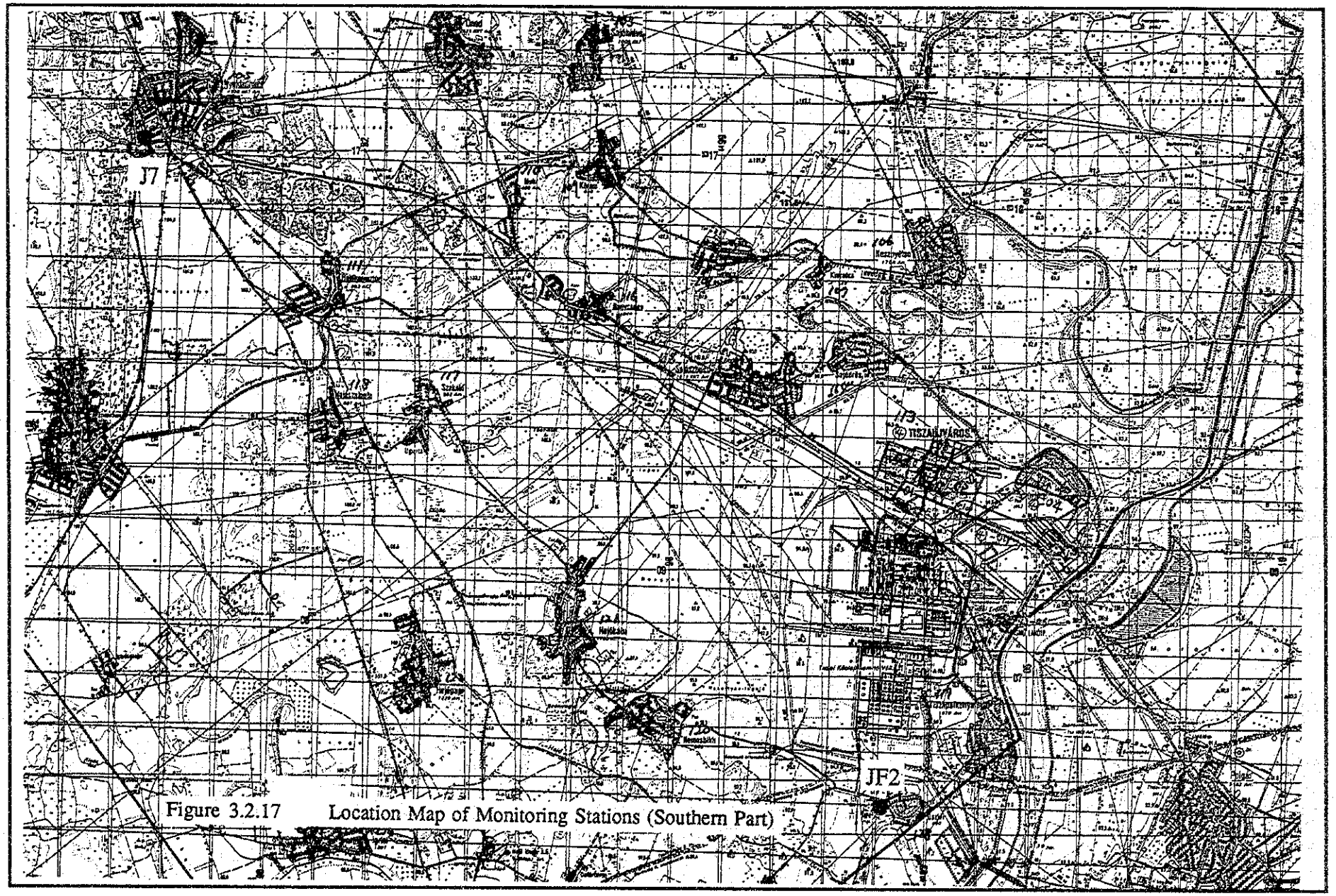
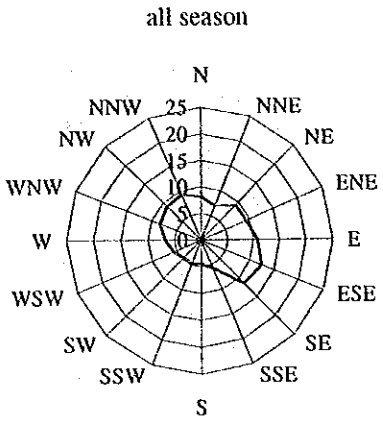
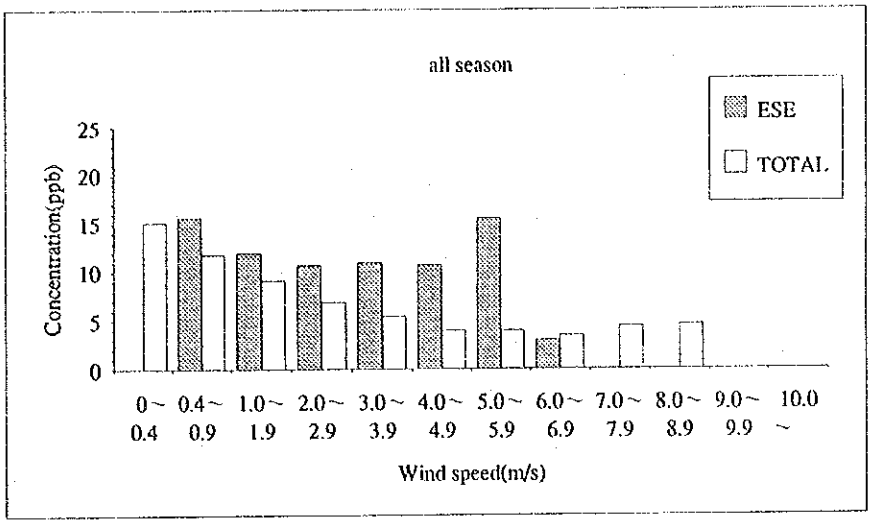
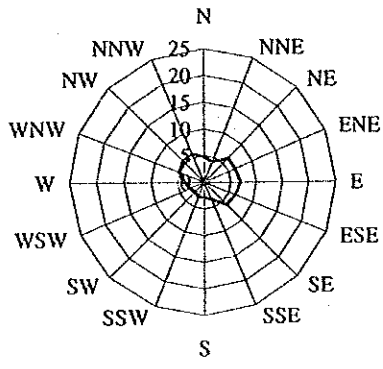
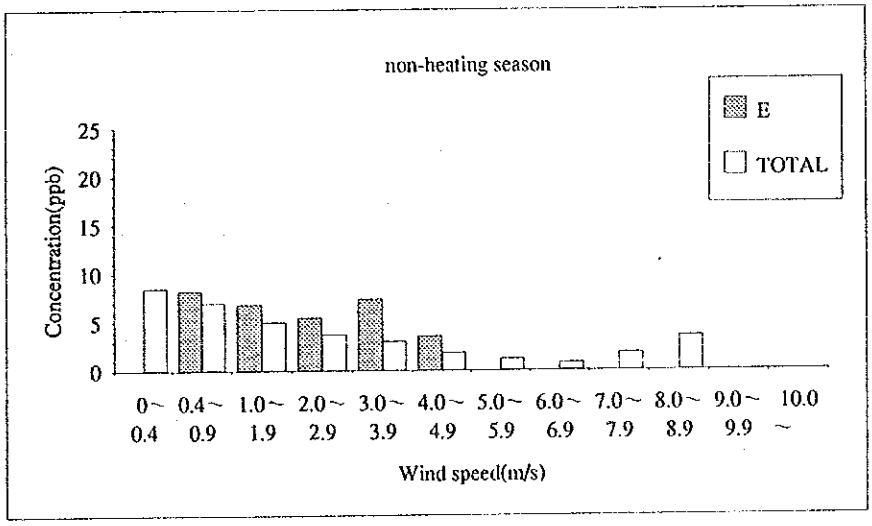


