5.1.4 Pollution Source Model

Source modeling is made by taking into account configuration and scale of emission sources. Sources (stack, road, etc.) are classified into three types as shown below.

	Type of Pollutant Sources		
	Poing Source	Line Source	Area Source
Industrial and Commercial Establishments	Large scale (about 50 sources)	-	Small scale
Automobiles	-	Major roads	Minor roads
Househoteds	-	-	All

(1) Stationary Sources

1) Point Sources

About 50 major plants are treated as point sources. Emission conditions such as effective stack height, emission rate, etc. are determined individually. The ÉKF file was used as the basis and necessary corrections were made based on the results of the questionnaire and visiting survey and the flue gas measurement survey.

2) Area Sources

Medium-to-small industrial and commercial sources and other small-scale sources including households are treated as area sources. Pollutant emission quantity for each grid element was calculated based on the population and per-capita consumption of fuels estimated from the result of the fuel consumption survey. The population by grid elements is shown in Figure D5.1.6 in Data Book.

(2) Automobiles

1) Line Sources

Standardized roads like national highways and major roads where the traffic volume is more than 10,000 vehicles/day are treated as line sources.

2) Area Sources

Roads other than above-mentioned roads are treated as area sources.

(3) Effective Stack Height

The effective stack height is defined as follows:

$$H_e = H_o + H$$

where,

H_e : effective stack height
H_o : actual stack height
H : rise of the plume above the stack

1) Point Source

The rise of the plume above the stack (H) is determined by the following equations:

Windy condition	:	CONCAWE equation
Calm condition	:	Briggs equation

2) Others

The effective stack hight (He) is determined to be as follows:

Motor Vehicle	: 1.5 m
Stationary area source	: 15.0 m

(4) Time Variation Patterns

Time variations of plant operation, traffic volume, and fuel use in households were determined to be as follows.

1) Stationary Sources

i) Point source

Operation hours by seasons indicated in the ÉKF data file were used.

ii) Area source

Referring to the results of the questionnaire survey on home heating, ratios of fuel use in households by seasons and time zones were determined to be as follows.

Seasonal :

Non-heating season	:	16.7 %
Heating season	:	83.3 %

Time-zonal :

Morning : 25.2 %
Afternoon : 30.8 %
Evening : 30.8 %
Mid-night : 13.2 %

2) Automobiles

Based on the results of the fuel consumption survey and the traffic volume survey of 24 hours, ratios of traffic volume by seasons and time zones were determined to be as follows.

Seasonal :

Non-heating season : 55 %
Heating season : 45 %

Time-zonal :

Morning : 31.2 %
Afternoon : 38.0 %
Evening : 24.0 %
Mid-night : 6.8 %

(5) Amount of Pollutant Emissions

The amount of pollutant emission is calculated for each season and each time zone. Amounts of pollutant emissions from area sources are calculated for each grid element.

5.1.5 Dispersion Equations

(1) Point Source Equation

When windy (u > 0.4 m/s), the following plume equation is used.

$$C(R,z)=\frac{Qp}{\sqrt{2\pi}\,\frac{\pi}{8}R\sigma zU}\cdot\left[\exp\left(-\frac{(z-He)^2}{2\sigma z^2}\right)+\exp\left(-\frac{(z+He)^2}{2\sigma z^2}\right)\right]$$

$C(R, z)$: Concentration at the location (R, z)
R : Horizontal distance (m) from a point source to a computation point
z : z coordinates (m) of the computation point (along height)
Qp : Point source intensity (Nm^3/s)
U : Wind speed (m/s)
He : Effective stack height (m)
σz : Vertical dispersion parameter (m) (using the Pasquill-Gifford chart)

When calm ($u \leqq 0.4$ m/s), the following puff equation is used.

$$C(x,y,T)=\frac{1}{(2\pi)}\int_{o}^{T}\frac{2Qp}{\sigma y^2\sigma z}\exp\left(-\frac{(x-Ut)^2}{2\sigma y^2}-\frac{y^2}{2\sigma y^2}-\frac{He^2}{2\sigma z^2}\right)dt$$

A steady-state solution for the calm condition was applied after integrating the above equation up to $t = \infty$, with $U = 0$, $\sigma y = \alpha t$, and $\sigma z = \gamma t$.

$$C(R,z)=\frac{Qp}{(2\pi)^{3/2}\gamma}\cdot\left(\frac{1}{R^2+\frac{\alpha^2}{\gamma^2}(z-He)^2}+\frac{1}{R^2+\frac{\alpha^2}{\gamma^2}(z+He)^2}\right)$$

$R^2 = x^2 + y^2$

α, γ : Coefficients for dispersion parameters for calm
$\sigma x = \sigma y = \alpha \cdot t$
$\sigma z = \gamma \cdot t$
t : Time lapse (s)

(2) Area Source Equation

When windy, the plume equation applicable to long-term average concentration is used, assuming that a square area source with a side 2a long is present in isolation.

$$C = \frac{QA}{\sqrt{2\pi u}} \int_{x-a}^{x+a} \frac{2a}{\left(\frac{\pi}{8}\varepsilon + 2a\right)\sigma z(\varepsilon)} \cdot [F] d\varepsilon$$

$$[F] = \exp\left(-\frac{(z-He)^2}{2\sigma z(\varepsilon)^2}\right) + \exp\left(-\frac{(z+He)^2}{2\sigma z(\varepsilon)^2}\right)$$

QA : Area Source intensity (Nm3/s)
u : Wind speed (m/s)
He : Effective stack height (m)
σ z : Vertical diffusion parameter (m)
2a : Length (m) of a side of a square area source

When calm, the following equation is used by applying the simplified puff equation (steady-state solution) to a circular area source that has the same area as a square area source with a side 2a long.

$$C = \frac{QA}{(2p)^{3/2} r} \int_0^{a'} \int_0^{2} \left(\frac{1}{R'^2 + b_1^2} + \frac{1}{R'^2 + b_2^2}\right) r \cdot d\theta \cdot dr$$

$$a' = \frac{2a}{\sqrt{\pi}}$$

$$R' = \left(r^2 + R^2 - 2\ r\ R\cos\theta\right)^{1/2}$$

$$b_1 = \frac{\alpha}{\gamma}(z - He), \quad b_2 = \frac{\alpha}{\gamma}(z + He),$$

(3) Line Souse Equation

When windy, the 2π / 16 equation which brings uniform concentration in the direction of y is used.

$$C = \int_{r_1}^{r_2} \frac{QL}{\sqrt{2\pi}\frac{\pi}{8} r \sigma z(r) u} \cdot \left[\exp\left(-\frac{(z-He)^2}{2\sigma z(r)^2}\right) + \exp\left(-\frac{(z+He)^2}{2\sigma z(r)^2}\right)\right] \cdot dr$$

z : z coordinate (m) at the computation point
r : Distance (m) from the computation point to a line source
r_1, r_2 : Integration interval (m) of a line source
QL : Line source intensity (Nm^3 / s.m)
u : Wind speed (m/s)
He : Effective stack height (m)
σz : Vertical diffusion parameter (m)

When calm, the following equation is used.

$$C = \int_{r_1}^{r_2} \frac{QL}{(2\pi)^{3/2} r}\left(\frac{1}{r^2+b_1^2}+\frac{2}{r^2+b_2^2}\right) dr$$

$$b_1 = \frac{\alpha}{\gamma}(z-He) \qquad b_2 = \frac{\alpha}{\gamma}(z+He) \qquad r^2 = x^2+y^2$$

5.1.6 Dispersion Parameters

Dispersion parameters for windy conditions are as shown in Table 5.1.1 which is the approximation of the Pasquill-Gifford chart, and those for calm and breeze conditions are shown in Table 5.1.2.

Table 5.1.1 Dispersion Parameters for Windy Conditions

$$\sigma_y(x) = \gamma y \cdot x^{\alpha y}$$

Atmospheric stability	αy	γy	Down-wind distance, x (m)
A	0.901	0.426	0 ~ 1,000
	0.851	0.602	1,000 ~
B	0.914	0.282	0 ~ 1,000
	0.865	0.396	1,000 ~
C	0.924	0.1772	0 ~ 1,000
	0.885	0.232	1,000 ~
D	0.929	0.1107	0 ~ 1,000
	0.889	0.1467	1,000 ~
E	0.921	0.0864	0 ~ 1,000
	0.897	0.1019	1,000 ~
F	0.929	0.0554	0 ~ 1,000
	0.889	0.0733	1,000 ~
G	0.921	0.0380	0 ~ 1,000
	0.896	0.0452	1,000 ~

$$\sigma_z(x) = \gamma z \cdot x^{\alpha z}$$

Atmospheric stability	αz	γz	Down-wind distance, x (m)
A	1.122	0.0800	0 ~ 300
	1.514	0.00855	300 ~ 500
	2.109	0.000212	500 ~
B	0.964	0.1272	0 ~ 500
	1.094	0.0570	500 ~
C	0.918	0.1068	0 ~
D	0.826	0.1046	0 ~ 1,000
	0.632	0.400	1,000 ~ 10,000
	0.555	0.811	10,000 ~
E	0.788	0.0928	0 ~ 1,000
	0.565	0.433	1,000 ~ 10,000
	0.415	1.732	10,000 ~
F	0.784	0.0621	0 ~ 1,000
	0.526	0.370	1,000 ~ 10,000
	0.323	2.41	10,000 ~
G	0.794	0.0373	0 ~ 1,000
	0.637	0.1105	1,000 ~ 2,000
	0.431	0.529	2,000 ~ 10,000
	0.222	3.62	10,000 ~

Table 5.1.2 Dispersion Parameters for Calm and Breeze

(1) Calm ($\leq$ 0.4 m/s)

Atomospheric Sability Classes	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

(2) Breeze (0.5 ~ 0.9 m/s)

Atomospheric Sability Classes	α	γ
A	0.748	1.569
A-B	0.659	0.862
B	0.581	0.474
B-C	0.502	0.314
C	0.435	0.208
C-D	0.342	0.153
D	0.270	0.113
E	0.239	0.067
F	0.239	0.048
G	0.239	0.029

In computation, dispersion parameter values were determined for the following groups of the stability classes based on the values of above tables and appearance frequency of each stability class:

Unstable :	A ~ B-C
Neutral :	C ~ D
Stable :	E ~ G

5.1.7 NO_2 Conversion Model

In order to separate the concentration of NO_2 from the computed NOx concentration, a statistical NO_2 conversion model is used. This model estimates the relationship between the concentrations of NOx and NO_2 statistically based on the observed concentrations of the both. This relation (equation) is used to estimate the NO_2 concentration from the computed value of the NOx concentration. The following form was assumed as the NO_2 conversion model, and coefficients a and b were evaluated by means of the least square method.

$$[\,NO_2\,] = a \cdot [\,NOx\,]^{b}$$

The concentration data of NOx and NO_2 at 9 monitoring stations for one year were used, and the following equation was obtained.

$$[NO2] = 1.09\,([NOx]_S + [NOx]_B)^{0.85}$$

where,

$[NOx]_S$: Computed NOx concentration caused by the all man-made pollution sources (μg/m^3)

$[NOx]_B$: Background NOx concentration (μg/m^3)

5.1.8 Method of Model Evaluation

Measured data at the ambient air quality monitoring stations are used for the evaluation of the reproducibility of the simulation model. The computed pollutant concentrations are compared with the measured data, and the accuracy of the computed value is evaluated according to the criteria shown in Table 5.1.3. Adjustment of model parameters is repeated until the conditions needed for Rank B are satisfied.

Table 5.1.3 Conditions for Evaluation of the Accuracy of the Dispersion Model

- Individual conditions pertaining to the conformity between calculated and measured values.

1. $a_0 \leq \frac{1}{3}(\bar{Y} - BG) + BG$
2. $a_0 \leq \frac{2}{5}(\bar{Y} - BG) + BG$
3. The inclination of a regressing line shall range from 0.8 to 1.2 and be as close to 1 as possible. In addition, the correlation coefficient shall be at least 0.71 and should possibly exceed 0.8.
4. $S'/\bar{Y} \leq \frac{1}{5}$
5. $S'/\bar{Y} \leq \frac{1}{4}$
6. $S'/\bar{Y} \leq \frac{1}{3}$

$\bar{Y}$: Mean measured value available form a measuring station
$\bar{X}$: Mean computed value for the measuring station
a_0 : $\bar{Y} - \bar{X}$
BG : Background values in the nature
$S'/\bar{Y}$: Variation coefficient obtained from $\bar{Y} = \bar{X} + a_0$

- Accuracy ranking pertaining to the conformity between computed and measured values.

(a) Rank A

Either the conditions 1, 3, and 5, or 1 and 4, stated above, be satisfied. Even if the conditions 1 and 4 are satisfied, the inclination of a regressing line should be as close to 1 as possible.

(b) Rank B

The conditions 2 and 5 shall be satisfied.

(c) Rank C

The conditions 2 and 6 shall be satisfied.

Note : It is desired that the inclination of regressing lines should also be as close to 1 as possible in the cases of Ranks B and C.

5.2 Air Quality Simulation Under the Present Conditions

5.2.1 Model Evaluation Against Observed Data

(1) Computation of Pollutant Concentrations at Monitoring Stations

In order to establish the air quality simulation model, computation of pollutant concentrations at the monitoring stations were made based on the present amounts of pollutant emissions. In these comparisons, Station J6 was excluded since the station lacked the data in October and around when high pollutant concentration occurred. For SO_2, JF1 was also excluded since the observed concentrations were considerably higher in comparison to emission loads and were very difficult to reproduce by the model.

1) SO_2

Tables 5.2.1 and 5.2.2, and Figure 5.2.1 show the comparisons of computed SO_2 concentrations with the observed data. As can be seen from Figure 5.2.1, the correlation between the measured values and the computed values is high. However, the computed values are a little lower than the observed values.

2) NOx

Tables 5.2.3 and 5.2.4, and Figure 5.2.2 show the comparisons of computed NOx concentrations with the observed data. Similar to SO_2, the correlation between the observed values and the computed values is high, but the latter is a little lower than the former.

Table 5.2.1 Computed Concentration of SO_2

	TIME	S02			PPB				
PERIOD	PERIOD	JF2	J1	J2	J3	J4	J5	J7	AVE.
ALL SEASON JAN.-DEC.	MORN.	12.1	7.4	14.6	19.2	13.7	14.5	9.3	13
	AFTER.	8.3	7.9	12.9	14.5	12.0	10.1	5.1	10
	EVEN.	8.3	9.3	14.4	13.6	15.5	18.2	10.5	13
	NIGHT	7.4	3.4	6.1	7.9	6.5	8.2	5.3	6
	DAY	8.8	6.8	11.7	13.3	11.6	12.5	7.4	10
NON-HEATING SEASON APR.-SEP.	MORN.	14.4	2.9	10.3	16.4	7.5	6.9	4.7	9
	AFTER.	7.3	3.5	6.7	7.6	4.9	3.6	2.2	5
	EVEN.	4.7	3.8	6.3	5.3	6.1	6.7	4.5	5
	NIGHT	5.8	1.3	2.9	3.2	3.2	4.7	3.1	3
	DAY	7.7	2.8	6.2	7.6	5.2	5.4	3.5	5
HEATING SEASON OCT.-MAR.	MORN.	9.7	11.8	18.8	22.0	19.9	22.1	13.9	17
	AFTER.	9.3	12.2	19.2	21.4	19.2	16.6	8.0	15
	EVEN.	12.0	14.8	22.5	21.9	25.0	29.7	16.5	20
	NIGHT	9.0	5.6	9.4	12.7	9.7	11.8	7.6	9
	DAY	10.0	10.8	17.1	19.1	18.0	19.6	11.2	15

Table 5.2.2 Observed Concentration of SO_2

	TIME	S02			PPB				
PERIOD	PERIOD	JF2	J1	J2	J3	J4	J5	J7	AVE.
ALL SEASON JAN.-DEC.	MORN.	11.7	6.2	15.5	14.4	8.1	11.7	8.2	11
	AFTER.	11.8	8.7	22.3	20.3	10.7	15.0	11.8	14
	EVEN.	7.9	5.8	17.1	19.4	11.4	19.3	11.4	13
	NIGHT	5.2	3.4	10.8	11.2	7.2	9.8	6.4	8
	DAY	8.9	5.9	16.2	16.2	9.3	13.9	9.4	11
NON-HEATING SEASON APR.-SEP.	MORN.	12.8	2.9	12.4	9.6	3.5	4.8	4.9	7
	AFTER.	10.7	3.8	17.0	11.4	3.9	4.1	5.2	8
	EVEN.	4.7	2.1	5.7	5.0	2.6	3.9	3.7	4
	NIGHT	2.2	1.1	2.9	2.9	1.2	2.6	2.4	2
	DAY	7.2	2.4	9.1	6.9	2.7	3.8	3.9	5
HEATING SEASON OCT.-MAR.	MORN.	10.6	9.5	18.9	19.2	13.3	18.2	11.5	14
	AFTER.	13.0	13.4	27.9	29.2	18.4	25.4	18.5	21
	EVEN.	11.1	9.4	29.3	33.9	21.3	33.9	19.1	23
	NIGHT	8.2	5.6	19.2	19.6	14.1	16.7	10.6	13
	DAY .	10.7	9.3	23.8	25.5	16.8	23.5	14.9	18

