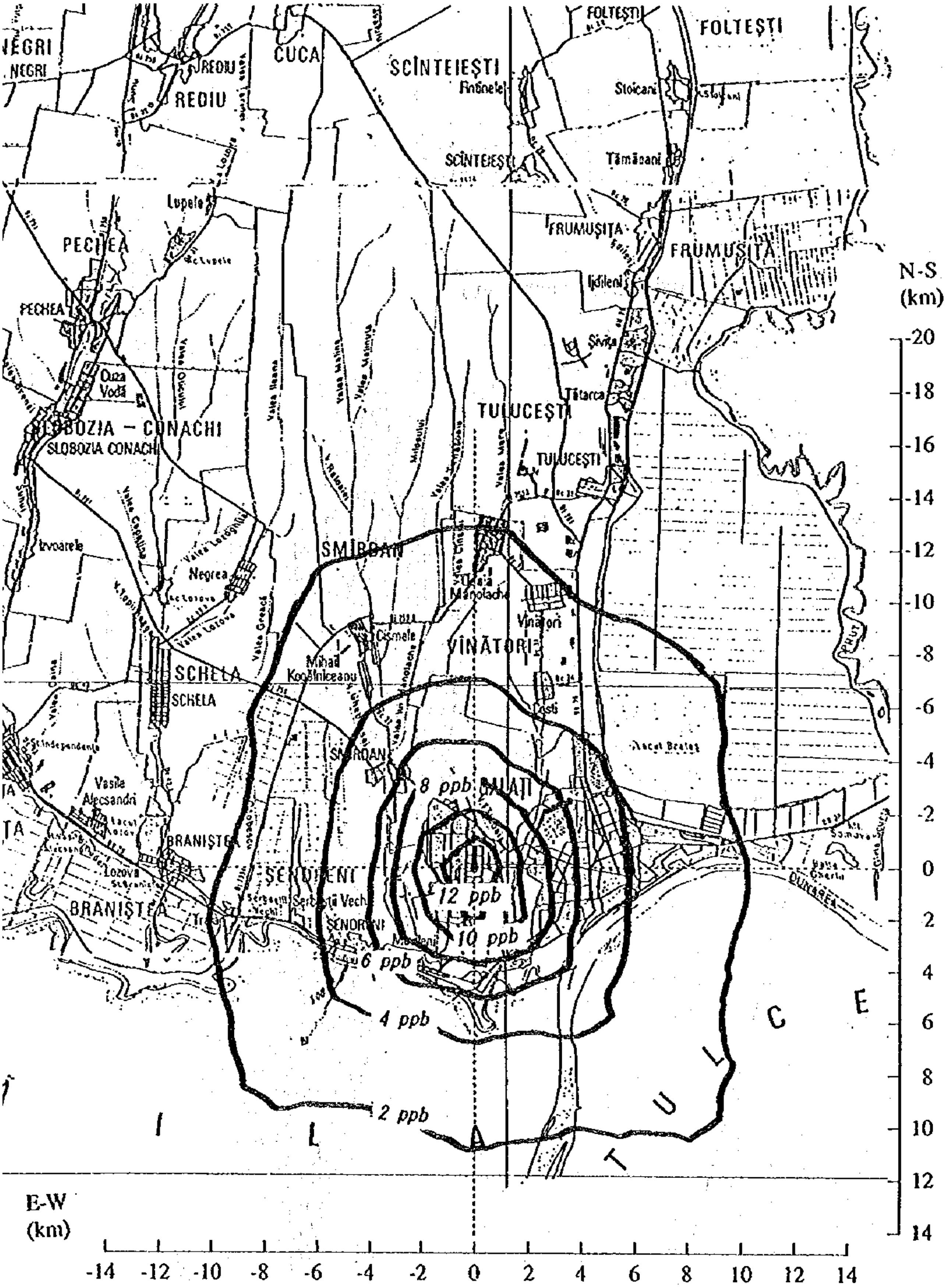


Fig.III.2-37. Contribution concentration (NO2) by SIDEX + RENEL (1992 : equal concentration drawings : Plane)

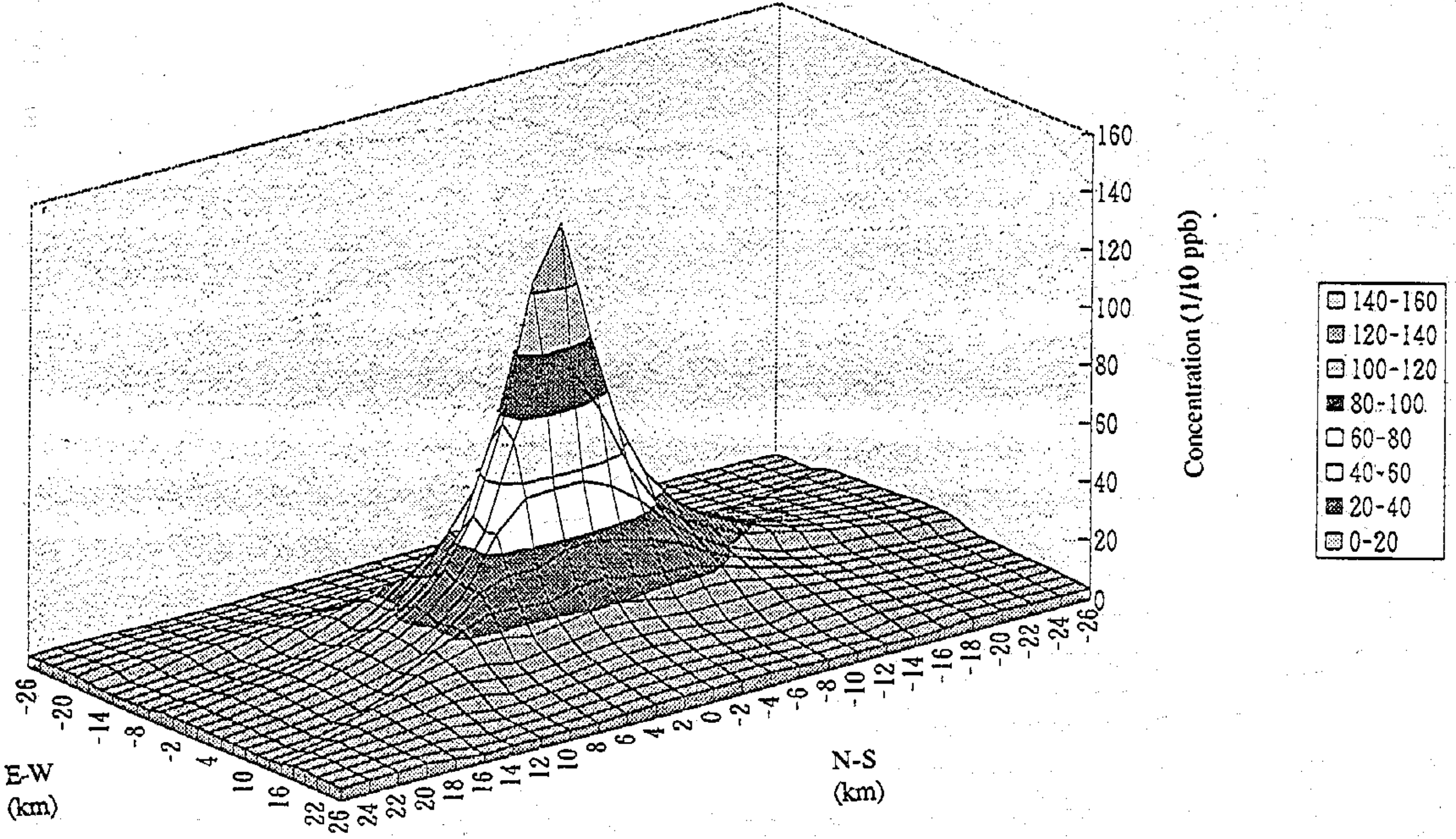


Fig.III.2-38. Contribution concentration (NO_2) by SIDEX + RENEL
(1992 : equal concentration drawings : Solid)

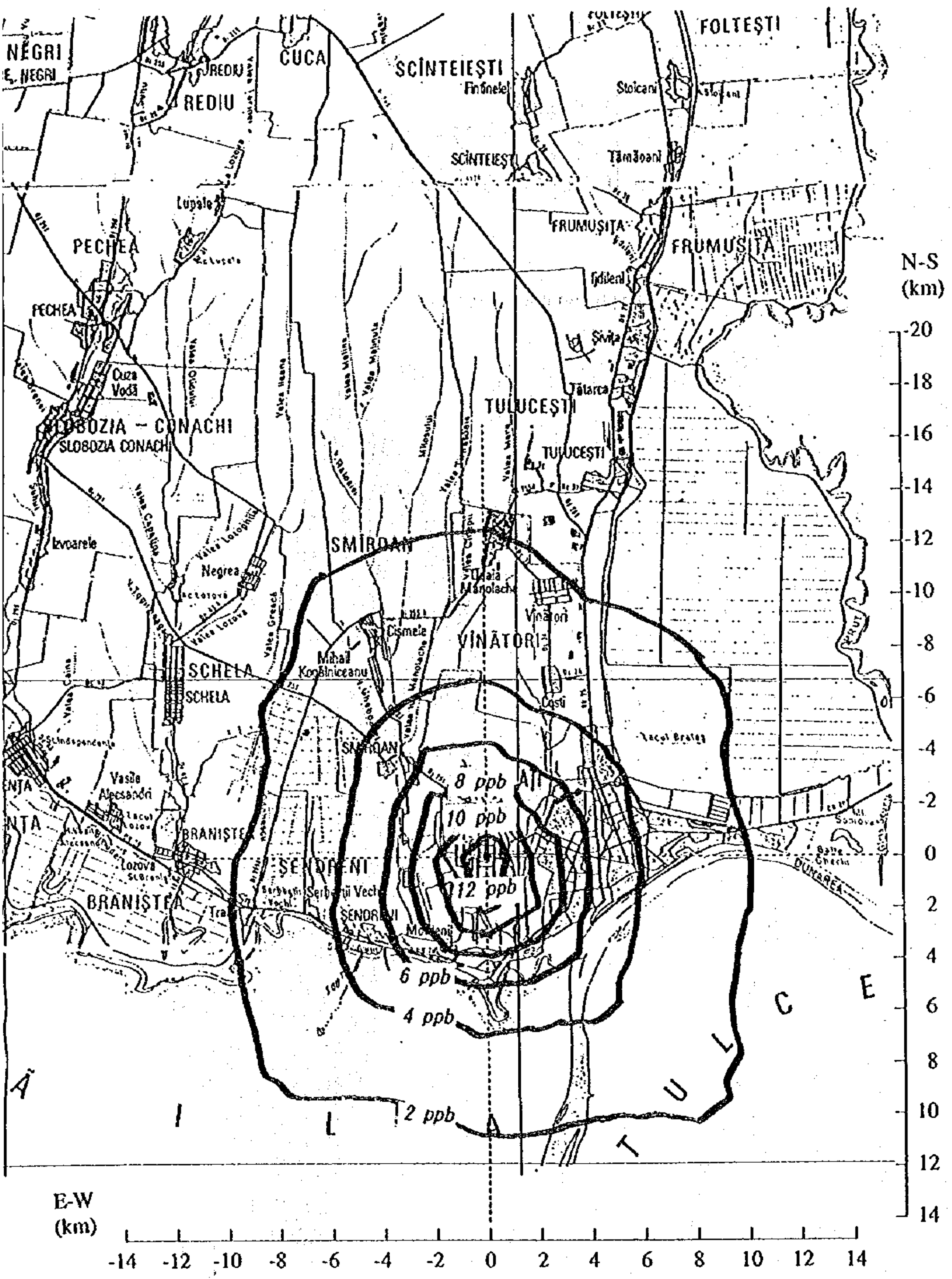


Fig.III.2-39. Contribution concentration (NO₂) by SIDEX + RENEL
(2002 before taking measures
: equal concentration drawings : Plane)

