

(2) Government Policy on Reconstruction of Power Stations

The Hungarian Government carried out a study concerning abolition of over-aged furnaces used in coal firing power stations and reconstruction projects in which environmental protection and improving energy efficiency were taken into consideration. It is presented below.

- 1) Considering the outdated power station network, the construction of separators and filters, widely applied in West Europe (e.g., desulfurization units, NOx filters) is not justifiable in most cases either from technical or economic terms. The relatively short "remaining life cycle" would question the implementation of such program of several tens of billion HUF, as environmental investment projects. Therefore the de-commissioning, reconstruction and conversion of fuel (e.g., replacing coal with natural gas, in most cases) - to be implemented during a period of patience, defined by legislation, and expectedly prior to the end of the century - can be the most likely solutions until the turn of the century. In addition to these actions, other projects should also be implemented in the blocks that will continue to operate also after the turn of the century for the protection of the environment. The capital expenditures of such projects are estimated, subject to factors with great impact on such costs, to be HUF 35 - 45 billion.
- 2) To retain the operational capabilities of existing power station blocks that are expected to function for longer time also following the turn of the century, such blocks need to be wholly or partially reconstructed. The said blocks will mostly be firing hydrocarbons. But the reconstruction of coal-firing blocks that can become profitable units on the long run will also become inevitable (the cost frame of such reconstruction projects can be quantified within a very wide band, subject to the influencing factors, i.e., something like HUF 5 - 20 billion).
- 3) In the middle of the 90s, new capacities will be required for replacing the missing import coal-firing power generating capacities to be de-commissioned. The requirement for a better controlled electricity system will appear on top on that. Until the end of the 80s, the regularly received, reliable supplies imported from the former Soviet region played a dominant role in the control and regulation of the system. The said task can only be resolved by the construction of gas turbine power blocks, as required, that can be constructed within short lead time (i.e., 2 - 3 years). Within the framework of this program, construction of capacities capable of outbalancing the fluctuations of daily peaks and waves will also be addressed (in

some cases, peak shaving turbines).

- 4) The program of gas turbine development will involve the construction of blocks with relatively low specific capital expenditures (only half or one-third in comparison with the base load power station) and with small per unit capacity, with a total capacity of some 700 MW. (With the help of the construction of units with small per unit capacity, demands can be more easily followed and met, as well as replacing imports can become simpler, through a flexible and gradual process. The program will require capital investment in a speed and rate tolerable and financeable by the country and the electricity sector. Therefore the figure mentioned above is only for orientation.)
- 5) Though the costs of fuel for the gas turbine power plants are higher than those of the coal-firing or nuclear stations, the capital expenditure requirements are significantly lower (subject to the specific location and type, it could be 350 - 700 USD/KW). This type of power plant is the most favourable for environmental aspects as well. The fuel of gas turbine power plants is mostly natural gas, whereas during the winter season gas oil. In the case of combined heat supply, the said heat production and electricity generation technology is capable to secure a very favourable rate of efficiency, i.e., 80-90 %. Considering the fact that the said rate of efficiency is more than twice higher than that of the traditional (condensation type) power stations, the increase of hydrocarbon demands is relatively moderate. This may case rise from the present 120 PJ up to 150 PJ by the turn of the century (and in the case of replacing coal-firing electricity generation capacities with natural gas firing units, this rise can be even higher). This will undoubtedly be a very critical element from aspects of the safety of supply and the present unilateral dependency in natural gas import (as the difference of 30 PJ would represent an additional volume of 1 bcm natural gas). Diversification of gas import should be an objective of the energy policy, irrespective of the said need.

2.3.5 Energy Prices

Table 2.3.11 shows the trends in prices of energy carriers in Hungary. Table 2.3.12 shows currently effective tariff structure of electric current.

Table 2.3.11 Energy Source and Energy Prices in January (HUF)

	1989	1990	1991	1992
Briquettes, Dorog-type (100 kg)	113.0	161.0	214.0	699.0
Fire-wood, unified price (100 kg)	135.0	193.0	256.0	314.0
Natural gas (m ³)	3.24	3.92	5.1	7.8
LPG (kg)	7.7	9.2	12.0	21.9
Household fuel oil (l)	8.0	9.2	11.9	21.2
Electric energy (kWh)				
day-time electricity				
in Budapest & selected bigger towns	1.7*	1.7	2.45	3.7
in other towns	2.05	2.05	2.45	3.7
in villages	2.45	2.45	2.45	3.7
night-time electricity	0.9	0.9	1.3	1.9
Gasoline (l)				
normal, 86 octane-number	22.5	27.2	47.6	57.0
super, 92 octane-number	24.0	28.7	50.6	60.0

Note : *For Budapest it was 1.25.

Source : A-14.

Table 2.3.12 Electric Current Tariff Structure

a) Tariffs with demand charge (Effective from 1 November 1990)

	Day HUF/kW, year	Peak HUF/kW, year	Day HUF/kWh	Peak HUF/kWh	Night HUF/kWh
Voltage category:					
Grid	2,040	4,440	3.00	4.50	2.25
Principal distribution station	2,160	4,560	3.10	4.60	2.30
Medium voltage 3 times of use	2,220	4,620	3.20	4.70	2.35
Medium voltage No. 1	2,340	4,800	3.60	3.60	2.50
Medium voltage No. 2	1,260	2,520	5.50	5.50	2.60
Low voltage No. 1	2,460	4,980	3.70	3.70	2.70
Low voltage No. 2	1,320	2,640	5.70	5.70	2.80
Purchase from auto-producers	-	-	2.70	4.50	2.00
Railway traction	-	-	3.15	3.15	3.15
Traction of trams	-	-	3.80	3.80	3.80

b) General tariffs

Demand kVA	Demand charge HUF/year
To 2.5	1,440
To 3.5	2,280
To 5.0	3,540
Over per kVA	720
Energy charge	6.20 HUF/kWh
Energy charge of night	3.00 HUF/kWh

c) Tariffs for households (Effective from 1 November 1993)

	HUF/kWh
Universal for households	
from 0 to 50 kWh/month	3.70
51 - 300 kWh/month	5.30
over 300 kWh/month	7.50
Separately recorded by night	
from 0 to 200 kWh/month	1.90
201 - 1000 kWh/month	2.70
over 1000 kWh/month	3.50
Energy charge for public lighting	4.20
Demand charge for spotlight	9,600 (HUF/kW, year)
Demand charge for high illumination	14,400 (HUF/kW, year)

d) Hourly Structure of the Time-calculation for Electric Current Tariffs

	Winter	Summer
Day	06.00 - 16.30	07.00 - 17.30
Peak	16.30 - 21.00	17.30 - 22.00
Night	21.00 - 06.00	22.00 - 07.00

Source : A-23.

2.3.6 Fuel Consumption in the Study Area

(1) Investigation of Fuel Consumption in the Study Area

1) Objectives

The Study Team investigated fuel consumption in the Study Area based on existing documents, questionnaires and interviews.

Objects of the investigation were all consumers in the Study Area according to the following classification:

- Major business establishments (32 establishments)
- Medium business establishments having furnaces with more than 120 kW (103,200 kcal/h or 432,000 kJ/h) of capacity (130 establishments)
- Small business establishments having furnaces with less than 120 kW of capacity (1,857 establishments)
- Communal consumers including the following:
 - i) household
 - ii) state and local government offices, institutions
 - iii) schools, kindergartens, institutions of public education
 - iv) institutions of health service
 - v) other organizations not belonging to business establishments
- Motor vehicles

Investigation of fuel consumption was made for one-year period divided into two seasons:

- Non-heating season : from April 1, 1992 to September 30, 1992
- Heating season : from October 1, 1992 to March 31, 1993

2) Fuel Consumption by Business Establishments

Basic data necessary for determining fuel consumption of establishments were collected on one hand from county authorities of the Bureau of Environment Protection, the Statistical Bureau and the Directory of Road Supervision, and on the other hand, as basis for comparison, from interviews and questionnaires filled out by major and medium business establishments.

3) Fuel Consumption by Communal Consumers

Basic data concerning communal consumers are available from the publications of the BAZ County Statistical Bureau. These data are registered by towns and other settlements. Basis for investigation of fuel consumption by the population was composition and the number of the population.

Schools and kindergartens were identified by number of classrooms, institutions of public education and health service by number of space. The rest are estimated values which were finally expressed altogether in number of flats according to the following classification:

- flats with gas pipes
- flats with propane-butane gas
- number of flats by the number of rooms in them
- number of flats having bathroom or other bathing facilities

Quantity of gas from pipelines provided for households was available from data by the Central Statistical Bureau by settlements, according to which summer time consumption is 10 % of that of the calendar year.

4) Fuel Consumption by Motor Vehicles

The investigation was limited only to roads. Railways were ignored since lines with heavy traffic are all electrified.

Objects of the investigation were all types of motor vehicles as shown below:

- cars
- all types of busses
- trucks (single and long)
- motorcycles

As basis for determining the quantity of the consumed fuel, data of a total traffic counting survey made in 1990 was used. Data on the 1992/93 traffic were calculated using so called ratio values of traffic progress (applied planning values) concerning roads located in the investigated area.

When calculating fuel consumption, fuel consumption rates for diesel or gasoline were considered for various types of vehicle.

Total traffic volumes for summer and winter were estimated to be 55% and 45% of the annual total volume, respectively.

5) Result

Results of above investigations are summarized in Table 2.3.13. According to the Table, business establishments account for 87% of the total energy consumed in the Study Area. The shares for communal consumers and motor vehicles are 9.5% and 3.6%, respectively.

Table 2.3.13 Result of Investigation of Fuel Consumption in the Study Area

		Non-heating season Apr. 92 - Sept. 92	Heating season Oct. 92 - Mar. 93	One year total Apr. 92 - Mar. 93
Business Establishments	Solid (t) (GJ)	1,135,453	1,456,592	2,592,045 27,414,938
	Liquid (t) (GJ)	181,014	119,570	300,583 12,121,938
	Gas (1,000 m ³) (GJ)	803,129	1,121,343	1,924,472 44,715,909
	Total (GJ)			84,252,430
Communal Consumers	Solid (t) (GJ)	13,083	423,031	436,114 6,105,600
	Gas (1,000 m ³) (GJ)	14,569	76,428	91,297 3,104,098
	Total			9,209,698
Motor Vehicles	Liquid (t) (GJ)	45,850	37,514	83,364 3,502,010
Grand Total (GJ)				96,964,138

(2) Production and Fuel Consumption in Power Stations and Iron Factories

The prominent energy consumers in the Study Area are three thermal power stations and the DIMAG group iron maker factories. The fuel consumption during one year period from April 1992 to March 1993 was as follows:

1) Borsod Power Station	10,333,129 GJ
2) Tisza I Power Station	14,426,355 GJ
3) Tisza II Power Station	26,276,258 GJ
4) DIMAG group	21,390,552 GJ
Total	72,426,294 GJ

In the total fuel consumption by business establishments in the Study Area at 84,252,430 GJ (see Table 2.3.13), the above total of the three power stations and iron factories accounts for 86%. Therefore, the general trend of the fuel consumption by industries in the Study Area can be well represented by these large fuel consumers.

Figures 2.3.12 through 2.3.15 show the yearly changes of fuel consumption and power and heat generation in the power stations, and Figure 2.3.16 shows the annual change of production by the DIMAG group factories.

The total power and heat production as well as fuel consumption by three power stations in 1992 was 60% of the peak year level (see Figure 2.3.15), and the production levels of iron products in 1992 were 1/3 to 1/2 of those in peak years (see Figure 2.3.16).

The decline of Borsod Power Station is the combined result of the recessed economy and superannuation of the boilers, turbines, generators, etc., and its recovery of generation activity with existing facilities is very unlikely.

After 1991, Tisza II Power Station increased its power generation with increased fuel consumption, since neighbouring countries slashed their electricity exports to Hungary.

These three Power Stations and the DIMAG group factories are largest emission sources of air pollutants in the area. With regard to SO₂ emission, these plants make up 95% of the emission from factories in the area including small factories, and 85% even when communal emissions are added.