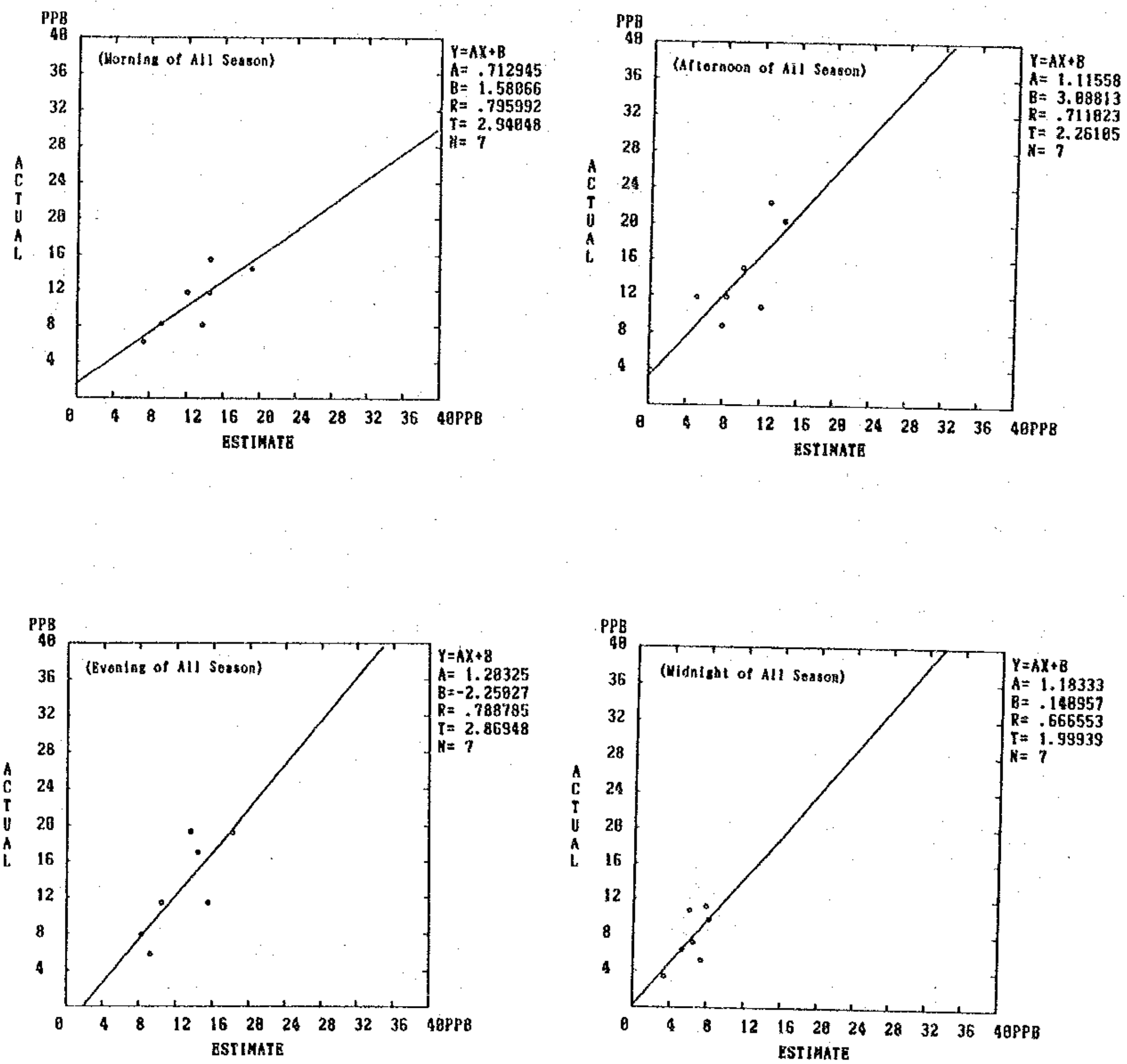


Figure 5.2.1 (1) Comparison of Computed and Observed Concentrations of SO_2

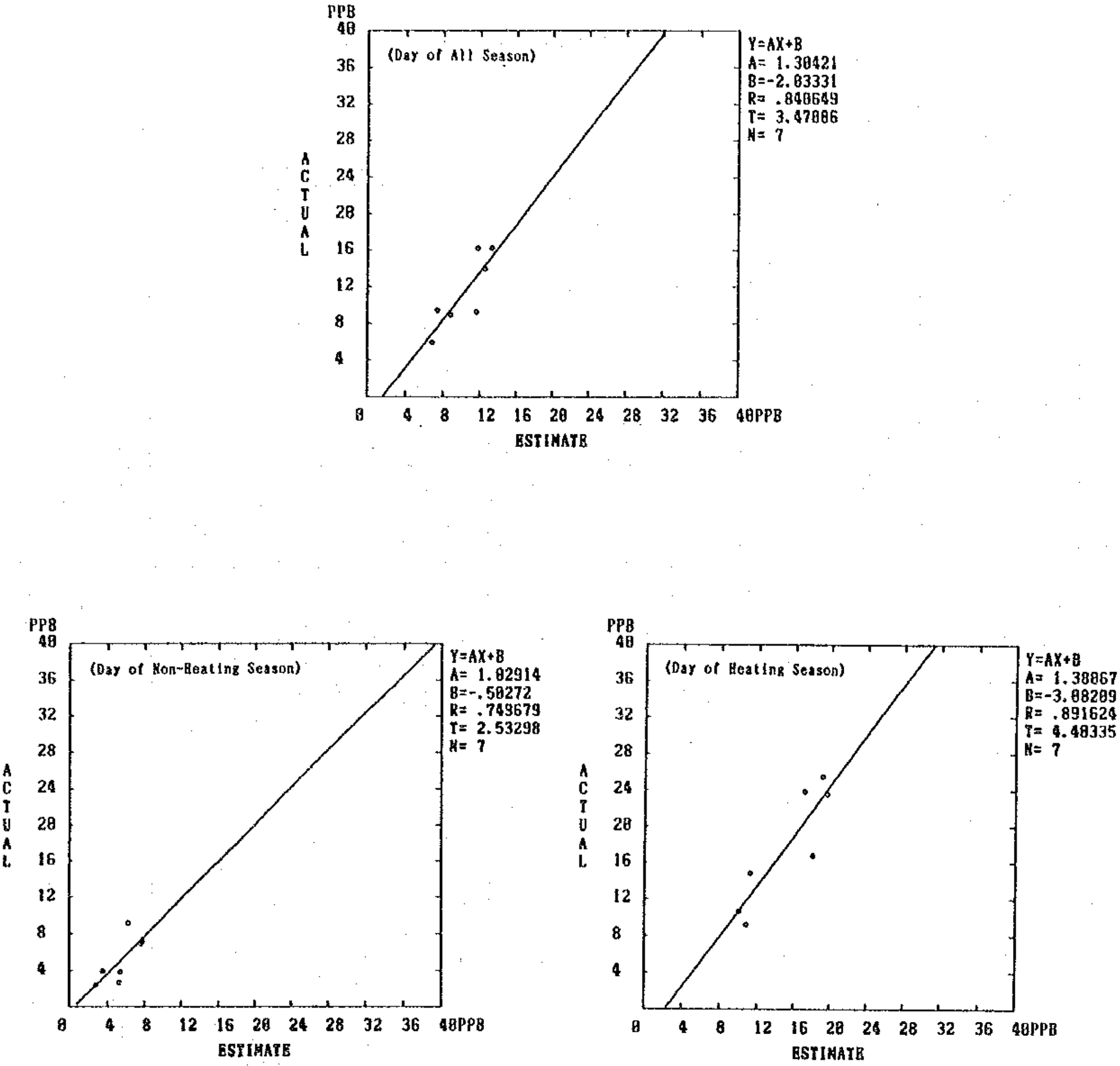


Figure 5.2.1 (2) Comparison of Computed and Observed Concentrations of SO_2

Table 5.2.3 Computed Concentration of NOx

PERIOD	TIME PERIOD	NOX						PPB			AVE.
		JF1	JF2	J1	J2	J3	J4	J5	J6	J7	
ALL SEASON JAN.-DEC.	MORN.	10.1	9.0	5.7	34.4	22.8	15.6	22.3	27.6	31.9	20
	AFTER.	5.4	5.8	3.4	21.4	12.7	9.0	11.3	18.0	14.0	11
	EVEN.	18.3	11.3	8.3	36.6	25.0	21.0	37.4	34.6	47.9	27
	NIGHT	3.1	4.0	1.7	13.7	7.8	4.5	10.5	9.1	15.8	8
	DAY	8.9	7.3	4.6	25.7	16.4	12.1	19.9	21.5	26.7	16
NON-HEATING SEASON APR.-SEP.	MORN.	2.3	6.5	1.4	29.7	11.8	5.0	8.0	17.4	13.3	11
	AFTER.	2.1	4.4	1.5	13.6	6.8	5.1	6.7	15.9	7.9	7
	EVEN.	9.6	7.7	3.7	27.7	14.7	10.4	23.0	24.9	37.8	18
	NIGHT	2.3	4.0	1.1	16.0	7.0	3.7	11.0	9.0	17.9	8
	DAY	4.1	5.5	1.9	21.2	9.9	6.0	12.3	16.5	19.4	11
HEATING SEASON OCT.-MAR.	MORN.	18.0	11.6	10.0	39.1	33.9	26.4	36.7	37.9	50.7	29
	AFTER.	8.7	7.2	5.3	29.3	18.5	12.9	16.0	20.1	20.0	15
	EVEN.	27.0	14.9	13.0	45.5	35.5	31.6	51.9	44.2	58.0	36
	NIGHT	3.8	4.1	2.2	11.4	8.6	5.2	10.0	9.1	13.8	8
	DAY	13.8	9.1	7.3	30.2	23.1	18.1	27.5	26.6	34.1	21

Table 5.2.4 Observed Concentration of NOx

PERIOD	TIME PERIOD	NOX						PPB			AVE.
		JF1	JF2	J1	J2	J3	J4	J5	J6	J7	
ALL SEASON JAN.-DEC.	MORN.	12.1	6.9	14.2	43.5	24.1	17.1	32.8	33.8	38.0	25
	AFTER.	8.9	4.6	9.2	28.7	15.7	13.9	23.7	23.4	24.7	17
	EVEN.	13.2	6.0	12.1	36.4	15.0	20.6	35.0	24.8	32.7	22
	NIGHT	9.5	6.3	8.7	24.8	14.1	13.6	20.2	14.7	23.7	15
	DAY	10.8	5.9	10.8	32.6	16.8	16.2	27.4	23.4	29.2	19
NON-HEATING SEASON APR.-SEP.	MORN.	7.5	6.4	10.9	33.5	19.0	10.4	20.3	24.2	30.8	18
	AFTER.	3.1	2.7	6.3	19.7	9.1	6.3	10.3	11.9	15.3	9
	EVEN.	5.9	4.3	8.5	23.7	8.2	9.7	17.0	14.5	22.4	13
	NIGHT	6.6	6.3	8.4	21.2	10.6	8.6	12.8	8.4	21.0	12
	DAY	5.8	4.9	8.4	24.0	11.4	8.7	14.8	14.1	21.9	13
HEATING SEASON OCT.-MAR.	MORN.	16.9	7.5	16.4	53.7	29.3	23.8	45.1	43.3	45.2	31
	AFTER.	14.9	6.6	11.2	37.8	22.3	21.5	36.8	34.9	34.1	24
	EVEN.	20.9	7.7	14.7	49.4	22.0	31.5	52.7	35.0	42.8	31
	NIGHT	12.8	6.3	9.0	28.5	17.7	18.8	27.4	21.1	26.5	19
	DAY	16.2	7.0	12.5	41.3	22.3	23.7	39.7	32.7	36.4	26

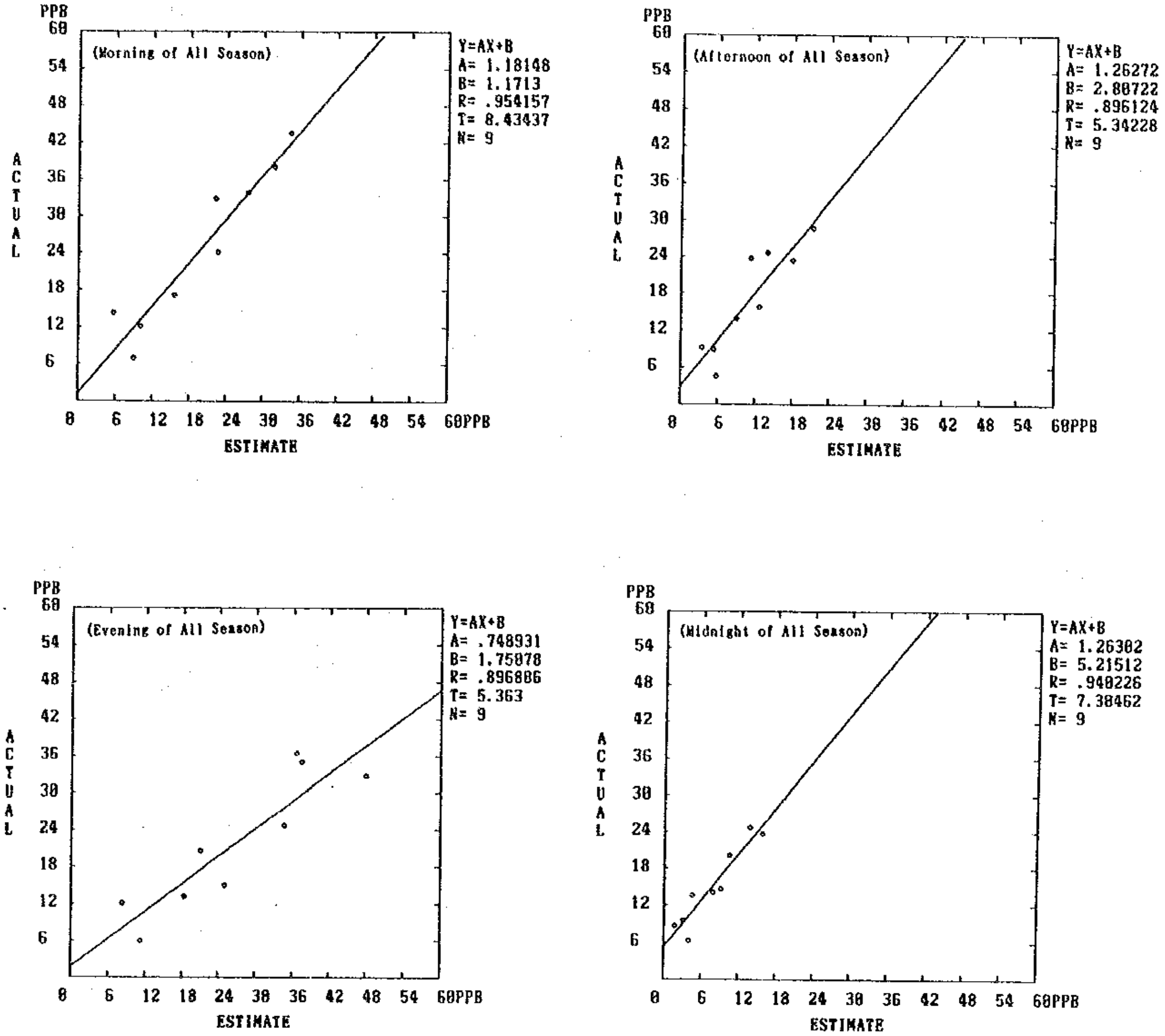


Figure 5.2.2 (1) Comparison of Computed and Observed Concentration of NOx

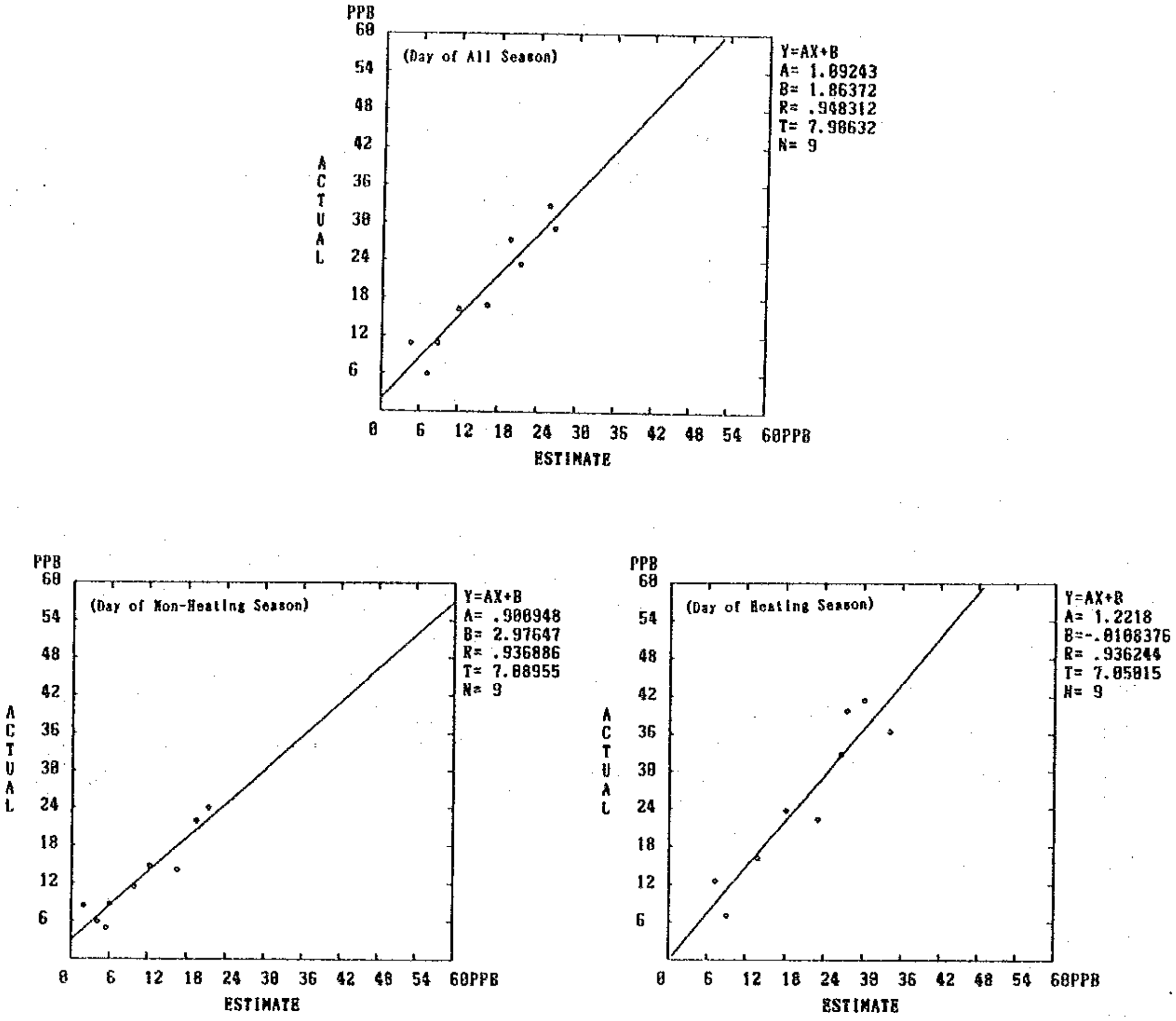


Figure 5.2.2 (2) Comparison of Computed and Observed Concentration of NOx

(2) Degree of Agreement Between Computed and Observed Values

Accuracy of the simulation model was evaluated based on the model evaluation criteria shown in Table 5.1.3.

1) SO_2

The evaluation result for SO_2 is shown in Table 5.2.5. Although the computed and the observed values do not agree well in certain time zones of the non-heating season, the overall performance of the model is judged to be satisfactory.

Table 5.2.5 Result of Model Evaluation for SO_2

Time Zone	Season		
	Non-heating Season	Heating Season	Year
Morning	-	A	A
Afternoon	-	A	A
Evening	C	B	A
Mid-night	-	B	C
Whole day	C	A	A

2) NOx

The evaluation result for NOx is shown in Table 5.2.6. Although the computed and observed values do not agree well in certain time zones, the daily averages of both seasons and whole year are ranked A. The model is sufficiently accurate to be used for long-term simulation. However, since the computed values are a little lower than the observed values, it is considered to be necessary to add a background concentration when computing the area-wide concentration distribution.

Table 5.2.6 Result of Model Evaluation for NOx

Time Zone	Season		
	Non-heating Season	Heating Season	Year
Morning	-	A	A
Afternoon	-	C	B
Evening	-	A	C
Mid-night	A	-	-
Whole day	A	A	A

(3) Background Concentration

Reproductions of the pollutant concentrations at the monitoring stations by the simulation model were generally satisfactory. However, the simulated values were a little lower than the actual values. Among various factors causing these differences, the following are considered to be significant :

1) Return of the pollutant into the computation area by circulating air flows or the change of wind direction
2) Presence of pollution sources in or out of the computation area whose pollutant emissions are not well known
3) Long time detention of the pollutant whose concentration is difficult to compute through the model
4) Errors associated with measured values
5) Absorption into and adsorption on the ground
6) Transformation of the pollutant in the atmosphere by reactions
7) Natural presence of the pollutant as a background

Since the above factors can not be evaluated individually, the difference between the observed values and the computed values are treated as "the background concentration".

In this study, the background concentration was determined for each pollutant in each season as shown in Table 5.2.7. The background concentration is to be added to the computed concentration.

Table 5.2.7 Background Concentration

Unit : µg/m^3 (ppb)

Pollutant	Season		
	Non-heating	Heating	Whole year
SO_2	0	8 (3)	3 (1)
NOx	4 (2)	10 (5)	6 (3)

5.2.2 Pollutant Concentration Distribution in the Study Area

(1) SO_2

The computed present concentration distributions of SO2 in the Study Area are shown in Figure 5.2.3 for annual average and in Figure 5.2.4 for heating season average.

The higher concentrations appear sporadically in the densely populated urban areas. The concentration is particularly higher in Miskolc, Ozd and Sajoszentpeter. The areas where the annual average concentration exceeds the ambient air quality standard for living area (70 μg/m^3) are:

- Whole area of Miskolc except part of the western and southern areas
- Central areas of Sajoszentpeter and Ozd

The concentration in the central part of Miskolc is more than 90 μg/m^3, i.e. nearly the level of the quality standard for industrial area (100 μg/m^3).

In the Heating season, the areas exceeding the annual standards spread further. The living area standard is exceeded also in the following areas:

- Wide area along the Route 26 from Miskolc to Kazincbarcika
- Ozd, Putnok, and their outskirts

Areas where the standard for industrial area is exceeded in the heating season are Miskolc, Sajoszentpeter, Kazincbarcika and their outskirts, and Ozd.

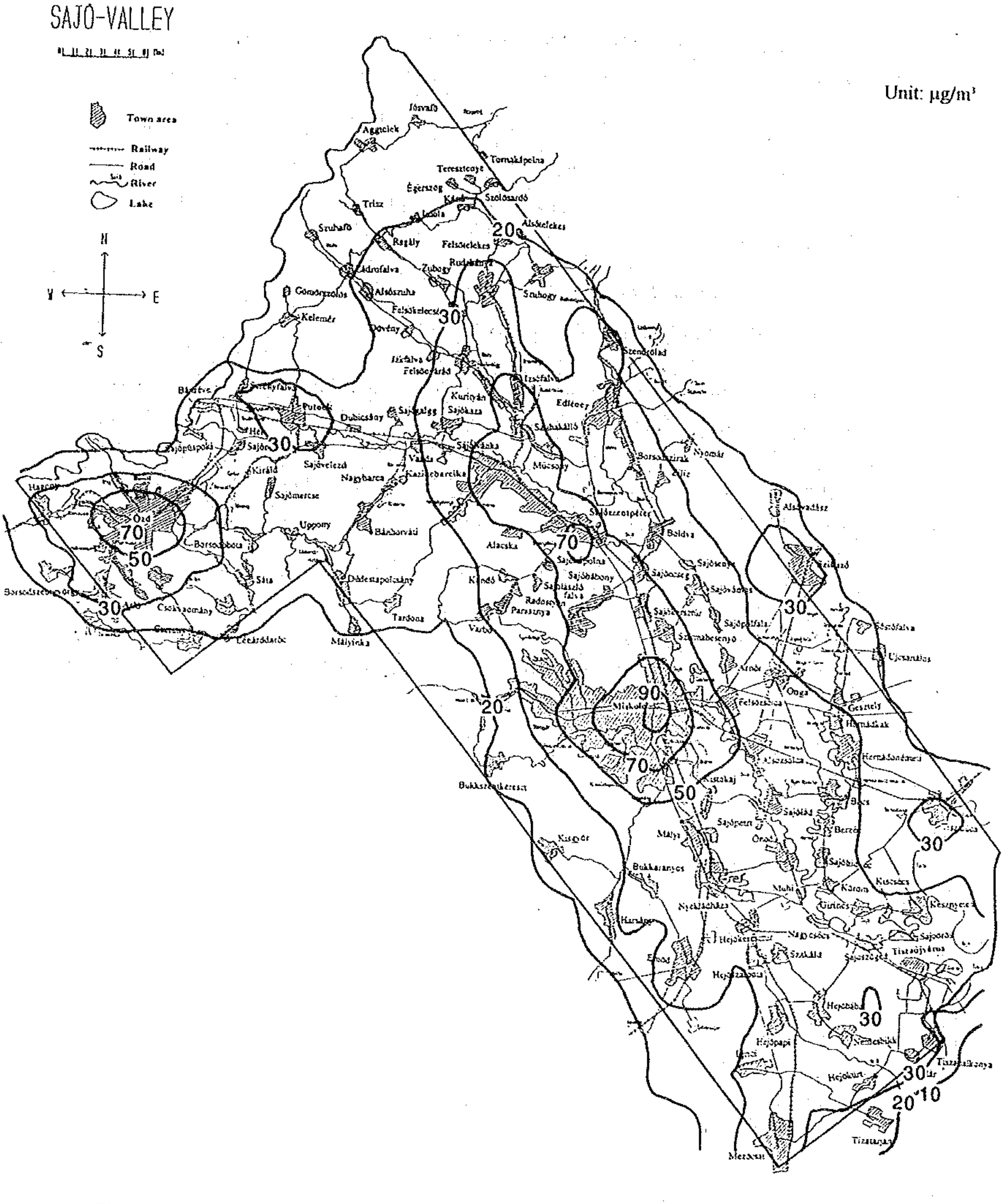


Figure 5.2.3 Annual Average Concentration Isopleth for SO_2 (All Sources)