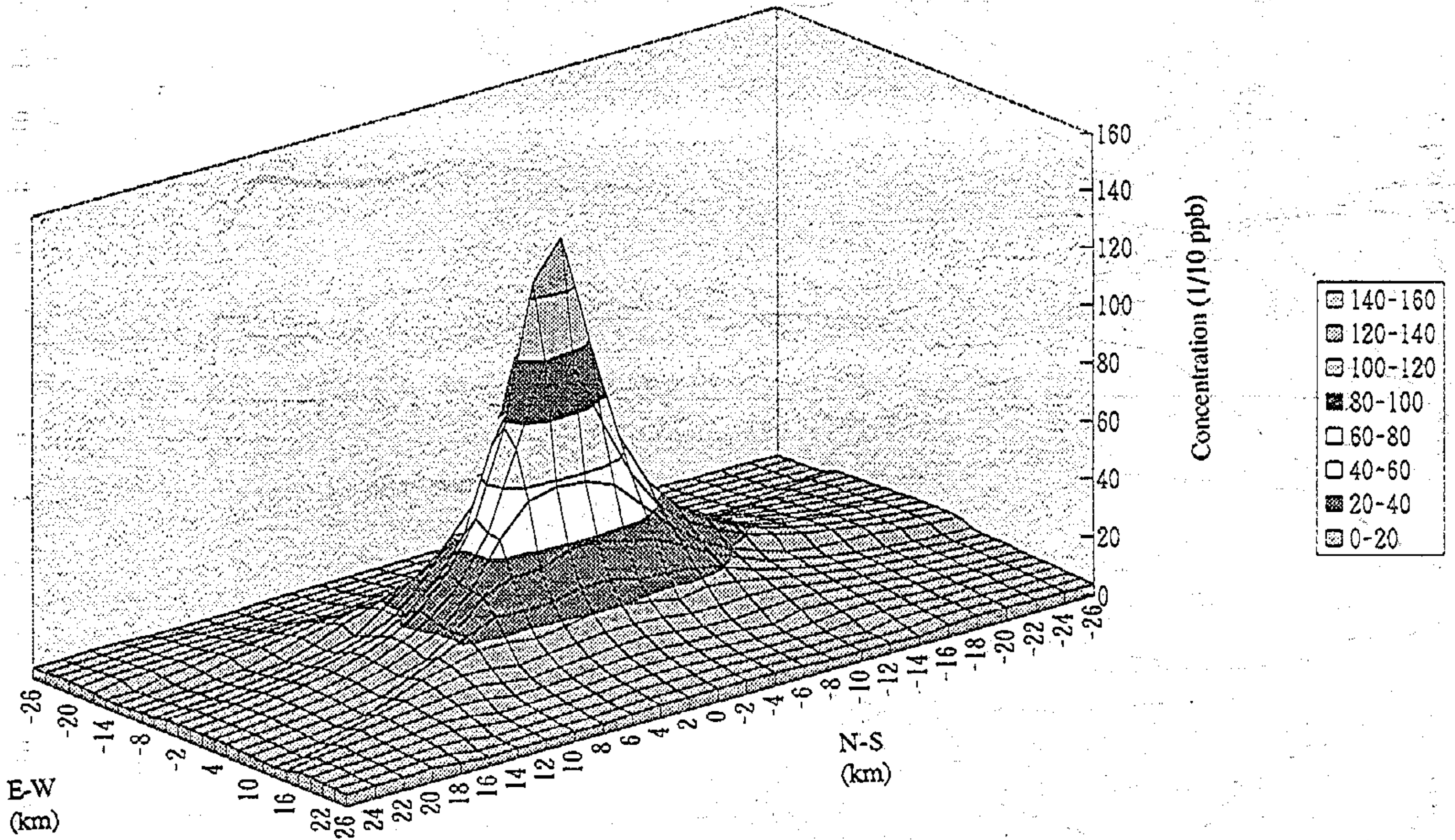


Fig.III.2-40. Contribution concentration (NO_2) by SIDEX + RENEL
(2002 before taking measures
: equal concentration drawings : Solid)

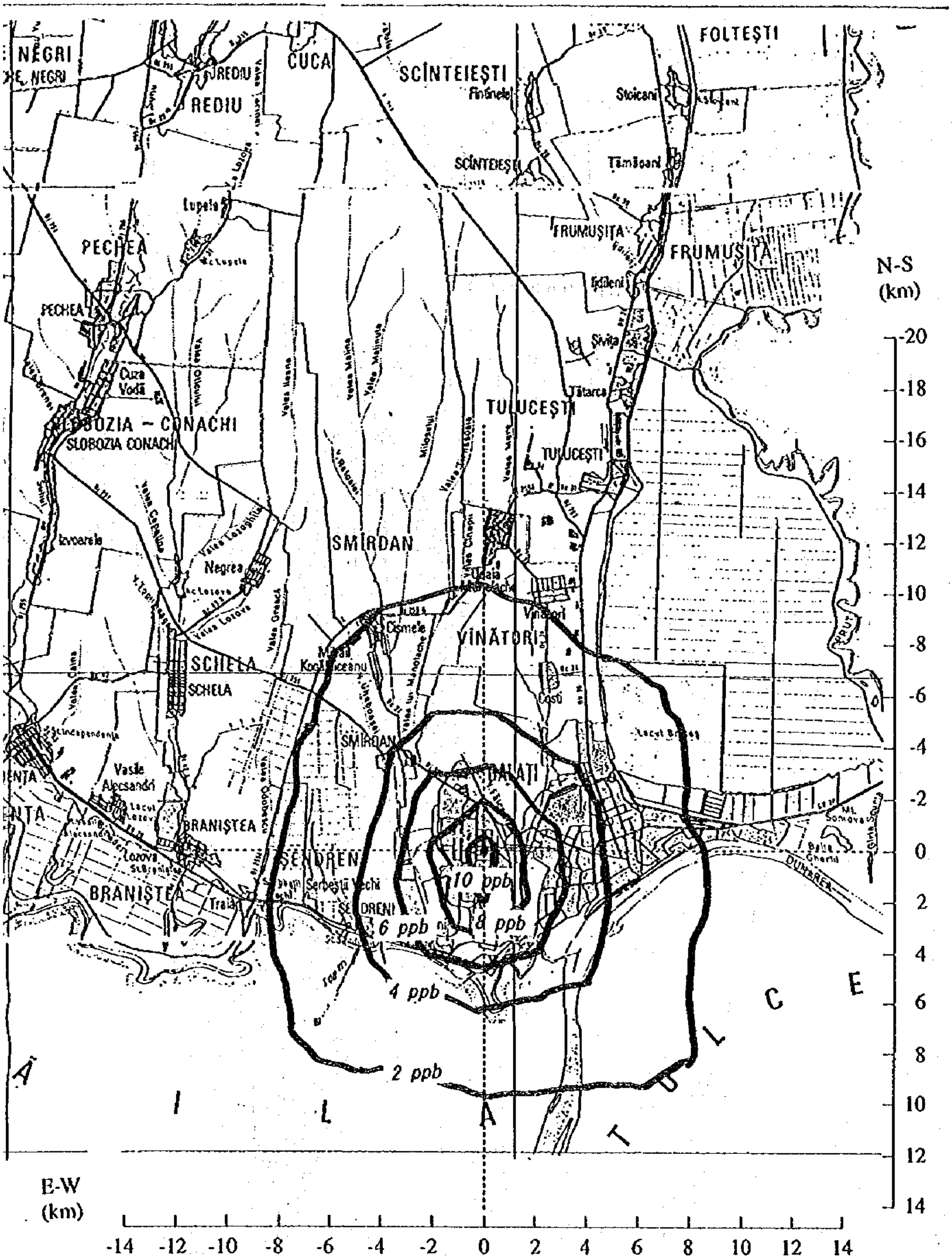


Fig.III.2-41. Contribution concentration (NO_2) by SIDEX + RENEL (2002 after taking measures : equal concentration drawings : Plane)

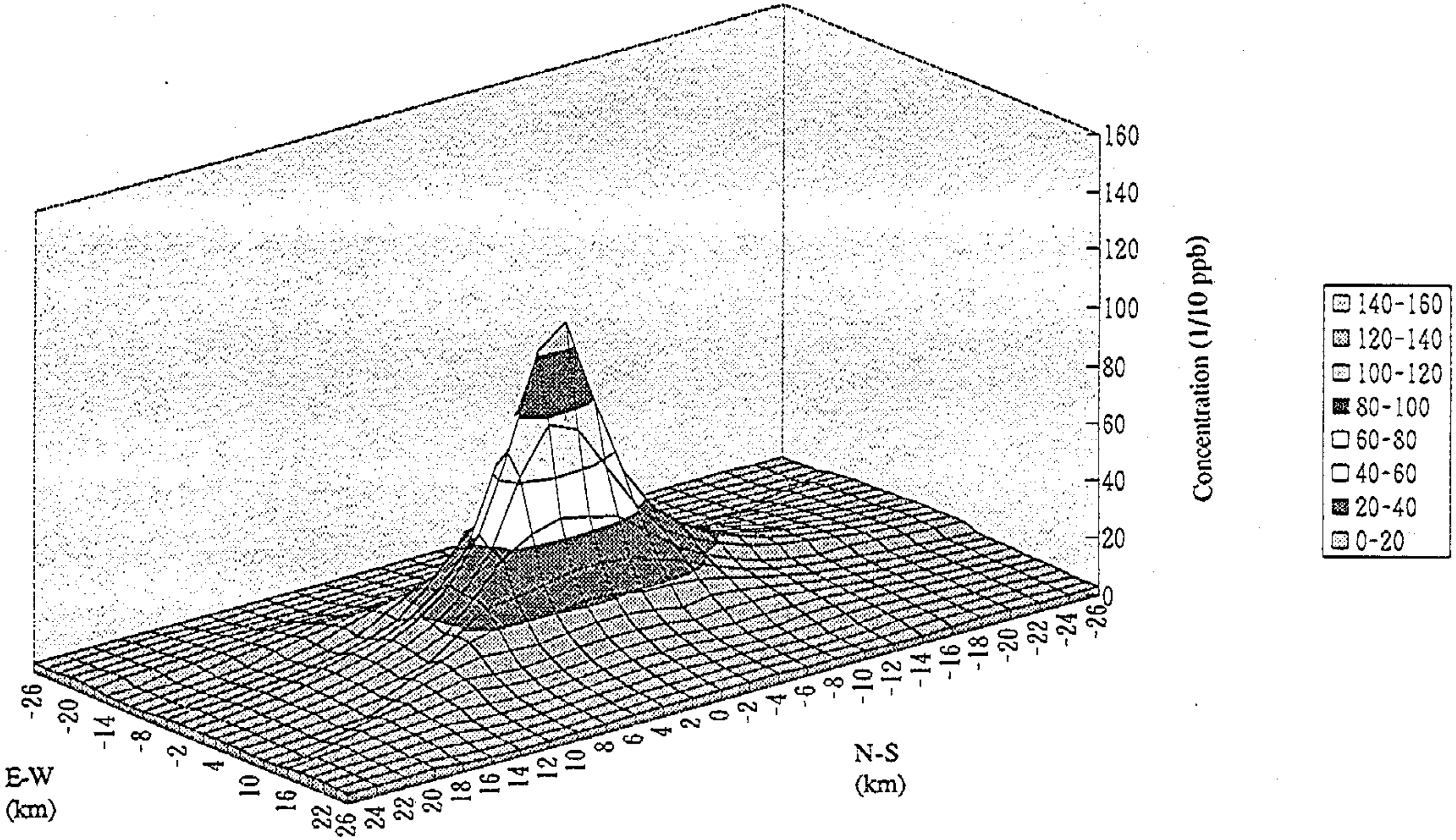


Fig.III.2-42. Contribution concentration (NO_2) by SIDEX + RENEL
(2002 after taking measures
: equal concentration drawings : Solid)