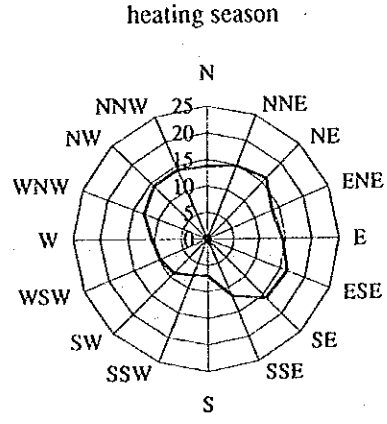
Figure 3.2.17 Location Map of Monitoring Stations (Southern Part)











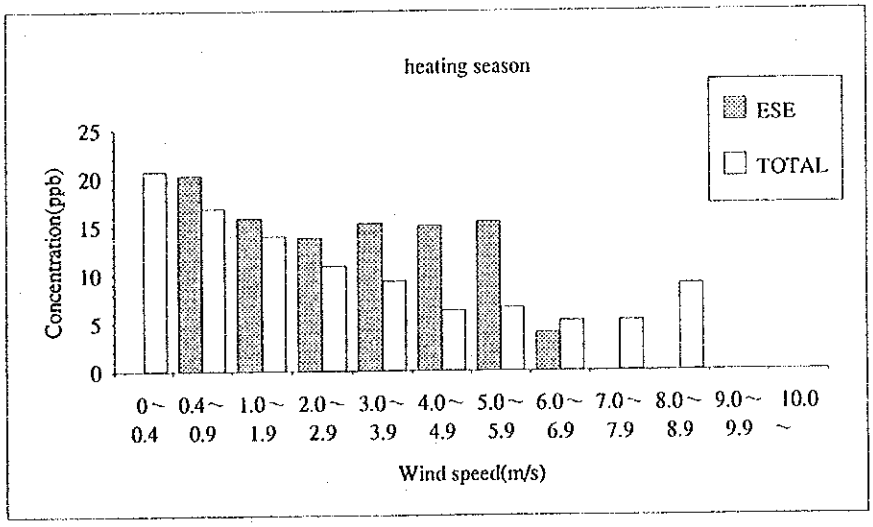
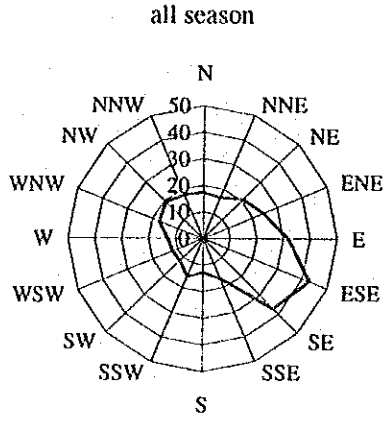
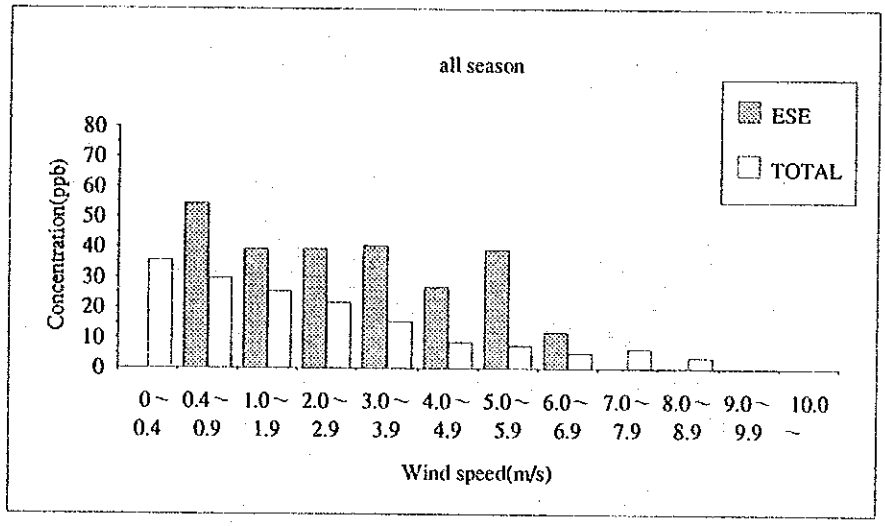
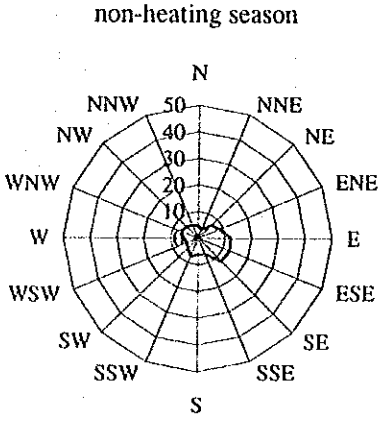


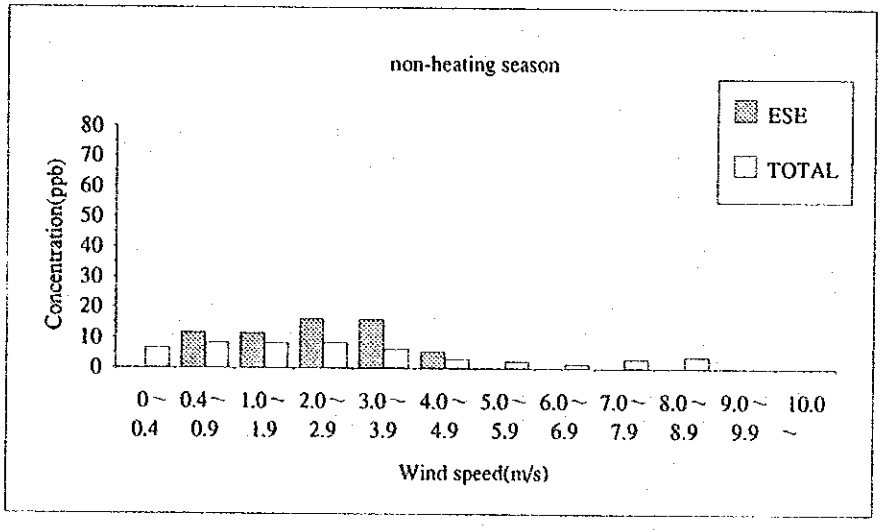
Figure 3.2.18 (1) Mean Concentration of NO_x by Wind Direction (JF1)