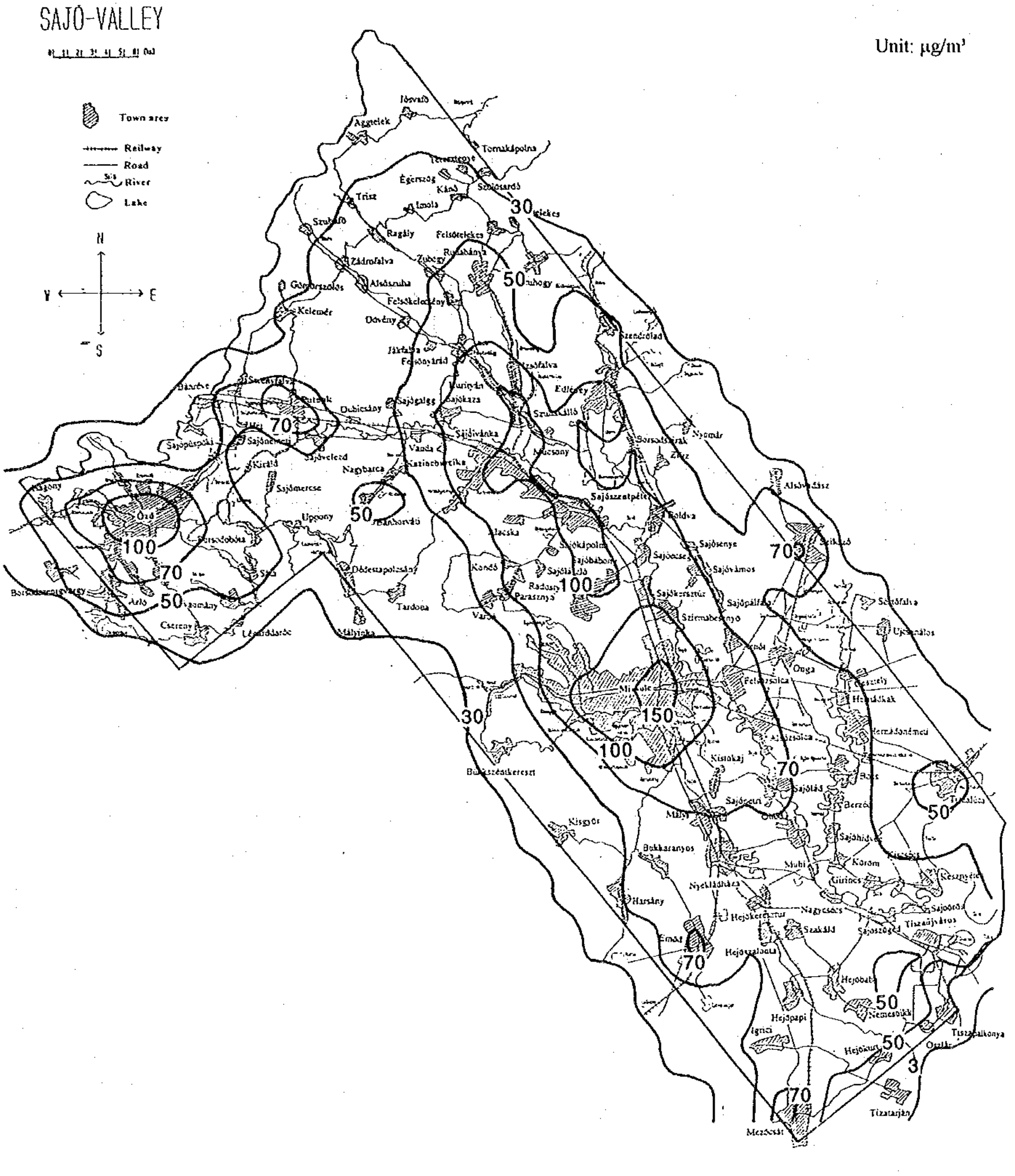


Figure 5.2.4 Concentration Isopleth for SO_2 in Heating Season (All Sources)

(2) NO_x

The present concentration distributions of NOx are shown in Figure 5.2.5 for the annual average and in Figure 5.2.6 for the heating season average.

The higher concentrations are observed in densely populated urban areas and peripheries of major roads. The distribution is rather continuous geographically.

The annual quality standard for Specially Protected Area (30 μg/m^3) is exceeded in Miskolc, part of Sajoszentpeter, and the area along the Route 26 connecting these towns. However, the whole area satisfies the quality standard for living area (100 μg/m^3).

In the heating season, the annual quality standard for specially protected area is exceeded in the area along Routes 3, 26 and 35, and in Ozd. No areas exceed the standard for living area.

(3) NO_2

Using the NO_2 conversion model described in Section 5.1.7, the concentration distributions of NO_2 were obtained from the computed concentration distributions of NOx as shown in Figures 5.2.7 (annual) and 5.2.8 (heating season).

The concentration distribution pattern is very similar to that of NOx. The concentration is higher in urban areas and peripheral areas of the major roads.

In the annual average, the quality standard for specially protected area (30 μg/m^3) is exceeded in the central zone and a part of southern zone of Miskolc. The whole area satisfies the living area standard (70 μg/m^3).

In the heating season, the annual standard for specially protected area is exceeded in Miskolc except the western zone, and in a part of the area along the Route 26.

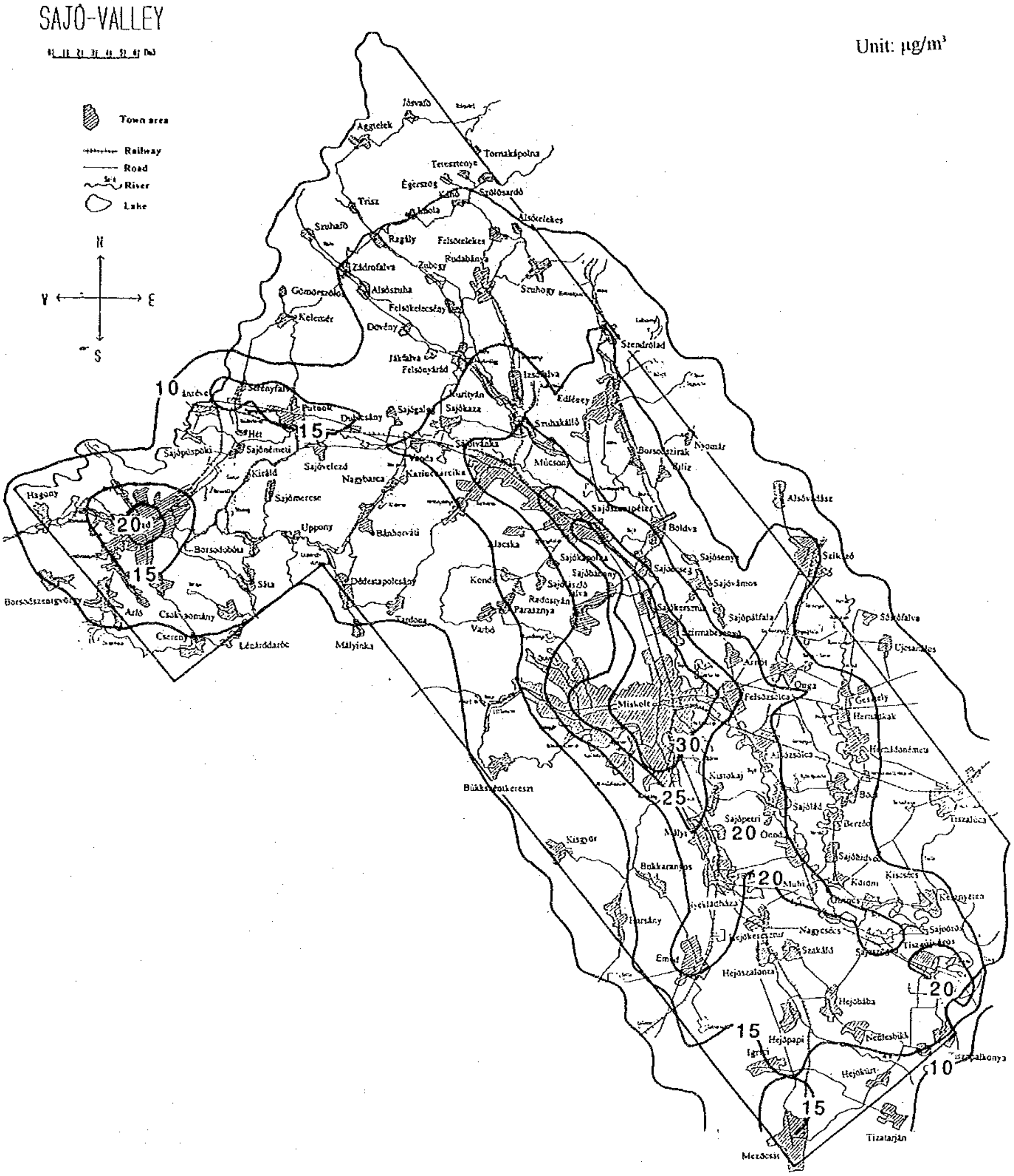


Figure 5.2.5 Annual Average Concentration Isopleth for NO_x (All Sources)

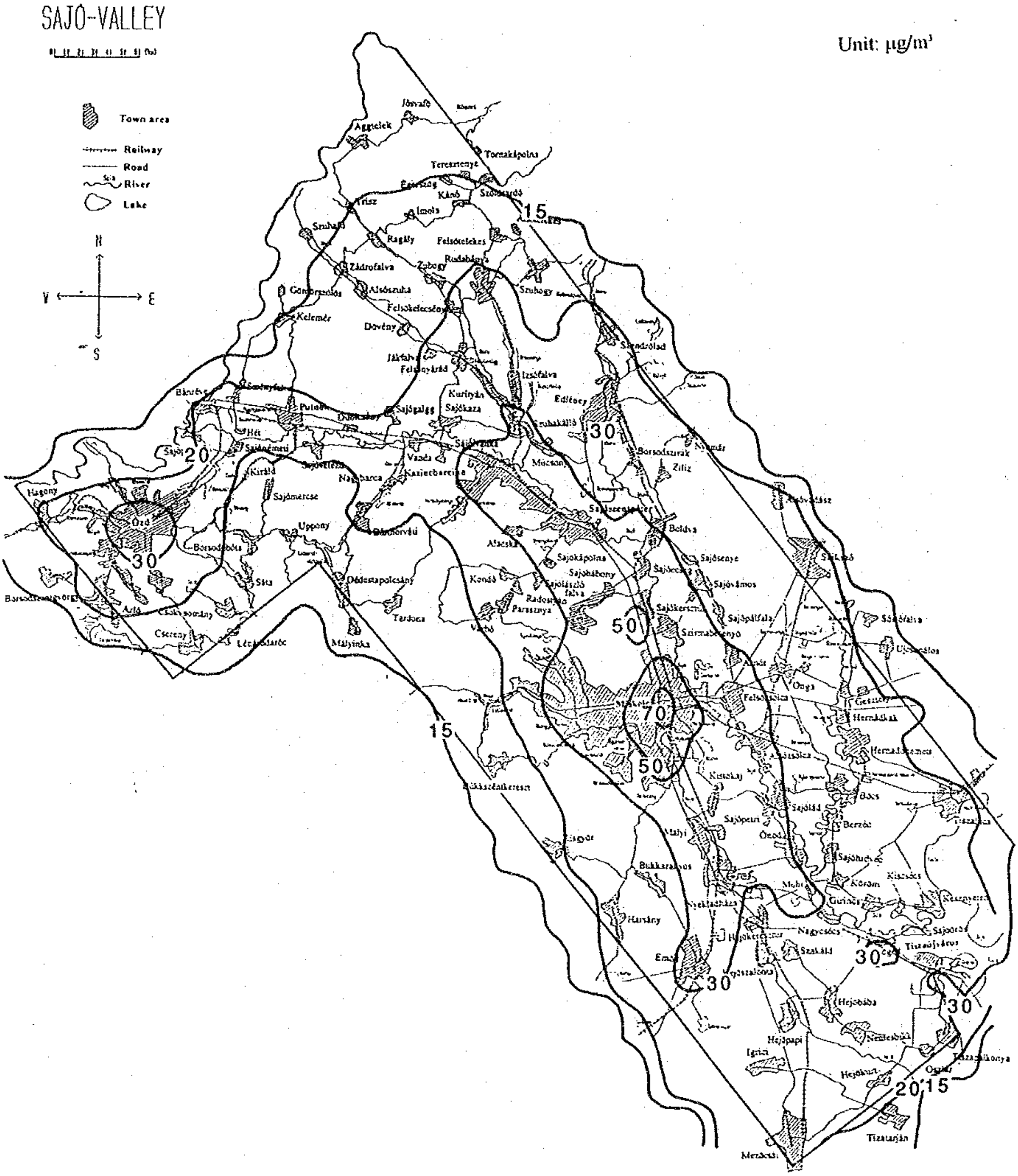
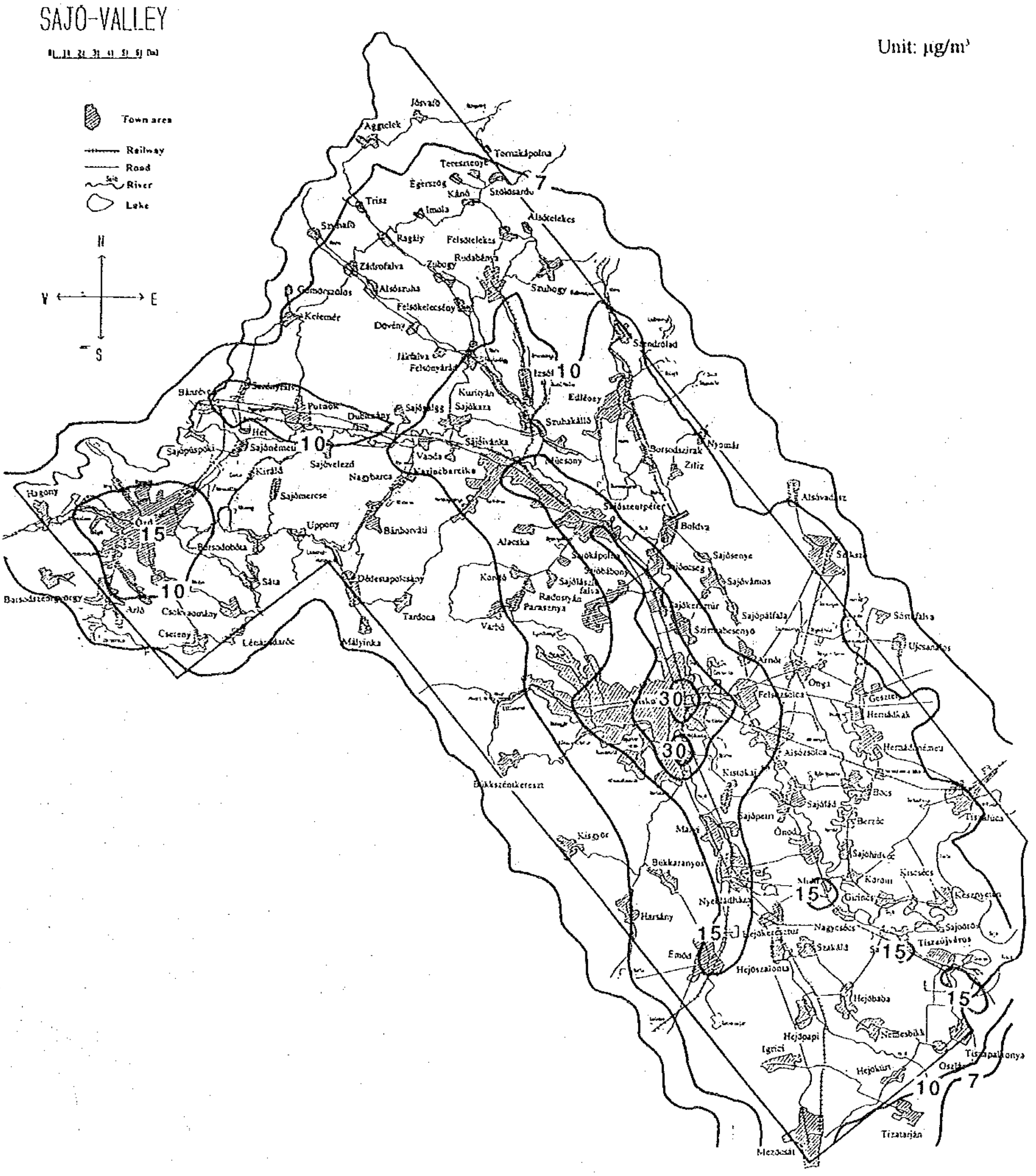
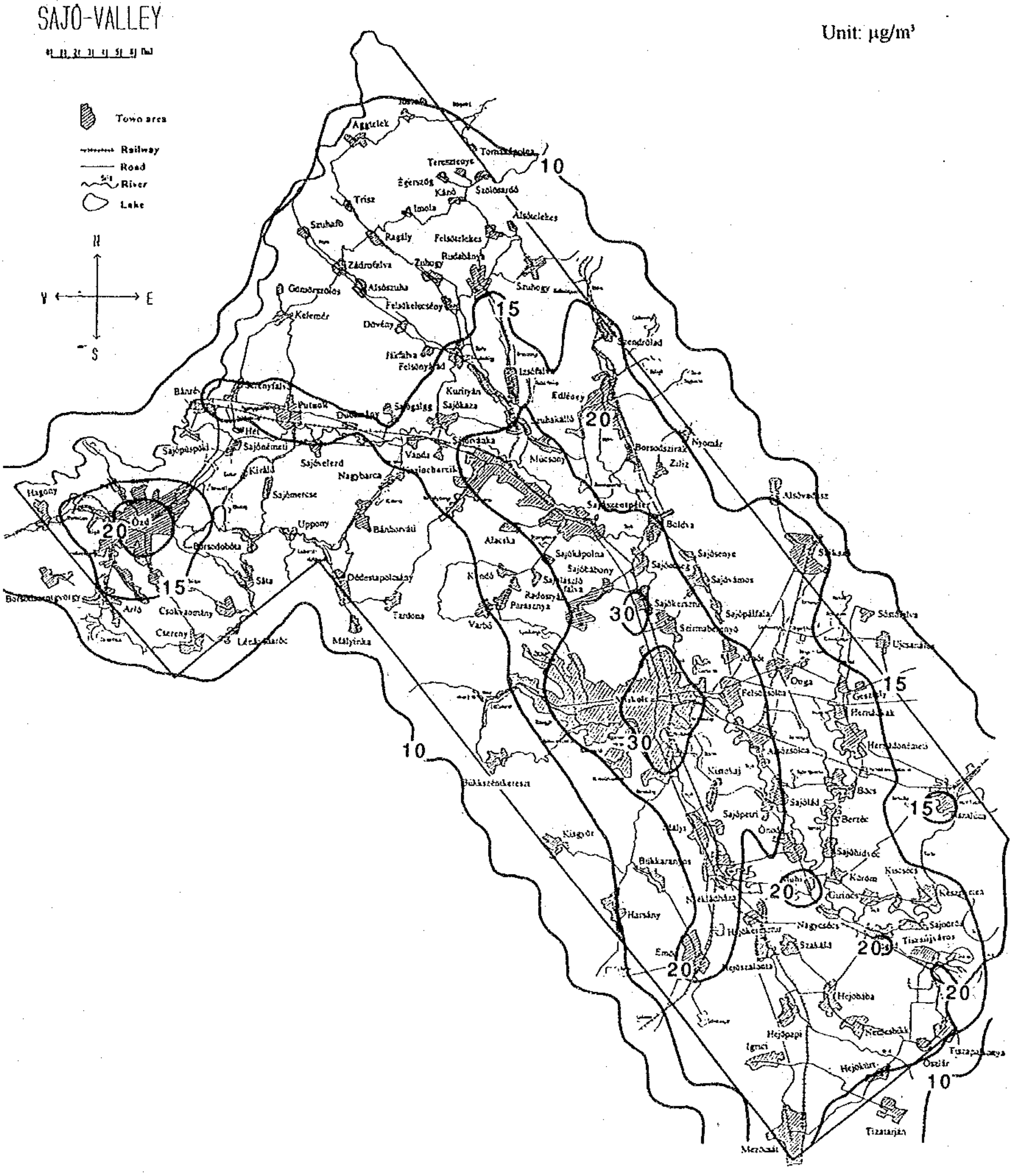


Figure 5.2.6 Concentration Isopleth for NO_x in Heating Season (All Sources)



Unit: μg/m³

Figure 5.2.7 Annual Average Concentration Isopleth for NO_2 (All Sources)



Unit: µg/m³

Figure 5.2.8 Concentration Isopleth for NO_2 in Heating Season (All Sources)

5.2.3 Analysis of Source Contribution to Ambient Concentration

(1) SO_2

Contribution ratios of pollution sources in the SO_2 concentration at the monitoring stations are shown in Table 5.2.8. "Communal" occupies the greatest contribution followed by "Industry", while the contribution of automobiles is small except some stations. In the seasonal tendency, the contribution of "Industry" is large in the summer and "Communal" is large in the winter. The greatest contribution of "Communal" is at JF1, that of "Industry" is at JF2, and "Automobiles" at J2 and J6.