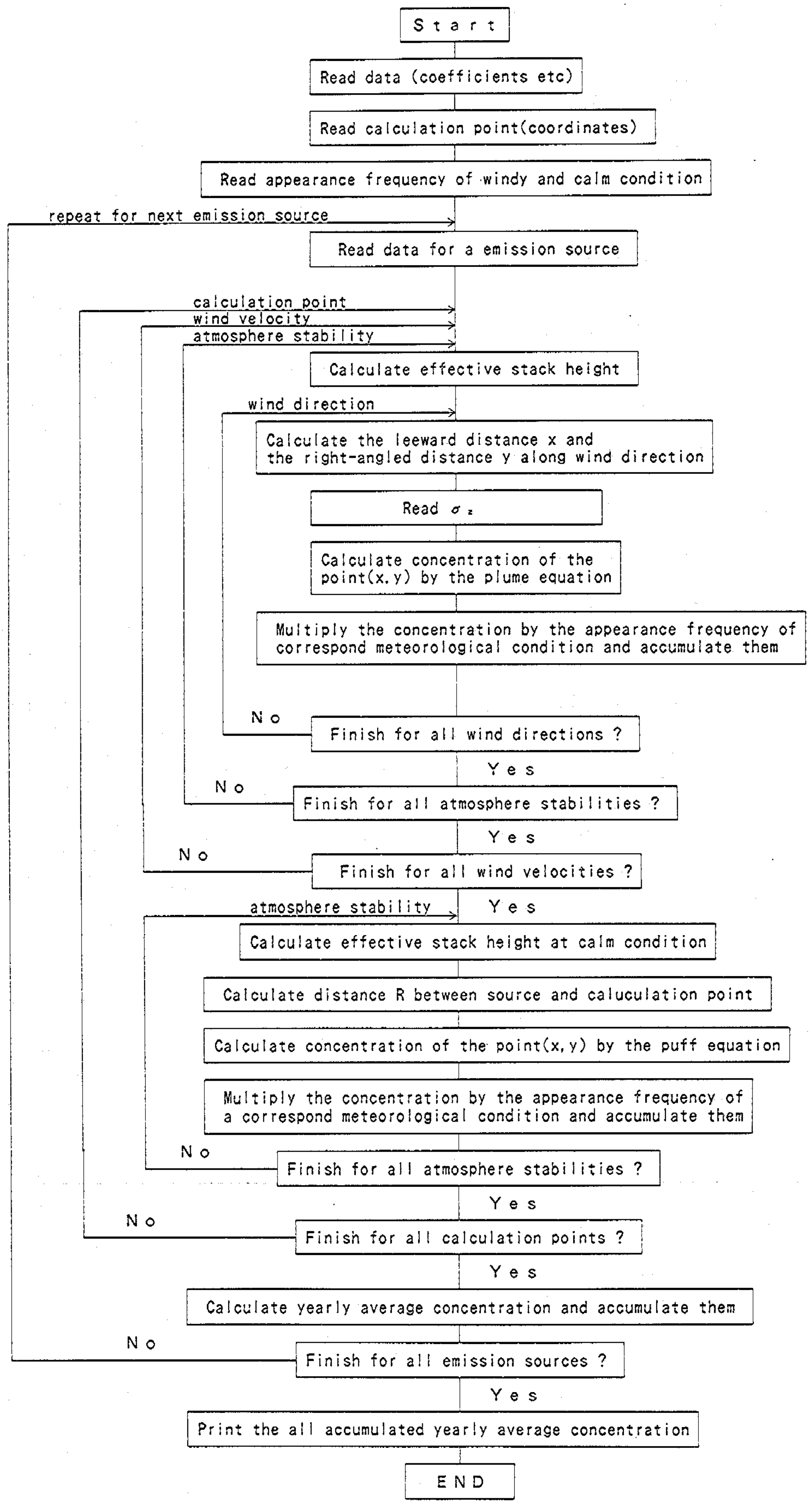


Fig. III.2-43 Procedure of simulation calculation

2) River water quality

Expected decreases of pollutants in the waste water from SIDEX after execution of the countermeasures are shown in Table III.2-17. More than 90% decrease can be expected, and especially the concentration of phenol which presently affects the water quality of the Siret and the Donau will be decreased by 99%, thus greatly contributing to the improvement of the environment around SIDEX.

Table III.2-18 Discharge Loads of Phenol, Ammonia and Cyanide after measures in 2002

Pollutants		Before measures	After measures	reduction
Phenol	loads(t/y)	84.1	0.5	△ 99%
	rate(g/t-steel)	15	0.1	
Ammonia	loads(t/y)	1,009	168	△ 83%
	rate(g/t-steel)	181	30	
Cyanide	loads(t/y)	25.2	1.7	△ 93%
	rate(g/t-steel)	5	0.3	

3. SURVEY AND STUDY OF SELECTED FACILITIES (MODEL PLANTS)

3.1 Coke Plant and Coke Chemical Plant

3.1.1 Present status of pollutants generated from coke plant and coke chemical plant

The generation of environmental pollutants from the coke oven battery (COB), the coke dry quenching facility (CDQ), and the coke chemical plant is shown in Fig. III.3-1. Treatment of harmful matter such as phenol and cyanide ion contained in the waste water and countermeasures against dust are most important.

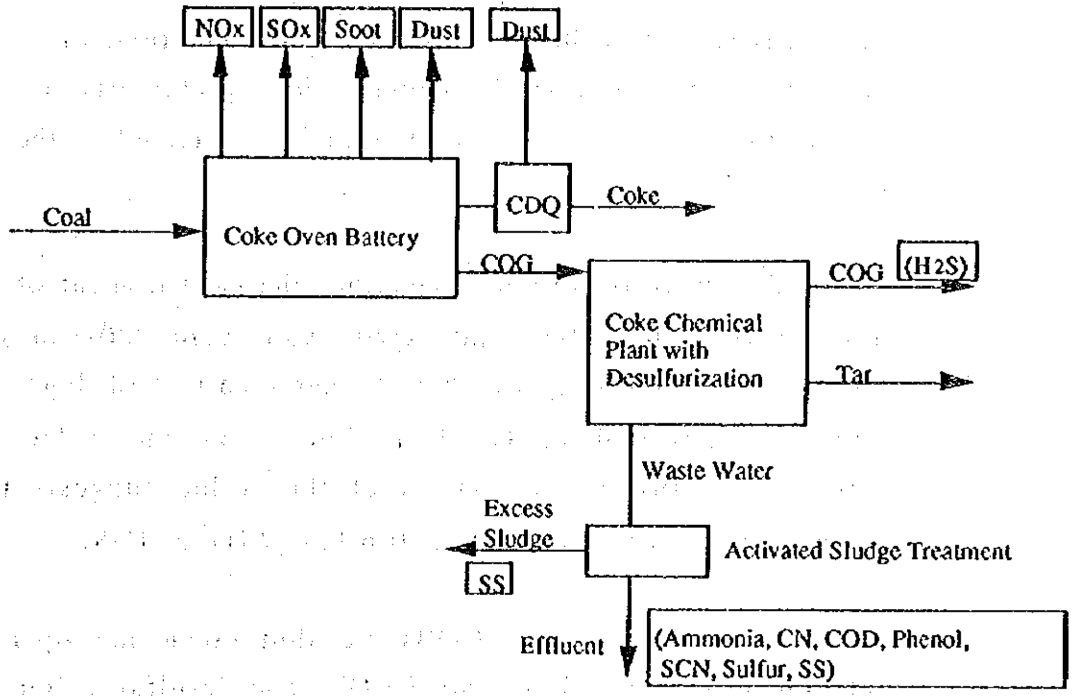


Fig. III.3-1. Pollutants from Coke Plant and Chemical Plant

3.1.2 Analysis of pollutants in waste gas, dust, and gas leakage

1) SOx

The concentration of SOx in the combustion waste gas from COB depends on the quantity of sulfur contained in the fuel gas (refined COG in the case of No.5 COB) and on the gas leakage rate between the coking chamber and the flue in case of damaged refractories of COB. Since the No.5 COB is comparatively young of about eight years after relining, the leakage of gas between the coking chamber and the flue is small and so the concentration of SOx in the waste gas seems to be caused mostly by the sulfur contained in the fuel gas.

The COBs in the first area where No.5 COB is located use COG only, and there are two COG refining lines in operation as shown in Fig. III.3-2, one of which is equipped with COG desulfurization equipment. Because the operation rate of the coke oven batteries in 1992 was as low as 80% of the rate at full operation, the generated volume of COG was small, which allows preferential use of the second refining line, lowering the sulfur contained in the refined COG.

Under the above operational situation, the measurement of emitted SOx in December 1993 and April 1994 were 280-320 mg/Nm^3 (conversion at O_2 3%), which is higher than that of Japan (30-60 mg/Nm^3, converted at O_2 3%), but clears the value of the Agreement. Inverse calculation of this value suggests that the sulfur content of refined COG is 0.6-0.7 g/Nm^3 as H_2S.

In 2002, if Nos. 1 to 4 COBs are shut down and operation is integrated into Nos. 5, 6, and 7 COBs and desulfurization plant is installed in No.2 Chemical plant (for No.7 COB), all the operating COBs will have the desulfurization equipment individually. This, in turn, will lead to the content of sulfur at 0.3-0.4 g/Nm^3 (desulfurization efficiency 80%) in Nos. 5 and 6 COBs and at 0.05 g/Nm^3 (desulfurization efficiency 99%) in No.7 COB, showing the values lower than the present.

Consequently, in 2002, SOx emission will clear the value of the Agreement.