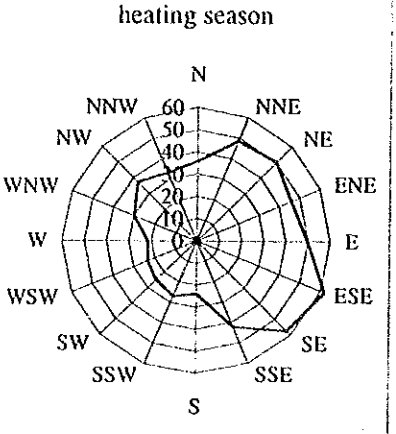
Figure 3.2.18 (2) Mean Concentration of NOx by Wind Speed (JF1)











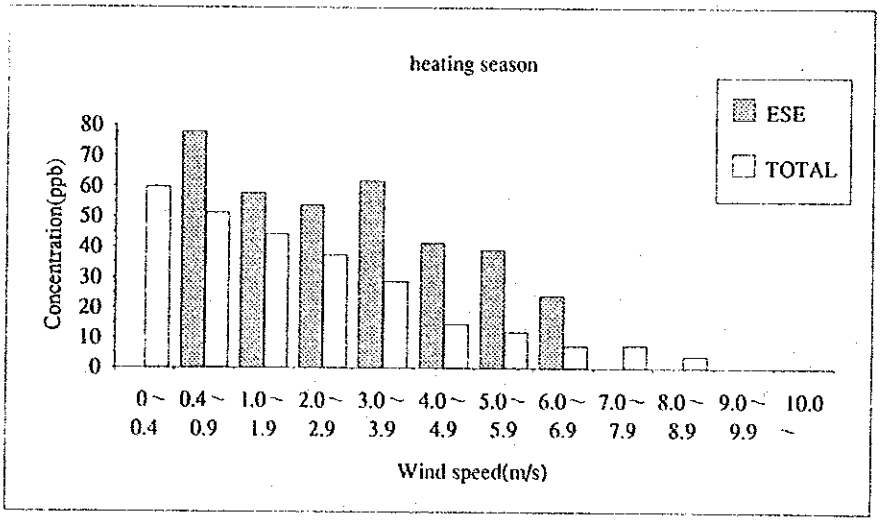


Figure 3.2.19 (1) Mean Concentration of SO_2 by Wind Direction (JF1)

Figure 3.2.19 (2) Mean Concentration of SO_2 by Wind Speed (JF1)

2) Station J2 (Figure 3.2.20 for NO_x and Figure 3.2.21 for SO_2)

This station is located in the industrial area in the northern part, and the NO_x concentration is highest here.

NO_x:

During the non-heating season, the NO_x concentration distribution by wind directions is almost uniform except the west winds. The concentration is generally higher when the winds are from the SE to SSE (the directions where the industrial complex is located). During the heating season, in addition to above tendency, the concentration becomes higher when the winds are from the SW to WSW.

According to the NO_x concentration by wind speed classes, the concentration averaged over all wind directions in the year decreases as the wind speed increases. The high concentration that appears under the SSE wind decreases according to the increase of wind speed up to 7 m/s. But, the concentration increases when the wind speed increases from 7 m/s to 9 m/s.

During the non-heating season, the high NO_x concentration that appears under the SE wind does not decrease according to the increase of wind speed up to 9 m/s. The reason for this is considered to be that the concentration is affected not only by low elevation pollutant sources, such as automobiles, but also by the stationary pollutant sources in the nearby industrial area.

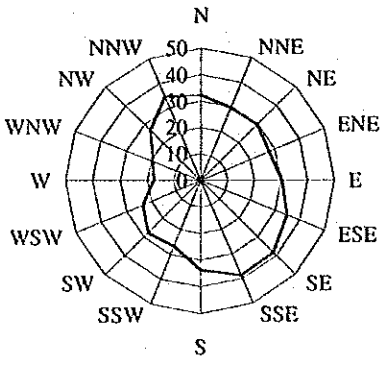
SO_2:

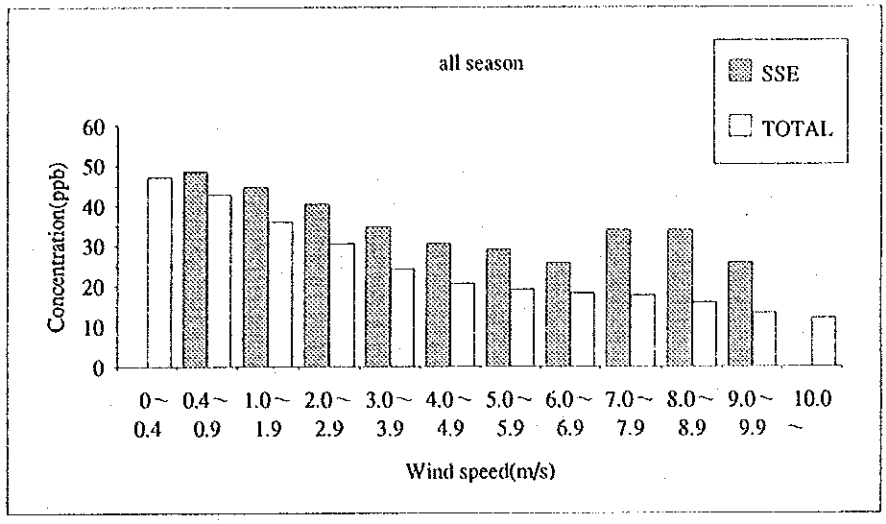
The variations of the SO_2 concentration by wind directions are greater than that of the NO_2 concentration. High SO_2 concentrations appear under SSE to SE winds. This tendency is outstanding during the non-heating season. Unlike the NO_x concentration, the SO_2 concentration is very low when winds are from W to N directions.

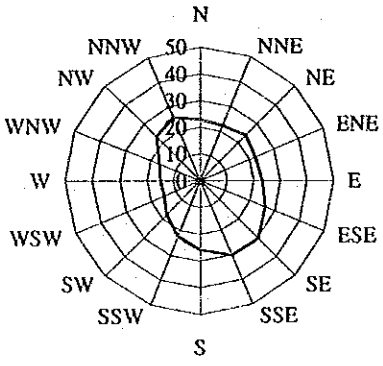
The tendency of the SO_2 concentration by wind direction during the heating season is quite different from the that during the non-heating season. It somewhat resembles the pattern of NO_x concentration. The SO_2 concentration during the heating season is high when winds are from the SE, NE and NNW directions which causes low SO_2 concentration during the non-heating season.