(2) NOx

Contribution ratios of pollution sources in the NOx concentration at the monitoring stations are shown in Table 5.2.9. As a whole, "Automobiles" occupies the greatest contribution followed by "Communal", while the contribution of "Industry" is considerably smaller than the other two except at some stations. In the seasonal tendency, the contribution of "Automobiles" is large in the summer. In the winter, the contributions of "Automobiles" and "Communal" are about the same level and these two together occupy more than 90% of the total.

In terms of location, Stations J2, J6 and J7 are largely affected by automobiles, and JF1 and J1 are affected by communal sources with relatively high ratios.

Table 5.2.8 Source Contribution to SO_2 Concentration at Each Monitoring Station (%)

		JF1	JF2	J1	J2	J3	J4	J5	J6	J7
Non-heating Season	Industry	40.7	90.9	70.4	58.1	76.3	67.3	50.9	45.1	48.6
	Communal	55.6	6.5	29.6	24.2	18.4	28.8	41.5	39.2	25.7
	Automobiles	3.7	2.6	0.0	17.7	5.3	3.8	7.5	15.7	25.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Heating Season	Industry	11.2	62.0	34.3	22.8	34.0	29.3	23.9	25.0	26.5
	Communal	86.7	35.0	64.8	70.2	62.3	68.0	72.1	70.7	59.3
	Automobiles	2.1	3.0	0.9	7.0	3.7	2.8	4.1	4.3	14.2
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All Seasons	Industry	16.5	74.2	41.2	32.2	46.3	37.6	29.4	29.7	31.5
	Communal	81.2	22.5	57.4	57.6	49.3	59.0	65.1	63.6	52.1
	Automobiles	2.4	3.4	1.5	10.2	4.5	3.4	5.6	6.8	16.4
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5.2.9 Source Contribution to NO_x Concentration at Each Monitoring Station (%)

		JF1	JF2	J1	J2	J3	J4	J5	J6	J7
Non-heating Season	Industry	7.3	32.7	21.1	3.8	15.2	18.3	6.5	4.8	3.1
	Communal	19.5	5.5	21.1	4.7	11.1	18.3	17.1	11.5	3.1
	Automobiles	73.2	61.8	57.9	91.5	73.7	63.3	76.4	83.6	93.8
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Heating Season	Industry	2.9	19.8	12.3	4.6	9.6	7.7	4.7	4.9	2.9
	Communal	56.9	28.6	56.2	27.2	37.4	48.9	46.2	41.0	14.4
	Automobiles	40.1	51.6	31.5	68.2	53.0	43.4	49.1	54.1	82.7
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
All Seasons	Industry	4.4	24.3	15.2	4.3	11.5	10.0	5.5	5.1	3.0
	Communal	47.8	20.3	50.0	18.0	29.1	41.7	37.2	29.6	10.1
	Automobiles	47.8	55.4	34.8	77.7	59.4	48.3	57.3	65.3	86.9
	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

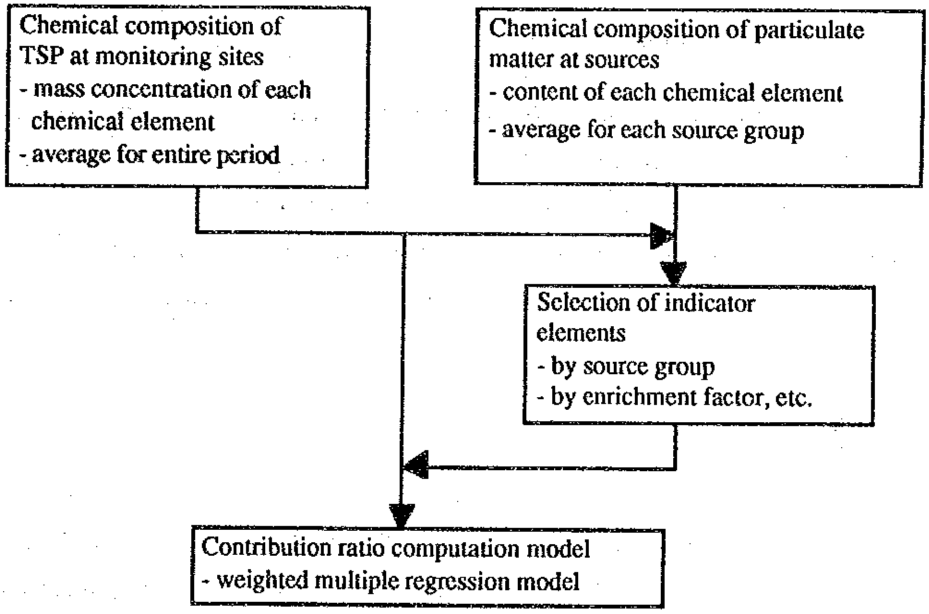
CHAPTER 6 ANALYSIS OF SOURCE CONTRIBUTION OF TSP BY CMB METHOD

6.1 Outline of the CMB Method

The CMB method (Chemical Mass Balance method) is one of receptor models for analyzing ratios of contribution of source groups to the ambient concentration of particulate matter. The method employs multi-variable regression analysis based on the mass conservation law on the data for chemical composition of particulate matter samples taken from the ambiant, where the concentration is known, and the chemical compositions of samples taken at emission source groups.

(1) Computational Flow for Contribution Ratio

General flow for computation of contributions by source groups to the ambient concentration of total suspended particulates (TSP) is as shown below.



(2) Data for Chemical Composition of TSP at Monitoring Sites

Samples taken as TSP at ambient air quality monitoring sites are analyzed for the contents of chemical elements such as various metals, ions and carbons. For each site, the average content of each element for entire period and deviations are calculated.

(3) Data for Chemical Composition of Particulate Matter at Sources

Samples taken at sources of TSP are also analyzed for their chemical composition in the same manner. Contents of the elements are averaged by groups of sources such as soil, steel production, coal burning, and automobile exhaust gas. Enrichment factor (EF) of each element for each source group is calculated for each monitoring site as follows:

$$EF = \frac{Xi,\ source}{Xi,atm.}$$

where,

Xi, source: content of element i in particulate matter from a source group

Xi, atm.: content of element i in TSP at a monitoring site

(4) Selection of Indicator Elements

Among the elements analyzed, those with large values of enrichment factor (e.g., greater than 2) are extracted for each source group. From these, elements whose content values are not considered to be sufficiently accurate or those that tend to be fractionated under atmospheric transport processes are further excluded.

(5) Computation Model for Contribution Ratio

The mathematical formulation of CMB method is explained as follows. The receptor model for estimating the contributions by pollution sources is based on the law of conservation of mass. For example, assuming that (p) numbers of emission sources exist and supposing no mass changing interactions occur, SPM concentration (C) measured at the receptor is obtained by taking the sum of contributions (Sj) of each emission source as in Equation (1).

$$C = \sum_{j=1}^{p} Sj \qquad (1)$$

Similarly, concentration (Ci) of component (i) in the SPM is expressed by Equation (2). Here (aij) is the mass fraction of source contribution (j) possessing component (i) at the receptor.

$$Ci = \sum_{j=1}^{p} aij\ \ Sj \qquad (2)$$

Assuming that (n) numbers of components are analyzed at the sources and receptors, then an equation is set up for each component. If the number (n) is greater than or equal to the number (p), the answer can be obtained by solving the set of p linear equations.

When the number (n) is greater than (p), a set of maximum accurate values is obtained by minimizing the value (χ^2) expressed in Equation (3).

$$\chi^2 = \sum_{i=1}^{n} \frac{\left(Ci - \sum_{j=1}^{p} aij \cdot Sj\right)^2}{Wi^{-2}} \tag{3}$$

where,

n: Number of indicator elements
p: Number of source groups
Ci: Mass concentration of element i in TSP at a monitoring site (μg/m3)
aij: Content of element i in particulate matter of source group j
Sj: Contribution of source group j to the concentration of TSP (μg/m3)
Wi: Weighting factor of element i determined by Ci and error in measured values of Ci

Case 1: $Wi^2 = Ci^{-2}$
Case 2: $Wi^2 = ci^{-2}$, where ci is error of Ci

Equation (4) is the matrix form expression of Equation (2).

$$\text{¢} = A\$ \tag{4}$$

Here (¢) is n-dimensional vector of component concentration, and (A) is n by p matrix of mass fraction of sources, and ($) is n-dimensional vector of contributions by sources.

Generally, the solution by the least square method is as follows.

$$\$ = ({}^{t}AWA)^{-1}\,{}^{t}AW\text{¢} \tag{5}$$

Here, (W) is a diagonal matrix with diagonal components of wi^2. Errors of estimations for the source contributions depend on the way the weights (wi) are chosen.

6.2 Composition Analysis of Particulate Matter

Analyses of chemical elements in the ambient total suspended particulates (TSP) and in the particulates from pollution sources were made.

6.2.1 Composition of TSP in the Ambient

TSP is sampled by high volume air samplers and its concentration and composition were analyzed.

(1) Measuring Points

Measuring points were selected from the automatic monitoring stations as follows:

Kazincbarcika	(J2)
Nyekladhaza	(J7)
ÁNTSZ-BAZ	(H1)

Locations are shown in Figure 3.1.1.

(2) Measuring Time

Sampling and measurements were made once per month at a sampling time of 24 hours. Sampling was performed over a one-year period from June of 1993 to May of 1994. In July, measurements were made twice at J2 and at J7.

(3) Elements Analyzed

Pb, Cd, Cr, Ni, Fe, Cu, Zn, Mn, Hg, Na, K, Ca, Mg, V, Ti, Al, SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}, C-ele, C-org

(4) Method of Analysis

Atomic absorption spectro-photometry, spectro-photometry and the non-dispersive infrared method (NDIR method) were used. Metallic ingredients were measured by resolving the sample with acid. Ions were extracted with water, and the carbon ingredients were brought back to Japan and directly classified into C-ele and C-org with the thermal carbon analyzer (NDIR). The C-org of carbon was separated by volatilizing the sample at 450 °C.

(5) Results

The result to be used in the source contribution analysis is shown in Section 6.3.1.

6.2.2 Composition of Particulate Matter at Emission Sources

Samples were taken from soil, stationary pollution sources, and automobiles. Elements analyzed were the same as those for TSP.

(1) Sampling for Analysis

1) Soil Samples

Soil samples were taken at 4 points shown in Figure 3.1.1. They are:

Kazincbarcika	(J2)
Nyekladhaza	(J7)
Miskolc	(EC1)
Mucsony (ash disposal site)	(JM1)

The soil samples were taken during May 26 - June 1, 1993.

2) Sample From Stationary Sources

Considering the industrial types whose emitting dusts contain rather large amount of polluting substances, 11 samples from 9 factories were seleded for composition analysis. The factories and combustion facilities selected are shown in Table 6.2.1.

Table 6.2.1 Stationary Sources for Dust Sample Taking

No.	Name of Enterprise	Facility
05/0	TISZAI EROMU RT. BORSODI HOEROMU	water tube boiler 100 t/h
07/0	PANNONGLAS IPARI RT. SAJOSZENTPETERI UVEGGYAR	glass melting tank oven
08/0	BORSODI ERCELOKESZITO MUZSGORITO KFT.	sintering furnace
09/2	SAGROCHEM KFT.	incinerator: solvent 100 kg/h, solid 60 kg/h
17/1	HEJOCSABAI CEMENT-ES MESZIPARI RT.	shaft kiln for limestone 19 t/h
17/1	HEJOCSABAI CEMENT-ES MESZIPARI RT.	cement kiln 83 t/h
18/0	STRABAG HUNGARIA EPITO KFT.	dryer for aggregate 60 t/h
25/1	TISZAI EROMU RT. I. HOEROMU	water tube boiler 125 t/h
25/2	TISZAI II HOEROMU	water tube boiler 670 t/h
26/3	KOROSI CS, S.U. KAZANHAZ	section boiler 0.232 MW
15/4	DNM DIOSGYORY NEMESACEL MUVEK FA.	blast furnace E.P. dust, cyclone dust E.P. dross

3) Automobiles

Sampling of dust from automobiles has been entrusted to the Institute for Transport Sciences. Number of samples and types of automobiles are as follows:

Passenger car : 4 samples (2-stroke engine, diesel and gasoline engine)
Light truck : 1 sample (diesel engine)
Heavy vehicle : 1 sample (diesel engine)

The dilution tunnel and low volume air sampler were used for the sampling of particulate matter in vehicle exhaust emissions.

The sampling was carried out in the following test modes:

1. ECE 15.04 : United Nations/Economic Commission
   for EUROPE : Urban Driving Cycle

2.1. 90 EUDC : Extra Urban Driving Cycle,
   max. speed of the cycle : 90 km/h
   130 km/h or 40 kW/1,000 kg power
   for low powerd cars
2.2. 120 EUDC : Extra Urban Driving Cycle;
   max. speed of the cycle : 120 km/h
3. Miskolc Mode 1
4. Miskolc Mode 2
5. 40 km/h constant speed
6. 60 km/h constant speed
7. 80 km/h constant speed
8. 100 km/h constant speed

(2) Method of Analysis

The method of analysis of the samples from each source is the same as that for TSP, but the soil samples were prepared for analysis by drying at 105°C in a dryer.

(3) Results

The results to be used in the source contribution analysis are shown in Section 6.3.2.

6.3 Source Contribution Analysis by the CMB Method

(1) Ambient TSP Concentration Used in the Analysis

In the analyses of the CMB method, the averages of the values measured eleven times at Stations J2, J7, and H1 during the period from July 1993 through May 1994 were used as the ambient TSP concentration.

The average concentrations of elements in TSP at each stations are shown in Table 6.3.1.

Table 6.3.1 The Average Concentrations of Elements in TSP

(Unit: μ g/m3)

	Kazincbarcika(J2)			Nyckladhaza(J7)			Miskolc-ANTSZ(H1)		
Component	Average	Cont.(%)	σ	Average	Cont.(%)	σ	Average	Cont.(%)	σ
TSP	110.1	100.0	46.1	105.28	100.0	46.2	80.21	100.0	33.3
Pb	0.072	0.0656	0.038	0.072	0.0683	0.055	0.086	0.1074	0.052
Cd	0.0017	0.0015	0.0013	0.0009	0.0008	0.0005	0.0016	0.0020	0.0009
Cr	0.0062	0.0056	0.0037	0.0096	0.0091	0.0096	0.0096	0.0120	0.0093
Ni	0.0035	0.0032	0.0015	0.0040	0.0038	0.0023	0.0039	0.0049	0.0032
Fe	2.185	1.9845	1.150	3.447	3.2745	3.197	3.748	4.6731	3.061
Cu	0.051	0.0467	0.103	0.116	0.1099	0.163	0.024	0.0295	0.009
Zn	0.062	0.0564	0.030	0.094	0.0894	0.066	0.088	0.1093	0.056
Mn	0.038	0.0347	0.021	0.063	0.0599	0.074	0.059	0.0731	0.050
Hg	0.0014	0.0013	0.0020	0.0012	0.0011	0.0014	0.0006	0.0008	0.0006
Na	0.384	0.3492	0.175	0.539	0.5124	0.508	0.357	0.4445	0.107
K	0.575	0.5221	0.258	0.554	0.5264	0.274	0.736	0.9182	0.525
Ca	1.957	1.7778	0.884	2.584	2.4539	1.766	2.028	2.5284	0.930
Mg	0.422	0.3835	0.271	0.361	0.3430	0.208	0.266	0.3317	0.134
V	0.0057	0.0052	0.0022	0.0075	0.0071	0.0041	0.0080	0.0100	0.0078
Ti	0.199	0.1804	0.236	0.209	0.1986	0.179	0.136	0.1696	0.213
Al	1.320	1.1988	1.113	1.434	1.3624	1.011	0.767	0.9558	0.334
SO4--	16.50	14.9856	10.76	10.92	10.3722	7.40	11.03	13.7572	6.04
NO3-	5.70	5.1763	4.90	3.81	3.6232	3.54	3.46	4.3103	2.81
Cl-	4.26	3.8652	8.05	3.86	3.6629	8.14	0.65	0.8149	0.54
NH4+	4.35	3.9534	3.41	2.32	2.2053	1.92	2.32	2.8924	1.98
Na+	0.25	0.2279	0.17	0.41	0.3851	0.43	0.29	0.3566	0.07
K+	0.54	0.4896	0.27	0.45	0.4231	0.22	0.62	0.7696	0.35
Ca++	1.25	1.1337	0.80	1.59	1.5149	1.17	1.37	1.7069	0.80
Mg++	0.133	0.1209	0.120	0.109	0.1040	0.080	0.102	0.1272	0.061
C-ele.	17.1	15.5231	12.1	15.3	14.5324	8.8	12.5	15.5616	6.0
C-org.	7.8	7.0514	5.4	6.9	6.5279	4.5	5.4	6.7891	3.3
C-total	24.9	22.5745	16.4	22.2	21.0604	13.0	17.9	22.3507	9.2

(2) Selection of Major Sources of TSP

Soil, major stationary sources, and automobiles were selected as major sources of TSP.

For soil, the soil composition near each monitoring station was decided based on the observation results.

For the stationary sources, the larger emission sources of particulate matter indicated in the observation results were selected for each fuel type as shown in Table 6.3.2.

Table 6.3.2 Selected Stationary Sources by Fuel Type

Major Fuel	Observed Stationary Sources
Brown Coal	TISAI HOEROMU
Heavy Oil	TISAI HOEROMU
Sinter (Coal and Cokes)	BORSODI ERCELOKESZJTO MUZSGORITO
Cement Factory(Natural Gas)	HEJOCSABAI CEMENT

As for the chemical elements of particulate matter emitted by automobiles, the average values of those from diesel engine vehicles were adopted for the analyses because of their large amount of emission of particulate matter.

Contents of elements of particulate matter at each pollution source are shown in Table 6.3.3.

Table 6.3.3 The Contents of Elements by Pollution Sources

(Unit: %)

Component	Soil			Stationary Source				Automobiles
	(J2)	(J7)	(EC1)	Brown-coal	Heavy Oil	Sintering (coal&coke)	Cement (natural gas)	Diesel
Pb	0.0015	0.0021	0.0022	0.0034	0.0079	0.3149	ND	0.0879
Cd	0.0012	0.0020	0.0015	ND	ND	0.0032	0.0014	0.0014
Cr	0.0012	0.0020	0.0015	0.0064	0.0083	0.0032	ND	0.0016
Ni	0.0015	0.0013	0.0017	0.0039	0.2662	0.0047	0.0215	0.0051
Fe	1.2549	1.6902	1.9811	1.9390	2.2121	3.4402	3.2812	0.1403
Cu	0.0012	0.0014	0.0019	0.0024	0.0021	0.0327	0.0124	0.0213
Zn	0.0047	0.0051	0.0126	0.0104	0.0061	0.0120	0.0272	1.0387
Mn	0.0436	0.0400	0.0608	0.0201	0.0033	0.0260	0.0107	0.0077
Hg	0.0000	0.0000	0.0000	0.0001	0.0000	0.0005	0.0002	0.0000
Na	0.0113	0.0208	0.0145	0.2280	0.1827	1.0175	ND	0.0000
K	0.1471	0.1523	0.2006	0.3366	0.0101	5.0729	ND	0.0000
Ca	1.1177	0.9380	0.3700	3.9146	0.2909	0.9825	8.1089	1.0359
Mg	0.4300	0.3506	0.3005	0.6354	0.0138	0.0362	ND	0.1613
V	0.0019	0.0014	0.0020	0.0106	1.0519	0.0030	ND	0.0009
Ti	0.2300	0.1845	0.2377	0.0702	ND	0.0036	ND	0.0049
Al	0.9447	1.3009	1.1264	3.2561	0.5108	0.1388	0.3126	1.4173
SO4--	–	–	–	1.2061	47.5758	1.5246	0.0000	0.0366
NO3-	–	–	–	0.0239	0.0358	0.1302	0.2885	0.0125
Cl-	–	–	–	3.7439	*	*	5.7693	0.4771
NH4+	–	–	–	0.0172	0.0393	0.2216	0.6154	0.0006
Na+	0.0011	0.0028	0.0044	0.0345	0.4061	2.5449	0.6250	0.6309
K+	0.0070	0.0023	0.0112	0.0176	0.5115	12.4077	0.3510	0.7384
Ca++	0.0225	0.0074	0.0098	0.0573	0.1122	2.0031	4.8366	0.0000
Mg++	0.0041	0.0014	0.0016	0.0093	0.0351	0.0426	0.0615	0.2451
C-ele.	0.9700	0.5000	0.4100	0.3195	5.3203	3.2945	32.6212	66.8226
C-org.	0.4800	0.7400	0.5100	0.0537	2.0390	1.2711	ND	9.5834
C-total	1.4500	1.2400	0.9200	0.3732	7.3593	4.5773	32.6212	76.4059

(3) Selection of Characteristic Elements

By comparing the element contents of the ambient TSP with that of the particulate matter at the source, the elements having the enrichment factor (EF) of more than 1 were selected. As a result, the following 17 elements were selected as being characteristic:

Pb, Cd, Cr, Ni, Fe, Cu, Zn, Mn, Na, K, Ca, Mg, V, Ti, C-ele, C-org.

(4) Result of Source Contribution Analysis

Based on the above-mentioned data, the contribution of TSP sources to the ambient concentration of TSP at monitoring stations J2, J7, and H1 was estimated and the result is shown in Table 6.3.4.

- At Station J2, the contribution of soil is the largest, having a ratio of 57.3%. Among the stationary sources, the contribution of brown coal fuel, such as that used at thermal power generation plants, is the largest at 25.1%. Automobiles' contribution is estimated at 5.3%.

- At Station J7, the burning of brown coal is the largest contributing emission source (45.2%). Its contribution is greater than the soil's 26.5%. As this station is located alongside a trunk road, the contribution of 12.3% by automobiles is greater than at other stations.