2) NOx

NOx contained in the combustion waste gas from COB largely depends on the operation rate, temperature, and type of the ovens. Results of the analyzed waste gas in December 1993 and April 1994 are that the NOx concentration is 480 mg/Nm^3 (converted at O_2 3%) and falls within the range of the Agreement value 500 mg/Nm^3. For reference, the results of Japan in 1992 were:

- 220-360 mg/Nm^3 in the case of lean gas combustion (1,000-1,200 kcal/Nm^3)
- 280-500 mg/Nm^3 in the case of rich gas combustion (3,800-4,200 kcal/Nm^3)

In 2002, high-productivity operation will be required due to the facility consolidation, and if no measures are taken, high temperature operation of COB will be needed, bringing about NOx at the concentration of about 665-810 mg/Nm^3. As improvement measures, therefore, execution of energy-saving measures for intensified control of COB combustion will restrain the average temperature of COB at about 1,295°C. Then, NOx can be decreased to about 545 mg/Nm^3. See Fig. III.3-3. Furthermore, as recommended in energy saving, change of fuel gas from only COG to mixed gas with BFG will lower NOx to about 400-490 mg/Nm^3, which is below 500 mg/Nm^3.

3) Soot

Though soot was not measured in the site survey because suitable sampling point was not available, the CO concentration was 0.1-0.2% in the waste gas and black smoke was sometimes seen from the chimneys, fairly a large amount of soot seems to exist when the operational conditions of COB are not good.

First of all, sampling points should be placed at the chimneys and soot should be measured periodically. The quantity of soot from the chimneys may be suppressed to be as low as the level of Japan (0-4 mg/Nm^3) by the improvement of combustion control.

4) Dust

(1) In charging and discharging materials into and out of COB, large generation of dust was observed, especially at discharging, because of no dust collectors. Therefore,

- To prevent dispersion of dust at discharging of coke:

  Installation of dust collection system similar to that of Japan is needed. In Japan, as general method of dust collection at discharging of coke from COB, hood of guide car suctions the generated dust and collected into the ground dust collector.

- To prevent dispersion of dust at charging of coal:

  In many of the steelworks in Japan, generated dust collected by pre-duster mounted on a charging car are collected into the ground dust collector, and at the same time, smokeless charging system (high-pressure gas liquor is injected in the ascension pipe to collect dust to the gas side) is installed. Employment of pre-duster/ ground dust collector system, however, is difficult for SIDEX because the ascension pipes are installed at both sides of the coke oven and also because this will increase the weight of the charging car. The best method, therefore, will be to employ improved smokeless charging system in order to restrain the dispersion of generated dust.

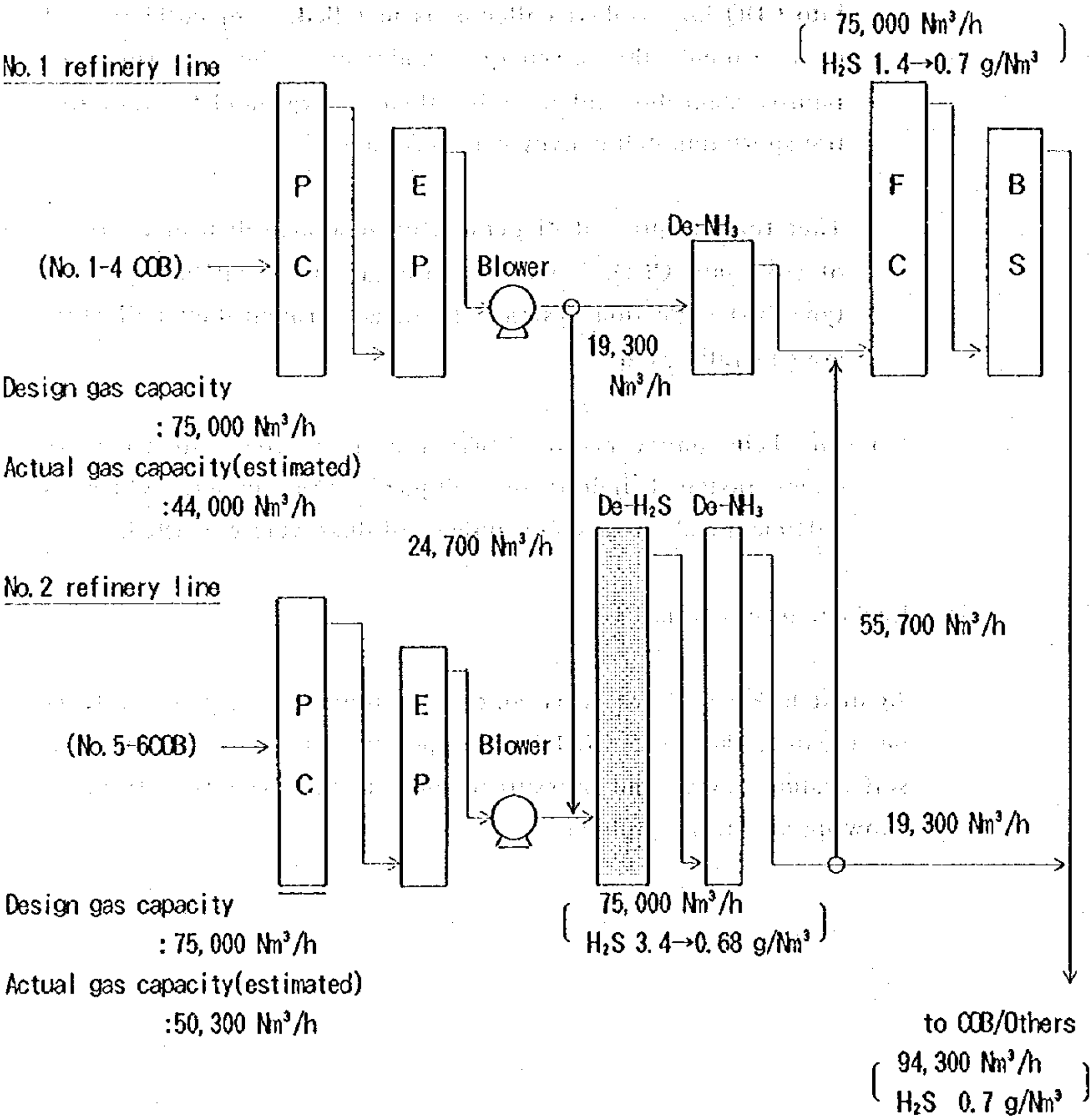
(2) High generation of dust was also observed at charging of coke into CDQ but no dust collector is installed. For collection of dust around the discharge equipment, the environment-improvement dust collector installed underground for the coke transportation belt conveyor is sufficient.

Therefore, to prevent dispersion of generated dust at charging of coke into CDQ, it will be necessary to install a Japanese-type dust collection system. In Japan, ground dust collectors are generally used.

(3) The belt conveyors for transportation of coal and coke are either installed indoor or equipped with covers, which is sufficient and no special problems of dust were observed.

5) Leakage of gas from COB

Against leakage of gas from coke oven doors or entry of air from the outside, the No.5 COB is equipped with new oven door with self-sealing device and pressure control in the oven is sufficient, showing no special problems.



PC:Primary cooler EP:Electric precipitator FC:Final cooler
BS:Benzol scrubber COB:Coke oven batteries

Fig. III.3-2. Outline of SIDEX's COG Refinery Lines in Coke Chemical Plant in No.1 area

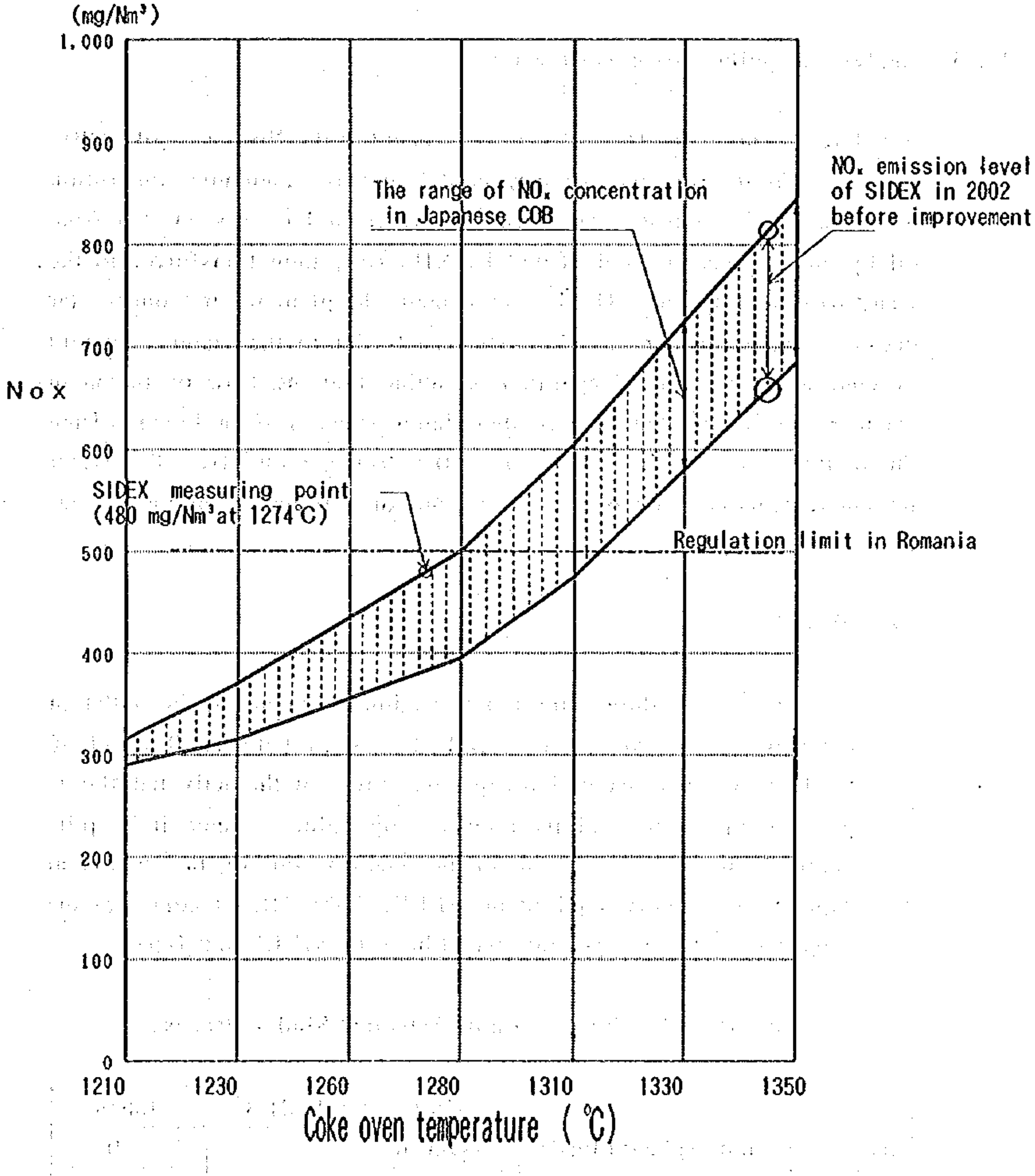


Fig. III.3-3. Relation of NOx & coke oven temperature
(An example of Japanese COB)

3.1.3 Analysis of pollutants in waste water

Fig. III.3-4 shows the flow of water treatment in the No.1 area of COBs. The gas liquor from the primary cooler and the ammonia absorption tower and the condensed water from the final cooler are separated from oil by the tar decanter and treated by NH3-still, then transferred to the water treatment system. On the other hand, the plant water from the tar decanter and rainwater are similarly transferred to the water treatment system, and after oil is separated, combine into the flow of the main waste water and treated by activated sludge process as in Japan. Then the treated water is discharged from the drainage outlets. The water treatment process consists of several unit operations as shown in Fig. III.3-5.