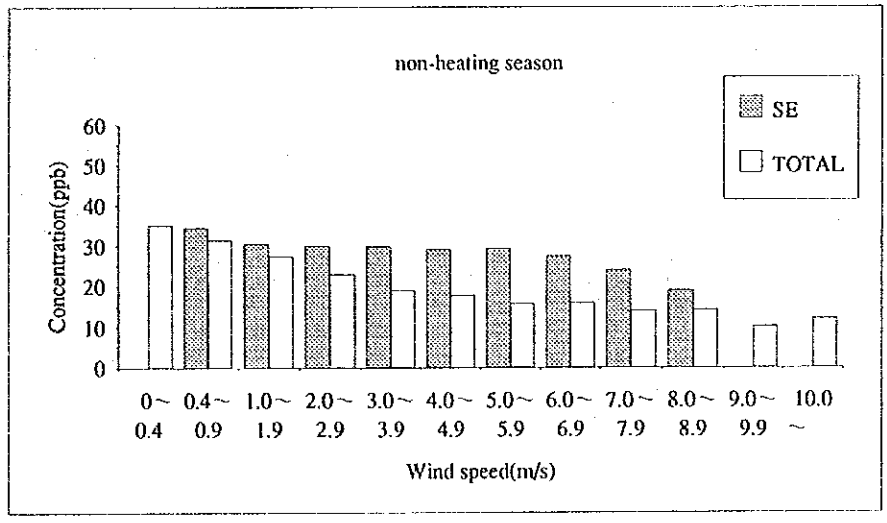
During the non-heating season, the SO_2 concentration is high under SSE winds in a wide range of wind speed: 2.0 to 9.0 m/s. Thus, it is thought that a small number of tall smokestacks (probably those in the Borsod Thermal Power Station) affect the concentration.

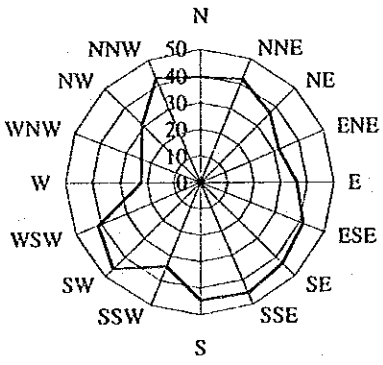
During the heating season, the high SO_2 concentration under the SW winds decreases drastically as the wind speed increases. It is believed that nearby low elevation pollutant sources, such as house heating, attribute to this tendency.











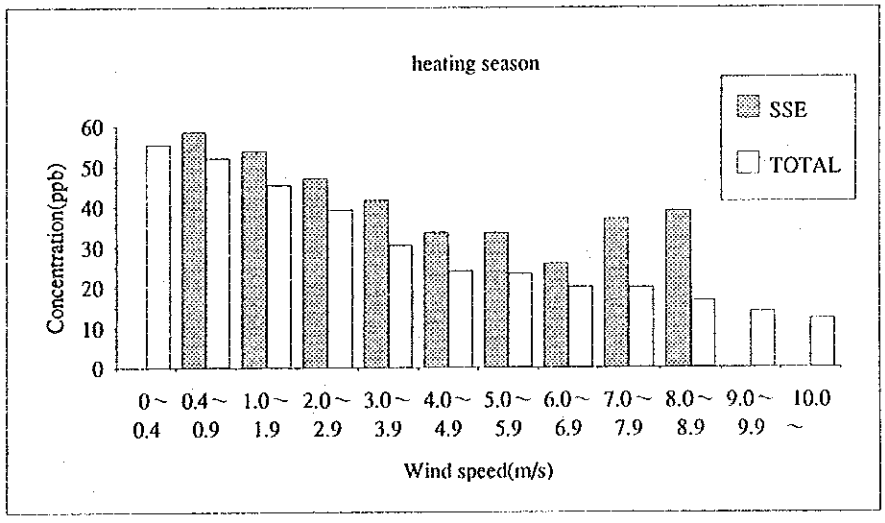
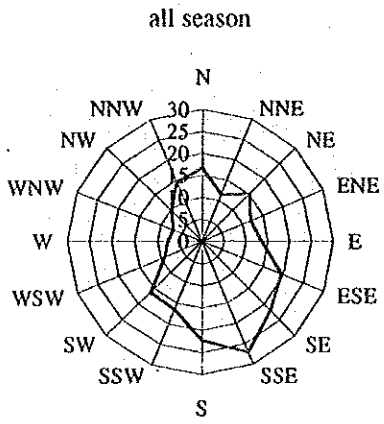
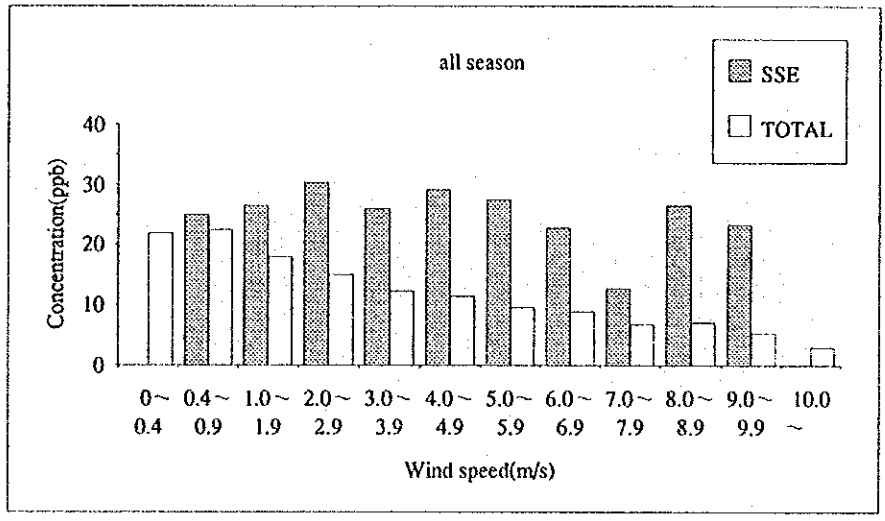
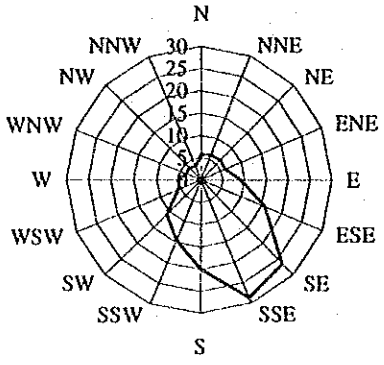


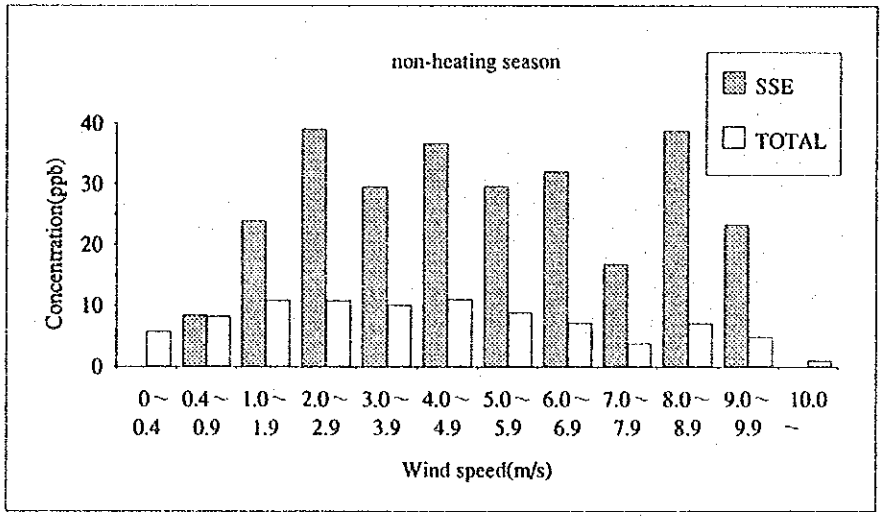
Figure 3.2.20 (1) Mean Concentration of NO_x by Wind Direction (J2)