- At Station H1, the contribution of soil is the largest at 45.7%. Of the stationary sources, coal sintering and cement production contribute by greater ratios than those at other stations. The burning of brown coal contributes by relatively small ratio. Automobiles contribute about 9.1%.

- At all stations, the contribution of pollutant sources burning heavy oil is very small.

Table 6.3.4 Source Contribution to Ambient TSP

Source	Kazincbarcika(J2)		Nyckladhaza(J7)		Miskolc(H1)	
	Conc.	%	Conc.	%	Conc.	%
Soil	64.5	57.3	23.8	26.5	45.5	45.7
Brown Coal	28.3	25.1	40.7	45.2	6.8	6.8
Heavy Oil	0.1	0.1	0.2	0.2	0.2	0.2
Sinter (Coal and Cokes)	11.5	10.2	8.8	9.7	25.0	25.1
Cement Factory(Natural Gas)	2.1	1.9	5.4	6.0	13.0	13.1
Automobiles (Diesel)	6.0	5.3	11.1	12.3	9.0	9.1
SUM	112.5	100.0	89.9	100.0	99.6	100.0
(Observed)	(110.1)	–	(105.3)	–	(80.2)	–

Chapter 7 STUDY ON AIR POLLUTION CONTROL MEASURES

7.1 Institutional Framework

7.1.1 Legal Framework

(1) Present Ambient Air Quality Standards

The ambient air quality standards in Hungary are in some cases stricter than the guidelines of the WHO, but generally the standards conform to those of the western European countries. For common air pollutants, the limit values are shown in Table 7.1.1.

Table 7.1.1 Ambient Air Quality Standards in Hungary

Air Pollutant	Concentration (mg/m3) [(ppm 20°C)]		
	Specially Protected Area	Protected Area I	Protected Area II
SO_2			
- Annual average	0.030 [0.011]	0.070 [0.026]	0.100 [0.038]
- 24-hours average	0.100 [0.038]	0.150 [0.056]	0.300 [0.113]
- 30-minutes value	0.150 [0.056]	0.250 [0.094]	0.400 [0.150]
NO_2			
- Annual average	0.030 [0.016]	0.070 [0.037]	0.120 [0.063]
- 24-hours average	0.070 [0.037]	0.085 [0.044]	0.150 [0.078]
- 30-minutes value	0.085 [0.044]	0.100 [0.052]	0.200 [0.105]
NOx			
- Annual average	0.030 [0.016]	0.100 [0.052]	0.150 [0.078]
- 24-hours average	0.070 [0.037]	0.150 [0.078]	0.200 [0.105]
- 30-minutes value	0.085 [0.044]	0.200 [0.105]	0.400 [0.209]
CO			
- Annual average	1.0 [0.86]	2.0 [1.72]	5.0 [4.29]
- 24-hours average	2.0 [1.72]	5.0 [4.29]	10.0 [8.59]
- 30-minutes value	5.0 [4.29]	10.0 [8.59]	20.0 [17.17]
SPM			
- Annual average	0.030	0.050	0.100
- 24-hours average	0.060	0.100	0.200
- 30-minutes value	0.100	0.200	0.300
O_3			
- 24-hours average	0.100 [0.050]	0.100 [0.050]	0.100 [0.050]
- 30-minutes value	0.110 [0.055]	0.110 [0.055]	0.110 [0.055]
Dust			
- Monthly total (g/m2/30days)	12	16	21
- Annual total (g/m2/year)	100	120	150
Lead			
- 24-hours average	0.0003	0.0003	0.0007
- 30-minutes value	0.0003	0.0003	0.0007

Notes :

1. Specially Protected Area : Nature conservation area
2. Protected Area I : Country's total territory except for "Specially Protected Area" and "Protected Area II".
3. Protected Area II : Regions which have industrial character

(2) Present Emission Standards of Stationary Sources

There are three types of emission standards specified in the regulation as described below.

1) Regional Emission Standards

Regional emission standards are based on the ambient air quality standards.

Point sources

The limit values (E_n) of regional emission are to be determined as follows:

$$E_n = E_f \cdot K_1 \cdot K_2 \qquad \text{(kg/h)}$$

where,

E_f : emission factor to the level categories of emission height, which should be determined by the following table.

Emission Height : H (m)	$E_{f,i}$ (kg/h · m3/mg)
$0 < H \leq 10$	2
$10 < H \leq 20$	6
$20 < H \leq 35$	90
$35 < H \leq 50$	700
$50 < H \leq 80$	2000
$80 < H \leq 100$	4000
$100 < H \leq 120$	6000
$120 < H$	30000

Value of E_f for the particular emission height categories:

$E_f = E_{f,i} / n$ (kg/h · m3/mg)

in which, n is the total number of building sources regarded as points and point sources emitting the same air-polluting material on the same site, on the same emission level

K_1 : permitted limit level of ambient air quality standard for 24 hours at the regional protection category on the site of the pollution source (mg/m^3)

K_2 : calculated value according to the following formula

$$K_2 = (100 - \text{Loading Index})/100$$

The loading index is a regulating value fixed by the authorities in connection with the degree of air-pollution in the region. The value of the loading index for major cities/towns in Sajó valley are shown in the following table.

Area Name	Dust	Gas (SO_2, NOx, CO, etc.)	Others
Alsózsolca	60	50	30
Felsőzsolca	60	50	50
Kazincbarcika	60	40	70
Tiszaújváros	70	50	50
Mályi	60	50	50
Miskolc	70	60	50
Nyékládháza	40	30	30
Özd	80	70	50
Sajóbábony	60	50	50
Sajókersztúr	60	50	50
Sajószentpéter	70	50	50
Serényfalva	60	50	50

The value of E_n is calculated down to the second decimal place.

The regional emission standards are to be determined for all pollutants.

<u>Building sources</u>

If the emitting surface of the building source is within 20 meters from the next existing dwelling house or institution and from its border, and from the planned dwelling houses or institutions, then the emission criterion is:

$$E_n = k \cdot V \cdot N \cdot 10^{-6} \qquad \text{(kg/h)}$$

where,

k : prescribed C_{max} value in the concerning standard for the given pollutant (mg/m^3)

V : volume of that air space of the building the pollutant is coming from (m^3)

N : frequency of the ventilation; number of the air-change per hour (h^{-1})
(If this value is unknown, in case of natural ventilation, value "N=5" should be taken into consideration.)

If the emitting surface of the building source is in a greater distance than 20 meters from the existing/planned dwelling houses and institutions and from their border, the building source is to be regarded as point source and the criteria should be determined according to the regulations on point sources.

2) Technological Emission Standards

The standards may be specified for newly established or reconstructed technological process as concentration of pollutants (in mg/m3) or as specific emission standards related to the amount of production (in kg-pollutant / t-production). Presently, the government is preparing technological emission standards for the technologies of great importance such as power plants, cement industry, aluminum industry, etc. Technological emission limits will be stricter than the regional emission limits.

3) Emission Standards by Transmission Models

The standards specifically prescribed for stationary sources may be determined by transmission models in cases where there are justification for them. The emission standards are stricter than the regional emission standards.

(3) Present Basic Fines System for Air-pollution Sources

1) Point Source

The basic fine to be paid for the given emission of air pollutant of a point source, broken down according to quarters of a year, is calculated as follows:

$$B = (E-E_n) \cdot t \cdot b_1 \qquad \text{(Forints/quarter of a year)}$$

where,

B: fine to be paid for a quarter due to exceeding of the emission criterion of the given pollutant (Forints/quarter of a year)
E: average value of effective emission for a quarter of a year (kg/h)
E_n: limit value of emission determined for the air pollutant at the given source (kg/h)
t: number of operating hours during a quarter of a year (hr./quarter)
b_1: key of fine (Forint/kg)

The value of b_1 can be determined from the following table. The degree of exceeding the limit value of emission (Z) should be determined as $Z = E/E_n$.

Degree of exceeding the limit value of emission (Z)	Key of fine b_1 (Ft./kg) Danger category of the pollutant 1	2	3	4
1.00 - 2.00	1.0	0.5	0.3	0.2
2.01 - 4.00	2.0	1.0	0.6	0.4
4.01 - 8.00	4.0	2.0	1.2	0.8
8.01 - 12.00	6.0	3.0	1.8	1.2
12.01 - 20.00	8.0	4.0	2.4	1.6
20.01 - 50.00	10.0	5.0	3.0	2.0
50.01 - 100.00	12.0	6.0	3.6	2.4
100.01 -	14.0	7.0	4.2	2.8

2) Building Source

The basic fine to be paid for the given emission of air pollutant of a building source is calculated as follows:

$$B_e = (E-E_n) \cdot t \cdot b_2 \quad \text{(Forints/year)}$$

where,

B_e: fine to be paid for the exceeding of the limit values of emission criterion of the given pollutant (Forints/year)

E: average value of the effective emission (kg/h)

E_n: limit value of emission determined for the air pollutant at the given source (kg/h)

t: number of operating hours per year (hr./year)

b_2: key of fine (Forint/kg)

The key of fine (b_2) is determined by the following table.

Danger Category of the air pollutant	b_2 (Forint/kg)
4	0.6
3	1.2
2	2.0
1	4.0

If the emitting surface of the building source is in a greater distance than 20 meters from the existing or planned dwelling houses and institution buildings and from their border, the value of b_2 is determined according to the rules stated for point sources.

(4) Present Emission Standards of Mobile Sources

1) Standards on the environmental protection inspection and control of motor cars

Motor vehicles registered in the country, except vehicles of the diplomatic corps and optional for military vehicles, undergo verification concerning their exhaust emissions, whose periodicity is as follows:

- motor vehicles equipped with a positive ignition engine and a three-way catalytic converter, and having controlled mixture preparation --------- 3 years
- other motor vehicles --- 1 year

The verification is performed by the technical inspection stations of the competent authorities or by authorized workshops. The eventual spot-checks of the emissions are made by the crews of the competent authorities.

According to the regulation of KHVM No.18/1991 (XII. 18), permissible level of typical types of mobile sources are as follows.

<u>Motor vehicles, agricultural tractors, and slow-moving vehicles (with an authorized gross weight of 3500 kg or less), equipped with a positive ignition engine (but without an exhaust gas catalytic converter)</u>

[CO, HC]

Type/model of Vehicle	CO content at the idling (vol. %)	HC content at the idling, and at 60% of the rated speed (unloaded) (ppm)
VAZ Lada, manufactured before January 1, 1987	4.5	1000
SKODA S105, S120, FIAT 126P	3.0	1000
FIAT 125P	4.5	1000
Wartburg 353, BARKAS B1000 (with two-stroke engine)	2.5	-
TRABANT 601 (with two-stroke engine)	3.0	-
DACIA, UAZ	4.0	1000
ZUK	4.0	1000
NYSA	4.0	1000
Others, manufactured between January 1, 1982 and January 1, 1988	3.5	1000
Others, manufactured before January 1, 1982	4.5	1000
Others, manufactured after January 1988	3.0	1000

Notes: 1. The permitted hydrocarbon limit values shall be effective only after May 1, 1993 for motor vehicles equipped with a four-stroke engine.

2. The hydrocarbon content shall be measured by a gas-analyzer calibrated to n-hexane equivalence.

Motor vehicles (with an authorized gross weight of 3500 kg or less), equipped with a positive ignition engine (and with an exhaust gas catalytic converter)

[CO, HC]

Mode of treatment of the exhaust gases	CO content at the idling (vol. %)	CO content at 60% of the rated speed (vol. %)	HC content with free running engines (ppm)
Three-way catalytic converter with controlled preparation of mixture	0.4	0.4	250
Other type of catalytic converters used in :			
four-stroke engines	1.0	1.0	400
two -stroke engines	2.5	2.5	2000

Motor vehicles equipped with a compression ignition diesel engine

- at free-acceleration from idle speed : K1 (m^{-1})
- at free-acceleration from a "raised" idle speed, or measured on a vehicle test bench with engine loaded : K2 (m^{-1})

K1 and **K2** are the light absorption coefficients as given below.

Category of vehicle	Engine type/model	K1	K2
Motor vehicles with an authorized gross weight of than 3500 kg or less		2.5	1.5
Motor vehicles with an authorized gross weight greater than 3500 kg	Naturally aspirated	3.5	1.5
	Supercharged	3.5	2.5

2) Standards on permitting motor cars into traffic and maintaining the operation of them

According to the regulation of KHVM No.6/1990 (IV. 12), CO content of the exhaust fume of typical types of mobile sources shall not exceed the limit defined as follows :

Motor vehicles equipped with a positive ignition (Otto) engine

Type/Model of Vehicle	CO Content of the Exhaust Fume (Vol. %)	
	basic run	at 60% of nominal rate of revolution
LADA made before January, 1 1980	4.5	5.0
LADA made after January, 1 1980	4.5	4.0
SKODA S105, S120	3.0	2.5
FIAT 126 P, ZIL 130	3.0	2.5
FIAT 125 P	4.5	2.5
WARTBURG, BARKAS B1000	2.5	2.5
TRABANT	3.0	3.5
DACIA, UAZ	4.0	4.0
ZUK	4.0	3.0
NYSA	4.0	4.5
ROBUR	4.0	2.5
Others	4.5	4.5

Motor vehicles equipped with a compression ignition (diesel) engine

for free acceleration from basic run $K \leq 3.5\ m^{-1}$
- for free acceleration from heightened basic run ($n = 1000 \pm 100 min^{-1}$) in case of suction engine $K \leq 1.5\ m^{-1}$
- turbo engine without smoke delimiter $K \leq 2.5\ m^{-1}$

K : light absorption coefficient

Moreover, the contamination content of the exhaust fume of typical types of mobile sources shall not exceed the limit values defined in the regulation.

The limit values are as follows.

Motor vehicles with an authorized gross weight of 3500kg or less and buses equipped with a positive ignition (Otto) engine

Gross weight of the vehicle m (kg)	Mass of Contamination Material emitted during Test (g/km)			
	Type approval of the vehicle (Type inspection)		Quality control of serial production	
	Carbon monoxide	Hydrocarbons and Nitrogen Oxides	Carbon monoxide	Hydrocarbons and Nitrogen Oxides
$m \leq 1020$	14.3	4.69	17.3	5.87
$1020 < m \leq 1250$	16.5	5.06	19.7	6.32
$1250 < m \leq 1470$	18.80	5.43	22.5	6.79
$1470 < m \leq 1700$	20.7	5.80	24.90	7.26
$1700 < m \leq 1930$	23.0	6.17	27.6	7.72
$1930 < m < 2150$	24.9	6.54	29.9	8.17
$2150 < m$	27.2	6.91	32.8	8.64

Notes: 1 The inspection procedure and calculation method is according to MSZ 21870/1-4 standard. (For comparison of the values calculated according to the standard to the above limit values, divide by 4.052).

2 The limit values for hydrocarbons and nitrogen oxides together should only be applied to from 1 st January, 1991 onward for the contingent of cars driven by two stroke engine ordered by commercial contract before 1 st January 1987 for the year 1986-90

(5) Present Standards for Fuels of Power Driven Vehicles

The main characteristics are as follows:

Leaded gasoline

Sulfur content (max.) : 0.05 %
Lead content (max.) : 0.15 g/l

Unleaded gasoline

Sulfur content (max.) : 0.05 %
Lead content (max.) : 0.005 g/l

Diesel fuel

Octane number (min.) 48
Sulfur content (max.) : 0.2 %

(6) Present Restriction for Two-stroke Engines

From January 1, 1992, cars and trucks with two-stroke engines can be used for public and commercial transport purpose (e.g. taxis, vans and light trucks) only if equipped with catalytic converters. The use of these types of cars for private (non-commercial) purpose is not restricted.

(7) Present Incentive Systems for Executing Control Measures

1) Central Environmental Protection Fund

The Central Environmental Protection Fund (hereinafter "CEPF") was regulated by the LXXXIIIrd Act of 1992 as a separated state fund earmarked for the environmental protection. CEPF is administrated by KTM and the decision making right on the utilization of the source belongs to KTM according to the Act. The rule of the operation and the utilization of CEPF in details, the procedural order and the main processes are contained in the Ministerial Ordinance No.20/1993(IV.23) of KTM.

CEPF provides a support for the followings:

- investments and technical measures directly promoting environmental protection;
- commercial solutions concerning the marketing of environmentally friendly products; and
- measures and actions aimed at strengthening the environmental awareness.

Main revenue sources of CEPF are the followings:

- the share of legally imposed environmental protection fines (air pollution fine, sewage fine, etc.);
- environmental product charge of fuels (fuel product charge);
- voluntary payment to and support for the Fund (PHARE program); and
- budgetary award.

According to the Act, the conditions and the types of financial support for projects are as follows. The total support cannot exceed 60% of the estimated total cost of the project.

<u>Grant (non-refundable support)</u>

- The total amount of the grant cannot exceed 30% of the estimated project cost; and
- Grant can be provided only for non-profit oriented activities.

Loan (Refundable support)

- Interest-free loan can be provided with a grace period of 1~2 years and the refund period generally within 1~5 years after the completion of the project; and
- Soft loan, where the interest of the loan ranges between 60~120 % of the basic interest rate set up by the National Bank, with grace period of 1~2 years and the refund period generally within 1~5 years after the completion of the project.

Pay off the interest of bank loan

Support can be provided to pay off the interest of bank loan drawn for the project, but not more in amount than 100 % of the amount calculated with the National Bank's basic interest rate.

Loan guarantee

Loan guarantee can be offered for at most 70 % of the amount of bank loan obtained for the purpose that directly promote environmental protection. In case of the bank loan for a very important environmental protection project, CEPF will assume responsibility for the bank guarantee required by the financial institution.

In the annual program for support in 1993, total amount of funds are estimated as follows:

Domestic sources

- General	600 ~ 1,000 million Forints
- Environmental product charge of fuels	1,500 ~ 1,700 million Forints
Total	2,300 ~ 2,700 million Forints

PHARE source : 6.3 million ECU (≈ 7.8 million US$ in the value of 1994)

The projects concerning air pollution control which are selected as high-priority tasks and can be funded from CEPF sources are as follows:

- Reduction of vehicle emissions (945 ~ 1,135 million Forints)
- Reduction of industrial emissions (30 ~ 50 million Forints)
- Reduction of domestic emissions (60 ~ 100 million Forints)
- Reduction of volatile hydrocarbon emissions and the use of CFCs (2.4 million US$)
- Introduction of energy saving methods satisfying the energy demands of households (0.6 million US$)

2) Others

Commercial customs tariffs are established and put down in legal rules in the case of goods imported to Hungary. Products can be granted various preferences with consideration to environmental protection. For instance, the customs tariff of cars with catalytic converter is 13 %, while that of the others is 18 %, and the customs tariff for the import of used cars is higher by 20 to 30 % than that of new ones. Moreover, preferential customs tariff of 0 % can be applied in case of the use of fluid absorbing materials for pollution controlling purposes, as well as catalytic converter, lead filter, gas analyzer and smoke measurement instrument for motor cars.

Hungary has incentive taxation (tax reduction) systems for purposes of environmental protection; production of some products and installation serving air pollution protection (fluidized bed pulverized coal dust fueled equipment, catalytic converter, exhaust-gas filter), professional services on air pollution protection planning and consultation, etc..

(8) The Draft Ambient Air Quality Standards proposed for the Future

The draft governmental decree on an air pollution abatement prepared in 1994 includes a revision of ambient air quality standards. The draft ambient air quality standards consists of Health Standards, Ecological Standards and Smog-alarm Limits, and the air pollutants are classified into classes of hazard level considering their damaging or endangering impact on the air quality.

The health air quality standards are applied to urban settlement areas which are classified as inhabited, recreational, institutionalized and green belt areas. Main parts of the standards are shown in Table 7.1.2, and 7.1.3.

(9) The Draft Emission Standards of Stationary Sources proposed for the Future

According to the draft governmental decree on an air pollution abatement, the Ministry for Environment and Regional Policy (KTM) ordains general and technological emission limit values concerning stationary air polluting point sources. In the license which is necessary for the operator (owner) of the air polluting source to use the environment, KTM can ordain special emission limit values which are stricter than the above-mentioned general and technological emission limit values, if the ambient air quality limit values at the affected area by the air polluting source cannot be ensured even in the case of maintaining the emission limit values. The special emission limit values are imposed on the basis of air quality control and assessment of spread which are carried out at the scene of the establishment for at least a year. KTM also ordains national total mass on emission limit values concerning certain branches of industry.

Table 7.1.2 Proposed Future Health Ambient Air Quality Standards of Air Pollutants regulated by Limit Values

unit: concentration (mg/m^3)

Air Pollutant	Hazardous Level	Short Time Limit Values		Long Time Limit Values
		30 minutes	24 hours	
SO_2	3	0.300	0.150	0.050
NO_2	2	0.150	0.100	0.070
O_3	1	0.150	0.100	-
TSP	3	0.300	0.200	0.100
CO	2	10.0	5.0	3.0
Hydrochloric	2	0.200	0.050	0.030
Benz(o)pyrene	1	-	0.000001	0.000001

Notes: 1. Short time limit values: the limit values for 30 minutes and 24 hours which are to be applied according to the following:

- to prevent the development of acute health problems;
- to evaluate the polluting effect to the largest extent; and
- to impose the permissible specific emission limit values of industrial air polluting sources within the frame of transmission calculations.

2. Long time limit values: the limit values referring to a period of half a year (heating, non-heating half year) and one year which are to be applied according to the following:

- to prevent the development of chronic health problems and environmental damage;
- to characterize the air quality of certain regions;
- to evaluate the results of air pollution abatement; and
- to conduct trend assessment.