1) Phenol

As Fig. III.3-6 shows, the concentration of phenol at the outlet of the water treatment system greatly fluctuates between 0.3 and 50 mg/lit maybe because of improper designing of the activated sludge process equipment and its improper operation. Since it is quite stable below 0.3 mg/lit in Japan, stabilization of the treatment capacity is urgently required in SIDEX. Table III.3-1 compares the activated sludge process equipment between SIDEX and Japan.

Table III.3-1. Comparison of Activated Sludge Process

	Unit	SIDEX	Japan
Aeration capacity (phenol load)	$kg/m^3.d$	-	1.0
Thickener retention time	hours	0.4	3.0
pH control	-	Applied	Applied
MLSS control	-	None	Applied
DO control	-	None	Applied
ORP control	-	None	Applied

Conclusively, the activated sludge process equipment of SIDEX has the following problems:

(1) Equipment problems

Aeration is not sufficient. The capacity of thickener for separation of sludge is quite small, compared with that of Japan.

(2) Operational problems

Sludge concentration, phenol rate, mixed liquor suspended solid (MLSS), dissolved oxygen (DO), oxidation reduction potential (ORP), etc. in the aeration tank are not controlled based on measurements.

After implementation of the measures mentioned in Section 3.1.4, the phenol concentration is expected to be decreased to be below 0.3 mg/lit, similar to that in Japan. The diluting process at the drainage outlet (design base 50 times, actual value 33 times) will lead to sufficient clearance of the Agreement value of 0.14 mg/lit at the drainage outlet.

2) Ammonia

The pH adjuster that can simultaneously treat free $NH4^+$ and fixed $NH4^+$ using NaOH and NH3-still are installed, which is sufficient, compared with most Japanese facilities having only the treatment of free $NH4^+$. The ammonia concentration at the outlet of the present water treatment system and at the drainage outlet is as high as 200-600 mg/lit and 31 mg/lit, respectively, showing not sufficient functioning of the facilities (see Fig. III.3-7). This may be because the concentration of ammonia at the outlet of NH3-still (at the inlet of activated sludge process equipment) is actually 1,000-3,000 mg/lit against the design value of less than 400 mg/lit, possibly caused by insufficient conversion from fixed ammonia to free ammonia due to no automatic control of pH in spite of large fluctuation of ammonia concentration of raw water. In addition, the material of heat exchangers at the NH3-still is Al alloy and is not good.

As measures, therefore, pH adjuster should be installed at the tank in front of the NH3-still in order to control pH precisely and also the material of the heat exchanger should be changed to stable one such as titanium.

Then the ammonia concentration at the exit of NH3-still will be 150-200 mg/lit (95% removal), 75-100 mg/lit at the outlet of the water treatment system, and 2.3-3.0 mg/lit at the drainage outlet, thus the Agreement value of 3 mg/lit will be cleared.

3) Cyanide ion (CN^-)

As pH adjustment and aeration in the waste water treatment system are not sufficient, the concentration of CN^- at the outlet of the system is as high as 2-15 mg/lit.
And the concentration is about 0.58 mg/lit at the drainage outlet after dilution, though the Agreement value is 0.03 mg/lit.

If SIDEX improve the system control similar to Japanese one as the measures, the CN^- concentration at the outlet of the system will be 1-4 mg/lit.
And if SIDEX add the new precipitator system after that, the CN^- concentration at the outlet of the system will be below 1 mg/lit.
As the result, the CN^- concentration at the drainage outlet will be lead to sufficient clearance of the Agreement value of 0.03 mg/lit at the drainage outlet.

4) Chemical oxygen demand (COD)

This is now not a control item but should be controlled in future.

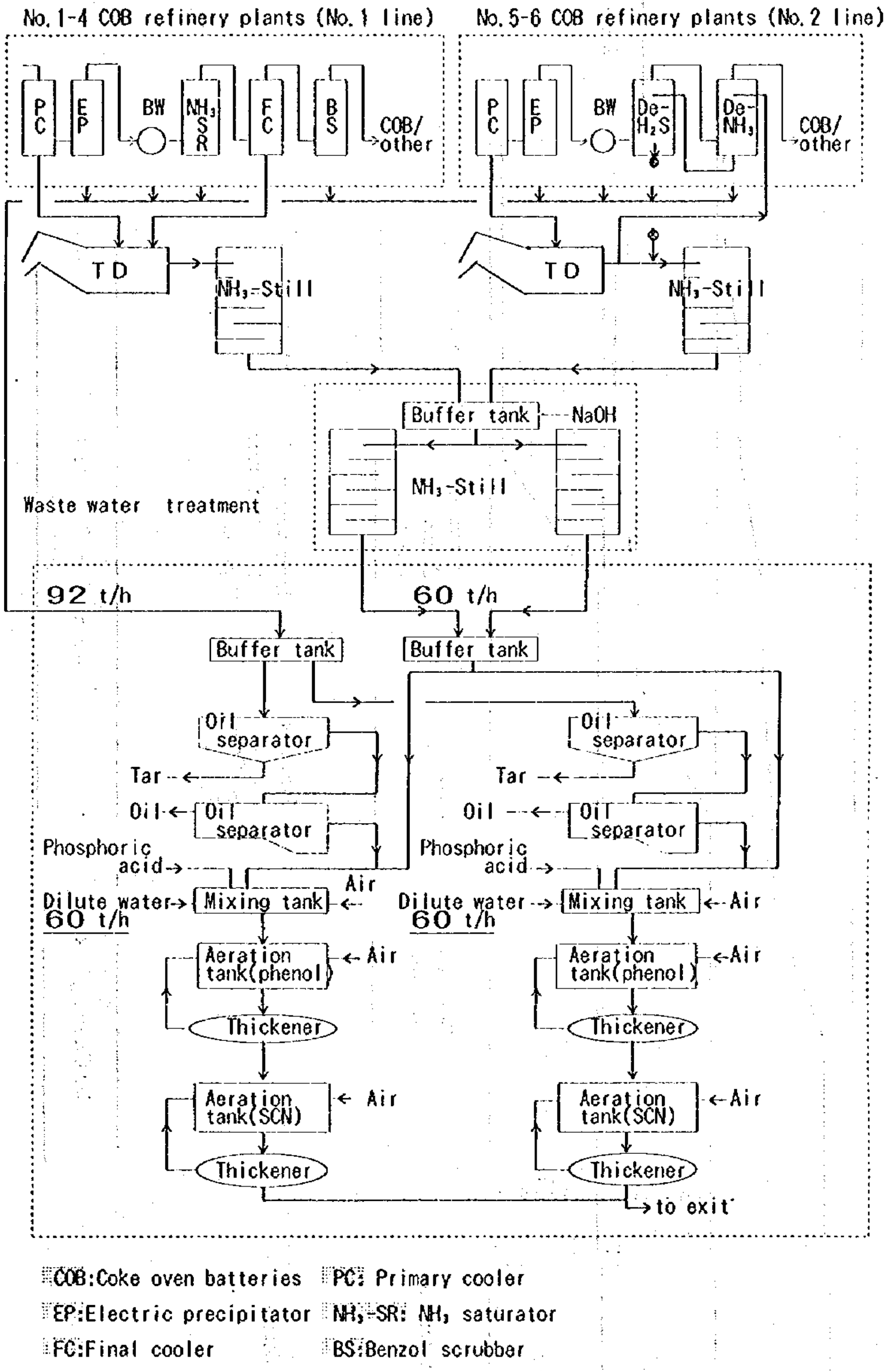


Fig. III.3-4. Flow Sheet of Waste Water Treatment Plant for Coke Chemical Plant in No.1 area

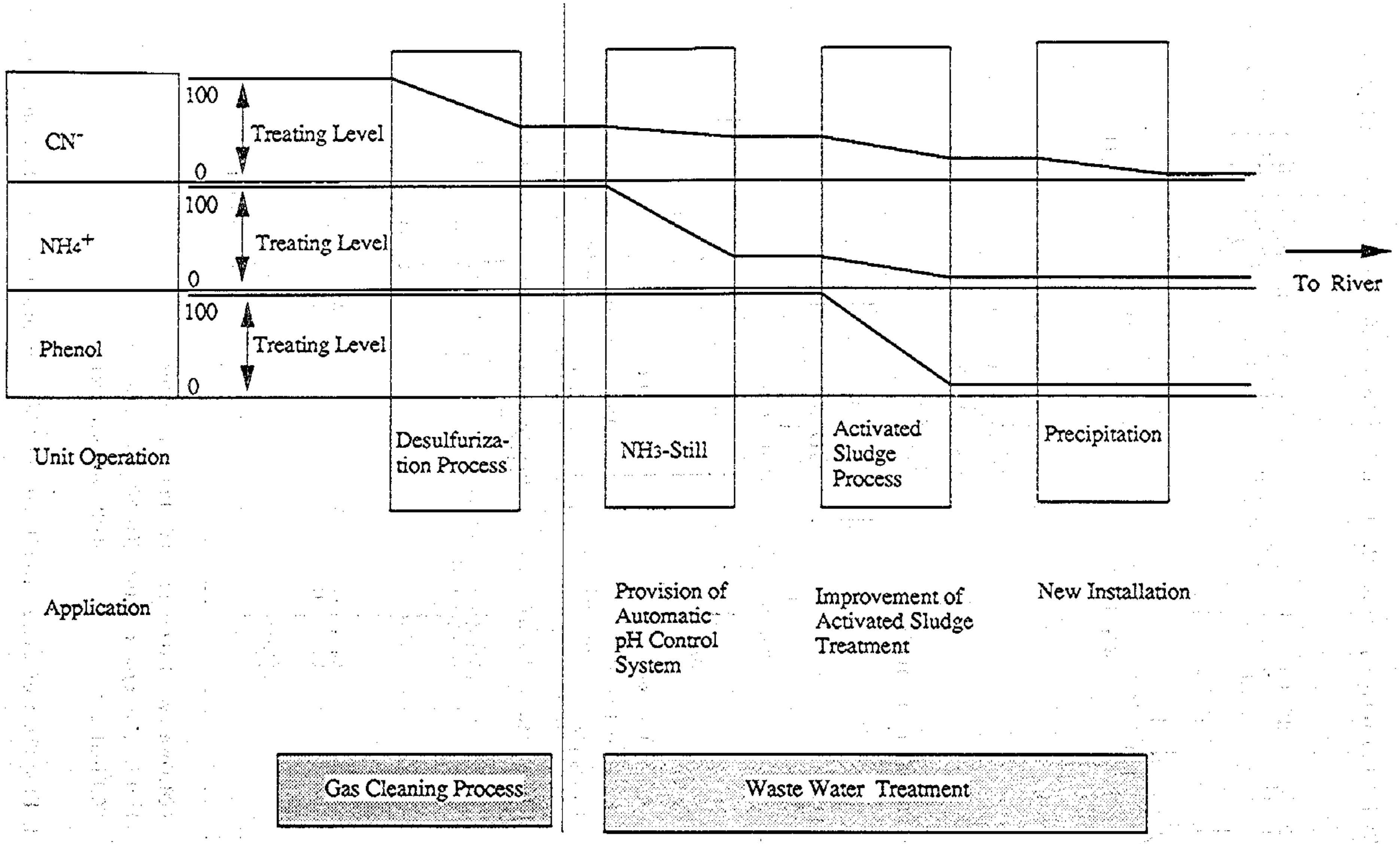


Fig. III.3-5. Schematic View of Waste Water Treatment Process in Coke Chemical Plant