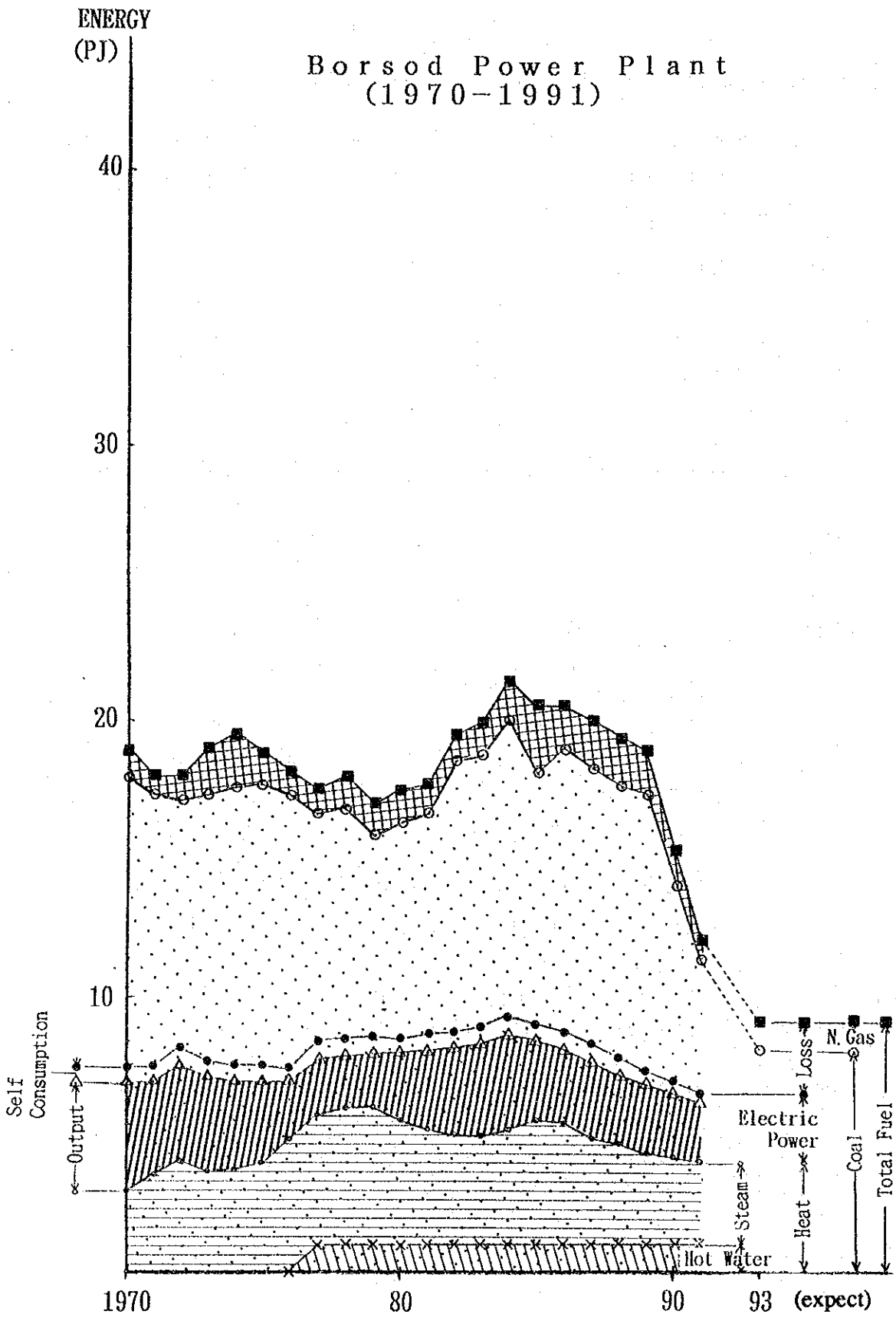


Figure 2.3.12 Fuel Consumption and Energy Output in Borsod Power Station

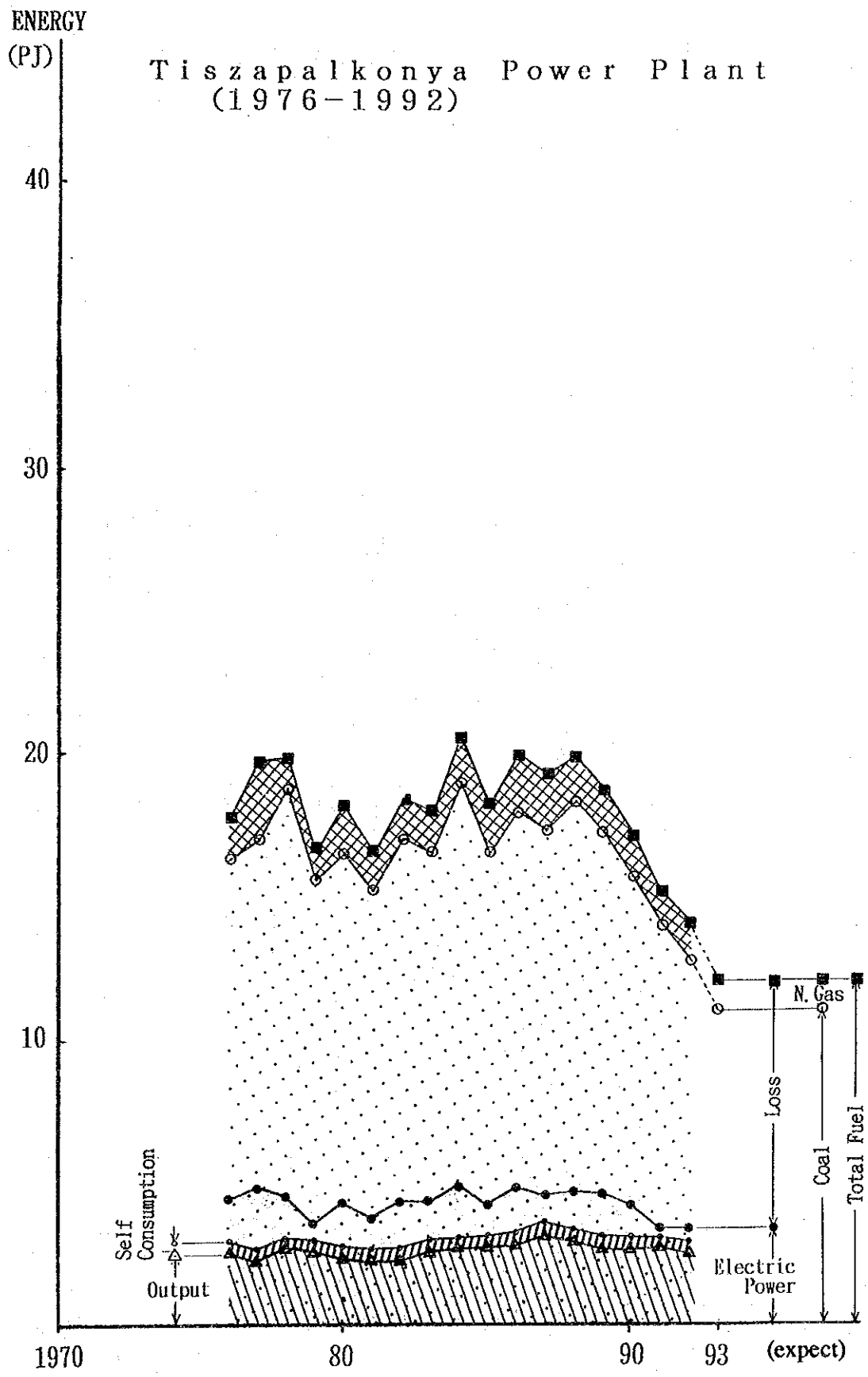


Figure 2.3.13 Fuel Consumption and Energy Output in Tisza I Power Station

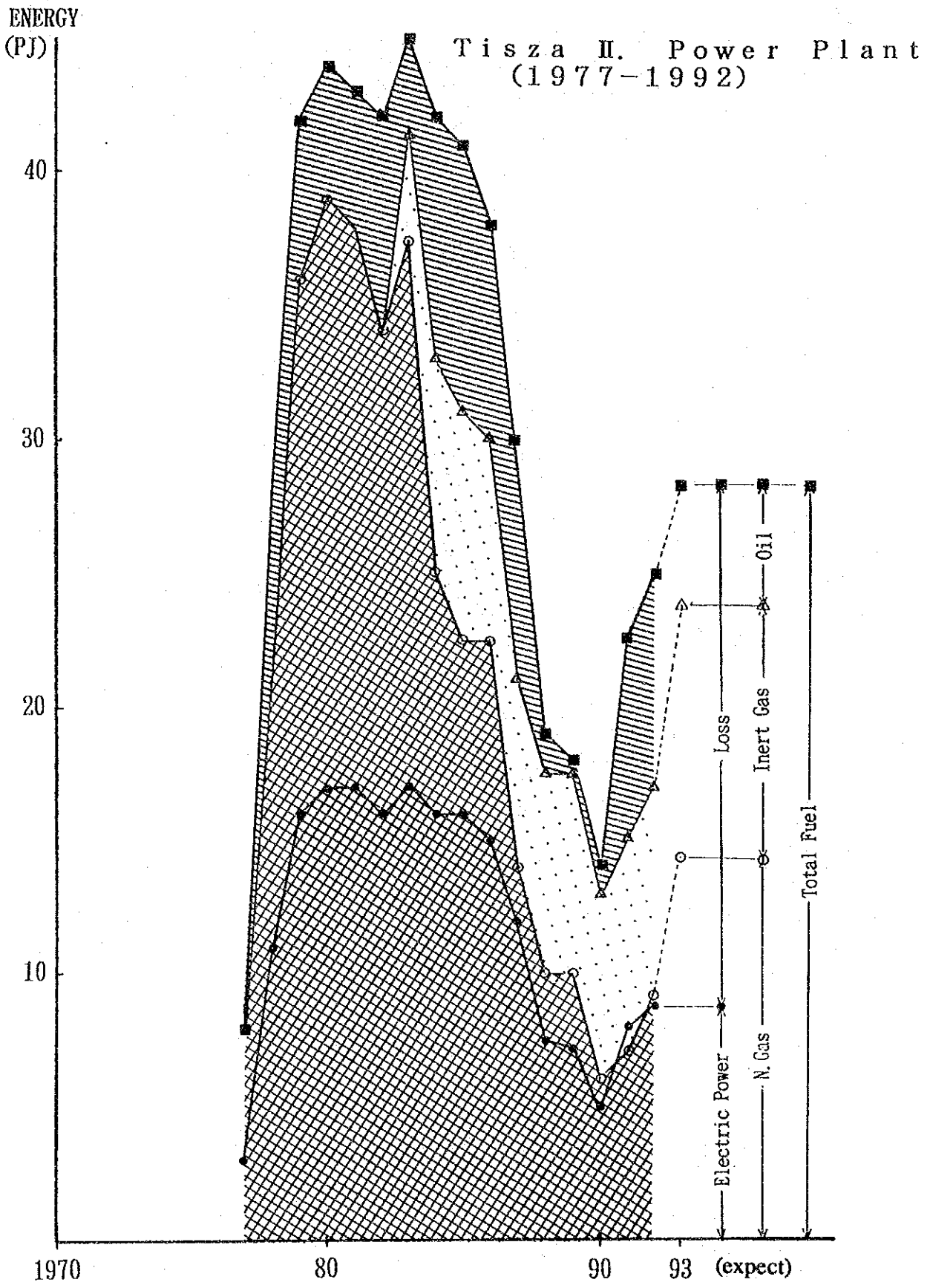


Figure 2.3.14 Fuel Consumption and Energy Output in Tisza II Power Station

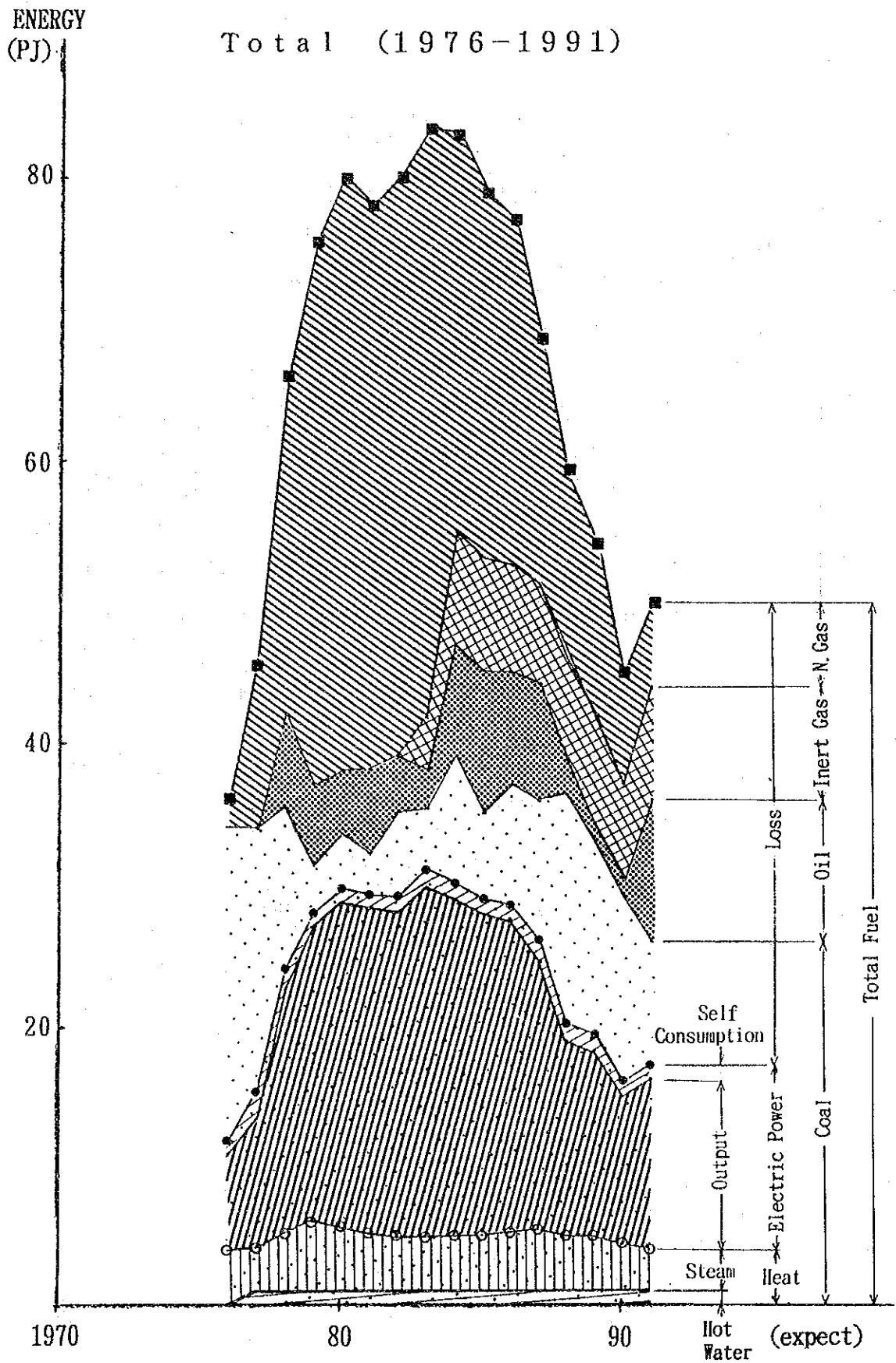


Figure 2.3.15 Total Fuel Consumption and Energy Output by Three Power Stations

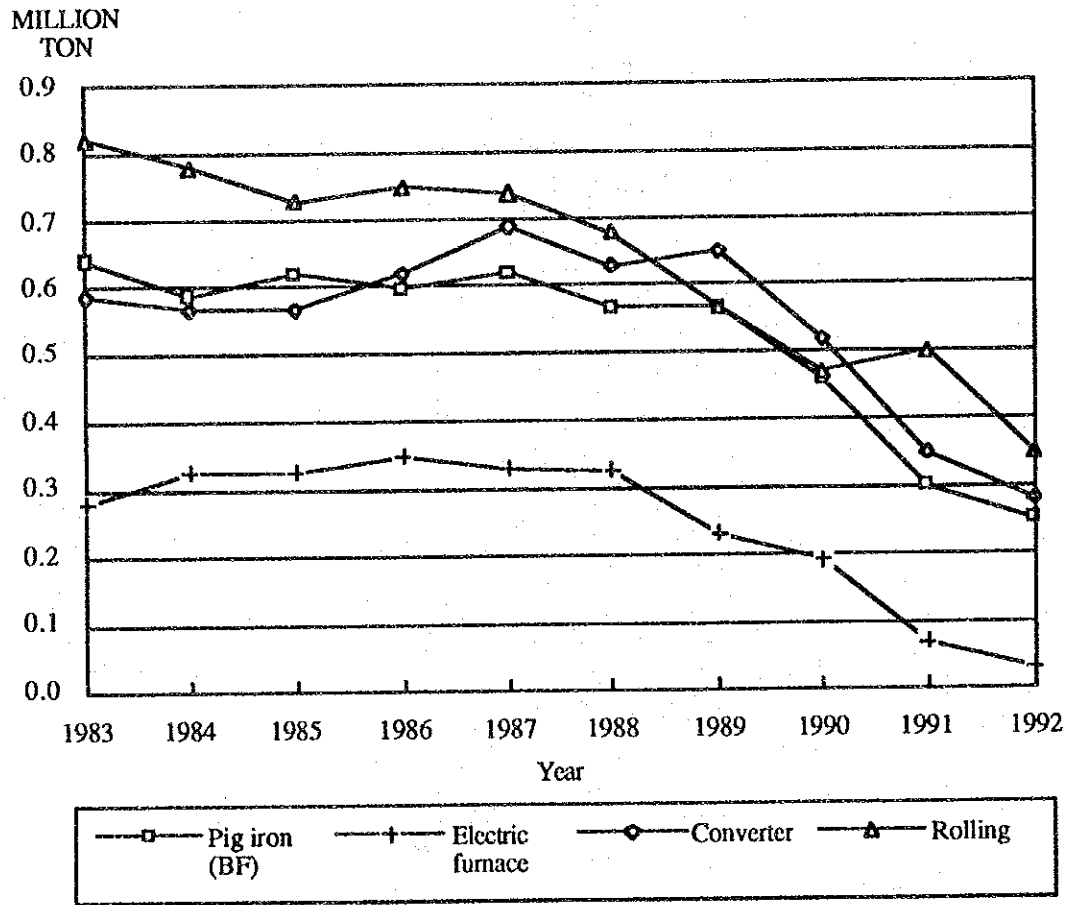


Figure 2.3.16 Yearly Change of Productions of DIMAG Group

2.3.7 Future Energy Demand

Forecasts of future energy demand in the national level are available from the Ministry for Trade and Industry (IKM) and Hungarian Electricity Companies (MVM Rt.).

IKM's forecast (Ref. A-21) in 1993 for the year of 2000 was based on two factors: 1) the average growth rate of the economy, and 2) the rate of annual reduction of average energy intensity. It is shown below.

The following were assumed:

Annual average growth rate of GDP (1990-2000): 3% (min.) - 4% (max.)
Annual reduction of total energy intensity (1990 - 2000): 3.0% (min.) - 3.5% (max.)
Annual reduction of electricity intensity (1990 - 2000): 2.0% (min.) - 2.5% (max.)

Then the forecast of demands for the year 2000 was made as follows:

Total energy demand: 1,200 PJ (min.) - 1,300 PJ (max.)
Electricity demand: 43 TWh (min.) - 46 TWh (max.)

MVM, considering above forecast as a guideline, studied future demand of electricity for planning development of their power plants. They supposed three cases of increase in electricity demand. The electricity demands forecasted are shown in Table 2.3.14 and Figure 2.3.17.

Table 2.3.14 Future Electricity Demand Forecast by MVM Rt.

Case for Demand Increase	1993 TWh	1995 TWh	2000 TWh	2005 TWh
Low increase	33.5	33	37	42
Medium increase		33	40	46.4
High increase		36	45	54

Source : Ref. A-24.

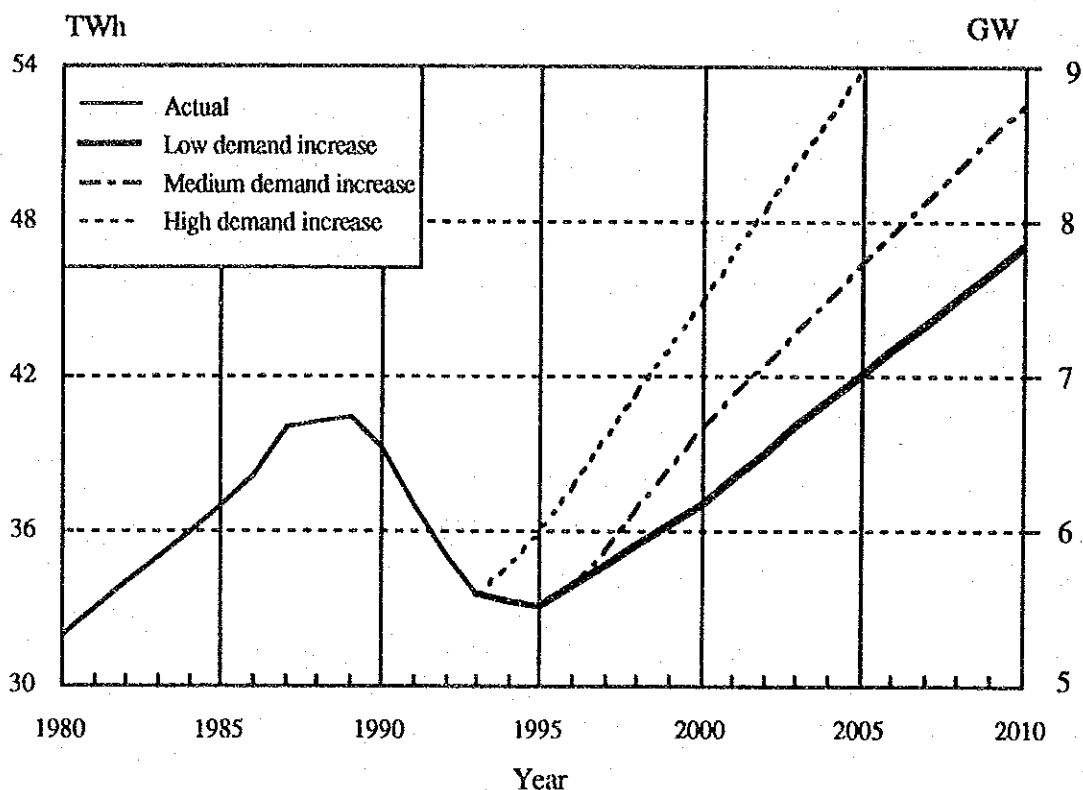


Figure 2.3.17 National Electricity Demand Forecast by MVM Rt.
(Source : Ref. A-24.)

In the recent discussion with the Hungarian authorities including IKM and MVM, they recommended the following figures for the future energy demand.

Annual average growth rate of GDP (1993-2000) : 1.5% (min.) - 2% (max.)
 Annual reduction of total energy intensity (1990-2000) : 2.5% (min.) - 3.0% (max.)
 Annual reduction of electricity intensity (1990-2000) : 2.0% (min.) - 2.5% (max.)

Total energy demand (2000) : 1,100 PJ (min.) - 1,200 PJ (max.)
 Electricity demand (2000) : 37 TWh (min.) - 40 TWh (max.)

Above minimum and maximum electricity demands correspond, respectively, to the cases of low demand increase and medium demand increase referred in Table 2.3.14 and Figure 2.3.17. More detailed figures for the case of the medium demand increase are shown in Table 2.3.15.

The ground for expectation of reduction of total energy or electricity intensity in above forecasts is that Hungary has been less effective in reducing its total energy intensity than the

majority of other industrialized countries as shown in Table 2.3.16, therefore, there are more possibilities of reducing it by modernizing the economic system and by accelerating technical development.

Table 2.3.15 Forecast of Electricity and Thermal Energy Demand for Cardinal Years
(for medium increase of demand)

	1995	2000	2005
Electric energy (TWh)			
System demand	33.0	40.0	46.4
Production by MVM Rt.	31.7	38.7	43.3
nuclear	13.5	13.5	13.5
coal	6.6	7.4	15.6
hydrocarbon	11.4	17.6	14.0
Thermal energy (PJ)			
Heat delivery by MVM Rt.	47.0	45.0	45.0
coal	15.1	13.8	8.9
hydrocarbon	31.2	30.5	35.4
Combustibles Requirements (PJ)			
Primary energy by MVM Rt.	382.4	418.5	453.2
nuclear	148.5	148.5	148.5
coal	88.9	88.9	137.9
hydrocarbon	145.0	181.1	166.8

Source : Ref. A-22.

Table 2.3.16 Changes in the Electricity Intensity - An International Comparison

	Rate of annual average change		
	1960 - 1980 %/year	1979 - 1989 %/year	1990 - 2000 forecast %/year
Austria	1.5	0.6	-0.8
Denmark	10.0	0.6	0.0
Belgium	4.0	0.3	-0.3
Sweden	4.1	1.9	-2.4
UK	2.6	-1.5	-0.9
France	4.0	1.8	-
USA	2.9	-0.6	0.0
Japan	2.0	-1.1	0.7
Hungary	1.9	1.4	(-2) - (-2.5)

Source : Ref. A-20.

CHAPTER 3

Chapter 3 ANALYSIS OF AIR QUALITY AND METEOROLOGICAL DATA

3.1 Outline of Monitoring

3.1.1 Ambient Air Quality Monitoring

Locations of automatic monitoring stations for ambient air quality and meteorology in the Study Area are shown in Figure 3.1.1. There were six existing stations (H1 ~ H3 and EC1 ~ EC3) before the start of the present study. Stations H1 ~ H3 were established by the Hungarian authority to monitor the ambient air quality in Miskolc City, and stations EC1 ~ EC3 were established by the PHARE (Poland and Hungary Aid for Reconstruction of Economy) program of EC to monitor the ambient air quality in Sajo Valley. Measuring items at these stations are shown in Table 3.1.1. The data measured at these stations are gathered and controlled by ÁNTSZ-BAZ.

In the Study, ten stations (JICA's monitoring stations) were newly established to strengthen the monitoring network in the Study Area. Their measuring items are shown in Table 3.1.2. Their characteristics are as follows:

- JF 1 : Data measured here are considered to represent the background level of ambient air quality in the Study area in summer and to show the effect from the household heating in winter.
- JF 2 : Data measured here are considered to represent the ambient air quality of the southern industrial zone in the Study area.
- J 1 : Data measured here are considered to represent the background level of ambient air quality in the Study area.
- J 2 : Data measured here are considered to represent the ambient air quality of the northern industrial zone in the Study area.
- J 3 : Data measured here are considered to represent the ambient air quality of the area affected by the northern industrial zone under the condition of dominant northwesterly wind.
- J 4 : Data measured here are considered to represent the ambient air quality of the suburban residential area.

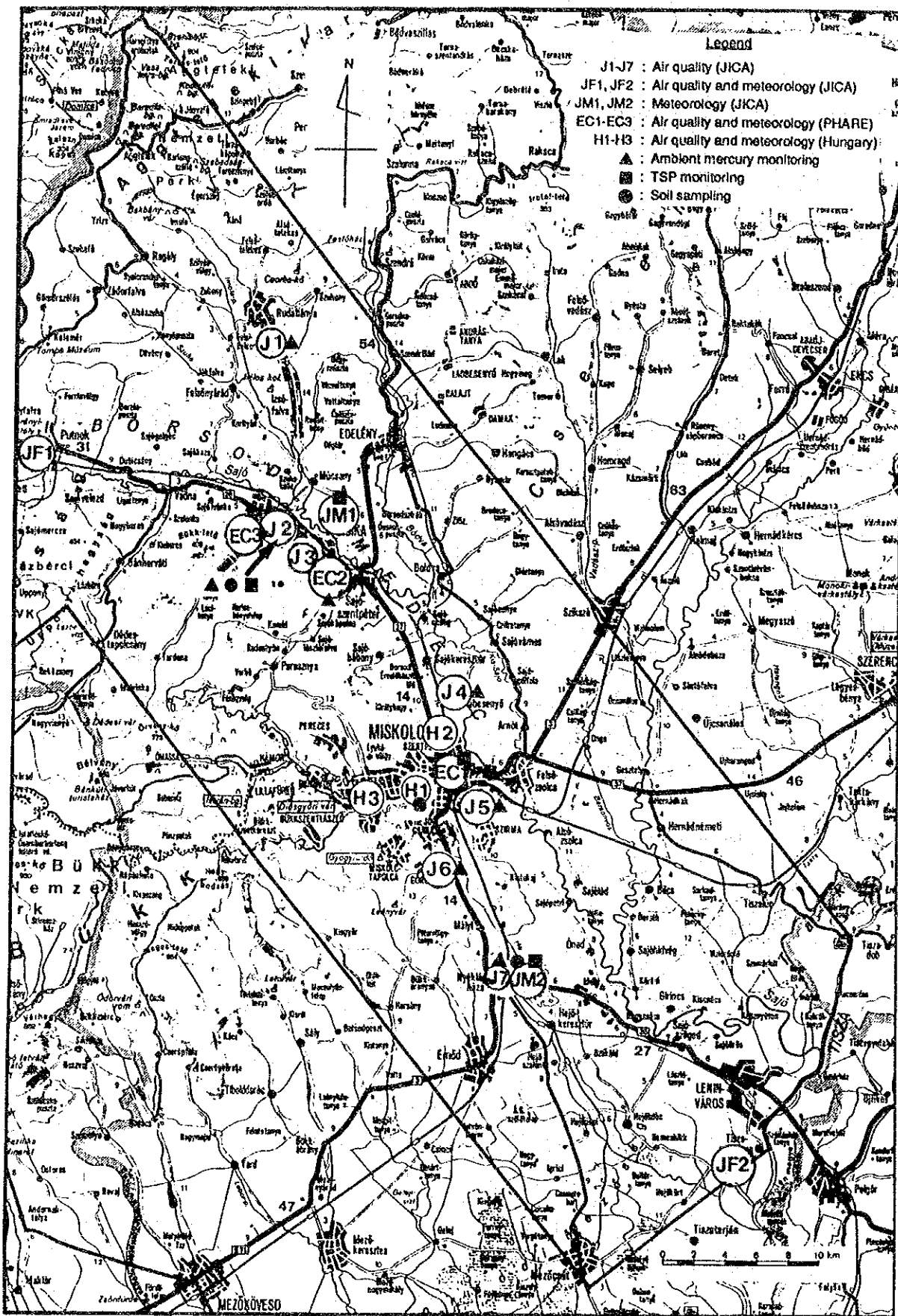


Fig. 3.1.1 Location Map of Automatic Monitoring Stations of Ambient Air Quality and Meteorology

Table 3. 1. 1 Measuring Items in Existing Monitoring Stations

Name of Station	Location	Measuring Items
H 1	ÁNTSZ-BAZ, Miskolc	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, Wind, Temperature, Radioactivity Background
H 2	Hospital, Miskolc	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, THC, CH ₄ , NMHC, Wind
H 3	DIMAG Rt., Miskolc	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, O ₃ , THC, CH ₄ , NMHC, Wind
EC 1	Búza-tér, Miskolc	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, O ₃ , THC, CH ₄ , NMHC, Wind, Temperature, Solar Radiation
EC 2	Mentők, Sajószentpéter	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, O ₃ , THC, CH ₄ , NMHC, Wind, Temperature, Solar Radiation, Atmospheric Pressure
EC 3	Chemical Secondary School, Kazincbarcika	SO ₂ , NO, NO ₂ , NO _x , CO, Dust, O ₃ , Wind, Temperature, Solar Radiation

- Note: 1) Wind: Wind speed and wind direction
 2) Data acquired at Stations H1-H2 are transmitted to ÁNTSZ-BAZ by telemeter system.