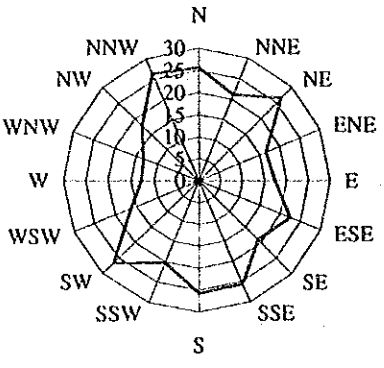
Figure 3.2.20 (2) Mean Concentration of NO_x by Wind Speed (J2)











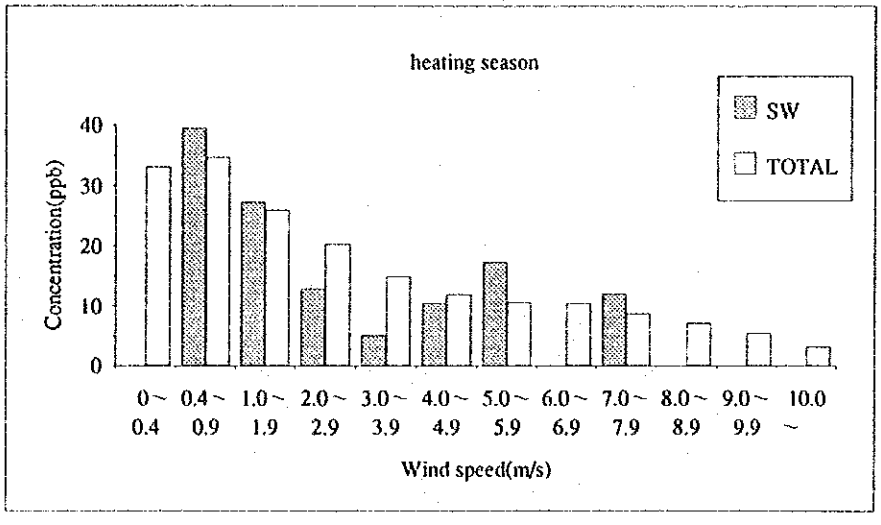


Figure 3.2.21 (1) Mean Concentration of SO_2 by Wind Direction (J2)

Figure 3.2.21 (2) Mean Concentration of SO_2 by Wind Speed (J2)

3) Station J3 (Figure 3.2.22 for NO_x and Figure 3.2.23 for SO_2)

This station is located in the northern industrial area and is about 1 km from the Borsod Thermal Power Station to the direction of SSE.

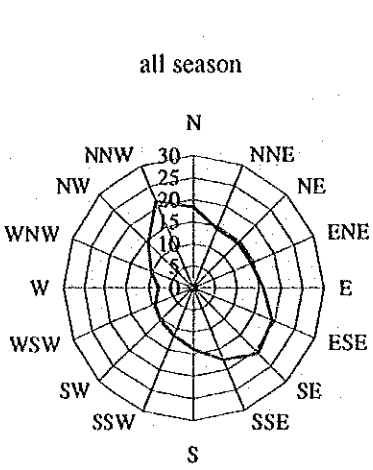
NO_x:

The average NO_x concentration is higher when the direction of the wind is from the NNW to SE during both the heating and non-heating seasons.

The the NNW winds which brings about the high NO_x concentration, effects of increase of wind speed is small on decreasing the NO_x concentration. As the NO_x concentration reaches a maximum level when the wind speed ranges from 2.0 to 2.9 m/s during the heating season, medium to high elevation pollution sources are thought to affect the concentration.

SO_2:

Compared to the NO_x concentration, the SO_2 concentration varies greatly during both the heating and non-heating seasons. The Borsod Thermal Power Station is situated approximately 1 km NNW of the monitoring station. Due to this short distance, SO_2 concentration is not affected by specific wind directions, unlike Stations J2 and JF2 which are affected. During the heating season, high concentrations appear when winds are from ESE to S directions where houses are present. The concentration appearance tendency, such as a drastic concentration decrease according to an increase of wind speed, shows the characteristics of low elevation pollution sources.



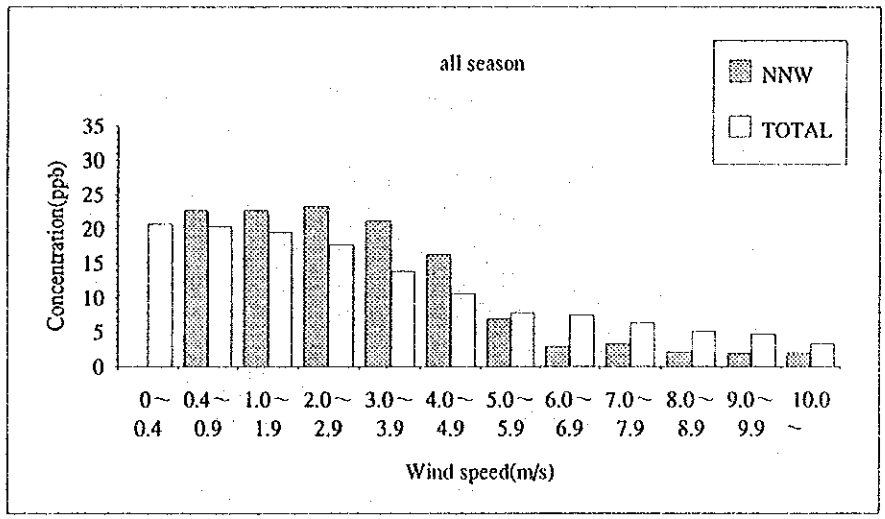
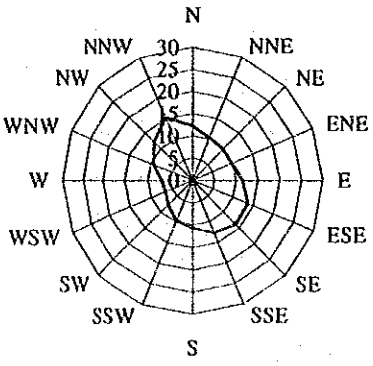
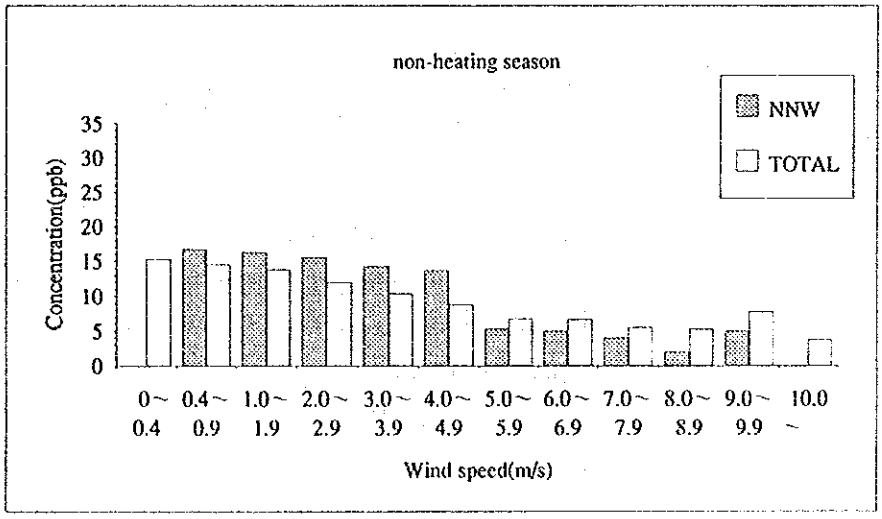
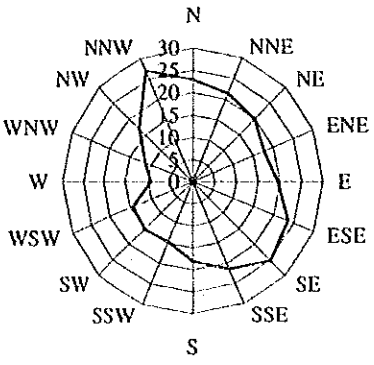