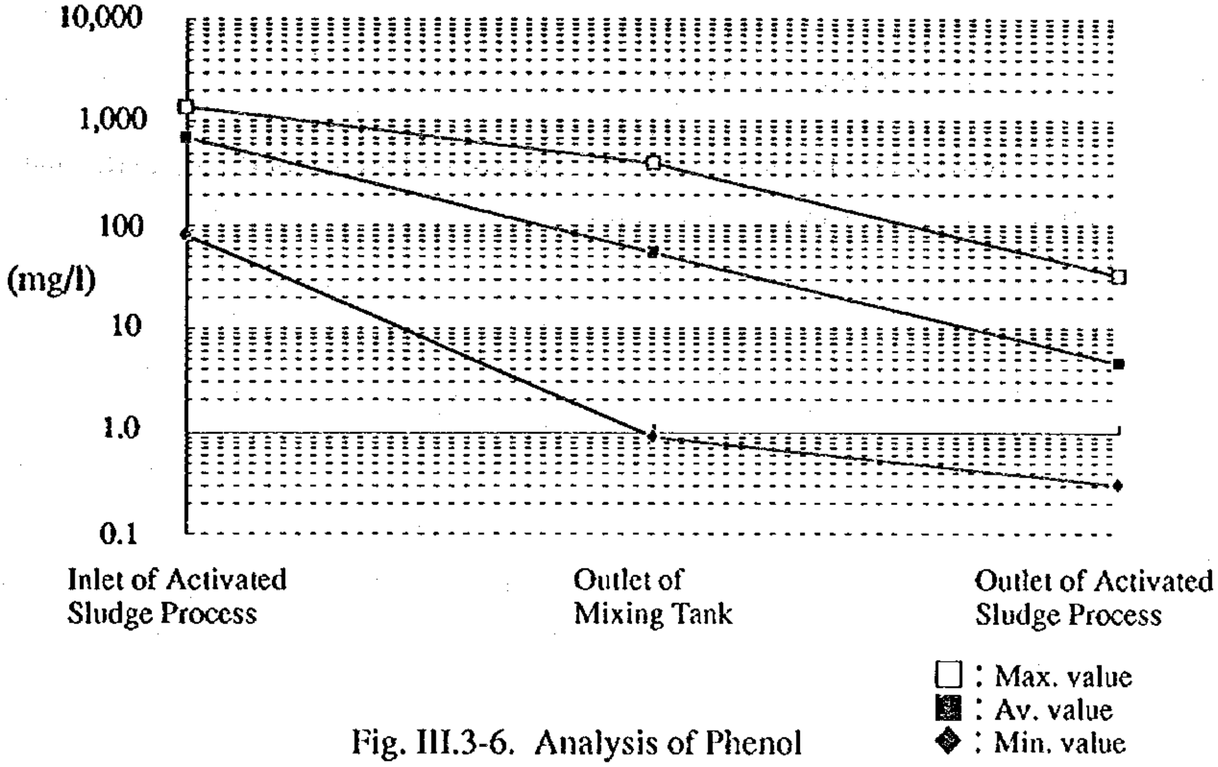


Fig. III.3-6. Analysis of Phenol

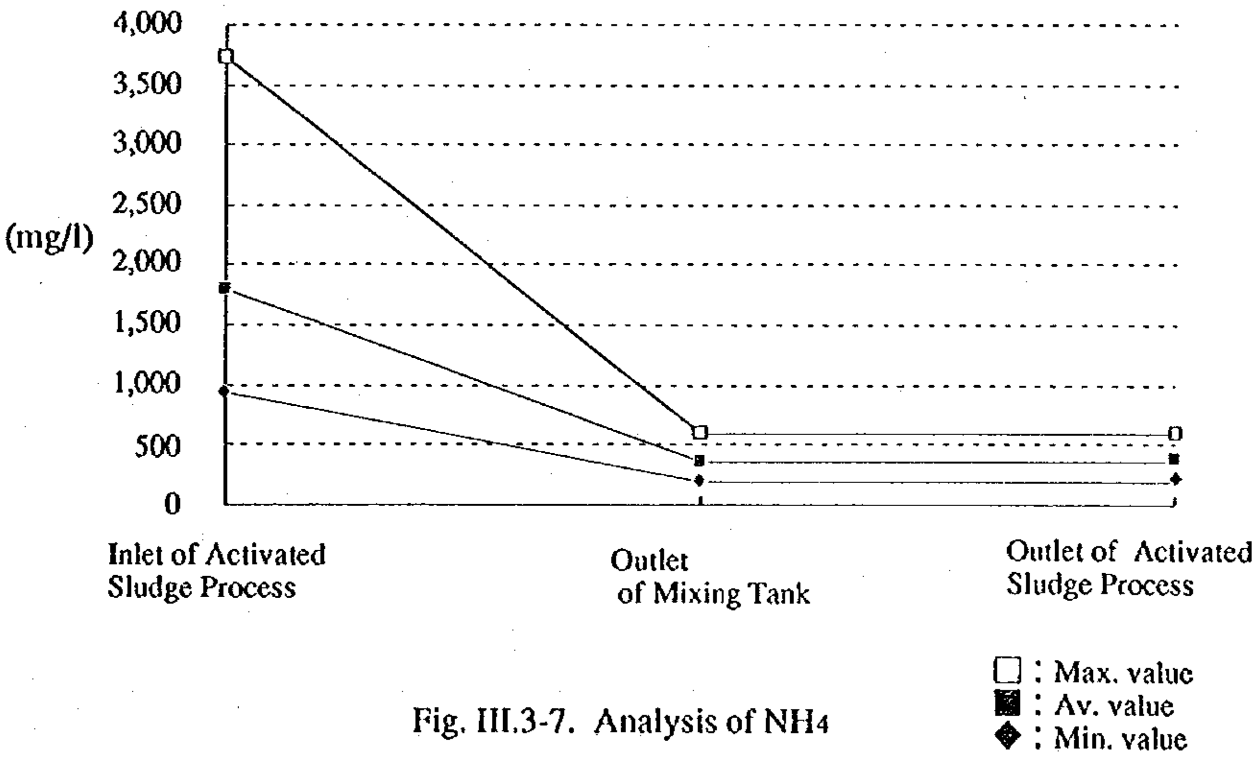


Fig. III.3-7. Analysis of NH_4

3.1.4 Measures and estimated effects

The environmental measures for the coke oven battery and their estimated effects are shown in the next tables.

3.1.4.1 Measures to decrease air pollutants (NOx, SOx, soot, dust)

Purposes		Measures	Details of Measures	Estimated Effects in 2002
1. To improve the operation (including enhanced control of operation and maintenance)	To decrease NOx, SOx, and soot by improvement of combustion control/ operation	• To identify abnormal combustion oven and to adjust it • To decrease damage to oven bricks and failure of coke oven machinery • To optimize operating conditions	As given in Section II.3.1.5.1	• Decrease of NOx: 85-100 t/y (810 → 720 mg/Nm^3) • Decrease of SOx: 0-5 t/y • Decrease of soot: 5 t/y
2. To add new functions or to renew the equipment	To decrease NOx, SOx, and soot by semi-automatic combustion control	• To install combustion control system with on-line instruments • Data processing by a personal computer	As given in Section II.3.1.5.1	• Decrease of NOx: 75-90 t/y (720 → 545 mg/Nm^3) • Decrease of SOx: 0-5 t/y • Decrease of soot: 5 t/y
	To decrease NOx by changing fuel gas from COG to mixed gas of COG and BFG		To decrease NOx in waste gas by decreasing flame temperature	• Decrease of NOx: 30-40 t/y (545 → 490 mg/Nm^3) • Decrease of SOx: 10 t/y
	To decrease dust during discharging coke out of COB and during charging coke into CDQ	To install a dust collector with ducts	To install a common dust collector for both the guide car and the charging device of CDQ (Bag filter capacity: 3,000 Nm^3/min.)	
	To decrease dust during charging coal into COB	To improve the smokeless charging system	① Changing the ascension pipe seal from mechanical type to water seal type ② Replacement of pumps for high pressure ammonia liquor	

3.1.4.2 Measures to decrease water pollutants (NH4, CN$^-$, Phenol)

Purposes		Measures	Details of Measures	Estimated Effects in 2002
To add new functions or to renew the equipment	To decrease phenol and CN$^-$ in the waste water by improving the equipment and the control system of activated sludge process (ASP)	•To improve the aeration equipment and the thickener •To install automatic control system	•Aeration tank/mixing tank: 1 set •Thickener: 1 set •To install instruments: 1 set (MLSS meter, COD meter, pH meter, ORP meter, flow meter) •To install the control system for adjustment of the control index (pH, COD, MLSS, ORP)	•Decrease of phenol: 0.3-84 t/y (50 → 0.3 mg/lit) •Decrease of CN$^-$: 1.7-18.5 t/y (15 → 4 mg/lit)
	To decrease NH4$^+$ by automatic pH control in the upstream of NH3-still	To install automatic control system of pH & flow rate	To install controller and instruments: 1 set (pH meter, caustic soda flow meter, etc.)	Decrease of NH4$^+$: 210-841 t/y (600 → 100 mg/lit)
	To decrease CN$^-$ in waste water	To install new precipitator	To install the following: •Thickener : 1 set •Flocculant dosing equipment : 1 set	Decrease of CN$^-$: 1.2-5.0 t/y (4 → 1.0 mg/lit)

3.1.4.3 Summary of estimated effects

1) Air pollutants

	Present (No.5 COB: 627.0 x 10^3 t-dry coal)	In 2002 (No.5 COB: 835.0 x 10^3 t-dry coal)	
		Before the improvement (Nos. 5-6 & 7 COBs with PCI system)	After the improvement (Nos. 5-6 & 7 COBs with PCI system)
• Concentration of NOx (mg/Nm^3)	340-440	665-810	400-490
• Concentration of SOx (mg/Nm^3)	280-320	130-170	120-150
• Concentration of soot (mg/Nm^3)	20	20	<5
• NOx emission (t/y)	150-190	430-520	240-290 (-120 to -230)
• SOx emission (t/y)	120-140	80-110	70-90 (-10 to -20)
• Soot emission (t/y)	9	13	3 (-10)

2) Water pollutants

	Present (No.5 COB: 627.0 x 10^3 t-dry coal)	In 2002 (No.5 COB: 835.0 x 10^3 t-dry coal)	
		Before the improvement (Nos. 5-6 & 7 COBs with PCI system)	After the improvement (Nos. 5-6 & 7 COBs with PCI system)
• Concentration of phenol (mg/lit)	0.3-50	0.3-50	0.1-0.3
• Concentration of $NH4^+$ (mg/lit)	200-600	200-600	75-100
• Concentration of CN^- (mg/lit)	2-15	2-15	0.3-1.0
• Waste water (m^3/h)	270	192	192
• Phenol emission (t/y)	0.7-118	0.5-84.1	0.2-0.5 (-0.3 to -83.6)
• $NH4^+$ emission (t/y)	473-1,419	336-1,009	126-168 (-210 to -841)
• CN^- emission (t/y)	4.7-35.5	3.4-25.2	0.5-1.7 (-2.9 to -23.5)

3.2 Sintering Plant

3.2.1 Outline of pollutants emission from sintering plant

Fig. III.3-8 shows the outline of pollutants emission from sintering plant.