Table 3. 1. 2 Measuring Items in JICA Established Monitoring Stations

Name of Station	Location	Measuring Items
JF 1	Városi Sportcsarnok, Putnok	SO ₂ , NO, NO ₂ , NO _x , CO, HC(THC, CH ₄ , NMHC), O ₃ , SPM, Wind, Solar Radiation, Temperature, Humidity
JF 2	Tiszatát TSZ, Oszlár	SO ₂ , NO, NO ₂ , NO _x , CO, HC(THC, CH ₄ , NMHC), O ₃ , SPM, Wind, Solar Radiation, Temperature, Humidity
J 1	Észak-Magyarországi Regionális Vízmű, Rudabánya	SO ₂ , NO, NO ₂ , NO _x
J 2	Tűzoltóság, Kazincbarcika	SO ₂ , NO, NO ₂ , NO _x
J 3	Észak-Magyarországi 408 Tűzépítelő, Berente	SO ₂ , NO, NO ₂ , NO _x
J 4	Polgármesteri Hivatal Mellett, Szirmabesenyő	SO ₂ , NO, NO ₂ , NO _x
J 5	Kisfaludi U. 94 - Alföldi U. 1 Kereszteződés, Martintelep	SO ₂ , NO, NO ₂ , NO _x
J 6	Park, Görömböly	SO ₂ , NO, NO ₂ , NO _x , O ₃ , SPM
J 7 (JM 2)	Közúti Igazgatóság, Nyékládháza	SO ₂ , NO, NO ₂ , NO _x , Wind, Net Radiation
JM 1	Borsodi Hőerőmű Szennyvíztelep, Mucsony	Wind

- Notes: 1) Wind: Wind Speed and Direction
 2) All data acquired are transmitted to ÁNTSZ-BAZ by telemeter system.

- J 5 : Data measured here are considered to represent the ambient air quality of the residential area in Miskolc City, and to supplement the data measured at the existing stations (H1, H2 and EC1).
- J 6 : Data measured here are considered to represent the ambient air quality of the newly developed residential zone.
- J 7 : Data measured here are considered to represent the ambient air quality of the area affected by the southern industrial zone under the condition of dominant southeasterly wind.
- JM 1 : Data measured here are considered to represent the wind condition of the northern part of the Study area.
- JM 2 : Data measured here are considered to represent the wind condition of the southern part of the Study area and the radiation condition of the whole Study area. The equipment are installed in the same container of the J7 station.

Installation and setting up of JICA's monitoring stations were carried out beginning in March 1993. Placement of container houses for 10 Stations JF1, JF2, JM1, J1, J2, J3, J4, J5, J6, and J7 (= JM2) was completed by the end of March. In April, preparation works were made for installation of monitoring equipment, and some equipment units were installed. Equipment units procured in Japan arrived on April 20 and were installed in the beginning of May. After adjustment and calibration works, all of above stations were on full operation on May 15, 1993.

3.1.2 Upper-layer Meteorological Observation

Meteorological observations of upper layer were conducted in four seasons as described below.

(1) Observation period

Spring : May 27 - June 2, 1993
Summer : July 17 - 22, 1993
Autumn : October 1- 6, 1993
Winter : January 17 - 22, 1994

(2) Observation sites

JF1 station (Putnok), 48.28° N, 20.43° E
JF2 station (Oszlár), 47.88° N, 21.03° E

(3) Observation items

Vertical profiles of air temperature by low-level sonde
Vertical profiles of wind direction/speed by navigation electric waves

(4) Equipment

Low-level sonde and receiver : PC-CORA Radiosonde System(VAISALR Co., Ltd.)

- i) navigating radiosonde
- ii) radiosonde receiver
- iii) omega receiver (for receiving navigation waves)
- iv) data processing unit

(5) Observation time

1:00, 5:00, 9:00, 13:00, 17:00, 21:00 as adjusted to be the same hours of observation in other places such as Budapest.

The observations were made 30 times at each site.

(6) Observation height

Up to 2,000 m from the ground with measurement at every 100 m.

3.1.3 Air Quality Measurement at Roadside

In this survey, concentrations of NO_x at roadsides were measured by a simplified method aiming to investigate influence of automobile exhaust gases to roadside air quality.

(1) Points of Measurement

Locations of measuring points of NO and NO₂ are shown in Figure 3.1.2. Details are as follows:

- Both sides of 10 locations of roads with a total of 20 points. Besides, 3 points were added in the No.4 location because of road intersection.

- 2 road cross sections

Section A: Route 26, near Sajocsegy

Section B: Kilian, near Kiss tabornok ut.

Each section consisting of 10 points (5 points each on both sides) with a total of 20 points : 0 m, 10 m, 20 m, 40 m, 100 m from the edge.

Decrement of the NO_x concentration with distance from the road edge is to be investigated.

- 5 points were selected from the locations of the automatic monitoring stations as shown below to compare the results of the simplified and the automatic measurements:

Kazincbarcika (J2), Berente (J3), Martintelep (J5), Görömböly (J6), Nyékládháza (J7)

(2) Measuring Items and Method

Items: NO and NO₂

Method: Simplified method developed by Yokohama Environmental Science Institute. Samplers were exposed for 3 continuous days, and were analyzed by spectrophotometer to obtain 3-day average concentration.

(3) Measuring Times and Periods

The measurements were made twice: summer and winter. The sampling in the summer was conducted during July 14 - 17, 1993, and that in the winter was conducted during February 7 - 10, 1994.

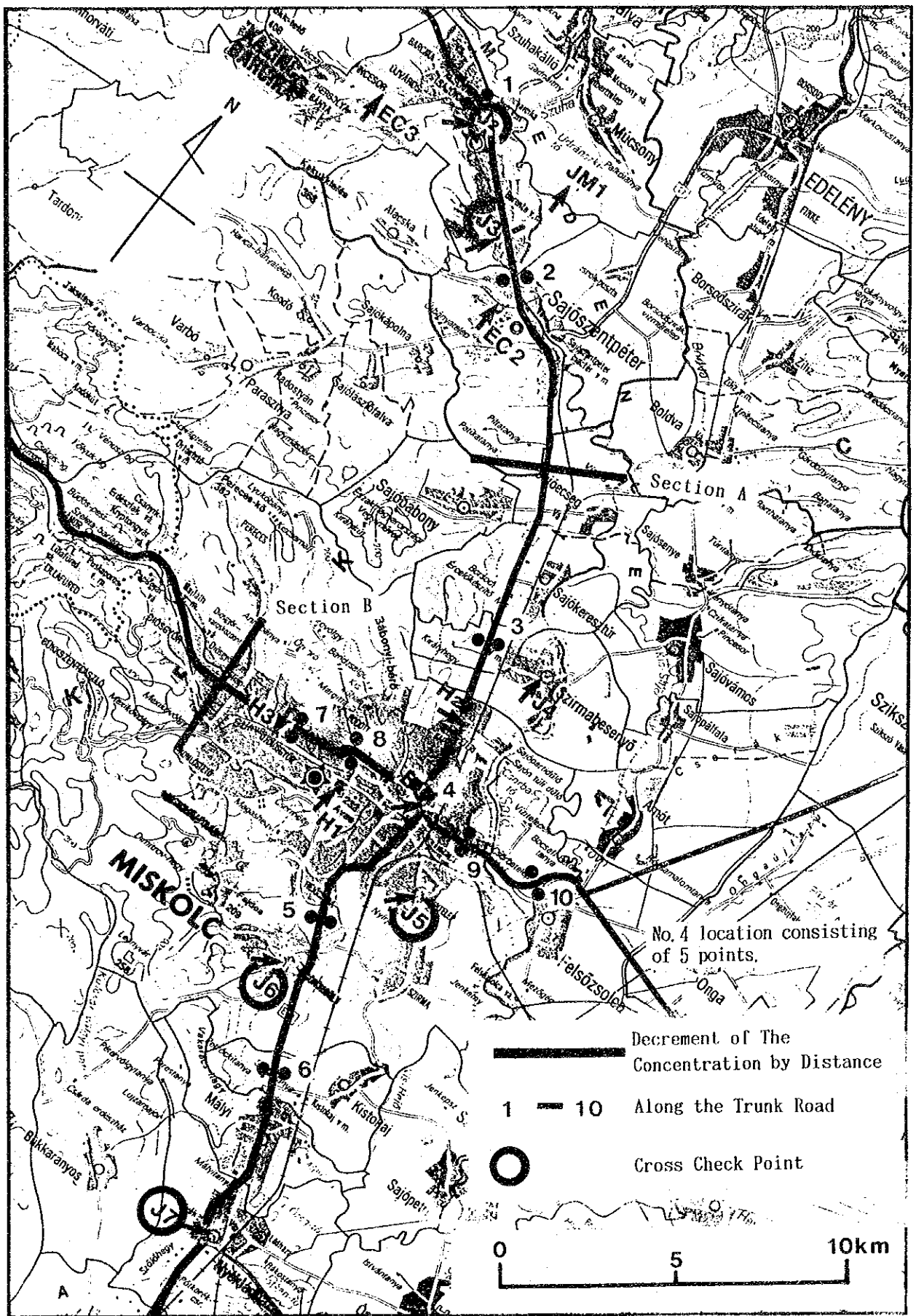


Figure 3.1.2 Locations of Roadside Measurement of NO and NO₂ by Simplified Method

3.1.4 Measurement of Ambient Concentration of Mercury

The ambient concentration of mercury was measured once per month during one-year period from May 1993 to May 1994 as described below.

(1) Measuring Points

The measurement was conducted at 8 stations among the automatic monitoring stations as shown in Figure 3.1.1. The sampling points of TSP and Soil are also shown in the figure. These 8 stations are as follows:

Rudabánya (J1), Kazincbarcika (J2), Kazincbarcika (EC2), Szirmabesenyő (J4), Martintelep (J5), Görömböly (J6), Nyékládháza (J7), Berente (J3)

Berente (J3) was added from the measurement in November, 1993. Additionally, measurement was also made at the background point (Szentlelek) in September and January, and at the BVK factory in September.

(2) Sampling Time

The sampling was made once per month for 24 continuous hours. The sampling periods are as follows:

May 26 - June 2, 1993, June 21 - 30, July 20 - 23, August 10 - 13, September 27 - 30, October 13 - 16, November 23 - 26, December 14 - 17, January 25 - 28, 1994, February 21 - 24, March 21 - 24, April 19 - 26, May 5 - 11

(3) Sampling and Analytical Methods

Ambient air is taken into a collection tube containing a silver tip, thereby converting mercury in the air to mercury amalgam. The collection tube is brought to the laboratory and the concentration of mercury is measured by a flameless atomic absorption spectrophotometer.

3.1.5 Measurement of Falling Dust

At present, there are 43 points established by ÁNTSZ-BAZ for measuring falling dust within the study area. This report covers the data taken between April 1993 and April 1994.

(1) Measuring Points

Measurements are not always made at every measuring point, but a sufficient number of measuring points have been used for determining the concentrations of falling dust in the study area.

The breakdown of 43 measuring points is as follows :

Ozd	7 points
Kazincbarcika	5 points
Sajoszentpeter	2 points
Miskolc	24 points
Tiszaújváros	5 points

Locations of these measuring points are shown in Figures D3.1.1 and D3.1.2 in Data Book.

(2) Methods of Measurement and Analysis

Sampling was made over a one-month period by using dust jars made of polyethylene.

The collected dust is extracted with distilled water and classified as soluble or insoluble. Water in the aqueous solution is evaporated, and the remainder is quantified by the gravimetric method.

The results of measurement are indicated in $g/m^2/month$ ($t/km^2/month$).

3.2 Analysis of Automatic Monitoring and Meteorological Observation Data

3.2.1 Air Quality at Automatic Monitoring Stations

The analytical results of measured data at the nine automatic monitoring stations for the period from May 16, 1993 to May 15, 1994 are presented below. Seasons are defined as follows:

- Heating season : October 16 through April 15
- Non-heating season : April 16 through October 15

(1) Outlines of Measured Data

The measured air quality data at all monitoring stations are summarized by seasons in Tables D3.2.1 (1) through D3.2.1 (5) in Data Book.

1) Nitrogen Oxides (NO_x, NO₂, and NO)

The ambient air quality standards of the nitrogen oxides in the Study Area are shown in Table 3.2.1.

Table 3.2.1 Ambient Air Quality Standards of NO_x (ppm)

		Protected Area I (JF1, JF2, J1, J4, J5, J6, J7)	Protected Area II (J2, J3)
NO _x	Annual average	0.052	0.078
	24 hours ave	0.078	0.105
	30 minutes ave	0.105	0.209
NO ₂	Annual average	0.037	0.063
	24 hours ave	0.044	0.078
	30 minutes ave	0.052	0.105

Stations J2 and J3 (located in industrial areas) correspond to Protected Area II. All other stations correspond to Protected Area I.

The measurement results of NO_x and NO₂ at each station by the evaluation periods of the standards are shown in Table 3.2.2.

Table 3.2.2 Measurement Results of NOx (ppm)

Protected Area		I			II		I				
Station		JF1	JF2	J1	J2	J3	J4	J5	J6	J7	
NOx	Annual Ave	0.011	0.006	0.011	0.033	0.017	0.016	0.027	0.023	0.029	
	24 hours Ave	98%	0.027	0.016	0.022	0.077	0.044	0.043	0.078	0.066	0.079
		Max	0.034	0.030	0.032	0.113	0.070	0.053	0.152	0.095	0.103
	30 minutes Ave	98%	0.037	0.024	0.036	0.118	0.060	0.060	0.120	0.087	0.118
		Max	0.076	0.115	0.158	0.304	0.190	0.166	0.297	0.285	0.274
	NO2	Annual Ave	0.007	0.004	0.008	0.020	0.012	0.011	0.016	0.013	0.016
24 hours Ave		98%	0.016	0.012	0.014	0.037	0.023	0.022	0.035	0.033	0.031
		Max	0.021	0.021	0.025	0.047	0.040	0.035	0.066	0.041	0.047
30 minutes Ave		98%	0.022	0.016	0.020	0.047	0.032	0.029	0.042	0.040	0.040
		Max	0.052	0.056	0.039	0.164	0.079	0.070	0.117	0.085	0.099

 : Over Ambient Air Quality Standard

i) NOx

- A high concentration of NOx was observed at Stations J2, J5, and J7. The annual average value at Station J2, the station having the highest concentration, was 0.033 ppm.
- The annual average values at all stations satisfied the ambient air quality standard.
- The annual 98% values (hereafter referred to as "the 98% value") of the daily average at Stations J5 and J7 exceeded the ambient air quality standards.

As for the maximum daily average values, those at Stations J2, J5, J6, and J7 exceeded the standards.

- The 98% value of the 30 minutes average at Stations J5 and J7 exceeded the ambient air quality standards. The maximum values of the 30 minutes average were recorded during the heating season. The maximum values of 0.304 ppm at Station J2 and 0.297 ppm at Station J5 greatly exceeded the ambient air quality standards of 0.209 ppm.
- At all stations, the NOx concentration values during the heating season exceeded those of the non-heating season. The values during the heating season were from 1.3 to 2.7 times those of the non-heating season. In particular, the concentrations at Stations JF1, J4, and J5 (stations in housing areas) became very

high during the heating season.

ii) NO₂

- The highest annual average value of 0.020 ppm was observed at Station J2. The second highest annual average value was 0.016 ppm at Station J5. Both values were below the ambient air quality standards for each area.
- The 98% values of both the average daily and 30 minutes average were below the ambient air quality standards at all stations. But, the maximum values of the daily average concentration exceeded the ambient air quality standards at some stations. At all stations except J1 and J3, the maximum 30 minutes values exceeded the ambient air quality standards.

As indicated above, the values for short evaluation times, i.e. the daily and 30 minutes average values, exceeded the ambient air quality standards.

The seasonal and hourly variations were large indicating a very high instantaneous concentration.

- The rate of NO₂ in NO_x (NO₂/NO_x) of the annual average value was in the range of 0.53 (at Station J7) to 0.74 (at Station J1) as shown in Table 3.2.3. But, the ratio during the heating season lowered to the range of 0.48 (at Station J7) to 0.71 (at Station J1). In particular, there was a significant reduction of the NO₂ ratio at such stations as J2, J5, and J7 where very high concentration values were observed. This phenomenon is thought to be caused by the decrease of the amount of solar radiation and the O₃ concentration during the heating season, thereby decelerating the oxidization process to produce NO₂.

Table 3.2.3 Ratio of NO₂ to NO_x

Kind of Value	MONITORING STATION								
	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
All season	0.69	0.73	0.74	0.61	0.72	0.65	0.57	0.57	0.53
Non-heating season	0.71	0.73	0.80	0.71	0.83	0.77	0.68	0.63	0.60
Heating season	0.68	0.70	0.71	0.55	0.66	0.61	0.53	0.53	0.48

- The rate of concentration increase of NO, the primary product of combustion, in the heating season was greater than that of NO₂ as shown in Table 3.2.4. The variation of the NO concentration by the seasons is greater than that of NO₂ in

both the 30 minutes average and the daily average values, since the NO concentration is greatly influenced by nearby pollutant sources.

Table 3.2.4 Ratio of Concentration (heating / non-heating season)

Kind of Value	MONITORING STATION								
	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
NO	2.65	1.54	2.38	2.47	3.13	4.32	3.47	2.79	1.90
NO ₂	2.57	1.24	1.38	1.26	1.40	2.01	1.85	1.82	1.18
NO _x	2.69	1.29	1.57	1.64	1.75	2.55	2.40	2.17	1.47

Table 3.2.5 Coefficient of Variation (30 Minute Value : σ / mean)

Kind of Value		MONITORING STATION								
		JF1	JF2	J1	J2	J3	J4	J5	J6	J7
All season	NO	1.25	1.56	1.90	1.65	1.88	1.76	1.88	1.45	1.55
	NO ₂	0.78	1.09	0.58	0.56	0.64	0.68	0.69	0.73	0.63
	NO _x	0.84	1.10	0.79	0.88	0.88	0.91	1.10	0.95	0.96
Non-heating season	NO	0.90	1.54	2.00	1.72	2.27	2.00	2.21	1.28	1.68
	NO ₂	0.81	1.11	0.58	0.61	0.65	0.66	0.73	0.68	0.65
	NO _x	0.75	1.08	0.73	0.83	0.83	0.82	1.07	0.83	0.93
Heating season	NO	1.12	1.45	1.69	1.42	1.54	1.37	1.53	1.23	1.39
	NO ₂	0.55	1.08	0.54	0.50	0.57	0.53	0.56	0.64	0.60
	NO _x	0.62	1.07	0.74	0.82	0.80	0.71	0.93	0.82	0.92

Table 3.2.6 Coefficient of Variation (24 Hour Value: σ / mean)

Kind of Value		MONITORING STATION								
		JF1	JF2	J1	J2	J3	J4	J5	J6	J7
All season	NO	0.86	0.75	0.96	1.06	1.19	1.14	1.19	0.92	0.89
	NO ₂	0.61	0.70	0.43	0.40	0.45	0.53	0.54	0.55	0.43
	NO _x	0.65	0.68	0.48	0.60	0.61	0.67	0.77	0.66	0.61
Non-heating season	NO	0.45	0.54	0.75	1.19	0.91	1.42	1.26	0.58	0.81
	NO ₂	0.48	0.45	0.41	0.45	0.41	0.43	0.47	0.33	0.39
	NO _x	0.46	0.42	0.43	0.64	0.45	0.58	0.64	0.39	0.52
Heating season	NO	0.70	0.75	0.82	0.84	0.96	0.77	0.89	0.73	0.80
	NO ₂	0.36	0.81	0.38	0.32	0.42	0.38	0.42	0.47	0.45
	NO _x	0.41	0.75	0.43	0.49	0.55	0.44	0.60	0.53	0.59

2) Sulfur Dioxide (SO₂)

The ambient air quality standards of SO₂ in the Study Area are shown in Table 3.2.7.

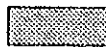
A summary of the measured SO₂ values for each standard evaluation time are shown in Table 3.2.8

Table 3.2.7 Ambient Air Quality Standards of SO₂ (ppm)

		Protected Area I (JF1,JF2,J1,J4,J5,J6,J7)	Protected Area II (J2, J3)
SO ₂	Annual average	0.026	0.038
	24 hours ave	0.056	0.113
	30 minutes ave	0.094	0.150

Table 3.2.8 Summary of Measured Results of SO₂ (ppm)

Protected Area		I			II		I				
Station		JF1	JF2	J1	J2	J3	J4	J5	J6	J7	
SO ₂	Annual Ave	0.028	0.009	0.006	0.016	0.016	0.009	0.014	0.009	0.009	
	24 hours Ave	98%	0.096	0.030	0.026	0.071	0.060	0.044	0.055	0.038	0.036
		Max	0.197	0.164	0.056	0.213	0.200	0.148	0.107	0.102	0.050
	30 minutes Ave	98%	0.136	0.062	0.038	0.113	0.094	0.053	0.075	0.053	0.045
		Max	0.417	0.407	0.200	0.501	0.487	0.325	0.205	0.321	0.170

 : Over Ambient Air Quality Standard

- The highest SO₂ concentration was observed at Station JF1 that was located in a housing area. The annual average value was 0.028 ppm which exceeded the ambient air quality standard. The 98% values of both the daily average and the 30 minutes average values exceeded the ambient air quality standards.
- The next highest SO₂ concentrations were observed at Stations J2 and J3 that are located in industrial areas and at Station J5 in a housing area. But the annual average and the 98% values of the daily average and the 30 minutes average at those stations were lower than the ambient quality standards. However, at seven of the nine stations, the maximum daily average values exceeded the ambient air quality standards. The maximum 30 minutes values exceeded the ambient air quality standards at all stations.