Table 7.1.3 Proposed Future Health Ambient Air Quality Standards of TSP and Its Certain Components

Air	Hazardous	Long Time	Limit Values
Pollutant	Level	30 days	Half-year, Year
TSP	3	20 g/m^2/30days	150 t/km^2/year
[from TSP] Lead	1	12 mg/m^2/30days	-
Cadmium	1	0.15 mg/m^2/30days	-
Water-soluble Fluorides, as F	2	50 mg/m^2/30days	-
Benz(o)pyrene	1	0.017 mg/m^2/30days	-

New emission standards have been proposed in the draft regulation of KTM. The emission limit values refer to a mean of 24 hours.

1) General Emission Standards

General emission limit values are valid in every case when there are no technological emission limit values imposed for the given technology. The limit values are classified into four categories concerning "solid materials and inorganic dust materials", "inorganic materials in vapor or gaseous state", "organic materials" and "carcinogenic materials".

The parts of the standards concerning "solid materials and inorganic dust materials" and "inorganic materials in vapor or gaseous state" are shown in Table 7.1.4. and 7.1.5.

2) Technological Emission Standards separately imposed on Certain Technology

These standards are to be imposed separately on 14 main industrial technics.

Among them, the standard on cement industry is shown in Table 7.1.6. The standards concerning some other industries are as follows.

Baking of ceramic products (mass flow is 10 kg/h or higher)

Limit value: SO_2 concentration of smoke-gases--- 1500 mg/m^3 (in relation to 18% O_2 content)

Mixing and producing asphalt

Limit values:Solid material concentration of smoke gases --- 20 mg/m^3 (in relation to 17% O_2 content)

Sulfur content of fuels (gas/oil/coal) -------------------------- 1 %

Formation of iron alloys with electronic or metallothermic processes

Limit value: Solid material concentration of smoke gases --- 20 mg/m^3

3) Technological Emission Standards of Firing Equipment with a Thermal Capacity of 15 MW and above

Standards concerning new firing equipment

In case of firing equipment established or reconstructed and operated after the regulation's entry into force with a rated (licensing) thermal capacity input of 15 MW or above, the technological limit values shown in Table 7.1.7, 7.1.8, 7.1.9 and 7.1.10 are to be imposed.

Table 7.1.4 Proposed Future General Emission Limit Values of Stationary Sources concerning Solid Materials and Inorganic Dust Materials

Air Pollutant	Air Pollutant Mass Flow (kg/h)	Limit Values (Permissible Max. Concentration) (mg/m^3)
Class 0	no greater than 0.5	150
(Solid Materials)	greater than 0.5	50
Class I (Cd, Hg, Tl)	0.001 or above	0.2
Class II (As,Pb, etc.)	0.005 or above	1.0
Class III (Cr, Cu, etc.)	0.025 or above	5.0

Notes: 1. Materials which are not listed in Classes I to III shall be considered as solid materials.

2. In case several materials belonging to different classes are present simultaneously, the emission limit values are:

Classes I and II together: 1 mg/m^3;
Classes I and III or Classes II and III together: 5 mg/m^3;
however, the limit value referring to the material's own class cannot be exceeded.

Table 7.1.5 Proposed Future General Emission Limit Values of Stationary Sources concerning Inorganic Materials in Vapor or Gaseous State

Air Pollutant	Air Pollutant Mass Flow (kg/h)	Limit Values (Permissible Max. Concentration) (mg/m^3)
Class I (Arsenic hydrogen, etc.)	0.01 or above	1
Class II (HCN, H_2S, etc.)	0.05 or above	5
Class III (Inorganic chlorine)	0.3 or above	30
Class IV (SO_X, NO_X)	5.0 or above	500

Table 7.1.6 Proposed Future Technological Emission Limit Values concerning Cement Industry

Technological Process	Emission Limit Values (mg/m^3)		
	Solid Material	SO_2	NO_X
New equipment	50	400	1300
Existing equipment		750	1800
- furnaces with raw material grinding	100		
- clinker ventilation	100		
- cement grinding	80		
- other	50		

Notes: 1. In case of existing equipment, the emission limit values shall be enforced from January 1, 1996. That equipment is considered "existing equipment" which operates or has a valid establishment license at the time the regulation comes into force.

2. The emission limit values refer to a 6% O_2 content of the smoke-gas.

Table 7.1.7 Proposed Future Technological Emission Limit Values concerning New Firing Equipment operated with Solid Fuels

Air Pollutant	Emission Limit Value (mg/m^3)		
	15 - 100 MW	100 - 500 MW	> 500 MW
Solid Material	100	50	50
CO	250	250	250
NO_X (given in NO_2) (Note 1)	650	600	600
SO_2 and SO_3 (given in SO_2)	(see Note 2)	(see Note 3)	400
Chlorides (given in HCl)	200	100	100
Fluorides	30	15	15

Notes:

1. In case of domestic lignite maximum 300 mg/m^3 (calorific value: < 7,000 kJ/kg)
2. 2,000 mg/m^3 or at least 60% desulphurating efficiency
3. Limit value except for the following conditions is obtained by interpolating the interval between the value for [15-100MW] and that for [>500MW]
    - In case of firing domestic brown coal and lignite, at least 90% desulphurating efficiency
    - In case of firing imported coal maximum 400 mg/m^3
    - In case of Fluidized Bed Combustion Boiler using domestic coal, at least 75% desulphurating efficiency
4. Concentration given in mg/m^3 refer to dry smoke-gas with 6% O_2 content at a normal state (273°K, 101.3kPa).

Table 7.1.8 Proposed Future Technological Emission Limit Values concerning New Firing Equipment operated with Liquid Fuels

Air Pollutant	Emission Limit Value (mg/m^3)		
	15 - 300 MW	300 - 500 MW	> 500 MW
Solid Material	50	50	50
CO	175	175	175
NO_X (given in NO_2)	350	350	350
SO_2 and SO_3 (given in SO_2)	1700	(see Note 2)	400
Chlorides (given in HCl)	30	30	30
Fluorides (given in HF)	5	5	5
Heavy Metals (Note 1) and Arsenic	2	2	2

Notes:

1. The following elements are to be taken into consideration: Arsenic, Cadmium, Cobalt, Nickel, Chromium, Lead and Vanadium
2. Limit value is obtained by interpolating the interval between the value for [15-300MW] and that for [>500MW]
3. Concentration given in mg/m^3 refer to dry smoke-gas with 3% O_2 content at a normal state (273°K, 101.3kPa).

Table 7.1.9 Proposed Future Technological Emission Limit Values concerning New Firing Equipment operated with Gaseous Fuels

Air Pollutant	Emission Limit Value (mg/m^3)		
	15 - 100 MW	100 - 500 MW	> 500 MW
Solid Material	5	5	5
CO	100	100	100
NO_X (given in NO_2)	200	200	200
SO_2 and SO_3 (given in SO_2)	35	35	35

Note: Concentration given in mg/m^3 refer to dry smoke-gas with 3% O_2 content at a normal state (273°K, 101.3kPa).

Table 7.1.10 Proposed Future Technological Emission Limit Values concerning New Firing Equipment (Gas Turbines)

Air Pollutant	Emission Limit Value (mg/m^3)	
	< 300 MW	> 300 MW
Solid Material (Soot) (Note 1)	4	2
CO	100	100
NO_X (given in NO_2)		
- fuel oils	200	170
- gases	150	90
SO_2 and SO_3 (given in SO_2) fuel oils	115	115

Notes:

1. The number of blackening is according to the Bacharach scale.
2. Concentration given in mg/m^3 refer to dry smoke-gas with 15% O_2 content at a normal state (273°K, 101.3kPa).

Standards concerning existing firing equipment

- In case of firing equipment which exists when the regulation comes into force or which was established and licensed before the regulation comes into force, the same standards as those concerning new firing equipment are to be enforced from January 1, 1999. Until the day of the enforcement, the above-mentioned equipment can exceed the limit values under certain conditions, however, the environmental fee shall be paid in a higher amount (as an air pollution fee) for the air pollution which exceeds the limit values.

- For solid fuel combustion furnaces altered into Hybrid Fluidized Bed Coal Dust Combustion Furnaces, the desulphurization rate shall be at least 60% and the emission concentration of NO_X cannot exceed 800 mg/m^3.

- For oil combustion furnaces, the emission concentration of SO_2 cannot exceed 2,100 mg/m^3 and the smoke-gas (above 500 MW) concentration of heavy metal and arsenic cannot exceed 2 mg/m^3.

- Concerning all the existing firing equipment belonging within the above-mentioned definition and operated by the Hungarian Electric Company, the following limit values (in annual periods) shall be maintained.

[SO_2] :	after January 1, 1996	max.	380,000 t/year
	after January 1, 2000	max.	280,000 t/year
	after January 1, 2004	max.	150,000 t/year
[NO_X] :	after January 1, 1996	max.	40,000 t/year
	after January 1, 2000	max.	35,000 t/year
	after January 1, 2004	max.	30,000 t/year
[Solid materials (Dust)] :			
	after January 1, 1996	max.	25,000 t/year
	after January 1, 2000	max.	20,000 t/year
	after January 1, 2004	max.	10,000 t/year

4) Technological Emission Standards of Medium-capacity Firing Equipment with a Thermal Capacity of 120 kW - 15 MW

The technological limit values by fuel types shown in Table 7.1.11 are to be imposed.

5) Technological Emission Standards of Small-capacity Firing Equipment with a Thermal Capacity of 4 kW - 120 kW

The technological limit values by fuel types shown in Table 7.1.12 are to be imposed from January 1, 1996.

Table 7.1.11 Proposed Future Technological Emission Limit Values concerning Medium-capacity Firing Equipment

Air Pollutant	Fuel Type	Emission Limit Value (mg/m^3)	
		Application Period	
		till December 31, 1998	from January 1, 1999
Solid Material	Gas and liquid fuels		
	Fuel oils	250	200
	Liquid fuels	250	150
	Gases	150	50
	Solid	250	200
Soot	Fuel oils and evaporating burners	3 (Bacharach-scale)	2 (Bacharach-scale)
	Liquid fuels	3 (Bacharach-scale)	1 (Bacharach-scale)
	Gases	1 (Bacharach-scale)	0 (Bacharach-scale)
	Solid	2 (Ringelmann-scale)	2 (Ringelmann-scale)
CO	Fuel oils and liquid fuels	650	170
	Gases	650	100
	Solid	800	250
SO_2	Fuel oils	2000	1700
	Liquid fuels	1000	1000
	Gases	300	150
	Brown coals	3000	3000
	other solid fuels	1500	1000
NO_X	Fuel oils	1000	800
	Liquid fuels	600	450
	Gases	400	250
	Solid	600	450

Note: Concentrations given in mg/m^3 of oils and gases are referred to 3 vol.% O_2 content and those of other fuels to 6 vol.% at a normal state (273°K, 101.3kPa).

Table 7.1.12 Proposed Future Technological Emission Limit Values concerning Small-capacity Firing Equipment

1)

Air Pollutant	Fuel Type	Emission Limit Value	
		Application Period	
		till December 31, 1998	from January 1, 1999
Soot	Fuel oils and evaporating burners	3 (Bacharach-scale)	2 (Bacharach-scale)
	Liquid fuels	2 (Bacharach-scale)	1 (Bacharach-scale)
CO	Fuel oils and liquid fuels	650 mg/m^3	170 mg/m^3
	Gases	650 mg/m^3	100 mg/m^3

2)

Thermal Load Data (kW)	Smoke-gas Loss (%)		
	Application Period		
	till Dec. 31, 1996	till Dec. 31, 1998	from Jan. 1, 1999
4 ~ 25	18	16	12
25.1 ~ 50	17	15	11
50.1 ~ 120	16	14	10

Note: Concentrations given in mg/m^3 refer to dry smoke-gas with 3 vol.% O_2 content at a normal state (273°K, 101.3kPa).

(10) The Draft Environmental Fee/Air Pollution Fee System for Air Polluting Sources

In the draft governmental decree and the draft regulation on fees relating to air pollution, new concept of "environmental fee (fee for using environment)" has been adopted instead of the present basic fine system.

Fee for using environment will be paid by the procedure and degree ordained by KTM for the total mass of air pollutant emissions of stationary air polluting sources. Amount of payment for the environmental fee is calculated as follows:

Basic fee (BF)

$BF = 1.0 \bullet M$ Forint/kg pollutant

where, M: multiplying number

- M=1 for pollutants belonging to the hazardous level "3"
- M=2 for pollutants belonging to the hazardous level "2"
- M=3 for pollutants belonging to the hazardous level "1"

Fee for using environment (FUE)

$FUEq = C \bullet A \bullet T \bullet BF \bullet 10^{-6}$

where, FUEq: fee for using environment to be paid in every quarter of a year [Forint/quarter]

C: concentration of the pollutant at the emitting place [mg/m^3]

A: airflow of the chimney/stack [m^3/hour]

T: operation hours in a quarter of a year [hour]

Air pollution fee is imposed for emission exceeding limit values. Amount of air pollution fee is maximum 10 million Forints in each case, and it is charged by the environmental authority taking into consideration the amount of pollutants, conditions of emission and the hazardous level. If the existing stationary air polluting source, not belonging to domestic activity, exceeds emission limit values during the moratorium period, the operator/owner of the existing polluting source is obliged to pay a multiple environmental fee (air pollution fee). Air pollution fee is five times or ten times more than the environmental fee.

Fee for using environment and air pollution fee will be paid like tax by the polluter voluntarily and will be paid in every quarter of a year. Besides these fees, fine will be inflicted in case of violating regulations concerning air quality protection. These fees and fines will be paid into the Central Environmental Fund. Upon formal request, an air polluter can claim a refund of up to 50% of the air pollution fee if it is used for the reduction of the emission from the polluting source.

(11) The Draft Emission Standards of Mobile Sources proposed for the Future

According to the draft governmental decree , emission limit values concerning mobile air polluting sources will be imposed on public vehicles, railway vehicles, aircraft, ships and vessels, agricultural machines, tractors, motorized power vehicles and slow vehicles. The draft governmental decree touches on the obligations concerning user, manufacturer, trader and seller of mobile air polluting source and its fuel.

1) Standards on the environmental protection inspection and control of motor cars

Draft regulation of KHVM on the environmental protection inspection and control of motor cars has been proposed to amend the present regulation of KHVM No.18/1991 (XII.18). This draft regulation is expected to come into force on January 1, 1996. Main items of amendment are as follows:

Period of the environmental protection inspection

Except for the first period and the period of the mileage prescribed by the manufacturer, the periodicity of the environmental protection inspection are determined depending on the design characteristics of the engine. The periodicity of the environmental protection inspection for motor vehicles are shown in the following:

[Motor vehicle equipped with a positive ignition (Otto) engine]

- traditional 2- and 4-stroke engine	12 months
- equipped with an uncontrolled, 3-way catalyzer	24/24/12 months
- equipped with a controlled, 3-way catalyzer	36/36/24 months

[Motor vehicle equipped with a compression ignition (Diesel) engine]

- traditional 2- and 4-stroke engine	24 months
- equipped with an oxidizing catalyzer	36/24/12 months
- equipped with a carbon deposit filter	36/36/36 months

[Motor vehicle used for the specific mileage and operational area]

Above-mentioned periods are altered with the multiplier "0.5" for the vehicles fulfilling public road service and with 30,000 km/year, and for buses.

Content and technology of the environmental protection inspection

Specific parameters to which should be referred at least for the inspection are described.

Permissible level of the exhaust gas pollutant emissions

[Motor vehicle equipped with a positive ignition (Otto) engine]

- the value defined in the existing regulation of KHVM No.18/1991 (XII.18)

[Motor vehicle equipped with an compression ignition (Diesel) engine]

- 1.2 times the free acceleration peak value measured with consent for a given type in accordance with European regulations
- the lowest values measured in accordance with Hungarian Standard and announced in the present regulation of KHVM No.18/1991 (XII.18)
- in case of vehicles equipped with a controlled or uncontrolled catalyzer , the maximum smoky exhaust cannot be higher than $(K_1, K_2 =)$ 0.5 m^{-1}

- in case of the buses used for city public transport, 0.6 times the limit values imposed in the present regulation of KHVM No.18/1991 (XII.18), after January 1, 1997.

2) Standards on permitting motor cars into traffic and maintaining the operation of them

New emission standards on permitting mobile air polluting sources into traffic are proposed in the draft joint regulation of KTM and KHVM. The parts of the standards are shown as follows:

Motor cars not exceeding the total mass of 3500 kg and with a planning speed above 50 km/h

The parts of permissible limit values of pollutant emissions of are shown in the following.

[Average pollutant content of the exhaust gas]

Permissible limit values are shown in Table 7.1.13.

[Carbon monoxide content at basic speed]

- Basic adjustment $C_{CO} \leq 3.5$ V/V%
- Determined adjustment $C_{CO} \leq 4.5$ V/V%

Trucks, buses and tractors equipped with compression ignition (Diesel) engine, with a total mass above 3500 kg and with a planning speed above 25 km/h

The permissible limit values of pollutant emissions are shown in the Table 7.1.14.

Motor cars provided with a Type-certificate before January 1, 1994 with a total mass not exceeding 3500 kg and with a planning speed above 50 km/h

The permissible limit values of pollutant emissions are shown in the Table 7.1.15.

Besides the emission limit values, the regulation also touches on that a motor car equipped with a positive ignition (Otto) engine with permissible total mass above 3500 kg cannot be permitted into traffic, and that a motor car operated only with leaded fuel cannot be permitted into traffic after December 31, 1994.

Table 7.1.13 Proposed Future Permissible Limit Values of Average Pollutant Content of the Exhaust Gas of Motor Car with a Total Mass not exceeding 3500 kg and with a Planning Speed above 50 km/h

Category of Motor Car	Field of Application	Limit Value (g/km)		
		CO	HC + NO_X	Particle (Note 4)
1	Type approval	2.72	0.97	0.14
	Quality control of serial production	3.16	1.13	0.18
2 - group I	Type approval from January 1, 1995	2.72	0.97	0.14
- group II		5.17	1.40	0.19
- group III		6.90	1.70	0.25
2 - group I	Serial production from January 1, 1995	3.16	1.13	0.18
- group II		6.00	1.60	0.22
- group III		8.00	2.00	0.29

Notes:

1. Category 1 is motor car of category M1 with at least 6 seats including the driver's seat and with the total mass not exceeding 2500 kg.
2. Category 2 is motor car of categories N1 and M1 with more than 6 seats or with the total mass above 2500 kg.
3. Categories M1 and N1 are in accordance with UNO ECE TRANS/SC1/WP29/78/Amend.3 (June 12, 1991).
4. Particle is to be investigated only in case of compression ignition (diesel) engine.
5. Motor car groups are defined as follows:
   - group I : reference mass ≤1250kg
   - group II : 1250<reference mass ≤1700kg
   - group III : 1700kg<reference mass

Table 7.1.14 Proposed Future Permissible Limit Values of Trucks, Buses, and Tractors equipped with Compression Ignition (Diesel) Engine, with a Total Mass above 3500 kg and with a Planning Speed above 25 km/h

Designated Emission Standard	Field of Application	Emission Limit Value (g/km)			
		CO	HC	NO_X	Particle
EURO I valid Jan. 1, 1994	Type Approval	4.5	1.1	8.0	0.36
	Serial Production	4.9	1.23	9.0	0.40
EURO II valid Dec. 31, 1994	Type Approval	4.0	1.1	7.0	0.15
	Serial Production	4.0	1.1	7.0	0.15

Table 7.1.15 Proposed Future Permissible Limit Values of Motor Cars provided with a Type-certificate before January 1, 1994 with a total mass not exceeding 3500 kg and with a Planning Speed above 50 km/h

Type of Motor Car	Field of Application	Displacement of Engine	Limit Value (g/test)			
			CO	HC + NO_X	NO_X	Particle
Positive Ignition (Otto) Engine	Type Approval	$V_h>2000$	25	6.5	3.5	-
		$1400 \leq V_h \leq 2000$	30	8.0	-	-
		$V_h<1400$	45	15	6.0	-
	Serial Production	$V_h>2000$	30	8.1	4.4	-
		$1400 \leq V_h \leq 2000$	36	10.0	-	-
		$V_h<1400$	54	19	7.5	-
Compression Ignition (Diesel) Engine	Type Approval	$V_h \geq 1400$	30	8	-	0.8
		$V_h<1400$	45	15	6.0	1.1
	Serial Production	$V_h \geq 1400$	36	10	-	1.0
		$V_h<1400$	54	19	7.5	1.4

Notes: The limit values for NO_X and particle included in the table are multiplied by 1.4 in case of a diesel engine with direct injection.

7.1.2 Air Pollution Control Organization

(1) Ministry for Environment and Regional Policy (KTM)

Main tasks of KTM are professional management and governmental coordination concerning air pollution abatement. Environmental Protection Bureau is a main executing body for several kinds of pollution control. In the scope of its role and jurisdiction, KTM mainly executes the following matters:

- Suggestions to the government on the national strategy and policy concerning air pollution abatement;
- Imposing the rules and regulations concerning air pollution abatement;
- Establishment of comprehensive air pollution control plan
- Emission and immission (ambient air quality) monitoring; and
- Management and application of Central Environmental Protection Fund

(2) Ministry for Transport, Communication and Water Management (KHVM)

KHVM is an authority who takes charge of an air pollution control caused by mobile air polluting sources. KTM mainly executes the following matters:

- Suggestions to the government on the national strategy and policy concerning control of mobile air polluting sources;
- Imposing the rules and regulations concerning control of mobile polluting sources;
- Administration and control of production, marketing and utilization of mobiles air polluting sources and fuels for them;
- Administration and control of traffic on public roads from the viewpoint of air pollution control; and
- Planning an optimum transportation networks from the viewpoint of air pollution abatement.

(3) Ministry of Welfare (NM)

NM is an authority who takes charge of air pollution abatement from the viewpoint of a public health.

(4) Ministry of Industry and Trade (IKM)

Main tasks concerning to air pollution abatement are taking the lead of industry and making a suggestion on control measures to be adopted.