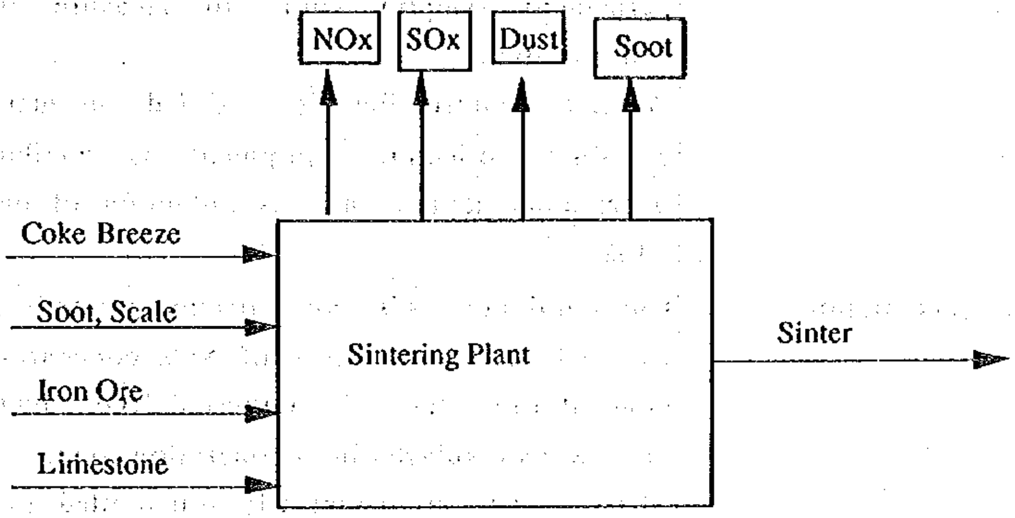


Fig. III.3-8. Pollutants from Sintering Plant

3.2.2 Measuring pollutants and monitoring system

The environmental pollution control system for the main exhaust gas from the sintering plant is important and should be firmly established. The pollutants measured and the monitoring system for the main exhaust gas in Japan are shown in Table III.3-2. In SIDEX, soot, SOx, and NOx are not measured and their monitoring systems are not provided. These pollutants should be measured, at least in a batch, periodically and controlled.

Table III.3-2. Environmental Control Systems for Main Waste Gas of Sintering Plants in Japan

Dust concentration	One continuous dust concentration meter is installed for each stack and measured values are always displayed in the operation room. About once a month dust sampling by gas suction is conducted from a permanent sampling hole to measure the dust concentration. When the control limit is exceeded, the maintenance of dust collecting equipment is conducted or operational action, such as reduction of output, is taken.
NOx concentration	One continuous NOx concentration meter is installed for each stack and values of NOx concentration, O_2 concentration, and 15%-converted NOx concentration are always displayed in the operation room. These values are constantly transmitted to a local agency through a communication line. When the control limit is exceeded, operational action is taken, for example, by reducing the output or increasing the amount of quick lime added.
SOx concentration	For each lot in the case of raw materials and fuels and for each shift in the case of sinter products, the sulfur content is analyzed and sulfur balance is calculated. When desulfurization equipment is installed, the SOx concentrations before and after the equipment are usually measured continuously.

3.2.3 Measurements of pollutants at No.7 sintering plant

Sampling and measuring of pollutants in the main exhaust gas from the No.7 sintering plant were conducted on 7 and 10 December 1993 during the first site survey. That is, the contents of dust at the inlet and outlet of E.P. and SOx and NOx at the outlet of the main exhaust blower were measured as shown in Table III.3-3. The concentration of dust is lowered from 600 mg/Nm^3 at the inlet of E.P. to 300 mg/Nm^3 at its outlet and the dust removing efficiency is quite as low as 50%. The concentration of SOx is 75-100 ppm and that of NOx is 100-130 ppm, lower than those of Japan by 30 to 50%. Considering that oxygen concentration is 18% and that air leakage is as much as 66% in SIDEX, however, the unit rate of generation is higher than that of Japan by about 50%.
It was confirmed at second survey that these pollutants values were similar to the results measured since then by SIDEX.

3.2.4 Analysis of the problems and measures

1) Measures for dust in the main exhaust gas from the sintering plan

As stated above, the removing efficiency of E.P. is quite as low as about 50% judging from the measurements at the site survey. To improve the efficiency of E.P. is therefore one of the essential measures for the improvement of the sedimented dust in Galati.

The gas retention time of the main E.P. is as long as 16 seconds and the charging capacity is as much as 55 kV for the 250 mm of distance between the electrodes. Therefore, the cause of low dust removing efficiency is presumed the high alkali content in material and that dust is not adsorbed by the dust collecting plate because of the reverse electrolytic dissociation caused by highly alkaline dust. Accordingly, the first measure should be to control the inflow of alkali through analysis of alkali contained in the raw material, sinter product and E.P.dust. In the case of high alkali dust, a common

E.P. cannot cope with the situation and E.P. of moving electrode type should be installed instead.

2) Measures for SOx in the main exhaust gas from the sintering plant

The sulfur balance at the present and in 2002 in SIDEX and in typical Japanese steelworks are calculated in Table III.3-4.

The sulfur inflow will be as high as 0.97 kg/t in 2002. However since the gasification rate is low and volume of exhaust gas is high, the SOx concentration in the exhaust gas will be 155 ppm (435 mg/Nm^3), similar to the level in Japan. Therefore, without restriction on oxygen concentration, the SOx concentration will overcome 500 mg/Nm^3 as the present value of Agreement in 2002. But the ratio of gasification if raised by the improvement of burning fuel will be same as 70% in Japan. In this case SOx concentration in the exhaust gas will be 245 ppm (700 mg/Nm^3) so that desulfurization by 30% will be required.-
In the case of O_2 15% calculation, the SOx concentration will be 930 mg/Nm^3 with gasification ratio 70%, requiring desulfurization by about 50%.

Dry type de-sulfurization system by moving bed of activated coke is suitable for SIDEX, since which stands beside river and so is restricted severely pollution of waste water. In this case, 75% desulfurization can be expected.

3) Measures for NOx in the main exhaust gas from the sintering plant

NO_2 balance is calculated in Table III.3-5 as in the case of SOx. On the assumption that the apparent NO_2 conversion rate is 33%, the concentration of NOx will be 166 ppm (337mg/Nm^3) even in future, similar to that in Japan, and without oxygen concentration restriction, the present Agreement value of 500 mg/Nm^3 will be cleared. In the case of oxygen concentration rate 15%, the NOx concentration will be 445 mg/Nm^3, requiring no denitration

4) General dedusting measures

The charge end and discharge end of the sintering plant need intensified dedusting.

To allow the dust at the discharge end to be sucked into the strand and to transfer the remaining air volume to the charge end, however, intensification of dedusting capacity without facility expansion will become possible.

Concerning the dedusting at the cooler, intensified recovery of sensible heat from the exhaust gas as energy-saving measures will lower the dust content of exhaust gas because dust is generated mainly in the high temperature zone of exhaust gas, and this will simultaneously solve the problem of dedusting at the cooler.

Table III.3-3. MEASUREMENT RESULT AT No. 7 SINTERING PLANT

1. DATA AND CONTENT OF MEASUREMENT

1st Measurement	07. Dec. 1993. 09:00 ~19:00	SOOT & COMPOSITION AT OUTLET OF EP.
2nd Measurement	10. Dec. 1993. 09:00 ~15:00	SOOT AT INLET OF EP. SOOT AT OUTLET OF EP.

2. RESULT OF MEASUREMENT

1) Soot Concentration

	INLET OF EP	OUTLET OF EP
1st Measurement	———	276 mg/Nm³
2nd Measurement	628 mg/Nm³	327 mg/Nm³

2) SO_x
1st Measurement SO = 75 ~ 100 ppm

3) NO_x
1st Measurement NO = 100 ~ 130 ppm

→ 30 ~ 50 % lower than in Japan
(Affected by dilution by air leakage.)

4) Oxygen
1st Measurement O_2 = 18.0 ~ 18.5 % → If process O_2% is 12 % air leakage is 67 % (20~30 % in Japan)

5) CO_2/CO
1st Measurement CO = 0.5 ~ 0.7 %
CO_2 = 3.25 ~ 3.5 %

6) Gas Velocity

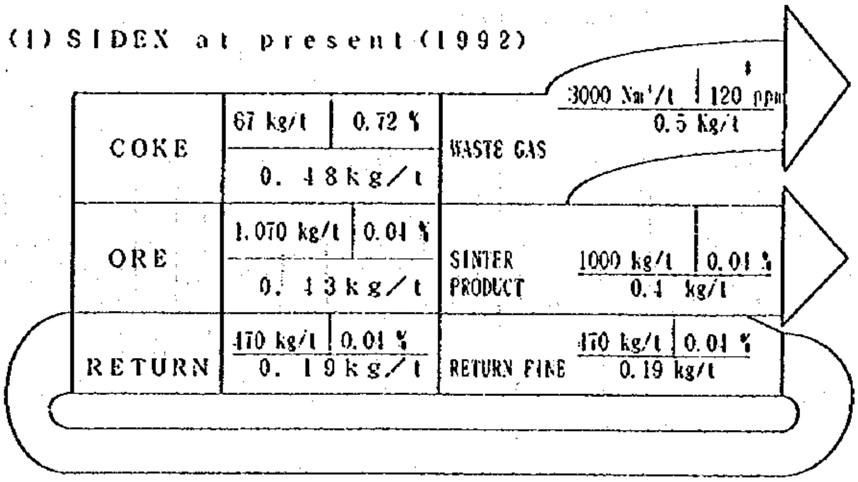
	INLET OF EP	OUTLET OF EP
1st Measurement	———	32.2 m/sec
2nd Measurement	20 m/sec	31.4 m/sec

7) Gas Temp. & Pressure

	INLET OF EP (17.7 m²)	OUTLET OF EP(12.0m²)
1st Measurement	———	107 ° C, -5 mmHg
2nd Measurement	110 ° C, -33 mmHg	105 ° C, -4.9 mmHg

Table III.3-4. Sulfur Balance

(1) SIDEX at present (1992)

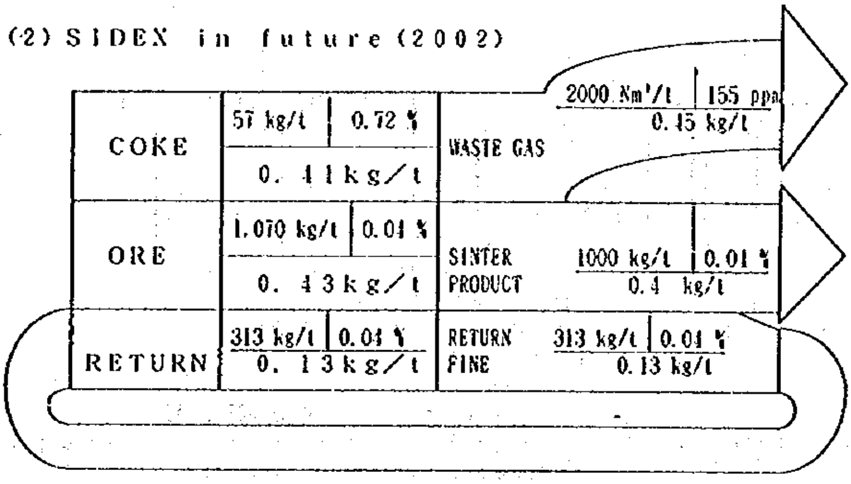


* This is the calculated value on the basis of sulfur balance.