- The seasonal variation of the SO₂ concentration was larger than that of the NO_x concentration. In particular, the SO₂ concentrations at Stations JF1, J4, and J5, located in housing areas, greatly increased during the heating season as shown in Table 3.2.9. This phenomenon is thought to be attributed to heating of individual houses.

Table 3.2.9 Ratio of Concentration (heating/non-heating season)

Kind of Value	MONITORING STATION								
	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
SO ₂	6.26	1.51	3.79	2.37	3.46	6.46	5.80	4.70	3.92

- As for the coefficient of variation (standard deviation σ /mean), there is a tendency that it is greater in the industrial areas than in the housing areas (see Table 3.2.10). In particular, during the non-heating season, the coefficients of the variation of hourly values at Stations J2, J3, and JF2 (located in industrial areas) were in the range of 2.4 to 2.9 which were greater than those at the other stations where the values were less than 2.0. It is believed that the high concentrations of SO₂ are caused by large-scale emission sources under certain wind directions and speed.

Table 3.2.10 Coefficient of Variation (30 Minutes Value : σ / mean)

Kind of Value	MONITORING STATION								
	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
All season	1.32	2.33	1.93	1.99	1.72	1.77	1.42	2.01	1.26
Non-heating season	1.39	2.88	1.96	2.46	2.43	1.85	1.13	1.85	1.11
Heating season	0.87	1.97	1.57	1.65	1.32	1.25	1.02	1.51	0.95

3) Carbon Monoxide (CO)

The concentration of carbon monoxide was measured at Stations JF1 and JF2. The annual average values were very small: 0.5 ppm at Station JF1 and 0.2 ppm at Station JF2. The 30 minutes values were relatively high, but the maximum value at Station JF1 was 3.6 ppm which was far less than the ambient air quality standard of 8.6 ppm.

The concentrations during the heating season were higher than those during the

non-heating season. Even though the concentrations were generally low, the seasonal variation is evident.

4) Ozone (O₃)

The ambient air quality standards of ozone are 0.05 ppm for the daily average and 0.055 ppm for the 30 minutes average.

The ozone concentration was measured at Stations JF1, JF2, and JF6. The 98% values of the daily average were in the range of 0.029 to 0.030 ppm which are below the ambient air quality standard. However, the 98% values of the 30 minutes average were in the range of 0.084 to 0.114 ppm which is above the standard value.

In general, the ozone concentration increases during the non-heating season when the amount of solar radiation is larger.

5) Suspended Particulate Matter (SPM)

The SPM was measured at Stations JF1, JF2, and J6 which belong to Protected Area I.

The ambient air quality standards of SPM in Protected Area I are 0.05 mg/m³ for the annual average, 0.10 mg/m³ for the daily average, and 0.20 mg/m³ for the 30 minutes average.

At each station, the measured annual average value was in the range of 0.022 to 0.026 mg/m³, the 98% value of the daily average was in the range of 0.062 to 0.072 mg/m³, and the 98% value of the 30 minutes average was in the range of 0.065 to 0.087 mg/m³. These values are below the ambient air quality standards.

All of the maximum daily average values were less than 0.10 mg/m³. All of the measured values except the maximum 30 minutes values satisfied the ambient air standards.

The maximum value of the 30 minutes average measured at Station J6 was as high as 0.752 mg/m³.

The SPM concentration during the heating season was higher than those during the non-heating season. The effect of house heating was noticeable.

6) Hydrocarbons (HC)

The concentration of hydrocarbon was measured at Stations JF1 and JF2. The annual average values of methane that is, to a great extent, contributed by natural sources were 1.76 ppmC at Station JF1 and 2.11 ppmC at Station JF2. The deviation (σ) of the 30 minutes values and the annual average values at both stations were small and the seasonal variations were not seen.

The high concentration of non-methane hydrocarbons (NMT) that is normally originated from man-made sources was observed at Station JF2 located near an oil refinery and petrochemical complex. The maximum value of the daily average was 1.16 ppmC, and the maximum value of the 30 minutes average was 5.54 ppmC. These maximum values are far below the ambient air quality standard in Protected Area I. The ambient air quality standard for the daily average is 3.0 ppmC and that for the 30 minutes average is 10.0 ppmC.

(2) Variation Characteristics of Air Pollutant Concentrations

1) Daily Variation

The daily variations of NO, NO₂, NO_x, SO₂, CO, O₃, and SPM concentrations and air temperature are shown in Figures D3.2.1 through D3.2.8 in Data Book.

- The figures show the large daily variations of NO and SO₂. During the heating season, the concentrations as well as the variations of NO and SO₂ increase. As NO₂ is a secondary product, the daily variation of NO₂ is smaller than those of NO and SO₂.
- As shown in Figures 3.2.1 and 3.2.2, particularly high concentrations of SO₂ and NO_x were observed toward the end of November. In particular, very high daily average concentrations of SO₂ at about 0.2 ppm were observed on November 28 at Stations JF1, J2, J3, J5, and JF2.
- The level of CO is normally low, but it becomes higher during the heating season. The level of SPM is also higher during the heating season. The O₃ concentration becomes lower during the heating season when the amount of solar radiation is smaller.

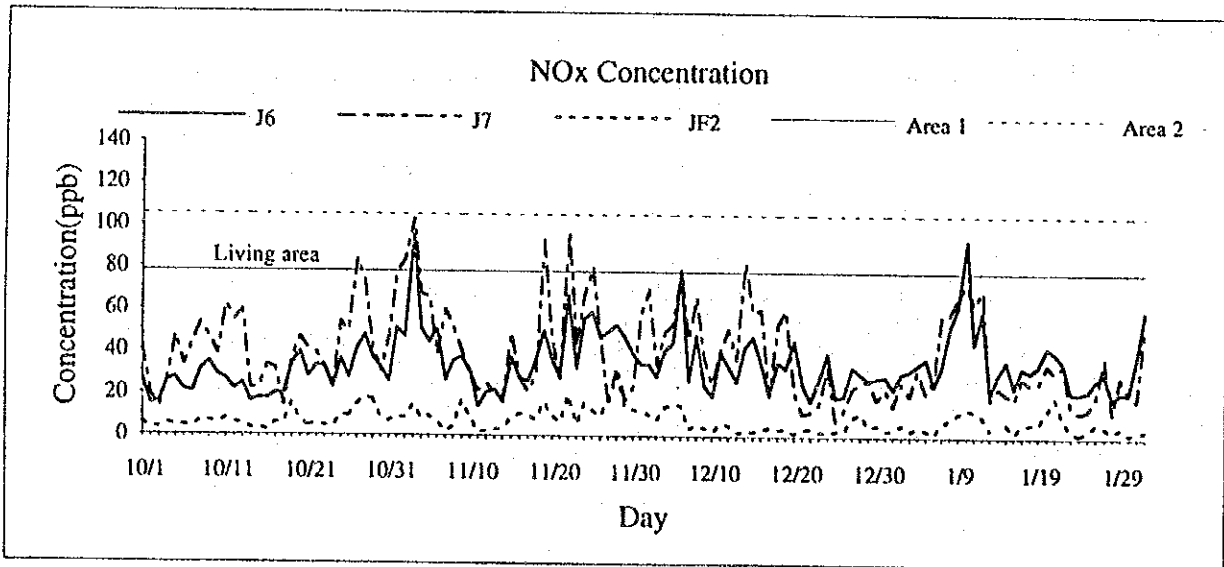
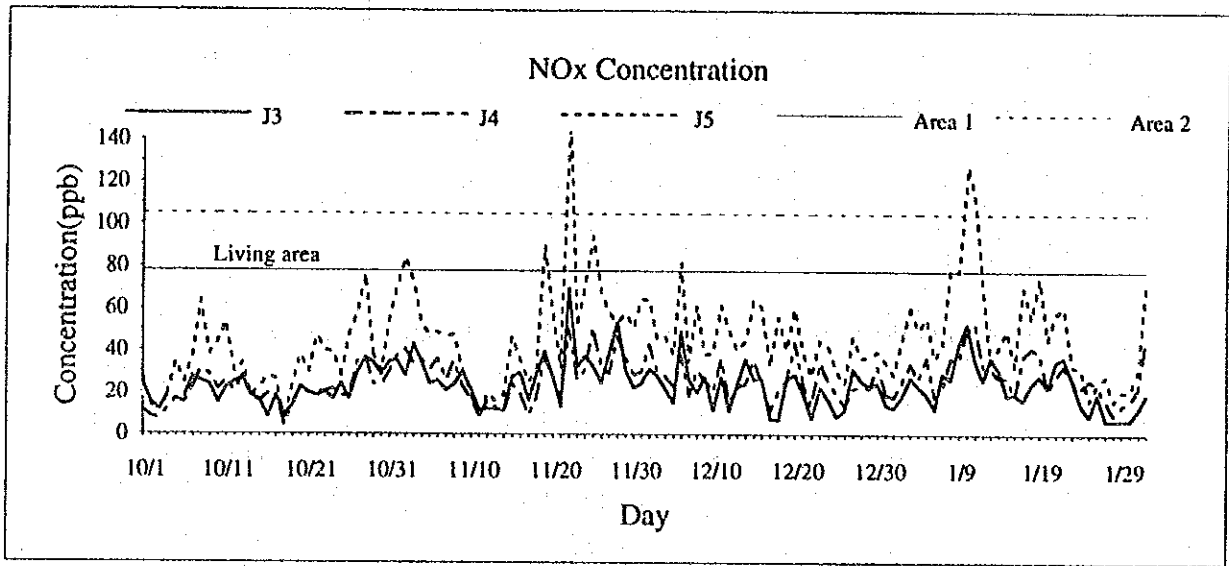
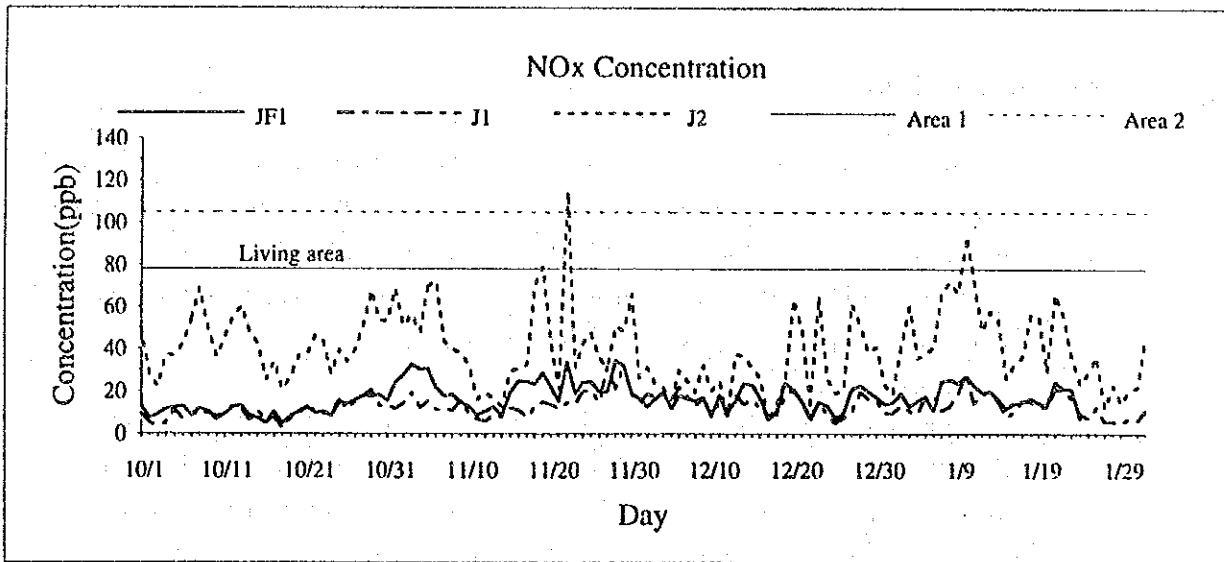


Figure 3.2.1 Daily Variation of NOx Concentration (October - January)

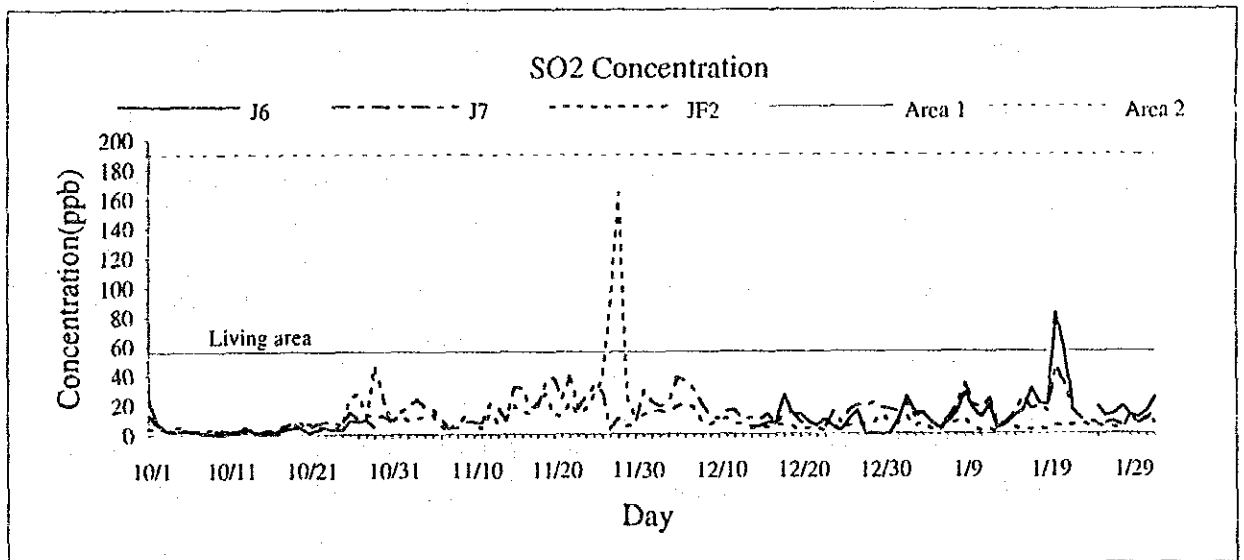
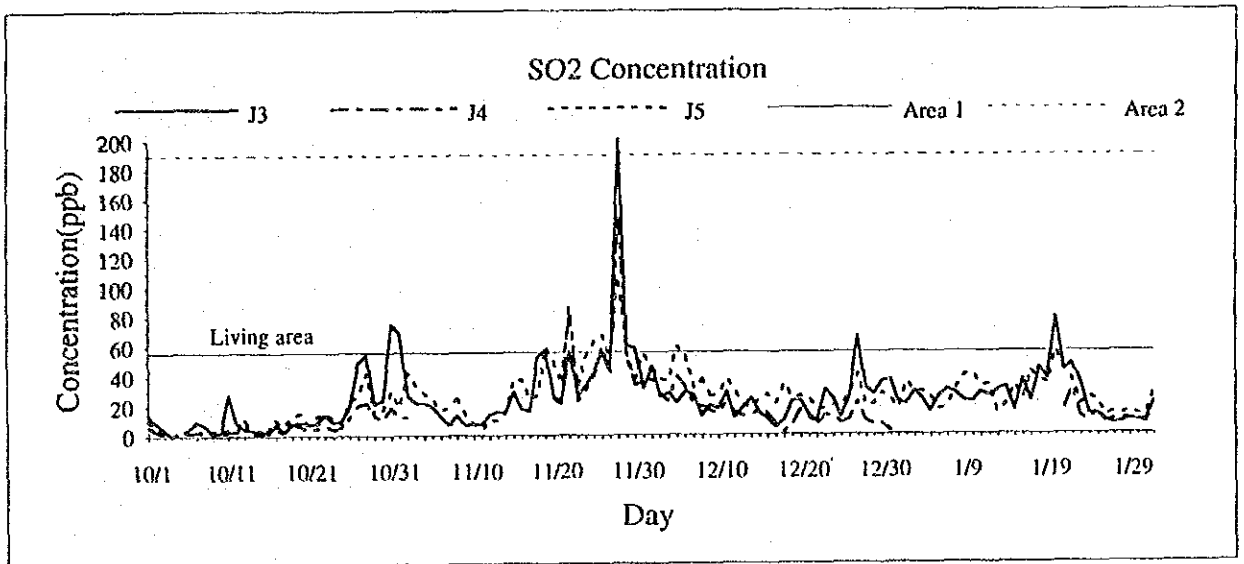
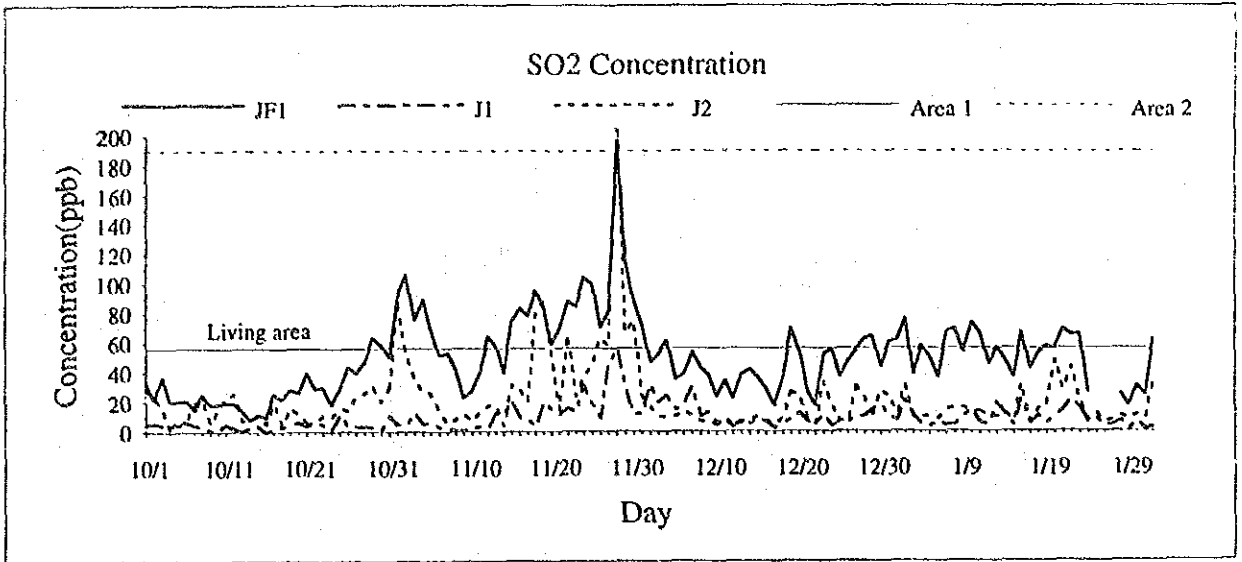


Figure 3.2.2 Daily Variation of SO₂ Concentration (October - January)

- The daily average air temperature below 0°C started to appear in the late October and the cold temperature continued until late February. The daily variation of SO₂ well corresponded to the temperature variation. When the temperature was below 0°C, a high concentration of SO₂ appeared. This is considered to be the effect of house heating.

2) Day of the Week Variation

The day of the week variations of NO_x and SO₂ concentrations are shown in Figures D3.2.9 and D3.2.10 in Data Book.

- Practically no day of the week variations of NO_x are seen at stations where concentrations were low. However, at Stations J2, J5, and J6 where relatively high concentrations were observed, the concentration tends to decrease on Saturdays and Sundays. It is believed that this phenomenon is related to changes in vehicle traffic volume.
- The day of the week variation of SO₂ concentration varies from station to station. It is believed that the SO₂ concentration is influenced by operating conditions of each pollutant source factories affecting each station.

3) Monthly Variation

The monthly variations of pollutant concentrations are shown in Figures D3.2.11 through D3.2.15 in Data Book.

- Among nitrogen oxides, the monthly variations of NO are greater than those of NO₂. In particular, the monthly variations at Stations J2, J5, J6, and J7 are large.
- SO₂ concentration becomes higher during the October through March period. Large monthly variations of SO₂ concentrations were observed at Stations JF1, J4, J5, and J6 which are located in housing areas.
- As for SPM and CO, the monthly variations at Station JF1 were particularly large.

4) Hourly Variation

The hourly variations of pollutant concentrations during the heating and non-heating seasons are shown in Figures D3.2.16 through D3.2.22 in Data Book.

- The hourly variations of NO concentrations were very large at Stations J2, J5, J6, and J7 which are located near major roads. These stations have two different hourly variation patterns: the non-heating season having one peak at 6:00 a.m. and the heating season having two peaks at 6:00 a.m. and 6:00 p.m.
 - The NO₂ concentration has a milder hourly variation than the NO concentration. The nature of NO₂ being a secondary product is considered to be the reason for this tendency.
 - The hourly variation of the SO₂ concentration varies from station to station. The hourly variation of Station JF1 (located in a housing area) has a pattern showing two remarkable peaks. Those at Stations J2 and J3 (located in industrial areas) and JF2, which is affected by the pollutant source of a large thermal power plant, have two different patterns: one peak in the non-heating season in which the concentration begins to increase after 9:00 a.m. and lowers by 3:00 p.m., and two peaks in the heating season (one in the morning and another from around 17:00 which continues throughout the night).
 - The hourly variations of SO₂ concentration at other stations have a tendency to show a high concentration from 18:00 through 0:00 during the heating season. House heating is believed to be the reason for this tendency.
 - The hourly variations of SPM concentration during the non-heating season show morning and evening peaks only at Station J6. The peaks are generally small. During the heating season, the hourly variations at Stations JF1 and J6 show two remarkable peaks. These variations are thought to be caused by house heating.
- The SPM concentration at Station JF2 shows no hourly variation even during the heating season.
- The O₃ concentration became higher during daytime and lowered during nighttime at all three stations; the correlation between the concentration and the amount of solar radiation is significant.