Figure 3.2.22 (1) Mean Concentration of NO_x by Wind Direction (J3)







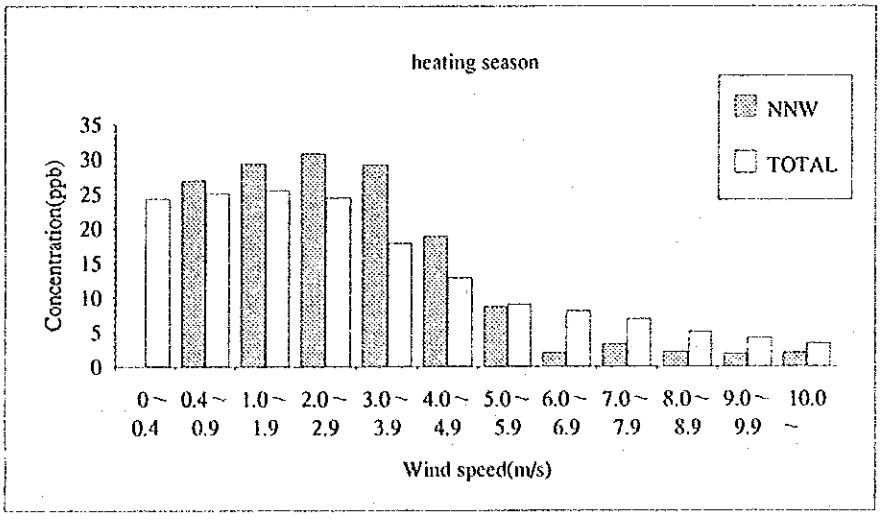
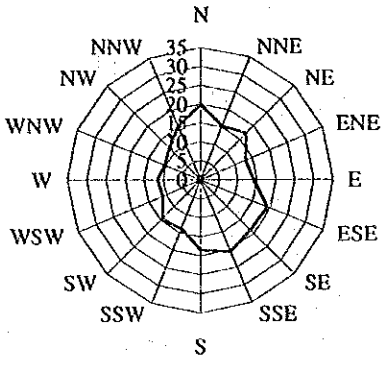
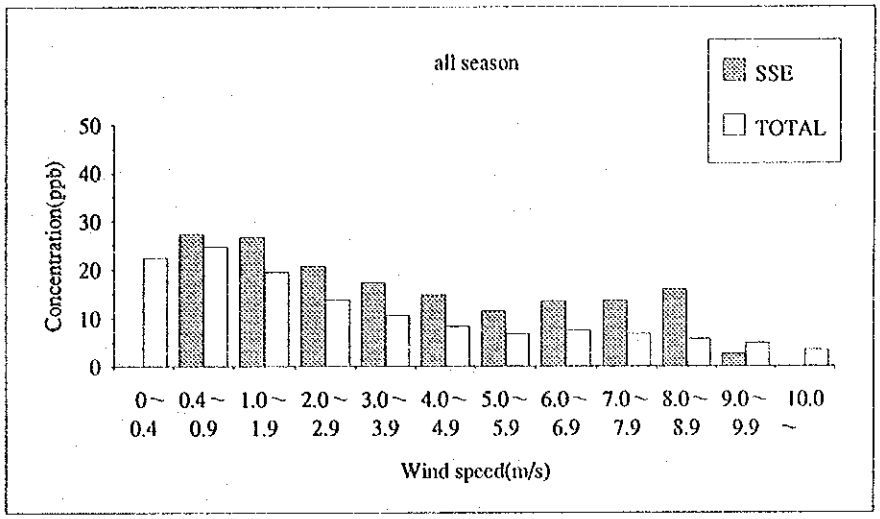
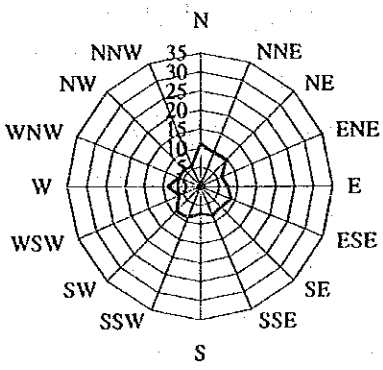
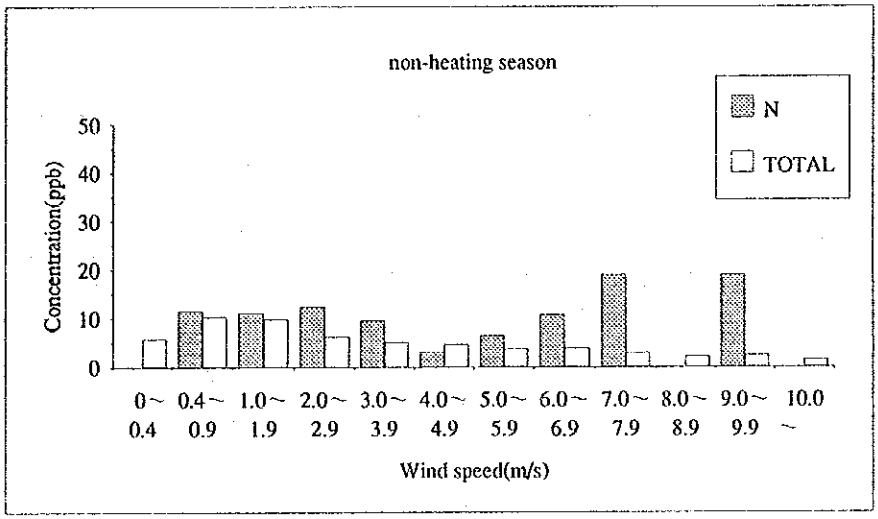