Calculation result

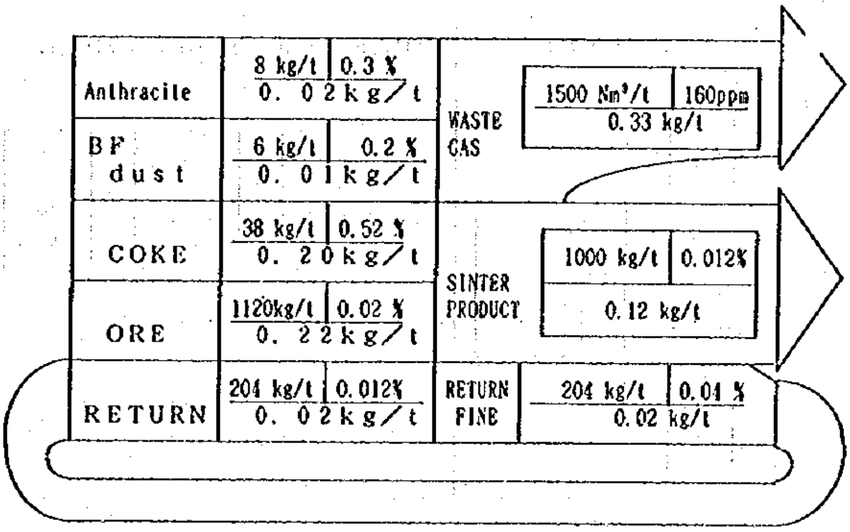
INPUT SULFUR	1.10 kg/t
EMISSION SULFUR	0.50 kg/t
EMISSION RATIO	46 %

(2) SIDEX in future (2002)



INPUT SULFUR	0.97 kg/t
EMISSION SULFUR	0.43 kg/t
EMISSION RATIO	44 %

(3) JAPAN at present (1992)



INPUT SULFUR	0.47 kg/t
EMISSION SULFUR	0.33 kg/t
EMISSION RATIO	70 %

A	B
C	

A: Unit consumption, kg/t sinter product

B: Sulfur concentration, %

C: Sulfur unit value, kg/t sinter product

Table III.3-5. Estimation of NO_2 Emission

SIDEX 1992

Nitrogen input volume from fuel

Coke breeze		N%		A
67 kg/t	×	1.1%	⇨	0.74 kg/t

Nitrogen volume as NO_2 in waste gas

Waste gas		NO_2 conc		B
3,000 Nm^3/t	×	120 ppm	⇨	0.71 kg/t

$$NO_2 \text{ change ratio} = \frac{B}{A} \times \frac{14}{46} \Rightarrow 30\ \%$$

SIDEX 2002

Nitrogen input volume from fuel

Coke breeze		N%		C
57 kg/t	×	1.1%	⇨	0.63 kg/t

NO_2 change ratio

D
33 %

$$NO_2 \text{ emission volume} = C \times \frac{D}{100} \times \frac{46}{14} = 0.68 \text{ kg/t}$$

$$NO_2 \text{ concentration in waste gas} = \frac{NO_2 \text{ volume}}{\text{Waste gas volume}} = \frac{0.68 \times 22.4 \times 10^6}{2000 \times 46} = 166 \text{ ppm}$$

Typical Example in Japan

Nitrogen input volume from fuel

Fuel		N%		A
Coke breeze 38 kg/t	×	1.1%		
BFD 6 kg/t	×	0.5%	→	0.50 kg/t
Anthracite 8 kg/t	×	0.3%		

Nitrogen volume as NO_2 in waste gas

Waste gas		NO_2 conc		B
1,500 Nm^3/t	×	190 ppm	⇨	0.58 kg/t

$$NO_2 \text{ change ratio} = \frac{B}{A} \times \frac{14}{46} \Rightarrow 36\ \%$$

3.2.5 Measures and estimated effects

The environmental measures for the sintering plant and their estimated effects are shown in the next tables.

3.2.5.1 Environmental measures for sintering plants

Ranking of measures		Outline of measures
I	Improvement of operation	1. Measures against soot in main exhaust gas (1) Keeping of the hammering function of the EP (2) Discontinuance of the reuse of EP dust (decrease in the alkali input by 1/8) 2. Measures against SOx (1) Decrease of coke breeze consumption 3. General dust-collection measures (1) Elimination of the clogging of dust-collecting pipe with dust (2) Maintenance of the seal of the dust-collecting hood
II	Partial modification of equipment	1. General dust-collection measures (1) Enhancement of the dust collection in the ore feeding part and sinter discharge part of a sintering machine
III	Expansion and renewal of equipment	1. Measures against dust in main exhaust gas (1) Installation of moving electrode type EP (2) Installation of desulfurization equipment (3) Establishment of control system for soot, NOx, and SOx concentrations 2. Measures against cooler dust Installation of equipment for recovering the sensible heat of cooler waste gas

3.2.5.2 Predictions of pollutant concentrations in main exhaust gas

	Dust (mg/Nm^3)	SOx (ppm)	NOx (ppm)
Present			
• Measured (O_2 18%)	280-330	50-100	100-130
• Corrected in terms of O_2 concentration (O_2 15%)	530-660	100-200	200-260
Future 2002			
• Estimated (O_2 16.5%)	<50	65 (75% desulfurization)	170 (No denitration equipment)
• Corrected in terms of O_2 concentration (O_2 15%)	-	85 (75% desulfurization)	227 (No denitration equipment)

3.3 Blast Furnace

3.3.1 Present status of pollutants generated from blast furnace

The pollutants generated from the blast furnace and the hot stove are shown in Fig. III. 3-9. To turn these pollutants into harmless matter and to reuse them effectively are the main targets.

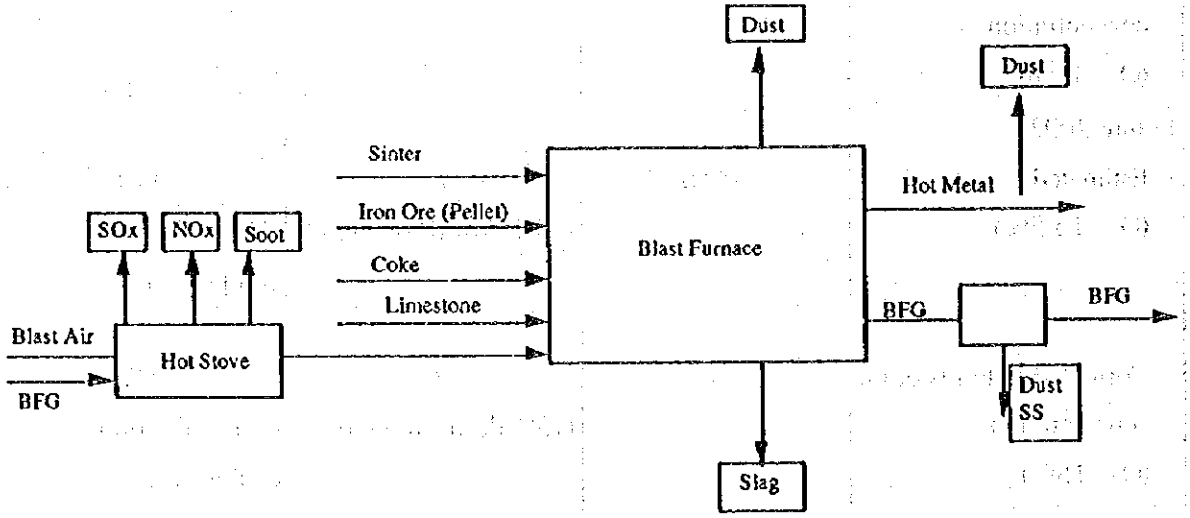


Fig. III.3-9. Pollutants from Blast Furnace

3.3.2 Analysis of the problems and measures

1) Dust generated from BF

The biggest environmental problem for the blast furnace is dust emission from the casthouse. Casthouse dust collectors of SIDEX, fully installed in Japan, are not functioning due to problems with filter bags and the control system. The required dedusting capacity for a BF of around 4,000 m^3 will be 15,000 Nm^3/min for each casthouse(for 6 BF, 15,000 x 2 casthouse = 30,000m^3/min.) according to operational experience in Japan, however the existing dust collector is 3000 m^3 x 4 , which is small and require capacity increase. In addition, enhancement of the runner cover is necessary to increase the dedusting efficiency.

As said the dust collection system for the cast floor requires large improvement. The dust collected by the dust collector should be transported to the thickener by industrial water to prevent incidental pollution.

2) Concentration of dust in BFG and soot from hot stove

The measurements made in the first site survey show that the concentration of dust in BFG, which is below 5 mg/Nm^3 in Japan, is as high as 105 mg/Nm^3. The measurement made later by SIDEX shows 85 mg/Nm^3. When calculated from these figures,the concentration of soot from the hot stove becomes 60-73 mg/Nm^3, exceeding the value of the Agreement. The reason will be improper operation of RSW and therefore water spray which meet the BFG quantity is necessary.

3) Emission of NOx and SOx from hot stove

The measurements made in the first site survey show that the concentration of NOx and SOx in the waste gas from the hot stove is 30-60 mg/Nm^3 and 1-2 ppm (oxygen concentration in waste gas is 3-5%) respectively, which are similar to the average levels in Japan, posing nearly no problems. In future, NOx may somewhat increase due to rise in the temperature of blast as caused by the decrease of BF fuel ratio. But the air-fuel ratio control at combustion, recommended as energy-saving measures, will be able to cope with the situation and large-scale measures for facilities may not be required.

4) BF waste water treatment

The waste water discharged from the thickener contains cyanide ion and phenol of less than 1 mg/lit. The level, however, is not a problem, considering the dilution rate of waste water. The SS in the waste water is as high as at about 300 mg/lit because of no filters, compared with that of Japan, but this is below the value of the Agreement and may not be a problem.

Withdrawal water from the thickener, however, flows into Marina Lagoon at 600 m^3/day. Dehydration of sludge and reuse (partly reused in the sintering plant) are needed. Analysis of the sludge back in Japan shows that it contains zinc 0.22%, T.Fe 32.8%, and carbon 9%, quite suitable for reuse. Analysis and control of the sludge should be started and continued in SIDEX, and if zinc will not be increased due to increased use of scrap, use of all the sludge in the sintering plant should be discussed.

The BF dry dust from the dust collectors is all reused in the sintering plant, and this should be continued.

5) BF slag treatment

Slag, the largest solid waste from steelworks, is all reused as cement material or road bed material in Japan. In SIDEX, however, only the slag in No.6 BF is given water granulation for reuse and almost all the slag from the other BFs is thrown away.

Accordingly, with good study of the demand, sales of slag to the outside should be promoted.