(3) Appearance Frequency Distribution of Air Pollutant Concentration

Analysis of the appearance frequency distribution of air pollutant concentration provides valuable suggestions for presuming pollutant sources affecting a station and for understanding characteristics of the station in air pollution.

Comparison of the characteristics of different stations and comparison of the appearance frequency distributions of different air pollutants in different seasons at each station were made by plotting the appearance frequency of the 30 minutes values on the logarithmic normal probability chart or the normal probability chart.

If the plotted cumulative frequency curve on a probability chart forms a straight line it can be considered that the frequency distribution follows that type of distribution, e.g. the logarithmic normal distribution or the normal distribution. The slope of the straight line indicates the degree of scattering of the distribution. A small slope indicates a large degree of scattering. In general, when air pollutant concentration is largely affected by a specific pollutant source, the frequency distribution has a large scattering and is reflected by a line having a small slope.

1) Comparison of the Appearance Frequency Distribution Between Stations

The comparison of the cumulative frequency distribution of the 30 minutes average concentration of each pollutant at different monitoring stations are shown in Figures 3.2.3 through 3.2.9.

As the appearance frequency distribution of O₃ concentration generally follows the normal distribution pattern better than it follows the logarithmic distribution pattern, the measured O₃ concentration values were plotted on a normal probability chart.

The appearance frequency distributions of concentrations of other pollutants generally follow the logarithmic normal distribution pattern.

Following are the characteristics of the appearance frequency distributions of the major pollutants: NO_x and SO₂.

- According to the appearance frequency distribution of NO shown in Figure 3.2.3, the straight lines for stations J2, J5, and J7, where high concentrations were observed, have small slopes that indicate large scattering of concentrations.

The cumulative frequency distribution curves of Stations J2 and J3 are concave. It is considered that the curves indicate a difference of pollutant source characteristics from those at Stations J5, J6, and J7 where the curves are nearly straight.

- As for NO₂ (see Figure 3.2.4), all of the cumulative frequency distributions,

except for the one at Station JF2, have lines that are almost straight. The line slopes are practically identical. These slopes are greater than those for NO indicating smaller scattering and smaller differences from station to station. According to the distribution curve of Station JF2, the distribution tendencies at the high and low concentration zones are different providing a hint that affecting pollutant sources in these zones are different.

- For NO_x (see Figure 3.2.5), all the cumulative frequency distributions, except for the one at Station JF2, have lines on the logarithmic normal probability chart that are practically straight. The high concentrations were observed at Stations J2, J5, and J7 where 3% of the concentration values in the year exceeded the ambient air quality standard of Protected Area I (Station J2 is regarded as Protected Area II).
- As seen in Figure 3.2.6, all the appearance distributions of SO₂ have smaller slopes than those for NO_x. The scattering of the distributions is large as that of NO.

The distribution curves of Stations JF1 and J5 look like concave. It is considered that the curves are composed of two distribution patterns because of the large difference of concentrations during the heating and non-heating seasons. Characteristics of the curves in each station are described in Section 2) that follows.

The distribution at Station JF2 shows a very unique pattern in comparison to those of other stations. The cumulative frequency distribution is composed of two straight lines connected at 30 ppb. The slope of the straight line in the high concentration zone is smaller (indicating a larger deviation) than the one in the low concentration zone. It is considered that the distributions in the high and low concentration zones are affected by different pollutant sources.

The highest concentration was observed at Station JF1 where 5% of the 30 minutes values in the year exceeded the ambient air quality standard.

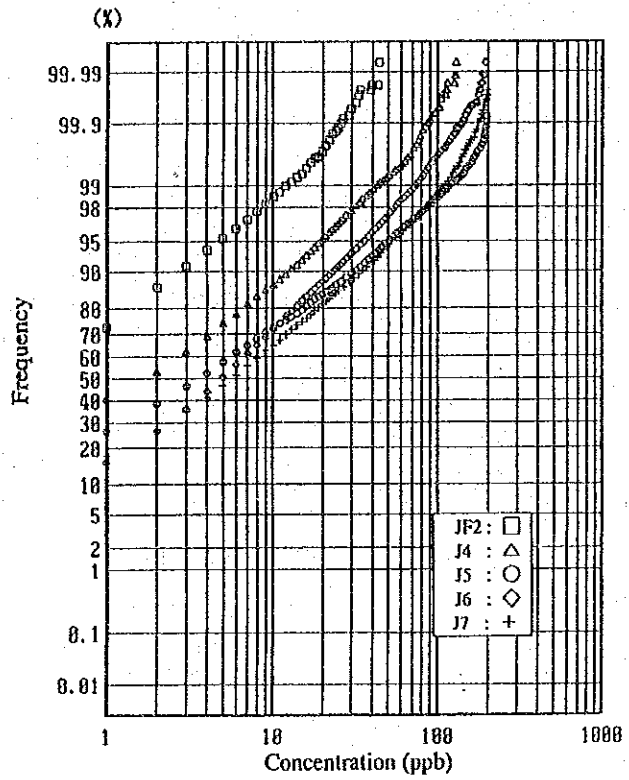
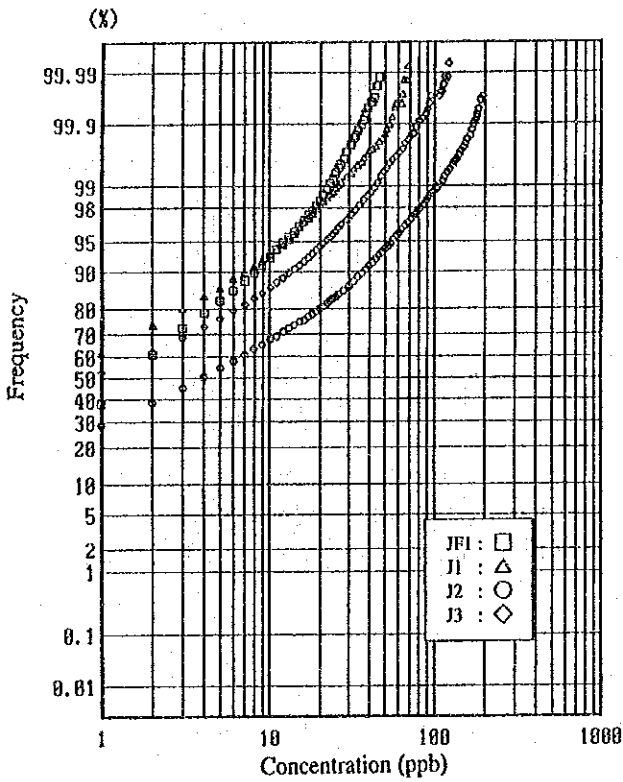


Figure 3.2.3 Cumulative Frequency Curve of NO Concentration (30 minutes value, all season)

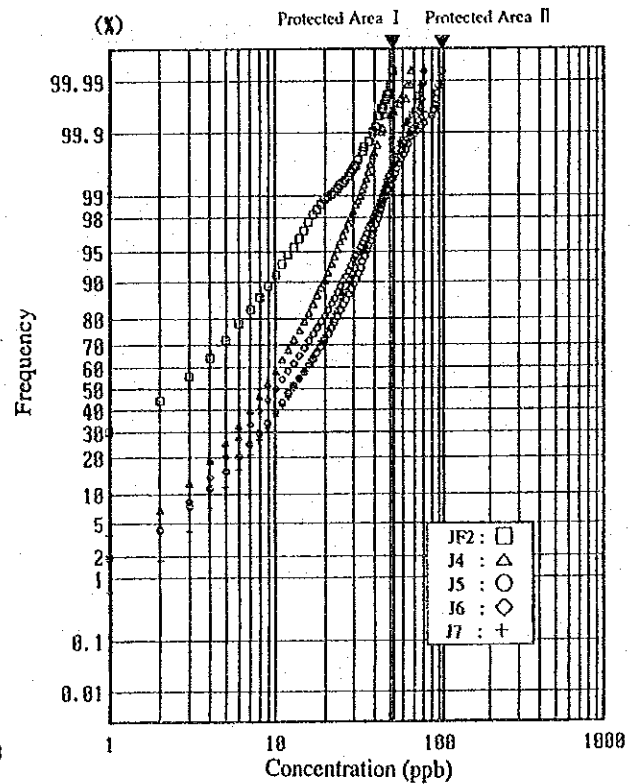
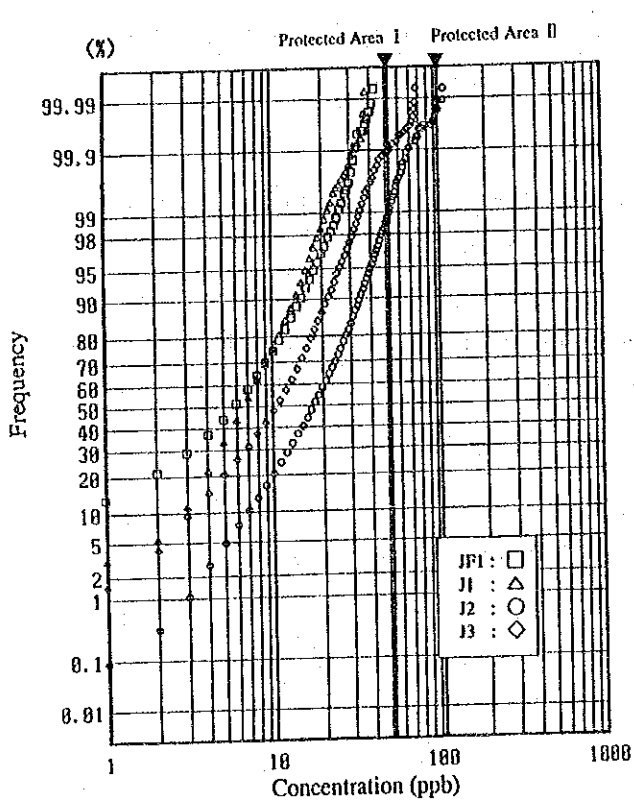


Figure 3.2.4 Cumulative Frequency Curve of NO2 Concentration (30 minutes value, all season)

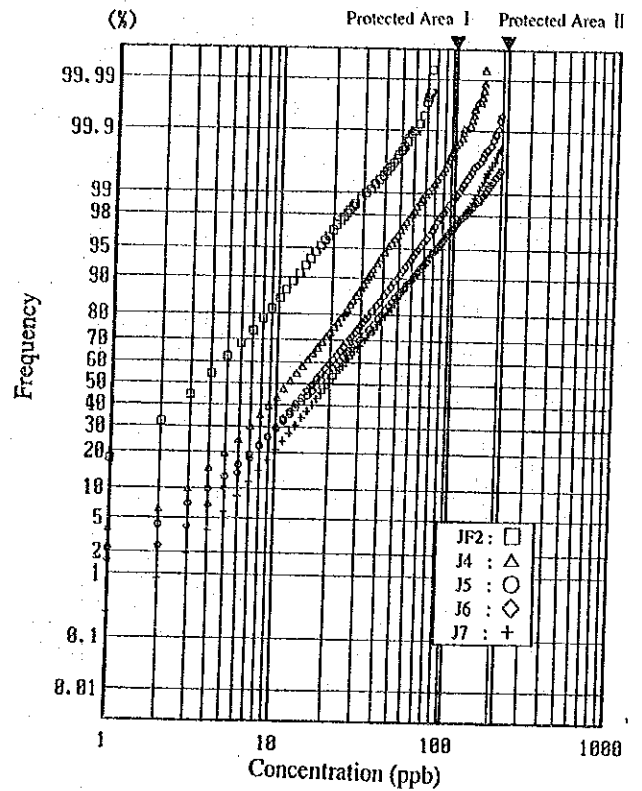
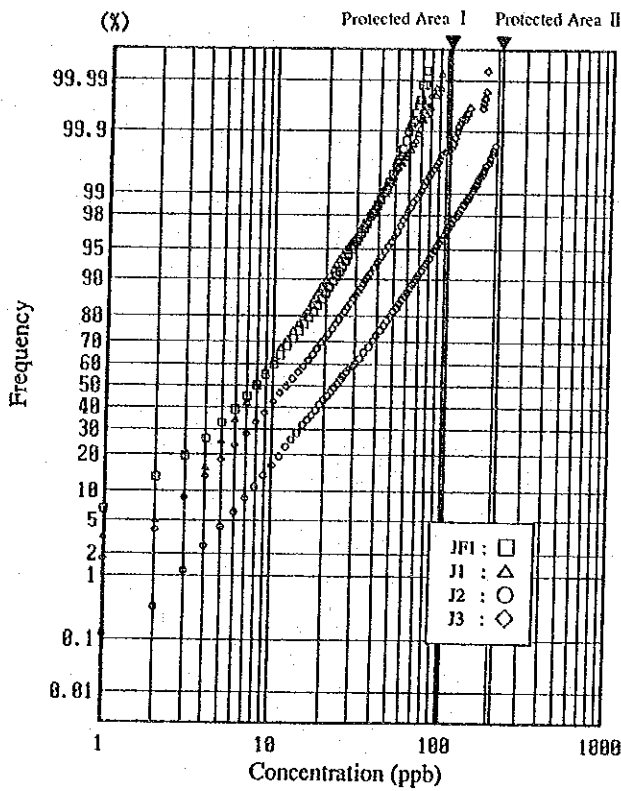


Figure 3.2.5 Cumulative Frequency Curve of NOx Concentration (30 minutes value, all season)

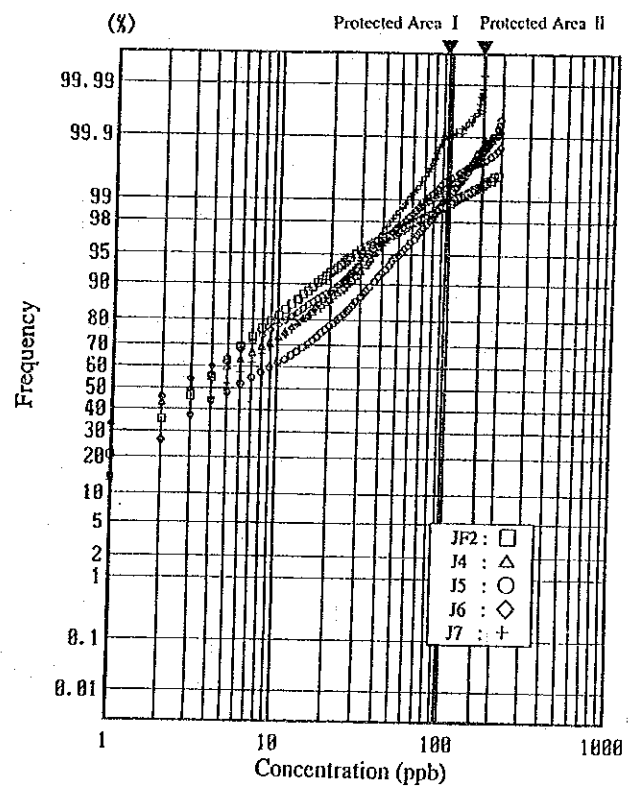
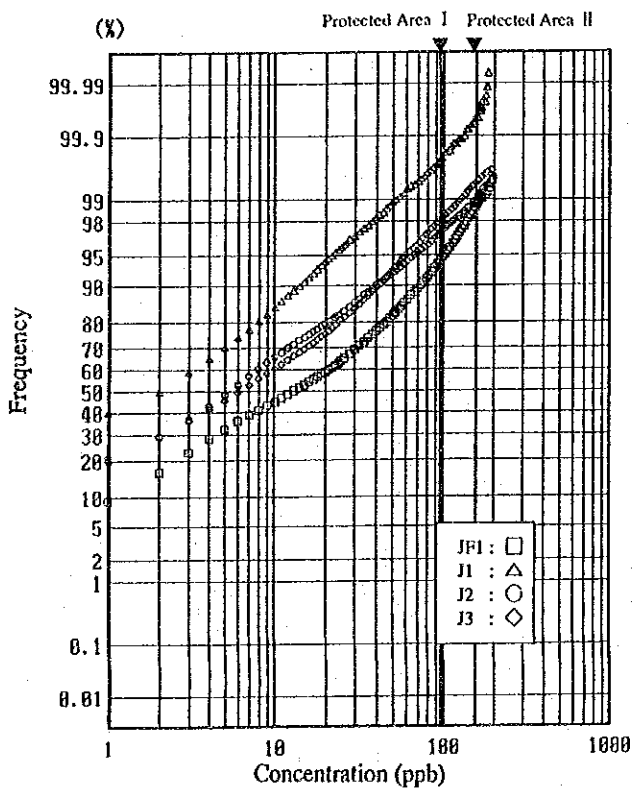


Figure 3.2.6 Cumulative Frequency Curve of SO2 Concentration (30 minutes value, all season)

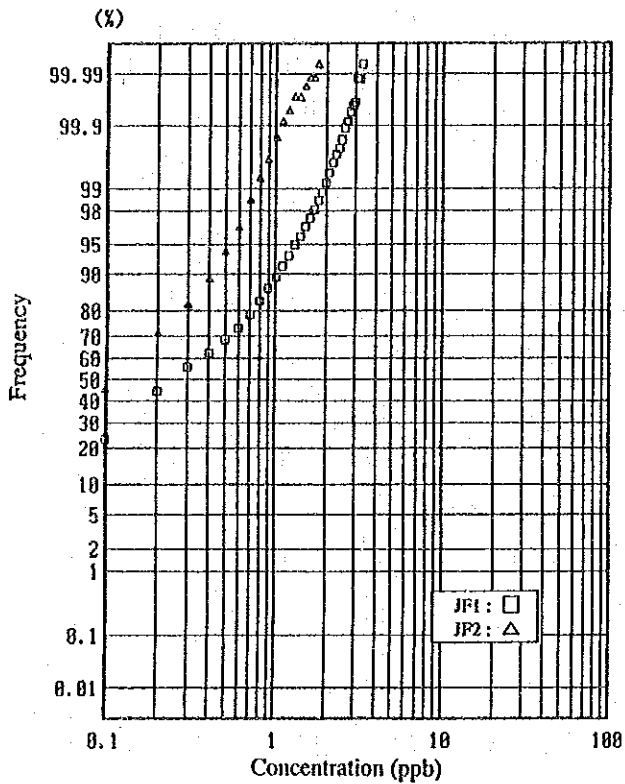


Figure 3.2.7 Cumulative Frequency Curve of CO Concentration (30 minutes value, all season)

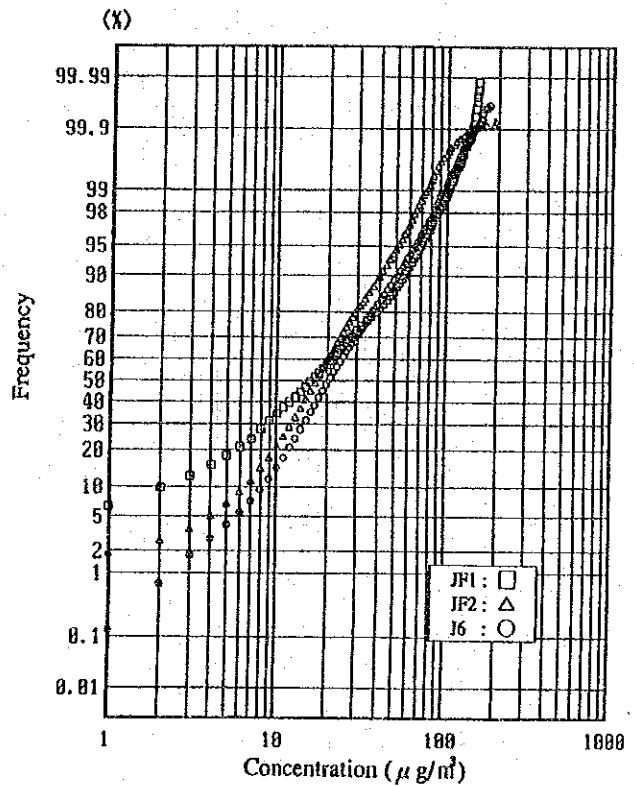


Figure 3.2.9 Cumulative Frequency Curve of SPM Concentration (30 minutes value, all season)

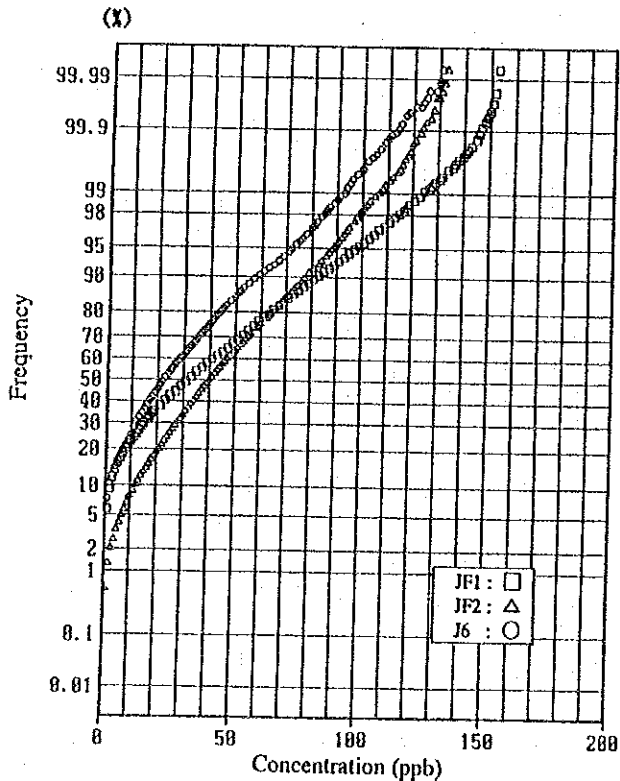


Figure 3.2.8 Cumulative Frequency Curve of O3 Concentration (30 minutes value, all season)

2) Characteristics of the Monitoring Stations Indicated by the Frequency Distribution of Concentration

The cumulative frequency distributions of the 30 minutes average concentrations of major pollutants, such as NO, NO₂, NO_x, and SO₂ at each station during the heating and non-heating seasons are shown in Figures D3.2.23 through D3.2.31 in Data Book.