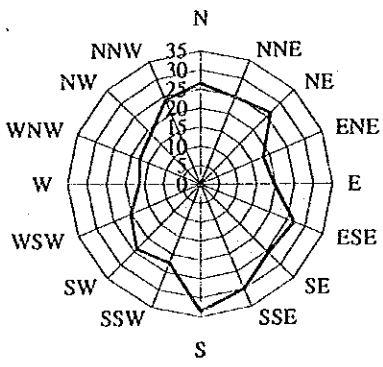
Figure 3.2.22 (2) Mean Concentration of NO_x by Wind Speed (J3)











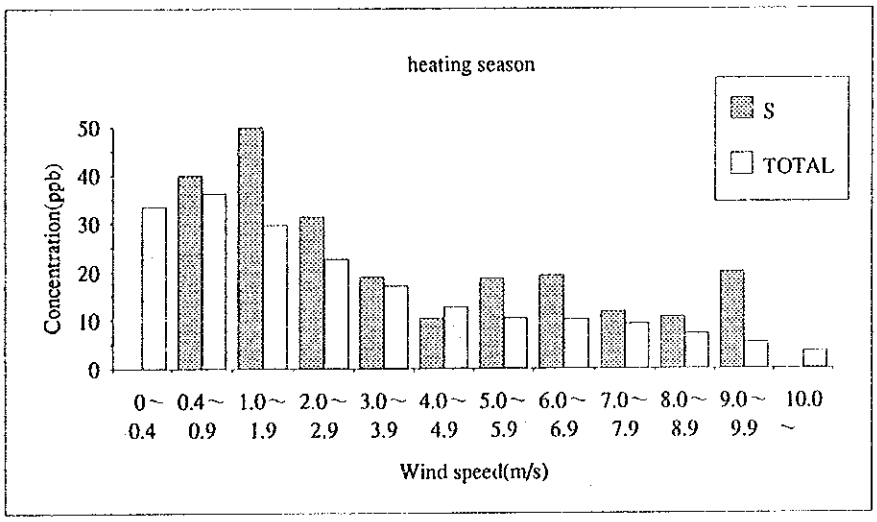


Figure 3.2.23 (1) Mean Concentration of SO_2 by Wind Direction (J3)

Figure 3.2.23 (2) Mean Concentration of SO_2 by Wind Speed (J3)

4) Station JF2 (Figure 3.2.24 for NO_x and Figure 3.2.25 for SO_2)

There is an oil refinery and petrochemical industry complex at 2 to 4 km north of the station and the Tisza I Thermal Power Station at 4 km NNE of the station.

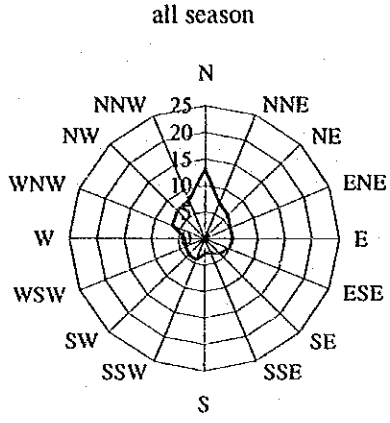
NO_x:

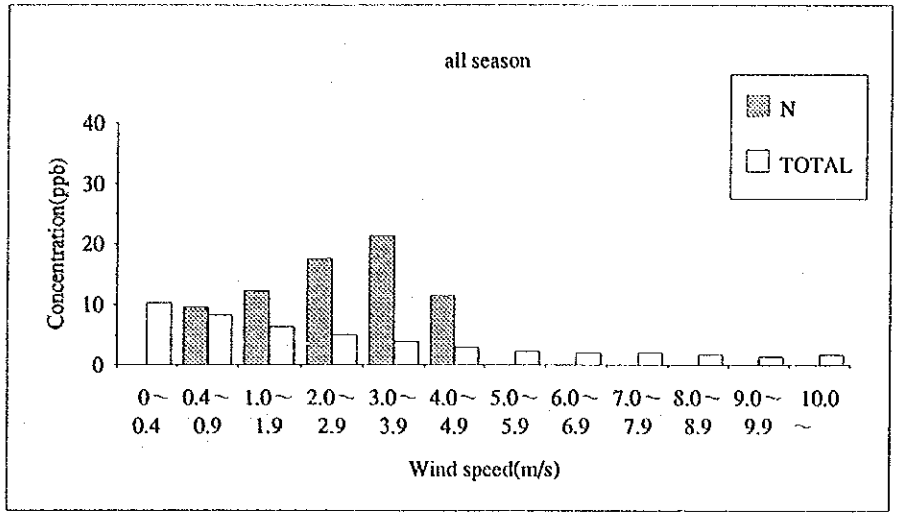
The NO_x concentration is high when winds are from the north during both the heating and non-heating seasons. During the heating season particularly, the concentration increases as the wind speed increases up to 5.0 m/s. It is evident that the oil refinery and the petrochemical industry complex and the thermal power plant are responsible for this tendency.

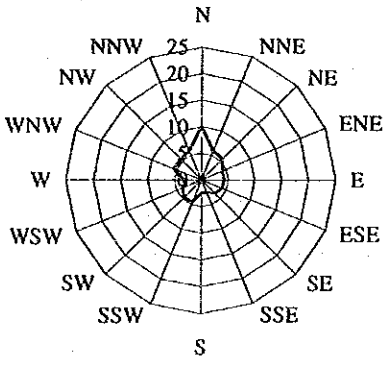
SO_2:

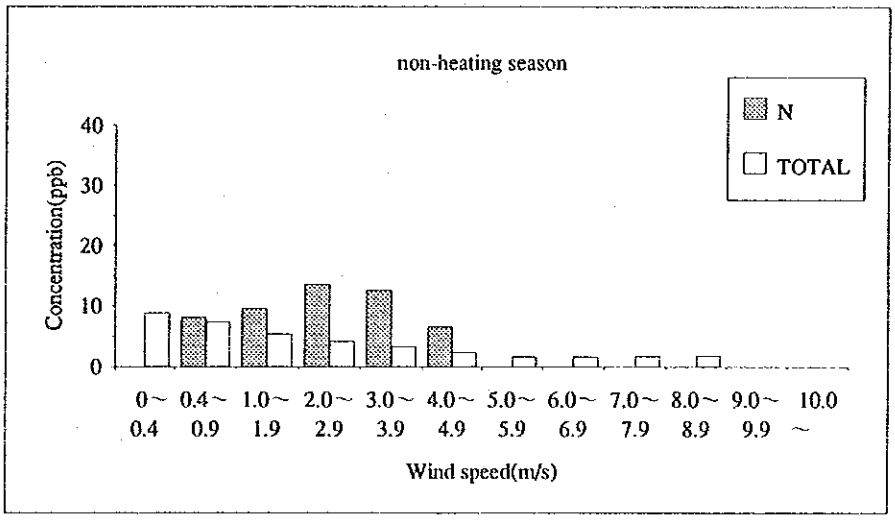
Abnormally high SO_2 concentrations appear, during the non-heating season, under NE winds with the speeds of 2.0 to 5.0 m/s.