(5) North Hungarian Environmental Protection Inspectorate (EKF)

There are 12 environmental protection inspectorates under the control of KTM, and EKF is one of them who acts as the first level body to execute environmental protection issues defined in various legal regulations. The area of jurisdiction is BAZ county and a most part of Heves county excluding the valley of Zagyva. Total number of the personnel of EKF is 137, and 16 staffs are exclusively working for the tasks concerning air pollution control.

Main tasks concerning to air pollution abatement are execution of on-the-spot inspection of stationary polluting sources, collection of the fines, and management of database of polluting sources declared. EKF also executes operation and maintenance of background level monitoring of ambient air quality. EKF saves, updates and uses the data of air pollutants measured by EKF or declared by the polluters. If the emission is above the limit values, EKF imposes a limitation to avoid the harmful state. Using the database, various reports are prepared for higher bodies and if requested, for mayor offices of some communities. Emission data measured by EKF are regularly transferred to ANTSZ.

Air Cleanness Protection division consists of 16 staffs including 10 engineers, and executes emission and immision monitoring/measurement. Environmental Assessment and Information department executes comprehensive environmental analyses, inspects/studies the impact on environment and coordinate the work of the remaining departments in joint tasks. Information division processes the data of pollutants declared by the polluters, and maintain the computer hardware and software systems in EKF. Laboratory produces absorbent liquids for air pollution protection measurements and executes an necessary analysis after the measurements.

As for collaboration with other administrative bodies, EKF and ANTSZ regularly inform each other of the air pollution data from the air quality monitoring stations. In case of high air quality values, the city mayor imposes smog alarm according to the suggestion of ANTSZ and EKF, and EKF proposes the shutdown of large air polluting sources. In case of extraordinary environmental pollution, EKF proposes preventive measures against the damage to County Civil Defense Command.

(6) BAZ County Transport Management Office (BAZKF)

Within the unified transport authority administration formed since 1991, county and capital city transport management offices executes the official tasks under the control of KHVM.

BAZKF executes both sides of air pollution control; namely the emission control of exhaust gas and the traffic control. BAZKF permits an assembly and a transformation of road vehicles, and conducts technical and environmental inspection of roads vehicles before their entrance into traffic. BAZKF also conducts periodically environmental protection inspection (included in an ordinary car inspection system) and surprise road-side environmental inspection of road vehicles.

(7) National Public Health and Medical Officer's Service (ANTSZ)

ANTSZ is an execution body for public health and medical affairs under control of NM. Main tasks concerning air pollution abatement are operation and maintenance of regional monitoring network of ambient air quality, research and studies on the relation between air pollution and public health.

(8) National Meteorological Service (OMSZ)

OMSZ is one of the extra-departmental organizations connected with KTM. Main tasks concerning air pollution abatement are operation and maintenance of national monitoring network of ambient air quality, meteorological observation, research and studies on the relation between air pollution and meteorology, and research and development on air quality simulation model.

(9) City Mayor Office

Main task of city mayor office concerning air pollution control is a announcement of smog-alarm. In case of pollution exceeds the smog alarm limit values, the city mayor office shall be on duty during the period beyond working hours. The city duty officer provides an information on the development and changes of the smog situation cooperating with OMSZ and is responsible for arranging the information and warning the inhabitants. City mayor orders the imposition of the specifications for smog alarm categories depending on the air pollution level.

The provision for limitation on the stationary polluting sources and on the mobile sources are made public according to the suggestion by the city duty officer. The city operation and city supply department take action to ensure the non-interruption of traffic, to arrange for mass transportation and to incorporate the city police office in imposition of limitation on vehicle use.

The head of the city operation and city supply department is responsible for updating the smog alarm plan.

7.2 State of Air Pollution Control at Stationary Sources

7.2.1 Quality of Fuels

(1) Solid Fuel

Among 85 coal samples analyzed for their quality, sixty-six (66) were brown coal and lignite produced in Hungary. With regard to the calorific value, lignite of Bukkabrany Coalfield near the study area has the lowest at 6,600 KJ/kg (1,580 kcal/kg), while brown coal of Tatabanya Coalfield has the highest at 20,500 KJ/kg (4,900 kcal/kg). Coal of Visonta coalfield has the lowest content of sulfur 1.5 - 1.6% at total sulfur, while that of Balinka has the highest at 5.18%. The total sulfur content of lignite and brown coal averages 2 - 3% and that of Edeleny shows higher values of 3.6 - 3.8%.

The feature of the coal produced in the study area is its low ash softening point (1,000°C-1,100°C) and most of it melts when it is burnt at 1,200°C-1,300°C. This is also proven by the fact that large amount of clinker is seen in the ash dumping ground of the Borsod Power Plant. One of the reasons why imported coal is used in the stoker firing furnace instead of coal produced in the Borsod coalfield is that the ash softening point is low as well as the content of sulfur.

The coal which has the least sulfur is imported coal from Russia and most of it except for one example has less than 1% at total sulfur (import permission is not given to coal with a sulfur content of more than 1%). Because the majority has some CaO in ash, SO_2 turns into $CaSO4$ and is fixed in the ash at a combustion temperature of 800 - 850°C (about 0.5 - 0.8 %).

However, this applies only in cases where the coal is burnt at the above low temperature. When it is burnt at more than 1,000°C and a large quantity of oxidizable gases such as O_2 and CO are contained in the exhaust gas, although sulfur is combined into $CaSO4$, much of it is oxidized or decomposed to SO_2. Therefore, the SO_2 concentration greatly increases in the high temperature range.

According to the experience of the Study Team in combustion tests using coals such as black coal, brown coal, lignite etc., the exhaust gas SO_2 concentration was found to be calculated as,

(total sulfur) x 0.9 x 2

rather than calculating from combustible sulfur except for the fluidized bed boiler where the furnace temperature can be maintained at 800 - 850°C. (It has been specified in analytical methods that combustible sulfur content in coal be obtained from the quantity of SO_2 emitted at a combustion temperature of 815°C .)

Total sulfur content of powdered brown coal burnt at Borsod Power Plant is 2.05-2.10%. Coal burnt at Tisza I Power Plant is brown coal produced at many coalfields such as nearby coalfields and in West Hungary and its sulfur content greatly depends on the type of coal. It can vary in the same boiler inspected on the same day. For example, for brown coal burnt between 10:00-13:00 on June 22 when the inspection was made, total sulfur was 3.10% and combustible sulfur was 1.99%. For the of brown coal burnt between 14:00-15:30, total sulfur was 2.57% and combustible sulfur was 1.77%. For the brown coal burnt between 10:30 and 14:30 on June 29, total sulfur was 2.04% and the combustible sulfur was 1.62%, while at 10:00 on July 1, total sulfur was 1.74% and combustible sulfur was 1.53%. Since the percentage varies greatly, it is difficult to estimate typical values.

However, generally speaking, it is desirable to burn brown coal from Borsod at a combustion temperature of 800 - 850°C by adding the proper amount of CaO in the fluidized bed in consideration of the property of the coal.

(2) Liquid Fuels

Quality of fuel oil greatly varies with production sites from where National Oil Refinery, Mol. RT imports. The sulfur content of the residue oil sampled in August (burnt at Tisza II Power Plant) was 2.91%. However, according to data reported in 1992, the sulfur content of fuel oil was as follows:

January	3.43%	Average: 3.90%
February	4.14%	
March	4.14%	
August	4.39%	Average: 4.30%
September	4.21%	
October	2.77%	Average: 2.74%
November	2.77%	
December	2.68%	

Moreover, at present, the plant imports fuel oil with a sulfur content of 1.5% from Russia because of the international price reduction of crude oil with a low sulfur content. Therefore, the sulfur content of residue oil is around 2%.

In the analyzed result, normal fuel oil has 2.95% sulfur and 0.2% nitrogen while intermediate heavy oil with a slightly lower specific gravity (0.9514) than that of fuel oil has 2.51% sulfur and 0.2% nitrogen. Heavy oils for industrial use have properties close to the international standards : it has 0.17% sulfur and 0.1% nitrogen. And heavy gas oil and kerosene have 0.16-0.22% sulfur.

As for gasoline, both Petrol No. 92 and 98 have a specific gravity of 0.75, 0.04% sulfur, and 0.15% Pb.

(3) Gas Fuels

The supply ratio of natural gas is approximately 50% import and 50% domestic production. In the study area, domestic natural gas produced at Hajdúszoboszlo gas field is mainly supplied (calorific value: 34,000 KJ/Nm^3 (8,120 kcal/Nm^3), CH4: 97,65%, total sulfur: 2.8mg/m^3). Imported natural gas is supplied from Russia's gas pipeline "Testveriseg" (calorific value: 35,860 KJ/Nm^3 (8,560 kcal/Nm^3), CH4: 98.35%, total sulfur: 3.9mg/m^3).

Because inert gas which is used in Tisza II Power Plant has almost equal percentages of CO_2 and CH4 (44%), its calorific value is as low as 16,160 KJ/Nm^3 (3,860 kcal/Nm^3) and its total sulfur is 2.2mg/m^3.

7.2.2 State of Air Pollution Control at Major Stationary Sources

(1) Outline of Stationary Pollution Sources in the Study Area

Among the large and medium size factories in the Sajo Valley area having potentiality of emitting air pollutants, 54 factories are operating. They include those factories that have gone bankruptcy but are still partially operating and 19 large-to-small size heating centers operating in the heating season. There are some factories that completely stopped operation after bankruptcy.

Examination of factories' answers to questionnaire submitted to EKF revealed that there are a total of 527 stacks emitting air pollutants in those 54 operating factories. Of these, 271 are emitting pollutants due to fuel combustion. Number of stacks emitting SO_2 due to combustion of coals and oils is 56 including 8 stacks of 3 power stations. One of these 8 stacks discharges exhaust gas collected from 4 flues (4 boilers).

Those operating stacks mentioned above can be categorized by pollution source characteristics as shown in Table 7.2.1.

Facilities that burn sulfur containing fuels such as coal and heavy oil are mostly boilers in power stations, chemical factories, a petroleum refinery, etc.

Table 7.2.1 Categorization of Major Stationary Pollution Sources

Pollution Source Category	Kind of Pollutants Emitted	Number of Stacks
1) Sources emitting air pollutants due to fuel combustion	a) SO2, NOx, CO, dust	56
	b) NOx, CO, HnCn, dust (natural gas used as main fuel)	215
2) Sources emitting air pollutants from production processes of chemical and petroleum products	Cl2, HCl, COCl2, HnCn, NOx, NH4NO3, dust	141
3) Sources of dust only (mostly metal factories)	dust	115

(2) General Situation of Air Pollution Control

Air pollution control measures must be studied for each type and scale of facilities. Pollution control situations in the major categories of stationary pollution sources in the Study Area are as follows.

There is no flue gas desulfurization facility in the factories in the Study Area. Some combustion facilities emit SO_2 with its amount exceeding the emission standards.

As for NOx, there are some facilities that seem to need combustion control with an appropriate air ratio. A certain facility seems to need low-NOx burners. But no specific measures are taken for these facilities.

For control of dust emission, electrostatic precipitators (EP) are installed in large-scale facilities such as a blast furnace in DNM and boilers in power stations. Sintering furnaces for iron ore in BEM are equipped with multi-cyclones with efficiency of 80-85 %. The blast furnace in DNM has no hood, therefore, iron ore dust escapes into atmosphere by about 4% of the total quantity. This amount is said to account for 75% of the total dust emission in Miskolc City. According to the decision of the Hungarian Government, the blast furnace is to be phased out by the year of 1996.

(3) Air Pollution Control at Power Plants

There are three thermoelectric power plants in the Study Area belonged to Borsodi Energetikai Kft and Tisza Eromu Rt, the power generation companies, as follows:

Borsodi Energetikai :

Borsod Power Plant	coal fired

Tisza Eromu Rt :

Tiszapalkonya (Tisza I) Power Plant	coal fired
Tisza II Power Plant	gas and/or heavy oil fired

For air pollution control, only EPs are installed at the two coal-fired power stations to collect dust, but they are very old, and inefficient. All the facilities in these two power plants are old, and lack both combustion efficiency and electric energy efficiency.

The current state of air pollutant emissions from each station in 1992 is described below.

1) Borsod Power Plant

Borsod Power Station is located near Kazincbarcika. It was built in 1955-57. It has ten conventional pulverized coal-fired boilers (100 t/h x 10), and six 30 MW turbine generator units. The installed capacity is 200 MWe.
The power station supplies electricity to the national electricity grid and heat energy to Kazincbarcika for district heating and to a nearby chemical company.
Production data of 1992 are as follows:

Electricity	599.33 GWh
Heat energy	3,167,737 GJ
Plant heat rate	14,208 KJ/KWh
Fuel input	
Brown coal	1,174,307 ton
Natural gas	31,857,000 Nm3
Oil	118 ton

The brown coal comes from Borsod mines. It is low-grade with high contents of ash and sulfur. Each boiler is equipped with an electrostatic precipitator (EP). The flue gas is discharged through 3 stacks. The stacks are 101 m high.

Borsod Power Plant's atmospheric emissions in 1992 are estimated to be as follows:

	Emissions (kg/h)			
	Dust	SO2	NOx	CO
Limit rate	160	600	240	12,000
No.1 stack	92.0	1,774	121.0	13.5
	89.5	1,376	117.3	13.0
	61.0	887	80.3	9.0
	81.5	1,670	107.2	12.0
No.2 stack	81.5	1,310	108.6	12.6
	55.7	962	73.9	8.5
	43.0	850	57.5	6.7
	49.8	958	66.5	7.7
No.3 stack	133.6	2,782	178.1	20.6
	79.2	1,456	105.1	12.0
	39.6	806	53.0	6.2
	52.0	1,056	69.4	8.1

2) Tisza I Power Plant

Tisza I Power Plant is located near Tiszaújváros. This power plant was commissioned in 1957-58. The installed capacity is 230 MWe. It has eight pulverized coal-fired boilers (125 t/h x 8).

The power plant supplies electricity to the national electricity grid and heat energy (hot water and steam) for district heating of Tiszaújváros, for a chemical company (TVK), and an oil refinery (TIFO). The boilers are fitted with EPs which were installed in 1977-80. Production data of 1992 are as follows:

Electricity	932.46 GWh
Heat energy	2,422,451 GJ
Plant heat rate	13,412 KJ/KWh
Fuel input	
Brown coal	1,328,871 ton
Natural gas	39,307,400 Nm3
Oil	476 ton

The brown coal comes from the Borsod and west Hungarian mines. The coal has high contents of sulfur and ash. The flue gas is discharged through 4 stacks of 120 m high.

Tisza I Power Plant's atmospheric emissions in 1992 are estimated to be as follows:

	Emissions (kg/h)			
	Dust	SO2	NOx	CO
Limit rate	90	375	150	7,500
No.1 stack	Nos. 1 and 2 boilers were under reconstruction.			
No.2 stack	150.3	1,497.7	137.6	157.9
	117.9	1,312.4	106.0	124.4
	100.4	1,325.9	88.8	100.4
	128.5	1,361.7	115.3	129.7
No.3 stack	38.7	1,233.4	115.2	131.8
	44.2	1,503.6	129.7	152.2
	34.3	1,417.0	99.0	111.6
	43.4	1,476.2	128.5	144.8
No.4 stack	115.0	1,316.0	123.5	141.3
	93.4	1,186.3	98.7	115.7
	82.0	1,283.9	85.6	96.8
	106.3	1,351.0	114.6	129.9

3) Tisza II Power Plant

Tisza II Power Station is located near Tiszapalkonya Power Station at about three kilometers from Tiszaújváros. Tisza II Power Station was commissioned in 1977-1978. It has four blocks each having a boiler for mixed combustion of oil and gas. The total boiler capacity is 670 t/h.

The installed power generation capacity is 860 MWe. It supplies electricity for the national grid.

Production data of 1992 are as follows:

Production	2,615.66 GWh	
Plant heat rate	9,883 KJ/KWh	
Fuel input		
	Natural gas	282,938,000 Nm3
	Inert gas	491,794,000 Nm3
	Oil	181,230 ton

The gas from 4 flues is discharged through a single stack of 250 m high.

Tisza II Power Plant's atmospheric emissions in 1992 are estimated to be as follows:

	Emissions (kg/h)		
	SO2	NOx	CO
Limit rate	1,875	750	37,500
No.1 block flue gas	319.0	158.7	9.4
	0.0	138.0	9.1
	2,075.0	170.0	9.1
	146.4	143.0	9.2
No.2 block flue gas	476.0	164.0	8.8
	587.0	126.0	8.6
	2,089.0	168.0	9.3
	190.5	137.0	8.6
No.3 block flue gas	457.7	164.0	9.3
	645.3	113.0	8.0
	572.0	142.0	8.1
	130.5	138.0	8.5
No.4 block flue gas	357.0	169.0	9.0
	838.0	160.0	9.2
	1,909.0	185.0	9.3
	139.9	161.0	8.8

4) Necessity of Emission Control

Concerning SO_2, all of three power plants exceeded the Hungarian emission standard level. But NOx and CO emissions are below the standard level. Dust emissions from Borsod Power Plant are below the standard level. Dust emissions from No.2 and No. 4 stacks in Tisza I Power Plant exceeded the standard level. As other stacks in the same station showed the emission values considerably below the standard level, the high emission values of No.2 and No. 4 stacks may be attributed to the faulty electrostatic precipitator. Since all of 3 plants show the SO_2 emission far above the standard level, measures to reduce the SO_2 emission are necessary.

(4) Air Pollution Control at Chemical Factories

Harmful gases, such as HCl, Cl_2, $COCl_2$, HNO_3, etc., emitted at high concentrations during processing of chemical and petroleum products are washed in absorbers with NaOH and H2O and released into the atmosphere. However, in most cases, only water spray scrubbers are used. Moreover, the ratio of liquid to gas is very low and the mixing is poor. (One pass is applied in most cases with no repetition.) These factors reduce efficiency. The desirable ratio of liquid to gas is 1:150 at minimum and 1:120 for optimum.

The attention should be paid in the future to the emission of SO_2 from the sulfur collector at MOL desulfurization plant. This is because its collection percentage is 90% or less due to the 'one pass' of the Claus method, and also because the emission quantity of SO_2 depends greatly on the sulfur content of the crude oil.

(5) Air Pollution Control at Metal Factories

Dust collectors such as bag filters and multicyclones are installed under the blast furnace of DNM company but the suction is insufficient. Moreover, problems concerning the collection and removal of the separated dust have not yet been solved. Because of the structural problem of the blast furnace (BF), more than 4% of the BF gas is emitted into the air each time the upper partition opens when raw materials are supplied, and this has become a serious cause of air pollution. It seems that great efforts have been made toward rebuilding this blast furnace. However, the Hungarian Government made a decision to phase out the blast furnace in DNM and the iron ore preparation plant in BEM.

(6) Heating Centers

The heating centers in the study area are shown in Table 7.2.2. None of these enterprises exceed the Hungarian emission standards for SO2, NOx, CO and dust. These heating centers are closely connected to the regional society and are positively dealing with air pollution control.

Table 7.2.2 Present State of Central Heating in the Sajó Valley Area

Name of area	No. of households covered by central heating	No. of households (1990)	No. of public facilities covered by central heating	Volume of public heating (m^3)	Fuels used
Miskolc	31,722	73,500	569	635,979	Natural gas and coal
Kazincbarcika*	8,010	12,776	267	130,299	Coal (power station)
Sajoszentpeter	348	4,629	13	2,300	Natural gas
Ozd	5,516	16,135	162	177,625	Natural gas and coal
Tiszaújváros	5,473	6,250	119	155,026	Coal (power station)
Emod	42	1,857	8	3,257	Oil
Putnok**	452	2,535	3	6,641	Oil** and wood

Note *: Of 8,010 households registered in a heating network, 6188 households receive hot water heating. The total number of households of the city is 12,776 as of October, 1993.

**: Use of natural gas began on October 15, 1993.

7.2.3 Existing Pollution Control Plans at Major Stationary Sources

(1) Borsod Power Plant

Since the facilities in this power plant are quite old, the company is planning to modernize the facilities in order to reduce pollutant emissions and improve power generation efficiency. According to the information given to the Study Team, six out of ten 100t/h existing boilers are to be phased out, and the following 2 projects are being planned.

1) New Installation of Circulating Fluidized Bed Construction System (CFBC)

Technical characteristics of CFBC system is discussed in Section 7.3.1. An outline of this project (called 150 MW circofluid extension) is as follows.

i) Main Equipment

Boiler:	Steam capacity (max.)	460 t/h
	Continuous steam generation(max.)	454 t/h
	Steam pressure	165 bar
	Steam temperature	540 °C

Steam mass flow (max.)	19.4 kg/s (70 t/h)
Temperature at out flow	420 °C
Planed pressure	188.0 bar
Combustion air flow	135.0 m^3/s (nominal)
Boiler efficiency:	
in case of brown coal (Borsod coal)	90 %
in case of black coal	92 %

Turbine generator:	150 MW, 3000 l/min.
Fresh steam	160 bar / 535 °C
Steam mass flow	126 kg/s (45 t/h)

ii) Flue Gas

Flue gas quantity and amounts of pollutant emissions are expected to be as follows :

Flue gas :

Flue gas flow	518,400 Nm^3/h
Outlet flue gas temperature	150 °C

Emission of pollutants :

Solid particles	50 mg/Nm^3	(26 Kg/h)
SO2	400 mg/Nm^3	(207 Kg/h)
NOx	200 mg/Nm^3	(104 Kg/h)

Comparison of the planned pollutants concentrations with the German standard limits for the capacity over 100 MW are as follows :

	German standards		Planned
Solid particles	80 mg/m^3	>	50 mg/m^3
SO2	650 mg/m^3	>	400 mg/m^3
NOx	600 mg/m^3	>	200 mg/m^3

The above data show that the planned values are below the limits of the German standard.