The stations can be classified into the following groups according to the location characteristics:

- i) JF1, J1, J4, J5, J6 : Located in housing areas and not affected by particular pollutant sources.
- ii) J2, J3 : Located in industrial areas.
- iii) JF2 : Located in a farming area but affected by certain large pollutant sources.
- iv) J7 : Located along a major road.

The characteristics of each group are as follows:

i) Stations JF1, J1, J4, J5, and J6

- There are no large pollutant sources nearby these stations. Except for Station J1 where there are no houses around, the stations are located in ordinary housing areas. The appearance frequency distributions of pollutant concentrations at these stations have very similar distribution patterns.

The cumulative frequency distributions of NO and SO₂ concentrations have small slopes, indicating large distribution scattering. The distribution patterns of both the heating and non-heating seasons are about the same. There is a remarkable increase of SO₂ concentration during the heating season at all of these stations.

- The seasonal variation of NO₂ concentration is small compared to those of other pollutants.
- The appearance frequency distribution curves of SO₂ concentration at Stations

J1, J4, J5, and J6 during the non-heating season have small slopes in the high concentration zones. The distributions have large scattering. This phenomenon is mainly attributed to the effects of a small number of pollutant sources during the non-heating season. These graphs show the characteristics of the hourly variation in which a high concentration appears instantaneously under the continuous low SO₂ concentration by certain weather conditions, such as particular wind directions.

ii) Stations J2 and J3

The characteristics of the appearance frequency distribution graphs of pollutant concentrations observed at these stations located in industrial areas can be summarized as follows:

- The seasonal variations of nitrogen dioxide concentrations are small. Particularly for NO₂, although the concentration is higher during the heating season in the low concentration zone, there is little difference between the heating and non-heating seasons in the high concentration zone.
- The appearance frequency distributions of SO₂ during the heating and non-heating seasons are very different. During the non-heating season there is a large scattering in the high concentration zone bordering with 10 to 20 ppb. As described above, it reflects instantaneous high concentrations caused by certain stationary pollutant sources.

iii) Station JF2

Station JF2 is believed to be affected by certain stationary pollution sources. The appearance frequency distributions of pollutant concentrations observed at Station JF2 have the following characteristics:

- The concentration of NO_x observed at Station JF2 has a small seasonal variation compared with those at the Station J2 and J3 group.
- The appearance distribution of the SO₂ concentration shows very particular characteristics. The cumulative frequency curve bends to separate into two different appearance distribution patterns not only in the non-heating season but in the heating season as well. It indicates the strong effects of stationary pollutant sources throughout the year.

- Further for SO₂, the frequency of the appearance of high concentration is higher during the non-heating season than during the heating season. This phenomenon is considered to be related to weather conditions; in particular, to the stability of the atmosphere.
- In general, the maximum ground-level concentration of a pollutant emitted from a high smokestack becomes higher under unstable atmospheric conditions (stability classes A through C) than under stable atmospheric conditions (E through G).

The location where the maximum ground-level concentration occurs during an unstable atmospheric condition is normally closer to the pollutant source than that during a stable atmospheric condition. The distance from the source to the maximum concentration location during an unstable atmospheric condition is in the range from a few hundred meters to several kilometers, while that during a stable atmospheric condition is more than several kilometers.

- During the non-heating season, atmospheric conditions normally become unstable. Pollutants from the Thermal Power Stations in Tisza causes a high pollutant concentration at Station JF2. As the atmospheric conditions during the heating season become more stable, it is believed that the location of the maximum concentration on the ground becomes further from the pollutant source and the appearance frequency of high concentration becomes lower than that during the non-heating season.

iv) Station J7

The characteristics of the concentration appearance distributions observed at Station J7 that is located along a major road are as follows:

- The seasonal variations of nitrogen oxides, particularly NO₂, are very small. The reason for this is considered that the major pollutant sources are automobiles and the seasonal variation of the pollutant emissions from these vehicles is smaller than those from house heating.
- The seasonal variation of SO₂ concentration is great. The appearance distribution patten of SO₂ concentration resembles those observed at the station group located in housing areas. As there is a housing area developed around Station J7, it is believed that house heating affected the appearance distribution

pattern.

(4) Correlation Analysis of Pollutant Concentrations

To understand the pollutant source characteristics at each monitoring station, and similarity of conditions of the pollutant dispersion fields and pollutant sources between the stations, analyses were made on the correlation between the pollutant concentrations at each station, and on the correlation between the stations for each pollutant.

1) Correlation Analysis of Pollutants

By obtaining the correlation coefficient of the concentrations (30 minutes values) of two pollutants, it is possible to evaluate whether or not they are affected by the same pollutant source.

Tables 3.2.11 and 3.2.12 show the correlation matrix of pollutants at Stations JF1 and JF2 that have vastly different characters.

- At Station JF1, it is quite natural that the correlation coefficients of NO_x and NO , and NO_x and NO_2 are large. The coefficients of correlation between each others of three pollutants, SO_2 , NO_x , and CO also exceed 0.8 in the year. The correlation coefficients of SPM versus SO_2 , NO_x and CO exceed 0.7.
- As the above tendency is seen only during the heating season, it is considered that the main pollutant source for Station JF1 during that season is house heating and it greatly affects not only the SO_2 concentration, but also NO_x , CO , and SPM concentrations.
- At Station JF2, the correlation coefficients of pollutants are small, other than each others of nitrogen oxides (NO , NO_2 , and NO_x) and of hydrocarbons (CH_4 , NMT , and THC). The correlation coefficient of SPM and CO becomes larger during the heating season. But the correlation coefficients of all other pollutants are small and do not vary by seasons.
- At Station JF2, the correlation coefficient of SO_2 and NO_x (the main pollutants) is small at only 0.462 even during the heating season. Thus, the main sources of SO_2 and NO_x are evidently different. It is believed that the SO_2 source must be the Tisza I Thermal Power Station and the NO_x sources must be the oil refinery and the petrochemical complex.

Table 3.2.11 Coefficients of Correlation Between Pollutants

(JF1 : 30 minutes all season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.5288	1.0000								
NOx	0.8355	0.9058	1.0000							
SO2	0.6107	0.7866	0.8095	1.0000						
CO	0.7339	0.8269	0.8984	0.8398	1.0000					
O3	-0.4479	-0.5244	-0.5579	-0.3693	-0.5204	1.0000				
SPM	0.6208	0.7408	0.7871	0.7698	0.8469	-0.4145	1.0000			
CH4	0.6153	0.7092	0.7613	0.6512	0.7939	-0.6391	0.7358	1.0000		
NMT	0.3417	0.6061	0.5710	0.4797	0.5921	0.5921	0.5921	0.3938	1.0000	
THC	0.5407	0.7715	0.7727	0.6543	0.8047	-0.3996	0.7377	0.7703	0.8889	1.0000

(JF1 : 30 minutes non-heating season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.3960	1.0000								
NOx	0.7004	0.9243	1.0000							
SO2	0.3047	0.4760	0.4898	1.0000						
CO	0.3562	0.6911	0.6787	0.5178	1.0000					
O3	-0.3015	-0.4507	-0.4619	0.0064	-0.1924	1.0000				
SPM	0.2120	0.3552	0.3630	0.3092	0.4731	0.0322	1.0000			
CH4	0.3758	0.5811	0.5919	0.2339	0.4045	-0.4805	0.1905	1.0000		
NMT	0.2878	0.3940	0.4406	0.2635	0.4860	0.1749	0.4147	0.0953	1.0000	
THC	0.4089	0.5856	0.6313	0.3233	0.5911	-0.0539	0.4402	0.5056	0.9065	1.0000

(JF1 : 30 minutes heating season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.4402	1.0000								
NOx	0.8417	0.8532	1.0000							
SO2	0.5483	0.7525	0.7666	1.0000						
CO	0.7336	0.7672	0.8847	0.7797	1.0000					
O3	-0.4724	-0.4514	-0.5415	-0.3591	-0.5889	1.0000				
SPM	0.5868	0.6812	0.7478	0.7026	0.7989	-0.4721	1.0000			
CH4	0.5814	0.5830	0.6827	0.5648	0.7665	-0.6885	0.7194	1.0000		
NMT	0.1840	0.4707	0.3981	0.2956	0.4138	-0.0007	0.3181	0.1576	1.0000	
THC	0.4909	0.6876	0.7010	0.5563	0.7676	-0.4455	0.6739	0.7475	0.7724	1.0000

: $r > 0.8$
 : $0.8 \geq r > 0.7$

Table 3.2.12 Coefficients of Correlation Between Pollutants

(JF2 : 30 minutes all season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.5837	1.0000								
NOx	0.8008	0.9502	1.0000							
SO2	0.3108	0.3895	0.4018	1.0000						
CO	0.3052	0.4416	0.4372	0.2102	1.0000					
O3	-0.3271	-0.4578	-0.4601	0.0036	-0.4329	1.0000				
SPM	0.2069	0.3798	0.3556	0.1820	0.5566	-0.2583	1.0000			
CH4	0.2717	0.3383	0.3486	0.0096	0.2597	-0.3838	0.2330	1.0000		
NMT	0.1456	0.2964	0.2700	0.0497	0.2484	-0.2461	0.1724	0.2071	1.0000	
THC	0.2699	0.4116	0.4013	0.0365	0.3258	-0.4115	0.2616	0.7918	0.7607	1.0000

(JF2 : 30 minutes non-heating season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.5701	1.0000								
NOx	0.7752	0.9558	1.0000							
SO2	0.2660	0.2810	0.3055	1.0000						
CO	0.0808	0.1363	0.1319	0.0532	1.0000					
O3	-0.3185	-0.4350	-0.4437	0.1549	-0.1294	1.0000				
SPM	0.0421	0.1084	0.0956	0.0181	0.0264	-0.0105	1.0000			
CH4	0.3739	0.3536	0.3975	-0.0866	0.0356	-0.3899	0.0637	1.0000		
NMT	0.1149	0.3010	0.2647	-0.0130	0.1557	-0.1962	0.0762	0.2302	1.0000	
THC	0.3380	0.4211	0.4353	-0.0753	0.1038	-0.4002	0.0853	0.8680	0.6814	1.0000

(JF2 : 30 minutes heating season)

Pollutant	NO	NO2	NOx	SO2	CO	O3	SPM	CH4	NMT	THC
NO	1.0000									
NO2	0.5853	1.0000								
NOx	0.8108	0.9465	1.0000							
SO2	0.3313	0.4627	0.4622	1.0000						
CO	0.3536	0.6167	0.5814	0.2665	1.0000					
O3	-0.3114	-0.4754	-0.4663	-0.0992	-0.5032	1.0000				
SPM	0.2723	0.5590	0.5092	0.2890	0.7916	-0.4098	1.0000			
CH4	0.2009	0.3298	0.3154	0.1014	0.4477	-0.3763	0.4066	1.0000		
NMT	0.1387	0.2810	0.2558	0.0704	0.2380	-0.2522	0.1969	0.1939	1.0000	
THC	0.2159	0.3946	0.3677	0.1103	0.4325	-0.4022	0.3762	0.7262	0.8150	1.0000

: $r > 0.8$
 : $0.8 \geq r > 0.7$

Table 3.2.13 Coefficients of Correlation Between Pollutants

(J3 : 30 minutes all season)

Pollutant	NO	NO2	NOx	SO2
NO	1.0000			
NO2	0.5726	1.0000		
NOx	0.9060	0.8637	1.0000	
SO2	0.2729	0.4967	0.4228	1.0000

Table 3.2.14 Coefficients of Correlation Between Pollutants

(J6 : 30 minutes all season)

Pollutant	NO	NO2	NOx	SO2	O3	SPM
NO	1.0000					
NO2	0.6786	1.0000				
NOx	0.9452	0.8798	1.0000			
SO2	0.2443	0.5381	0.3996	1.0000		
O3	-0.4008	-0.4568	-0.4621	-0.1781	1.0000	
SPM	0.5488	0.6545	0.6437	0.4700	-0.3069	1.0000

(J3 : 30 minutes non-heating season)

Pollutant	NO	NO2	NOx	SO2
NO	1.0000			
NO2	0.5700	1.0000		
NOx	0.8498	0.9136	1.0000	
SO2	0.1174	0.3071	0.2431	1.0000

(J6 : 30 minutes non-heating season)

Pollutant	NO	NO2	NOx	SO2	O3	SPM
NO	1.0000					
NO2	0.6996	1.0000				
NOx	0.9235	0.9179	1.0000			
SO2	0.1478	0.3370	0.2622	1.0000		
O3	-0.3308	-0.2651	-0.3258	0.1510	1.0000	
SPM	0.2042	0.3436	0.2962	0.2380	0.0141	1.0000


(J3 : 30 minutes heating season)

Pollutant	NO	NO2	NOx	SO2
NO	1.0000			
NO2	0.5538	1.0000		
NOx	0.9176	0.8379	1.0000	
SO2	0.2236	0.5270	0.3965	1.0000

(J6 : 30 minutes heating season)

Pollutant	NO	NO2	NOx	SO2	O3	SPM
NO	1.0000					
NO2	0.6308	1.0000				
NOx	0.9453	0.8479	1.0000			
SO2	0.1540	0.5310	0.3297	1.0000		
O3	-0.4163	-0.5104	-0.4984	-0.1193	1.0000	
SPM	0.5572	0.6842	0.6662	0.4640	-0.3859	1.0000

 : $r > 0.8$

 : $0.8 \geq r > 0.7$

- At other stations, the coefficients of correlation between each others of nitrogen oxides (NO, NO₂, and NO_x) are large. But the correlation coefficient of NO_x and SO₂ is small. As examples, the correlation coefficients matrix at Stations J3 and J6 are shown in Tables 3.2.13 and 3.2.14.

2) Correlation Analysis of Monitoring Stations

In the correlation analysis of the monitoring stations, the similarities of atmospheric dispersion fields and that of characteristics of the pollutant sources among the stations are to be discerned.

The correlation coefficient matrix of NO_x is shown in Table 3.2.15 and the correlation coefficient matrix of SO₂ is shown in Table 3.2.16.

- As for NO_x, the correlation between Stations J4, J5, and J6, which are located relatively close to each others, is large. On the other hand, Stations JF1 and J3 have large correlation coefficients with Stations J4 and J6, which are remotely located.

Among the nine stations, Stations J1 and JF2 have small correlation coefficients with other stations. This fact indicates that Stations J1 and JF2 have relatively independent dispersion fields or governed by characteristic pollutant sources.

- As for SO₂, Stations JF1 and J4 have large correlation coefficients with other stations. The coefficients of correlation between J2 and J3, between J4 and J3, J5 and J6, and between J7 and J6 are large. These stations are located relatively close to each others.
- Being similar to NO_x, coefficients of correlation of SO₂ concentration between Station JF2 and other stations are small. Station JF2 is independent from others.
- For NO_x, the correlation between certain stations is evident during the heating and non-heating seasons. But the correlation between each station's SO₂ concentration is small during the non-heating season. Such stations having high correlation with other stations during the heating season are affected greatly by individual house heating.

Table 3.2.15 Coefficients of Correlation Between Monitoring Stations

(NO_x : Daily average all season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.4939	1.0000							
J1	0.6915	0.4693	1.0000						
J2	0.7148	0.3692	0.6132	1.0000					
J3	0.8486	0.5852	0.7298	0.7541	1.0000				
J4	0.8449	0.4215	0.6910	0.7167	0.8010	1.0000			
J5	0.7781	0.4785	0.5998	0.6402	0.7928	0.8883	1.0000		
J6	0.8318	0.5568	0.6832	0.6387	0.8361	0.8036	0.7962	1.0000	
J7	0.6319	0.4390	0.4913	0.5268	0.7147	0.6520	0.7784	0.7108	1.0000

(NO_x : Daily average non-heating season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.2939	1.0000							
J1	0.2772	0.0325	1.0000						
J2	0.7866	0.2469	0.2611	1.0000					
J3	0.8401	0.3436	0.2659	0.6801	1.0000				
J4	0.6898	0.1467	0.2801	0.7643	0.6411	1.0000			
J5	0.7228	0.3109	0.2661	0.6355	0.7714	0.7131	1.0000		
J6	0.7647	0.3644	0.2656	0.5638	0.7656	0.5999	0.7270	1.0000	
J7	0.6688	0.2573	0.4134	0.4771	0.7718	0.5607	0.8481	0.6893	1.0000

(NO_x : Daily average heating season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.5300	1.0000							
J1	0.6364	0.5011	1.0000						
J2	0.6372	0.3643	0.5722	1.0000					
J3	0.8170	0.6158	0.7557	0.7337	1.0000				
J4	0.7125	0.4571	0.6710	0.6290	0.7801	1.0000			
J5	0.6476	0.4766	0.5263	0.5461	0.7271	0.8743	1.0000		
J6	0.7306	0.5822	0.6537	0.5832	0.8014	0.7247	0.7123	1.0000	
J7	0.5874	0.4495	0.4043	0.4592	0.6529	0.6455	0.7474	0.6983	1.0000

 : $r > 0.8$


 : $0.8 \geq r > 0.7$

Table 3.2.16 Coefficients of Correlation Between Monitoring Stations

(SO₂ : Daily average all season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.4394	1.0000							
J1	0.7261	0.5066	1.0000						
J2	0.7146	0.5520	0.6613	1.0000					
J3	0.7787	0.5950	0.7068	0.8050	1.0000				
J4	0.7985	0.6410	0.7689	0.7639	0.8519	1.0000			
J5	0.8314	0.4671	0.7088	0.6279	0.7791	0.8901	1.0000		
J6	0.6323	0.2136	0.5313	0.5813	0.6605	0.8455	0.7227	1.0000	
J7	0.7226	0.2275	0.5751	0.5022	0.6096	0.6881	0.7956	0.8843	1.0000

(SO₂ : Daily average non-heating season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.0309	1.0000							
J1	0.3969	-0.0313	1.0000						
J2	0.4931	-0.1001	0.3908	1.0000					
J3	0.2899	0.4454	0.1827	0.2701	1.0000				
J4	0.3078	0.1023	0.0542	0.1972	0.4421	1.0000			
J5	0.3229	0.1107	0.1096	0.3066	0.4066	0.7810	1.0000		
J6	0.4278	0.2059	0.1369	0.2322	0.3955	0.5884	0.7211	1.0000	
J7	0.4637	0.2379	0.1253	0.3949	0.4566	0.6745	0.7458	0.8112	1.0000

(SO₂ : Daily average heating season)

Station	JF1	JF2	J1	J2	J3	J4	J5	J6	J7
JF1	1.0000								
JF2	0.5410	1.0000							
J1	0.6353	0.5915	1.0000						
J2	0.7369	0.6712	0.6228	1.0000					
J3	0.7240	0.6442	0.6498	0.8341	1.0000				
J4	0.7283	0.7482	0.7274	0.7759	0.8325	1.0000			
J5	0.7125	0.5398	0.6238	0.5934	0.7187	0.8518	1.0000		
J6	0.4620	0.3046	0.4139	0.5642	0.5711	0.8109	0.6133	1.0000	
J7	0.4982	0.1695	0.4246	0.3942	0.4478	0.5569	0.6702	0.8531	1.0000



: $r > 0.8$



: $0.8 \geq r > 0.7$

3.2.2 Surface Meteorology

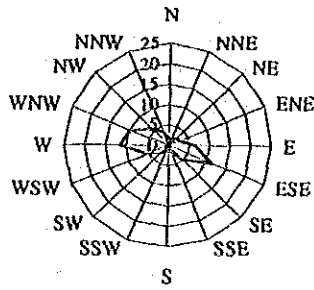
(1) Wind Direction and Speed

1) Wind Direction Distribution

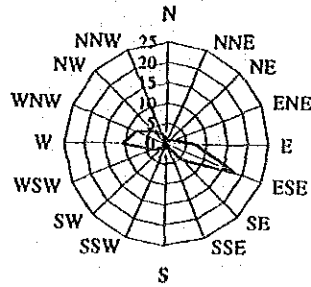
The wind direction distribution diagrams at the four surface meteorological observation stations (JF1 and JM1 in the northern part, and JF2 and J7 in the southern part) during the heating and non-heating seasons are shown in Figure 3.2.10 (also in Tables D3.2.2 and D3.2.3 in Data Book). Diagrams by time zones in each season are shown in Figures D3.2.32 through D3.2.35 in Data Book.

- At Station JF1, the prevailing wind direction throughout the year is ESE and the predominant wind direction is W - ESE axis which is the valley direction. The seasonal variation of the wind is small. The variation of the wind by time zones is also small during both the heating and non-heating seasons, except that the prevailing wind direction during the heating season is ESE for 24 hours, while the one during the heating season is ESE during the daytime and W during the nighttime.
- At Station JM1, the prevailing wind direction is in the range of NW to NNW throughout the year. The predominant wind is on the NNW - SSE axis which corresponds to the topography. The seasonal variation of the wind is small. For the 24 hour period during the non-heating season, a cyclic wind direction pattern appears : from 00:00 to 06:00 the NNW wind is predominant, after that it is gradually replaced by the SSE wind. During the heating season also, there is such a wind direction cycle, but its change is small and the hourly variation is small.
- At Station JF2 in the southern part, the prevailing wind direction is SW and the predominant wind is on the SW-NE axis. During the 24 hour period in each season, the appearance patterns of the prevailing wind direction and the predominant wind change only slightly.
- At Station J7, the N wind is very distinctive. The predominant wind axis is N - SW to SSW. The direction corresponds to the valley orientation which forms the Tisza River. The seasonal variation of wind is small. For the 24 hour period, however, there is a cyclic wind direction change during the heating and non-

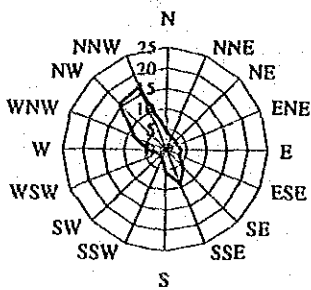
JF1 Station (non-heating season)
Calm=25.4%



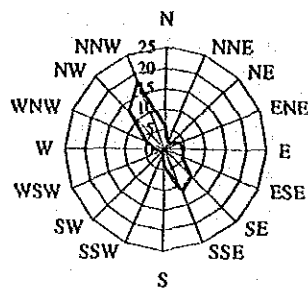
JF1 Station (heating season)
Calm=30.5%



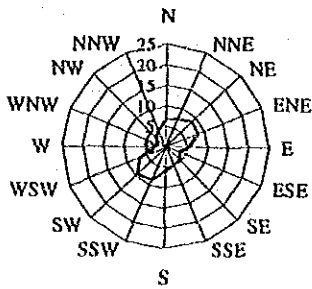
JM1 Station (non-heating season)
Calm=7.2%



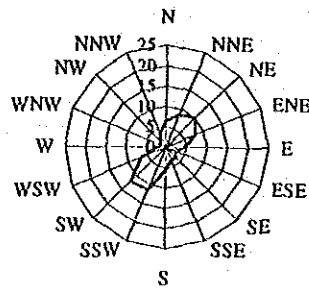
JM1 Station (heating season)
Calm=10.6%



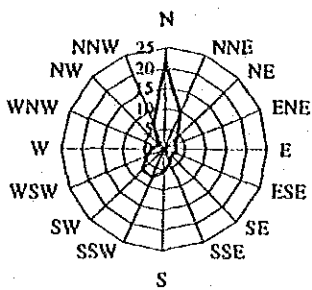
JF2 Station (non-heating season)
Calm=7.1%



JF2 Station (heating season)
Calm=8.0%



J7 Station (non-heating season)
Calm=11.3%



J7 Station (heating season)
Calm=9.9%

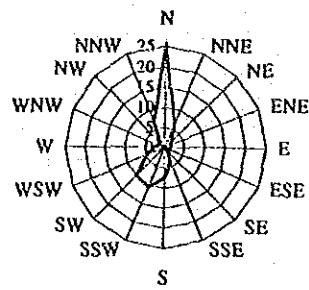


Figure 3.2.10 Wind Direction Distribution Diagram (JF1, JM1, JF2, J7)

heating seasons. North winds prevail during the early morning to noon periods and SSW winds prevail in the afternoons.

2) Wind Speed Condition

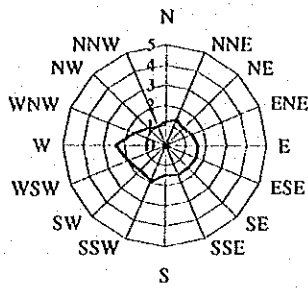
The average wind speeds for different directions at the four surface meteorological stations (JF1 and JM1 in the northern part, and JF2 and J7 in the southern part) during the heating and non-heating seasons are shown in Figure 3.2.11 (also in Tables D3.2.2 and D3.2.3 in Data Book).

- The average wind speeds at Station JF1 are the smallest; they are in the range of 1.2 to 1.3 m/s. The average wind speeds at the other stations are in the range of 2.0 to 2.4 m/s. At the two stations in the southern part, the average wind speeds are higher in the heating season than in the non-heating season.
- The hourly and monthly variations of wind speed are shown in Figures 3.2.12 and 3.2.13, respectively. According to the hourly variation graph, the average wind speed varies from station to station, but the wind speed decreases during the nighttime then gradually increases after sunrise at all stations throughout the heating and non-heating seasons. There is a wind speed peak at 16:00 to 17:00 during the non-heating season and at 13:00 to 14:00 during the heating season.

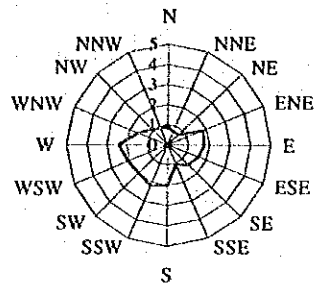
The wind speed variation range during the non-heating season is greater than the one during the heating season. The average nighttime wind speed during the heating season is greater than the one during the non-heating season.

- As for the monthly variation of wind speed, the speeds are low in November and February and highest in March in all stations. This pattern corresponds favorably with the monthly variations of air pollutant concentrations shown in Figures D3.2.11 through D3.2.15 in Data Book. During a month having a small average wind speed, the concentrations of NO_x and SO_2 are high.
- According to the appearance frequency distributions of wind speeds (Figure 3.2.14), the 1.0 to 1.9 m/s rank has the highest frequency at all stations except JF1. At Station JF1, the highest appearance frequency is CALM (0 to 0.4 m/s wind).

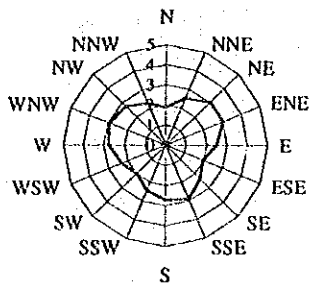
JF1 Station (non-heating season)
V.Mean=1.3m/s



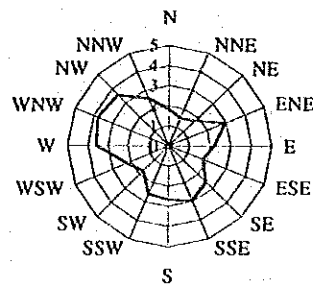
JF1 Station (heating season)
V.Mean=1.2m/s



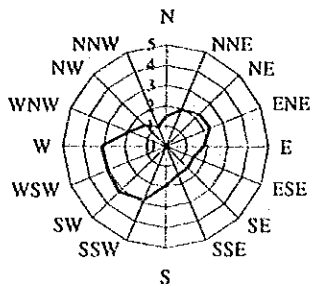
JM1 Station (non-heating season)
V.Mean=2.4m/s



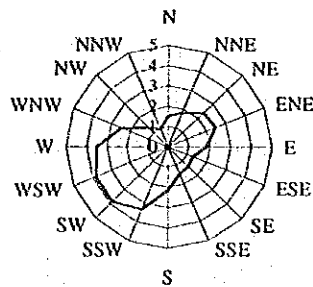
JM1 Station (heating season)
V.Mean=2.4m/s



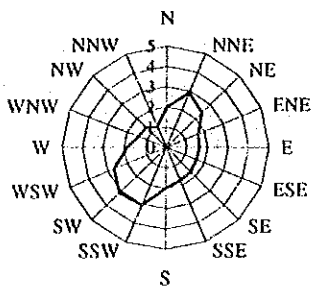
JF2 Station (non-heating season)
V.Mean=2.0m/s



JF2 Station (heating season)
V.Mean=2.3m/s



J7 Station (non-heating season)
V.Mean=2.0m/s



J7 Station (heating season)
V.Mean=2.3m/s

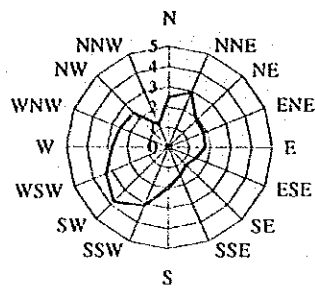


Figure 3.2.11 Mean Wind Speed by Wind Direction (JF1, JM1, JF2, J7)

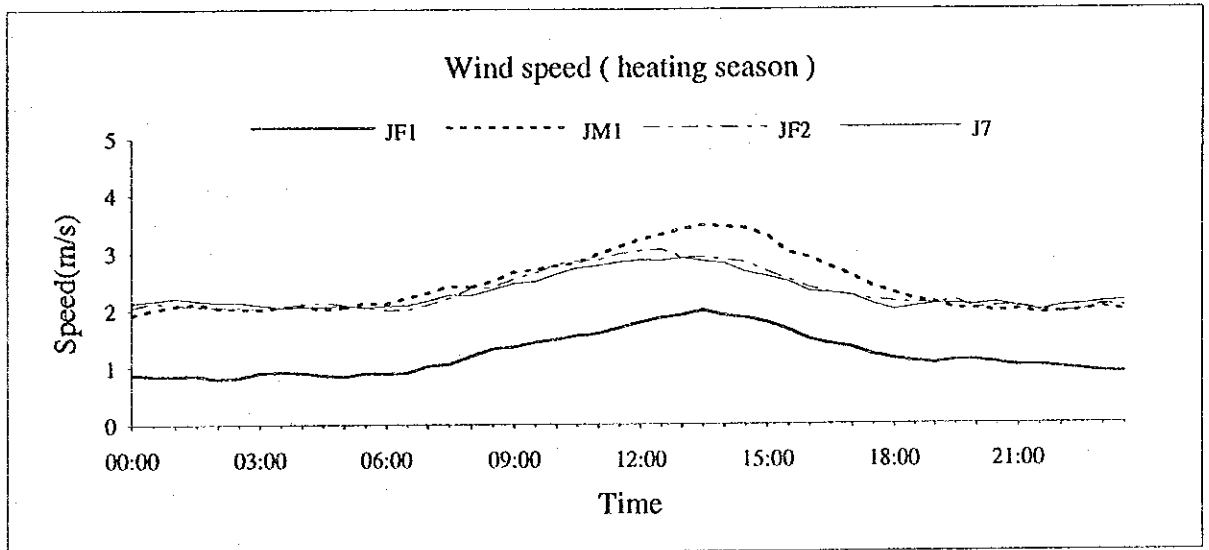
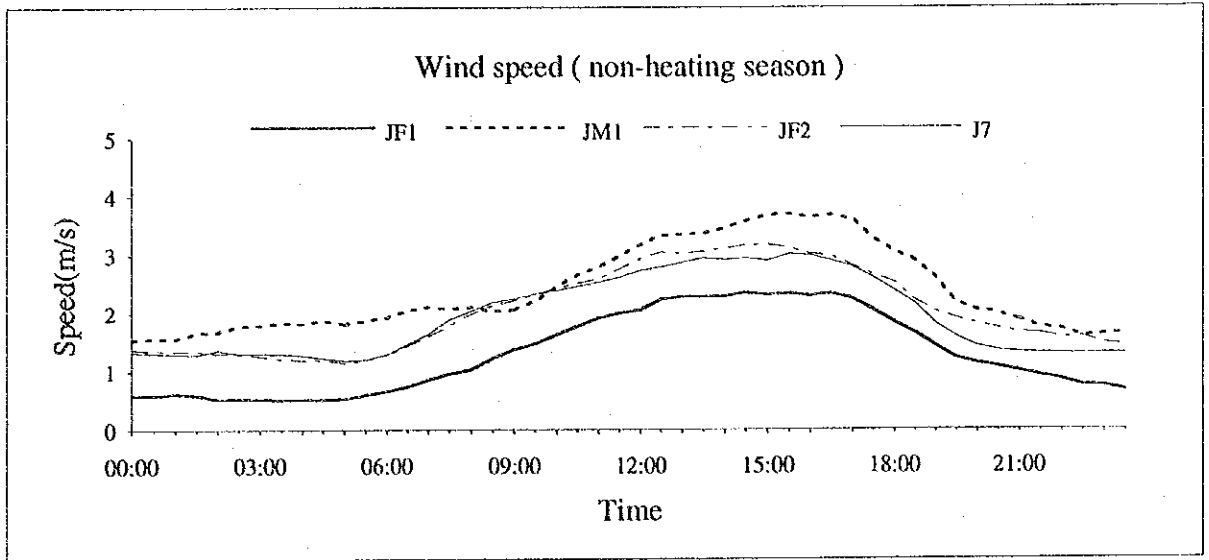


Figure 3.2.12 Hourly Variation of Wind Speed (JF1, JM1, JF2, J7, 00:00-23:30)

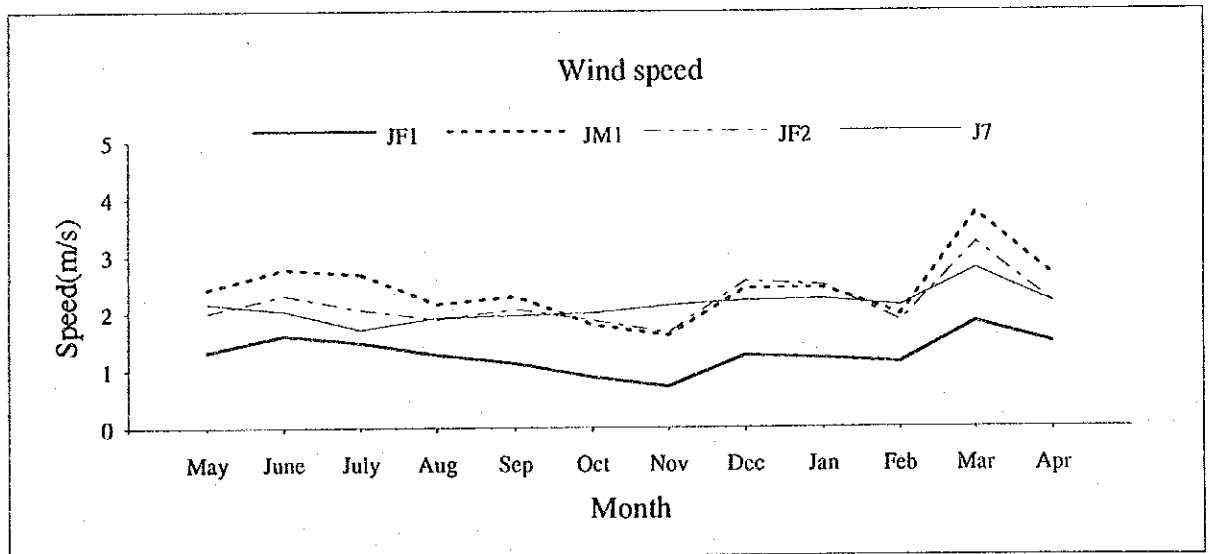


Figure 3.2.13 Monthly Variation of Wind Speed (JF1, JM1, JF2, J7 : May - April)

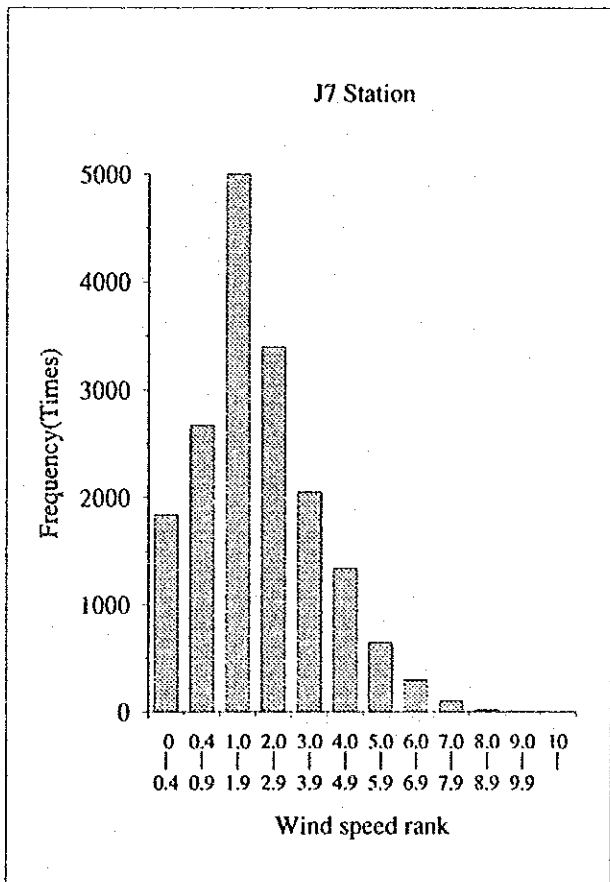
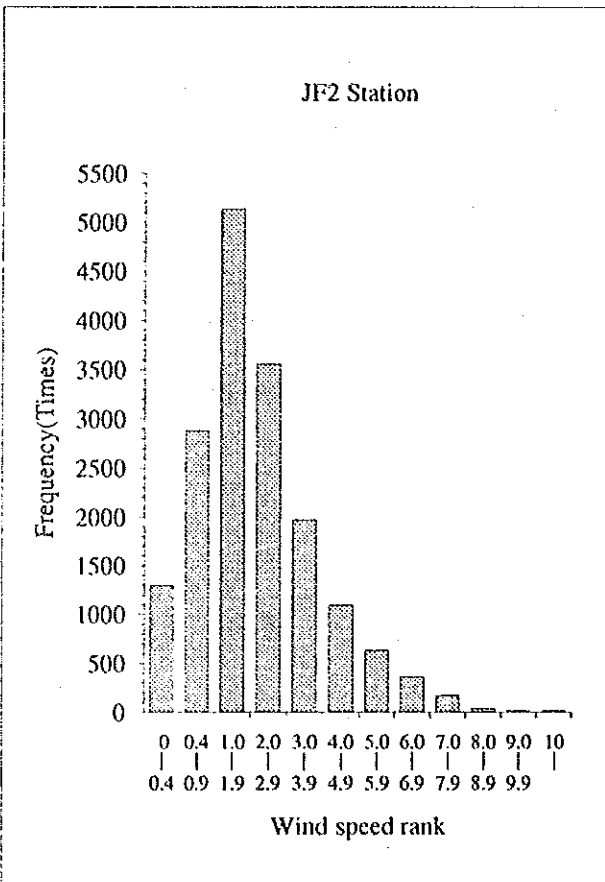
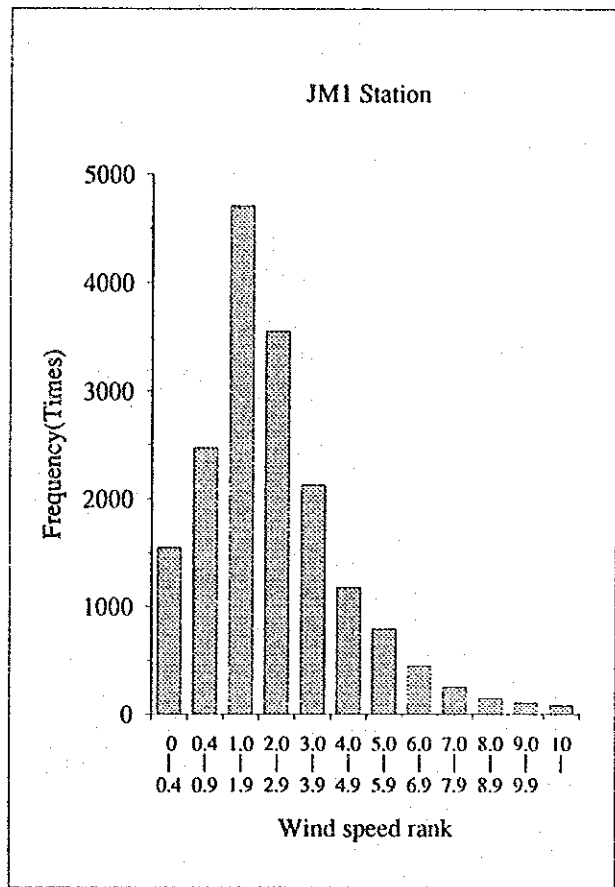
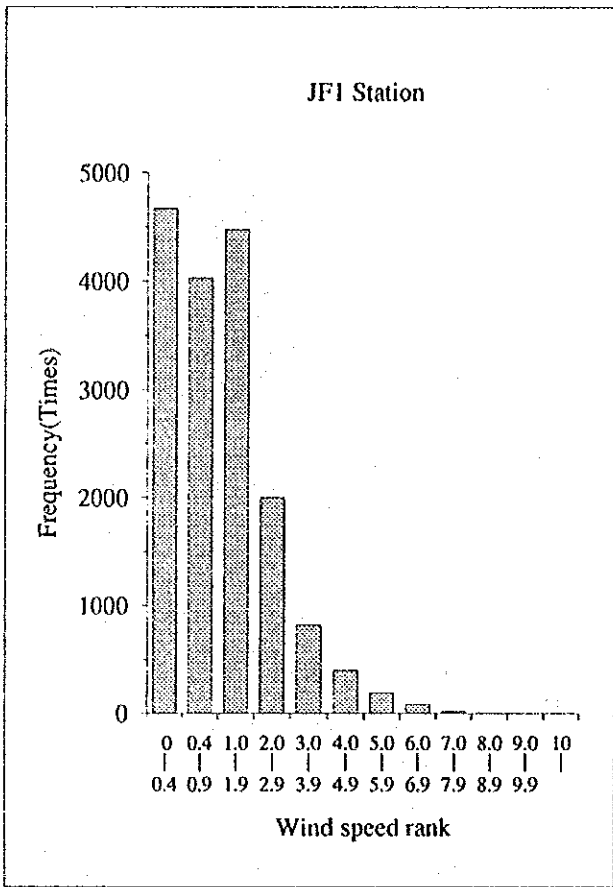


Figure 3.2.14 Appearance Frequency of Wind Speed Ranks (all seasons)

(2) Solar Radiation and Net Radiation

The hourly variations by month of solar radiation and net radiation are shown in Figures D3.2.36 through D3.2.38 in Data Book. Throughout a year, both the solar radiation and net radiation become greatest during May and June and gradually decrease until December when they reach minimum levels.