2) Conversion of 100t/h Boilers Into Hybrid Fluidized Bed Combustion System (HFBC)

A study concerning conversion of four 100 t/h boilers into hybrid fluidized bed combustion (HFBC) boilers was conducted by the power plant company.

HFBC system is a combination of fluidized firing and coal-dust firing, and is a patent of the Hungarian Institute of Electric Power Research (VEIKI). Technical characteristics of the HFBC and its applicability to this power station are discussed in detail in Section 7.3.1.

Its main advantages are as follows:

- The SO_2 and NOx emissions decrease.
- The contamination of furnace surfaces decreases.
- It provides stable firing at partial load even without supplementary firing.
- It can be established at a relatively low cost.

3) Discussion

The CFBC system, planned to be employed in the Borsod Power Plant as described above, is drawing attention in the combustion-related industries as a latest technology. When this type of boiler is operated with a combustion temperature at about 950°C, its combustion efficiency is quite high; remaining ash is almost white with very low content of unburned carbon. Therefore, the operation at this temperature would save fuel consumption by about 10 % in comparison with conventional boilers. However, the optimal range of combustion temperature to attain maximum desulfurization efficiency within the boiler (85 % or more) is between 800°C and 850°C. The desulfurization efficiency decreases to 20-30 % or less when operated at 950°C; SO2 reduction including fuel saving effect is only 30-40 % or less at this temperature. Thus, the operating conditions for high combustion efficiency and high desulfurization efficiency contradict each others.

According to the Study Team's investigation of existing CFBC boilers in several countries, most of them are operated at about 950 °C to pursue economic effect.

Since the combustion temperature can be easily controlled, one alternative is to find optimum operating temperature of the boiler, with both the combustion efficiency and the desulfurization efficiency taken into consideration.

(2) Tiszapalkonya (Tisza I) Power Plant

For this power plant, MVM RT. plans to decrease gradually the productions of electricity and heat energy towards the future. Firstly, 3 boilers out of existing 8 boiler are to be abolished by 1995. For remaining boilers, retrofitting works for 2 boilers are to be completed in 1994, and the works for another 2 boilers are to be completed in 1995. Planned production output in 2005 is 1,700 TJ of heat energy and 35 GWh of electricity as compared with about 2,200 TJ of heat and 800 GWh of electricity in 1993.

As the production level is to be decreased drastically, no emission reduction facilities for SO_2 and NOx are planned to be installed.

(3) Tisza II Power Plant

This power plant is a very important electricity producer in the Hungarian electric system. The production of electricity has been 2,615 GWh in 1992 and 3,008 GWh in 1993. According to MVM Rt., the production level will be incresed until the year 2000 (3,805 GWh) and will be decreased to 1,581 GWh in 2005. The shortage of electricity is to be supplied from Donamenty thermal power plant which will be newly installed in 1999.

No emission reduction facilities for SO_2 and NOx are planned to be installed.

(4) DNM metal Factory and BEM Ore Preparation Plant

The Hungarian government has made a decision on the policy for the reorganization of the Borsod steel industry. The blast furnace in DNM and related facilities such as LD converter (DNM) and iron ore preparation plant (BEM) are to be phased out by the year of 1996, although the companies had planned to improve their facilities including these facilities. Improvement plans for remaining facilities presented by the companies are as follows.

1) Combined Steel Work

- Implementation of independent primary and secondary suction in case of ASEA kettle-metallurgy, umbrella type suction by drawing off, utilization of separated dusts
- Settlement of independent suction and separation system at continuous steel caster, and closed treatment of utilized dust
- In case of capacity-increasing of UHP arc furnace, solving additional suction and separation in accordance with needs
- In case of kettle-repairing technologies: umbrella type suction, closed waste treatment for reuse
- Increased maintenance of environmental protecting equipment, automatic signalling of emission transgression, total utilization of separated dusts and drosses
- Study of utilization of converter-torch-gas (for heating or other technologies)
- Increasing of manufacturing capacity of continuous steel casting, decreasing by this the energy-need and environmental pollution of rolling-mill furnaces
- The closed system treatment of all collected dusts and drosses for all equipment, and their suctions

2) Rolling Mills

- Re-examine the necessity of numerous heating-furnaces, the possibility of decreasing. For moderation of energy loss of the remained furnaces, the not needed gaps of furnace chambers have to be closed. The furnaces, heat-utilizing boilers, if it is possible, have to be heated by BF gas or mixed gas (BF gas will not be used).
- Natural gas burners with capacity of more than 1,000 m3/h have to be changed to low NOx burners.
- Rust-waste arising from rolling has to be collected, stored in a closed system, and totally reused.
- For energy-saving and environmental protection, problems of missing automation and measuring instruments of the heating equipment have to be solved.
- The number of the ingot-polisher machines has to be reexamined, and the ingot-polishers survived have to provided with more efficient suction, and jet-filter type dust-separators. In case of building up secondary suction, individual separable places have to be solved. Separated dusts have to be totally reused.
- In rolling mills, the collecting-pipes have to be provided with oil-indicator (to indicate oil pollution in cooling-water in case of breakdown), which can control chemical-dosing, and oil-separation of water-cleaning work-shop as well.

3) Energy Supply

- The composition of smoke gasses of furnaces has to be continuously controlled in view of energy saving and environmental protection.
- The high capacity natural gas burners have to be changed to low NOx type.

4) Waste Processing Storage

- Wastes have to be transported on depot by closed transportation facilities. Roads in the factory have to be cleaned of dust.
- Dross processing and separating works in waste depot have to be made in closed, roofed area. To eliminate air pollution, waste depot has to be stabilized by recultivation or chemical treatment.
- The waste water (getting into the ground) of the depot, and water of the brook have to be totally utilized for the waste processing technologies.
- The open air storage of iron-containing muds and dusts has to be stopped, they should be worked up immediately, and re-utilized in metallurgy.

5) Technologies of Other Work Shops

- The number and importance of furnaces in HAMOR RT. and DAV Ltd. have to be re-examined. The lasted furnaces have to be urgently modernized and provided with energetical measuring and controlling system.
- The out of date technology of sand-preparatory work-shop has to be stopped, new one must be provided, or sand has to be obtained from outside source.
- The air pollution of casting houses can be reduced by umbrella-suction and closed technology (cleaning of casts, steel casting, sand-mould making and drying).
- Remove oil pollution of the ground and water, automatic control of oil getting into the cooling-water system of HAMOR RT. and CH RT.
- The sulfuric-acid steeper must be stopped, planting a new one instead or installation of mechanical grinding technology is necessary.

(5) DIOSGYORI Steel Mill and Casting Factory (DAV)

The following facility plan was provided by the company for suction devices and dust collectors used to trap solid waste (dust) generated by the electric furnace of electric steel mill I.

1) Emission Sources

i) Two 17.5t Electric arc furnace

First, to supply scrap for the 17.5t arc furnace using a crane, the furnace is drawn forward. The scrap is put in and the furnace returned to its original position. Next, an electrode is put in the furnace to melt the scrap. Inspection is made at the insertion opening and certain substances may be added. Because it is a rocking arc furnace, it can be turned over with the electrode in it. The hot water is drained, then chemicals are added to repair the fireproof wall inside the furnace. Waste is created at each stage.

When the electrode is lowered at the time of fusion, a large quantity of waste is created first with the excess pressure in the furnace.

When the furnace door is opened, a large quantity of waste escapes because of the excess pressure inside. However, this will not occur when the materials are provided with the furnace.

ii) One 2.5t electric arc furnace

Materials are provided with a scoop. Then the electrode is lowered to melt the materials. Inspection is made at the furnace door and some substances may be added. The rocking arc is turned over to drain the hot water.

When the electrode is lowered and the furnace door is opened at the time of fusion, the pressure is excessive because of the heat, and a large quantity of waste escapes.

2) Bell-shaped Suction Device

The bell-shaped suction device is to be installed according to the length of the electrode and the movement of the furnace. The bell-shaped suction device is installed on the steel frame structure. When the electrode is replaced, the bell-shaped suction device and the steel frame structure are moved on caterpillar tracks. The rotating arm is moved through 180 degrees.

- Bell-shaped suction device of 17.5 t arc electric furnace
  Diameter: 2,500 mm
  Area: 4.9 m^2
  Air flow velocity: 1.4 m/s
  Flow rate of air and smoke: 6.95 m^3/s (25,000 m^3/h)

- Bell-shaped suction device of 2.5 t arc electric furnace
  Diameter: 1,750 mm
  Area: 2.4 m^2
  Air flow rate: 1.4 m/s
  Flow rate of air and smoke: 3.33 m^3/s/12,000m^3/h

- Average dust flow rate:
  2.5t furnace : 5.2 kg/h in average
  17.5t furnace : 11.00 kg/h in average

3) Dust Collector

Filter of the suction system
Type: 2 pieces VFP-40/4-C
Rated capacity: 25,000 m^3/h
Filter area: 240 m^2
Type: 1 piece VFP-40/2-C
Rated capacity: 12,000 m^3/h filter
Area: 120 m^2

Through the filter of the dust collector, dust concentration will be $5mg/m^3$.

4) Dust Processing

Dust is transferred from the dust tank with a caterpillar movement and put in the container.

Amount of dust in one quarter
Hours of operation: 1000 hours/quarter
17.5t furnace : 19.8t/quarter
2.5t furnace : 5.25t/quarter
Total amount of the dust in each quarter
Q*=19.8+19.8+5.25=44.85 t/quarter
The amount in each quarter is equivalent to about 6 of 3.5 m^3 containers.

7.2.4 Problems in Air Pollution Control of Stationary Sources

(1) Coal Supply

The current production cost of coal in Hungary is about Ft. 220 - 230/GJ, and pricing competitive with imported oil should be at most Ft. 140 - 180/GJ or less.

Despite the high production costs, not all of the Hungarian coal mines are closing down. One of the reasons is that existing Hungarian coal-fired power plants can operate only by coals of a low caloric value (international coals have 25,000 - 30,000 kJ/kg, while Hungarian coals have only 12,000 kJ/kg). Another reason is that imported coal is not necessarily cheaper than Hungarian coals. The rivals of Hungarian coals are not necessarily imported coals, but natural gas and oil. Instead of the current coal-based power plants, however, the government plans to establish power plants with gas turbines and atomic energy sometime in the future. In 1993, Hungarian power-plants are to receive about 100,000 PJ domestic coal. Hungarian coal policy is obviously related to employment problems.

Formerly there were 35 deep mines in Hungary, now there are about 20, and by 2000 their number is likely to be reduced to 3 - 5. In 1990, there were some 50,000 workers in Hungarian coal mining, and by the end of 1992, the number reduced to about 30,000.

1) Structure of Coal Mining

The structure of coal production in Hungary (in peta joule) is as follows :

	1992	1995	2000
Surface-produced lignite	39	45	45
Black coal	18	16	8
Brown coal	101	79	52
Total	158	140	105

Coal mines to be closed down or remained by 2000 are as follows :

Coal mines as of 1992		Planned last year of production
Mecseki coal mines	Vasas	1994
	Komlo	1997 - 2000
	Szaszvar	1992
	Surface	-
Dorogi	Alagut	1992
	Lencsehegy	1996 - 2000
Tatabanyai	Many I/a	1999
	Zsigmond	1993
	Surface	1992
Oroszlanyi	Markushegy	-
	Surface	1994
Veszpremi	Ajka	1999
	Dudar	1993
	Varpalota	1993
Borsodi	Edeleny	1999
	Lyuko (*)	-
	Putnok	1995
	Feketevolgy	1998
	Rudolf	1992
	Surface	1994
Nogradi	Menkes	1992
	Nyirmend	1992
	Szekvolgy (Kereg)	-
	Surface	1992
Matraalji	Thorez	-
	Bukkabrany	-

Note : (*) Dubicsány coal mine will be opened in the future in place of Lyuko mine.

2) Coal for Borsod Power Plant

On November 12, 1992, the Cabinet ruled about the establishment of "Coal- mine / Power-plant Complexes." Accordingly, three such complexes were organized on January 1, 1993 :

1. Matravideki Energetics Share-holding Company
2. Mecseki Energetics Share-holding Company
3. Ajkai Energetics Share-holding Company

According to current plans, the Tisza Power Plant Company in the Sajo Valley area will be merged with the Lyuko Coal Mine Company in BAZ County to form a new establishment called "the Coal Mine/Power Plant Complex" on January 1, 1994.

As far as domestically-produced brown coal is concerned, the Borsod power plant will have no alternative source of fuels but to use brown coal supplied mainly from the Lyuko coal mine, and then from the Dubicsány coal mine after the expected closure of the Lyuko mine. Quality of coals from these two mines are said to be similar. Meanwhile, the Borsod power plant is planning to employ the HFBC system developed based on the coal of the Ajka mine. However, as will be described in Section 7.3.1, when the Lyuko coal is used, the desulfurization rate of the HFBC system is not as high as that achieved by the use of the Ajka coal. This problem has to be solved in employing the HFBC system in the Borsod power plant.

(2) Energy Consumption

Until 1989 when Hungary was liberated from Soviet dominance and began shifting towards market economy, energy intensity of the country remained very high as shown in Figure 7.2.1. In contrast to low prices of produced goods, energy consumption was high. Energy consumption per US$1,000 of goods was four to five times higher than Japan's rate, and three times higher than the average of all industrialized nations. This is partly because the country, under the control of the former Soviet block, had not given careful consideration to competitiveness in the international market, and partly because the government's policy had attached no importance to energy saving efforts and energy efficiency. Soviet-style operations dominated both the manufacturing and farming industries.

During the 1973 oil shock, no special measures were taken by the government. Seven to eight years later in the early 1980s, the government began to formulate its energy policy, which was not intended to save energy, but was aimed at shifting the country's source of energy from oil to natural gas following instructions from the Soviet Union. Since the government had adopted and formed a Soviet-dependent economy, Hungary came under the pressure of the Soviet Union, and the country was unable to utilize sufficiently the oil pipeline from the Adriatic Sea.

Although Hungary imported electricity from other countries, a large amount was supplied by the East block nations. Before the economy was liberalized, the price of

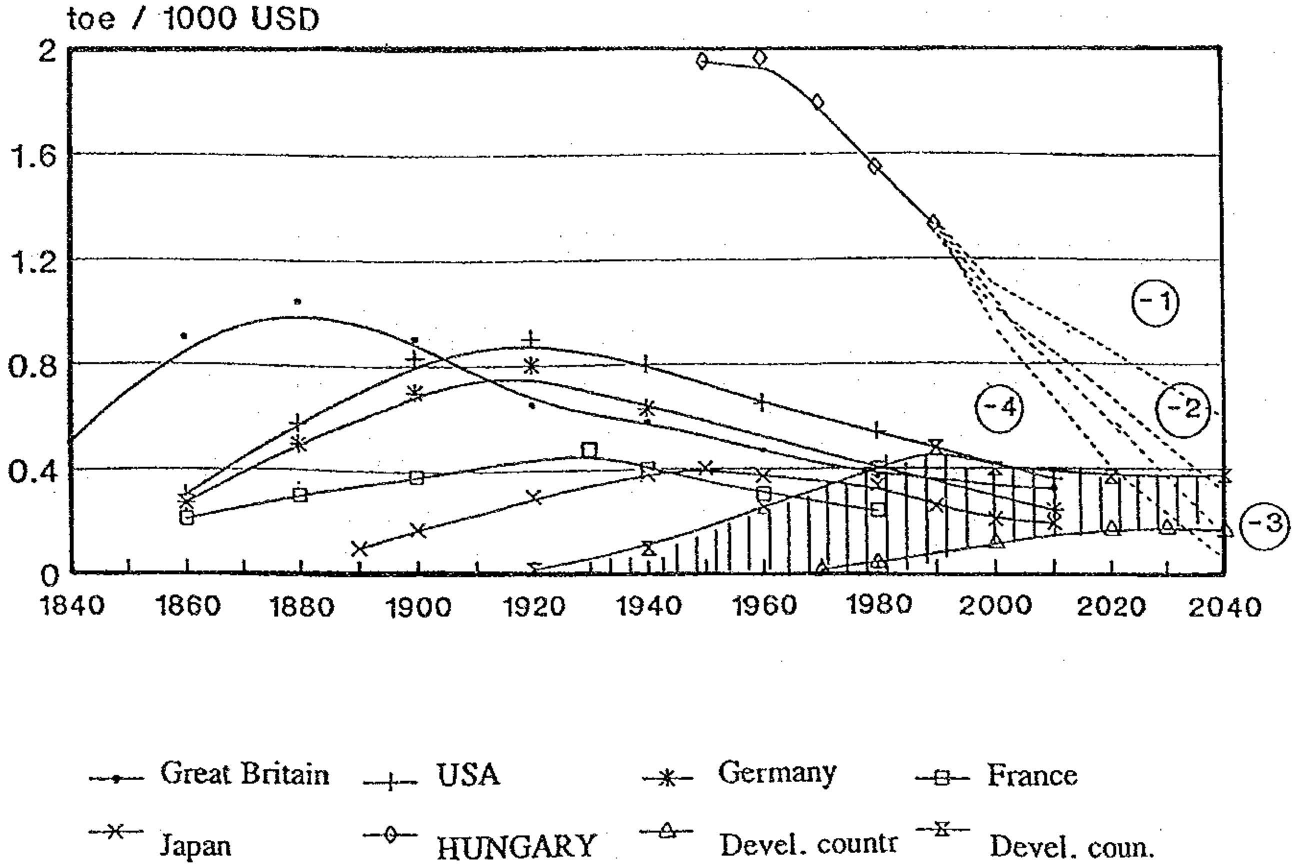


Figure 7.2.1 Movements of Energy Intensity - An International Comparison

electricity was set at a lower rate than in other countries. In the 1990s, electricity prices have been raised to international market prices. In 1990 and 1991, natural gas was purchased at market prices higher than those in Germany and France in the European Community.

Examples of waste of energy by companies are described below.

1) DNM KFT.

Blast Furnace

The double sluice-chamber is provided on the top of the BF, and internal pressure of BF gas is high. Therefore, when the upper sluice is opened for feeding ores, coke and limestones, this gas runs away into the atmosphere. In this way the loss-gas takes a sum of about 4 - 6 % of the produced BF gas. The quantity of the loss-gas, owing to the height, temperature, pressure and poisoning-danger, is not directly measurable. On the basis of calculations and gas-analysis, the total loss-gas in 1992 was 19,619,700 m^3. BF gas has heating value of 800 - 900 kcal/m^3. If the average is taken as 850 kcal, the loss of energy amounts to about 4 tera joule.

LD Converter

The converter is a 80 ton normal capacity with top oxygen-blowing. Its average portion time is about 50 minutes, which includes 12-15 minutes of blowing. A sucker-cover fits to the mouth of the converter, but the closing of this cover is not complete. The arising converter gases become cool by a heat-utilizing boiler, then dust content is separated by a double, Venturi type (Baumco manufactured) water-system gas cleaner. The efficiency of cleaning is suitable : the dust emission from the 70 m stack is 1.4 - 2.4 kg/hour. The content burns away from converter-gas on top of this stack ; an automatic natural gas burner is installed. Disadvantages of this system are that no heat is utilized and CO burns only when the concentration is above 12.5 %. Therefore, it not burns during first 2 minutes and the last 2 - 3 minutes of the blowing, thereby releasing CO into the air.

Some examples of energy saving in ironworks in Japan are as follows.

Table 7.2.3 shows pricipal measures for energy saving in iron factories.

Table 7.2.4 shows specific energy consumption (energy consumption per unit product) in DNM from 1988 to 1992. The specific energy consumption remained in the same level during this period.

Table 7.2.3 Principal Measures for Energy Saving in Iron Factories

Process	Measure	Function
Pig iron process	coke dry quenching (CDQ)	recovering wasteheat of red heat coke after dry distillation of coal
	recovery of wasteheat of sintered steel	recovering energy which are exhausted at sintered plant
	power generation at top of blast furnace	power generation by turbine with high pressure gas at top of blast furnace
	recovery of wasteheat in hotwind furnace	recovering and utilizing low heat exhaust gas from hot wind furnace
	coke oven gas (COG)	recovering and utilizing by-product gas of coke oven
Steel mill process	recovery of slag heat	recovering and utilizing heat of slag at blast furnace and converter
	converter gas (LDG)	recovering and utilizing by-product gas from converter
Rolling process	direct rolling	not through heating furnace but by direct rolling of slag
	insertion of heat slag	inserting heat slag into heating furnace before cooling down
	preheating by jet flow of heating furnace	spraying exhaust gas of heating furnace to pillet for preheating
	slag cooling boiler	recovering heat of slag to produce steam
	controlling number of revolutions of blower	controlling revolutions of blower for E.P. of blast furnace, according to volume of electric power

Table 7.2.4 Specific Energy Consumption in DNM

		1988	1989	1990	1991	1992
Blast Furnance						
Coke	kg/t	598.2	573.7	553.5	543.1	554.4
natural gas	m3/t	27.5	32.0	-	-	-
Electricity	kwh/t	16.29	16.3	16.1	15.11	17.4
Oxygen	m3/t	-	-	16.18	16.22	7.3
B.F. gas	m3/t	918.6	857.0	863.5	904.99	817.08
LD Converter						
Natural gas	m3/t	18.6	18.8	21.5	24.9	19.96
Electricity	kwh/t	54.2	47.51	44.75	32.21	26.75
Oxygen	m3/t	65.1	64.16	62.75	62.25	58.0
Erectric Furnace (UHP)						
Natural gas	m3/t	13.2	13.1	19.2	33.5	21.67
Electricity	kwh/t	549.61	523.07	510.73	522.5	497.85