The annual variation of solar radiation is very large. The greatest solar radiation in June is 7.5 times greater than the highest radiation in December.

(3) Appearance Frequency of Atmospheric Stability Classes

The atmospheric stability is an index for expressing dispersiveness of substances in the atmosphere. As shown in Table 3.2.17, the atmospheric stability is divided into A (extremely unstable) to G (extremely stable) classes according to wind speed, the amount of solar radiation, and the amount of net radiation.

Table 3.2.17 Pasquill's Atmospheric Stability Classes (Modified)

Wind Speed (U) m/s	Solar Radiation (T) kW/m ²				Net Radiation (Q) kW/m ²		
	T≥0.60	0.60>T ≥0.30	0.30>T ≥0.15	0.15>T	Q≥-0.020	-0.020> Q≥-0.040	-0.040>Q
U<2	A	A-B	B	D	D	G	G
2≤U<3	A-B	B	C	D	D	E	F
3≤U<4	B	B-C	C	D	D	D	E
4≤U<6	C	C-D	D	D	D	D	D
6≤U	C	D	D	D	D	D	D

When the atmospheric stability is unstable, dispersion of emitted pollutants in the air is accelerated. The pollutants emitted from a low smokestack is easily dispersed and the concentration level rapidly decreases on the ground. On the other hand, pollutants released by a tall smokestack easily reach to the ground by dispersion, and a high concentration of a pollutant occurs on the ground.

When the atmosphere stability is stable, it is difficult to disperse pollutants. Pollutants emitted from a low smokestack are advected at high concentration. Contrarily, pollutants released from a tall smokestack do not easily fall to the ground. Thus, the concentration of pollutants on the ground is low.

Figure 3.2.15 shows the appearance frequency of each atmospheric stability level that was obtained from the wind speed, solar radiation, and net radiation at each station.

The atmospheric stability classes of D (neutral) and G (extremely stable) are prevalent at each station. The frequencies of these two classes are 62.3 to 70.4% of all classes that appeared.

The appearance frequency distributions of the stability classes during the non-heating season greatly differ from those during the heating season. During the non-heating season, class D (neutral) appears less frequently than during the heating season. The frequencies of classes A through D (unstable side) appear more frequently. The frequency of G is also high.

During the heating season, the frequency of class D (neutral) is high because, as described earlier, the nighttime average wind speed is greater and the solar radiation is smaller.

The appearance frequencies of each atmospheric stability class for a 24 hour period at Stations JF1 and JF2 are shown in Figures D3.2.39 and D3.2.40 in Data Book. The stability classes at both stations are in the stable side from evening to early morning (from 00:00 to 06:00 and from 18:00 to 24:00). During the daytime in general, the appearance frequencies of the unstable side classes are remarkable, although in the summer season, the appearance frequency of stability class D is high.

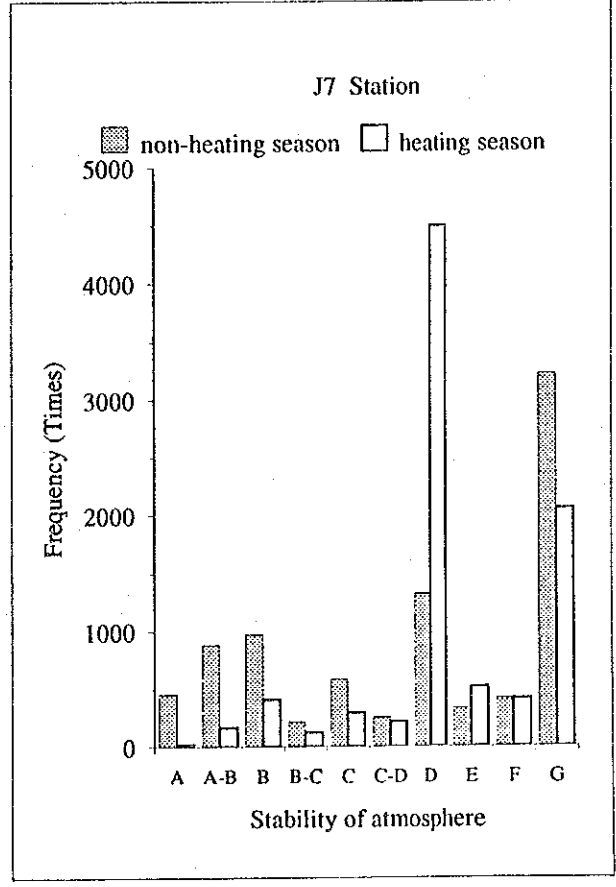
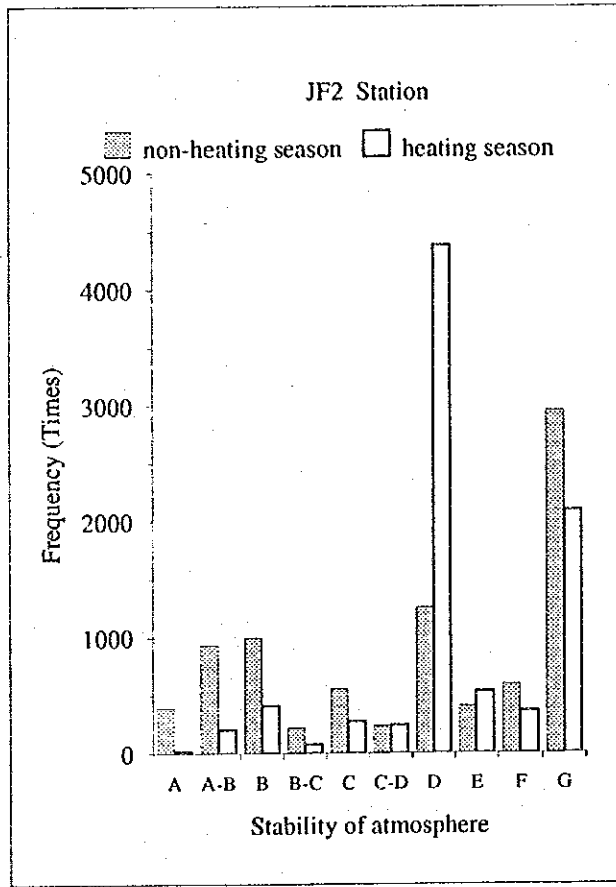
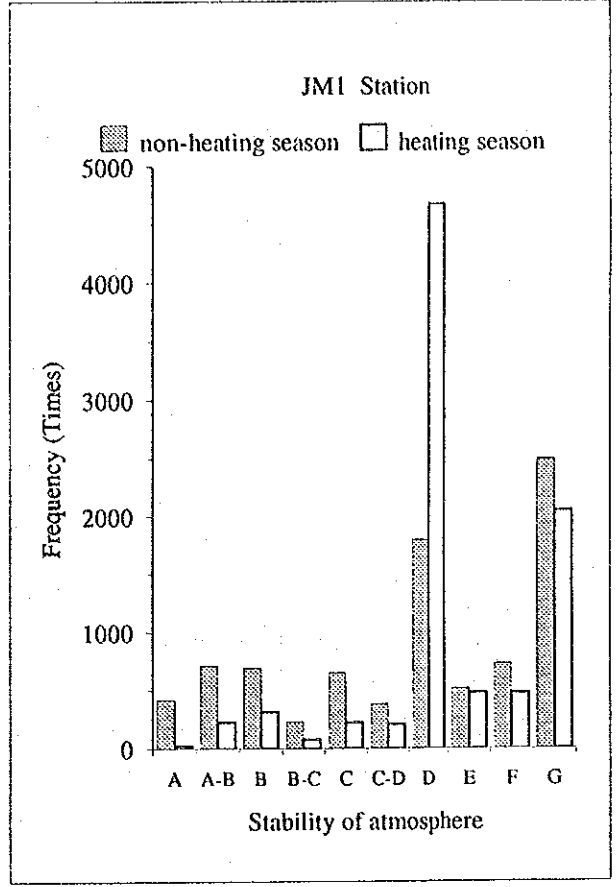
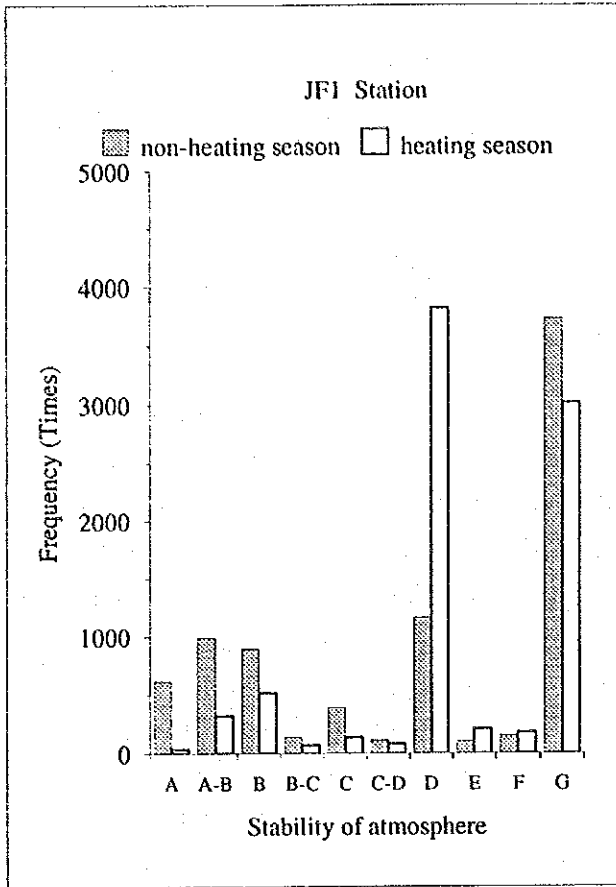


Figure 3.2.15 Appearance Frequency of Stability Classes (JF1, JM1, JF2, J7)

3.2.3 Upper-layer Meteorology

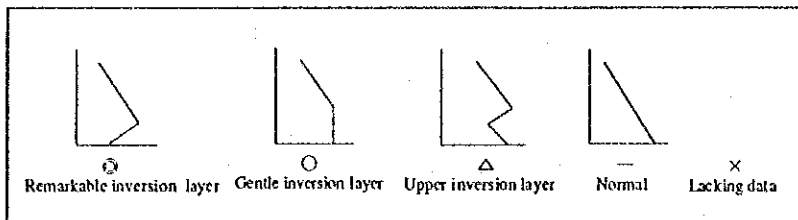
(1) Occurrence of Inversion Layer

According to the result of the upper-layer meteorological observation, the occurrence of the surface inversion layer is as shown in Table 3.2.18.

As seen in the Table, the inversion layer was observed at all observation periods. During the spring and summer seasons when solar radiation becomes strongest, the surface inversion layer starts to grow around 21:00 at both Stations JF1 and JF2. Near the ground surface, a relatively strong air temperature inversion continues throughout the night. The inversion weakens at sunrise and ceases around 9:00. During the fall and winter seasons, the inversion is not so strong. However, upper-layer inversion at the altitude of 100 to 400 m is frequently observed. In particular, during the winter season, the upper-layer inversion that lasts for an entire day -- as observed on January 20 and 21 -- is seen occasionally.

Table 3.2.18 Occurrence of Inversion Layer

spring	month day	5/27			5/28			5/29			5/30			5/31			6/1			6/2													
	Time	13	17	20	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17	21	1				
	JF1	×	×	⊙	⊙	⊙	×	—	—	—	⊙	⊙	—	—	—	⊙	⊙	—	—	—	⊙	⊙	—	—	—	⊙	⊙						
	JF2	—	—	⊙	⊙	⊙	△	—	—	△	○	△	—	—	—	⊙	⊙	—	—	—	△	△	—	△	—	⊙	⊙	—	—	×	×	×	
summer	month day	7/17			7/18			7/19			7/20			7/21			7/22																
	Time	13	17	21	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17						
	JF1	—	⊙	⊙	⊙	⊙	—	×	—	⊙	⊙	⊙	—	—	—	⊙	⊙	—	—	—	⊙	○	○	×	—	△	—	—	—	—	—		
	JF2	—	△	⊙	⊙	⊙	△	—	—	⊙	⊙	⊙	△	—	—	—	⊙	⊙	—	—	—	⊙	△	△	△	—	△	×	×	○	—	—	
autumn	month day	10/1			10/2			10/3			10/4			10/5			10/6																
	Time		16	20	0	4	8	12	16	20	0	4	8	12	16	20	0	4	8	12	16	20	0	4	8	12							
	JF1		⊙	—	△	△	△	—	—	△	△	△	△	—	—	—	—	—	△	△	—	△	—	—	—	—	⊙	⊙	○	△	—		
	JF2		—	⊙	△	△	△	—	—	×	△	×	△	—	—	×	△	—	△	×	×	△	△	—	—	—	⊙	⊙	⊙	△	—		
winter	month day	1/17			1/18			1/19			1/20			1/21			1/22																
	Time		17	21	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17	21	1	5	9	13	17						
	JF1		⊙	⊙	⊙	—	—	—	⊙	⊙	×	○	○	—	⊙	⊙	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	○	
	JF2		⊙	△	△	—	—	—	○	⊙	⊙	⊙	⊙	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	×



(2) Vertical Profiles of Wind Speed and Temperature, and the Hourly Variation of Pollutant Concentrations

The relationships between the vertical profiles of wind speed and air temperature, and the hourly variations of pollutant concentrations observed are shown in Data Book : Figures D3.2.41 through D3.2.44 for Station JF1 and Figures D3.2.45 through D3.2.48 for Station JF2.

1) Station JF1

- During the spring and summer seasons, very strong surface inversions were observed from midnight through dawn. The SO₂ concentration was low, therefore the relationship between the surface inversion and the SO₂ concentration is clear. On the other hand, the NO_x concentration obviously increased when a surface inversion layer occurred.
- During the fall and winter seasons, strong inversions were not observed and neutral to stable atmospheric conditions continued throughout each day.

During the winter season, upper-layer inversion at an altitude of 100 to 400 m continued and the atmospheric condition is comparable to a lid covering.

Within the surface boundary layer the winds were very low and high concentrations of NO_x and SO₂ occurred.

2) Station JF2

- The occurrence condition of an inversion layer at this station is similar to the condition at Station JF1. Strong inversions were seen during the spring and summer seasons and weak inversions continued during the fall and winter seasons.
- The NO_x concentration tends to become higher when the inversion layer appears. But, there is no such tendency for the SO₂ concentration.
- The characteristics of the hourly variation of pollutant concentration at this station show that the variation NO_x concentration as well as the SO₂ concentration is extreme and that the effects of a large stationary pollutant source are very clear.

- During the spring and summer seasons, the NO_x and SO_2 concentrations are extremely high when the wind is from NNE to NE directions. The effect of the Tisza I Thermal Power Station that is located in the same direction is evident. But, during the fall and winter seasons, when the wind is from the same direction, the SO_2 concentration does not increase while NO_x concentration increases. The reason for this is thought to be that the pollutants from the power plant do not reach the station because of the stable atmospheric conditions during the heating season while the pollutants from the plant reach the station under unstable atmospheric conditions during the non-heating season.
- As the NO_x concentration is higher when the inversion layer appears, the NO_x concentration is largely influenced by low-elevation pollutant sources.

3.2.4 Cross Analysis of Meteorology and Pollutants

The cross analysis was conducted of the meteorological data and pollutants (NO_x and SO₂) concentration data that were monitored at the same time and at the same stations or nearby stations shown in the following table. The purpose of the analysis is to learn the directions of pollutant sources that affected the stations and the characteristics of the sources.

Area	Station	Ambient Air Quality Monitoring Stations	Surface Meteorological Stations
Northern Part of Study Area		JF1	JF1
		J2	JM1
		J3	JM1
Southern Part of Study Area		JF2	JF2
		J7	J7(JM2)

The location maps of the monitoring stations are shown in Figures 3.2.16 (northern part) and 3.2.17 (southern part). Detailed maps of these stations are shown in Figures D3.2.49 through D3.2.53 in Data Book.

(1) Average Pollutant Concentrations by Wind Directions and Wind Speed Classes

It is possible to presume the direction of major pollutant sources by knowing the pollutant concentration of each wind direction.

In general, according to the relationship between wind speed and pollutant concentration, when an influencing pollutant source is at a high elevation, such as a factory's smokestack, a high pollutant concentration occurs under relatively high wind speed rather than under mild wind. On the other hand, when the pollutant source is at a low level, such as vehicles and house heating, a high pollutant concentration occurs under mild wind conditions and the concentration becomes lower as the wind speed increases.

By knowing the pollutant concentration under different wind speeds, it is possible to presume the type and elevation of the major pollutant source.

1) Station JF1 (Figure 3.2.18 for NO_x and Figure 3.2.19 for SO₂)

NO_x:

When the wind speed increases, the NO_x concentration decreases as a whole. But under the ESE wind direction in which a high concentration appears, no decrease of concentration is observed until the wind speed reaches 6.0 m/s. The NO_x

concentration in the heating season was higher than in the non-heating season. The concentration was higher under NNE to NE winds.

SO₂:

During the non-heating season, SO₂ concentration was lower. The concentration was higher only when the wind was from the E to SE directions.

During the heating season, SO₂ concentration was higher under a wide range of wind directions (the NNE to SE range). The decrease of the concentration due to wind speed increase was not observed.

The above phenomena provide a hint that the SO₂ concentration was affected by remote tall smokestacks during the non-heating season and by nearby low pollutant sources during the heating season.

During the non-heating season, nearby pollutant sources do not affect the SO₂ concentration and the level of concentration is low. Thus, the effects of the smokestacks in the industrial area (including the Borsod Thermal Power Station) that is located to the southwest of Station JF1 become distinct. However, during the heating season, the effect of nearby house heating increases, and the concentration distribution by wind speed shows mixed effects of high and low elevation sources. This tendency is also seen in the NO_x concentration during the heating season.

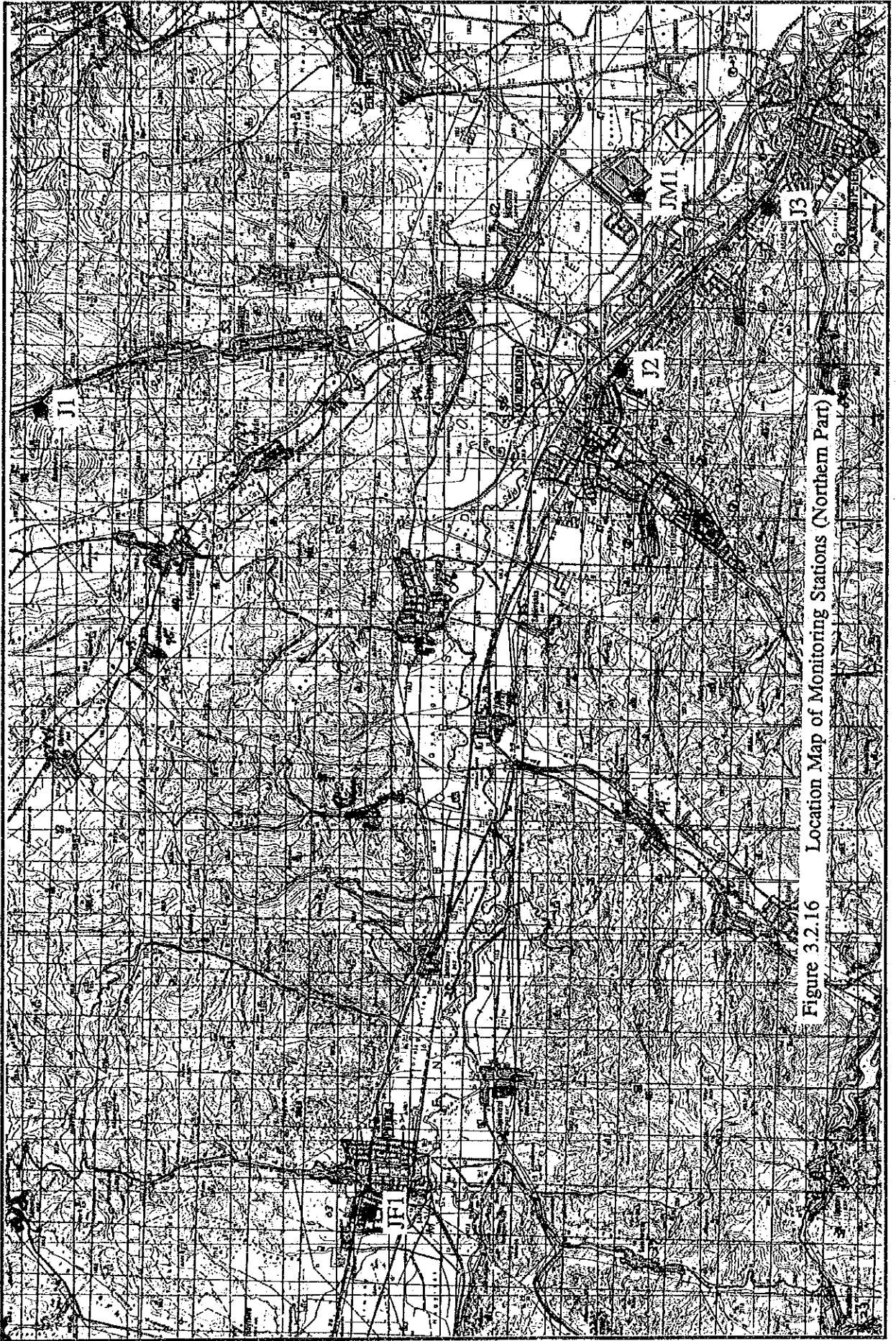


Figure 3.2.16 Location Map of Monitoring Stations (Northern Part)