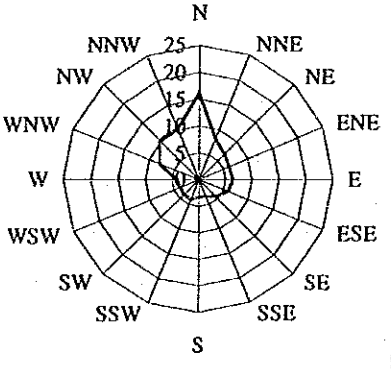
During the heating season, high concentrations appear when the wind direction is NNE to E and WNW to NW. Also, the concentration decreases as the wind speed increases. These phenomena are considered to be brought about as follows : 1) since the atmospheric conditions become unstable during the non-heating season, the SO_2 released by the Tisza I Power Station reaches the monitoring station thereby causing high SO_2 concentrations, 2) during the heating season, the atmospheric conditions become stable and the effects from the Tisza I Power Station become negligible, but house heating in the nearby housing area (located to the east of the monitoring station) greatly affects the concentrations.











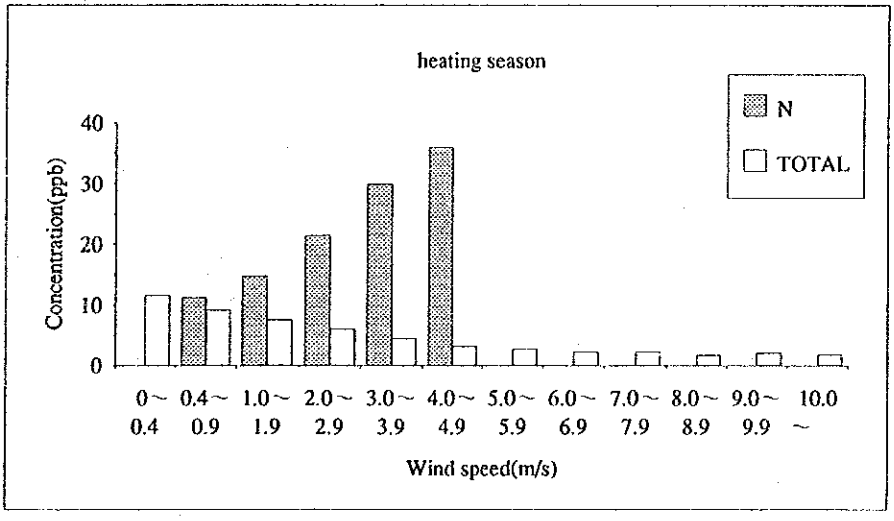
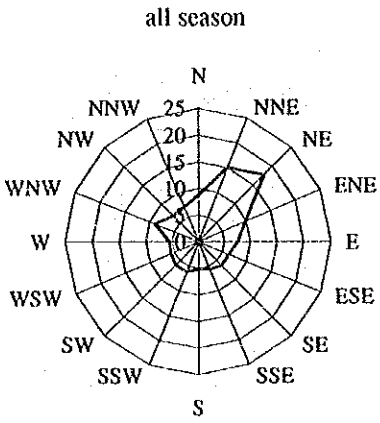
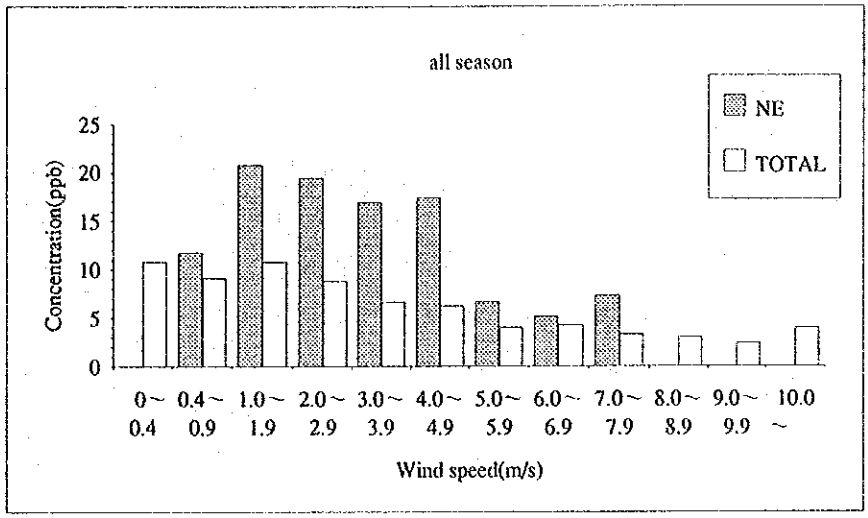
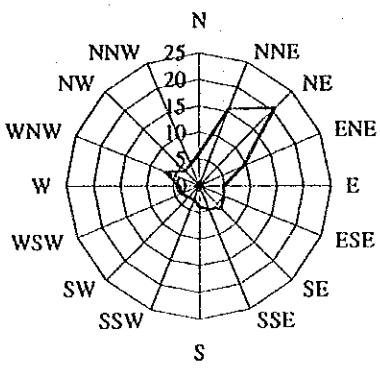


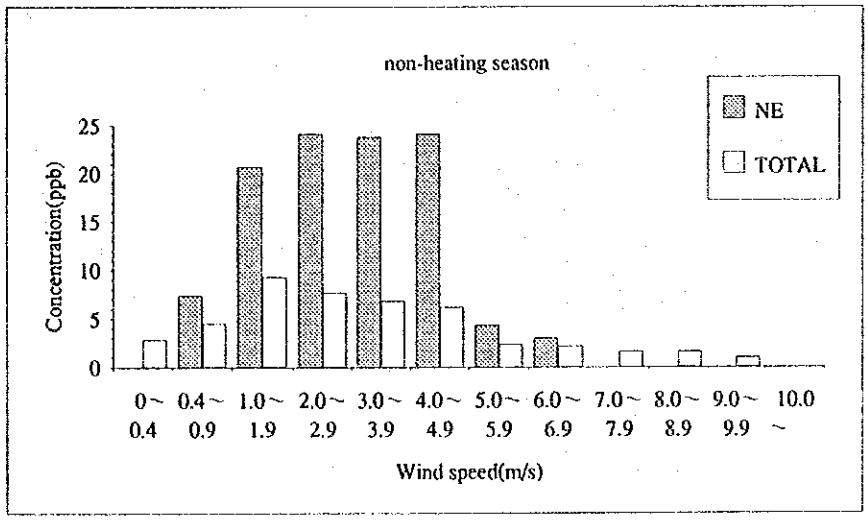
Figure 3.2.24 (1) Mean Concentration of NO_x by Wind Direction (JF2)

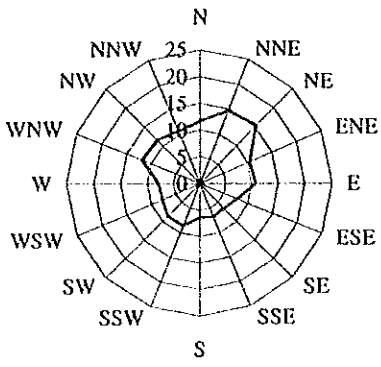
Figure 3.2.24 (2) Mean Concentration of NO_x by Wind Speed (JF2)











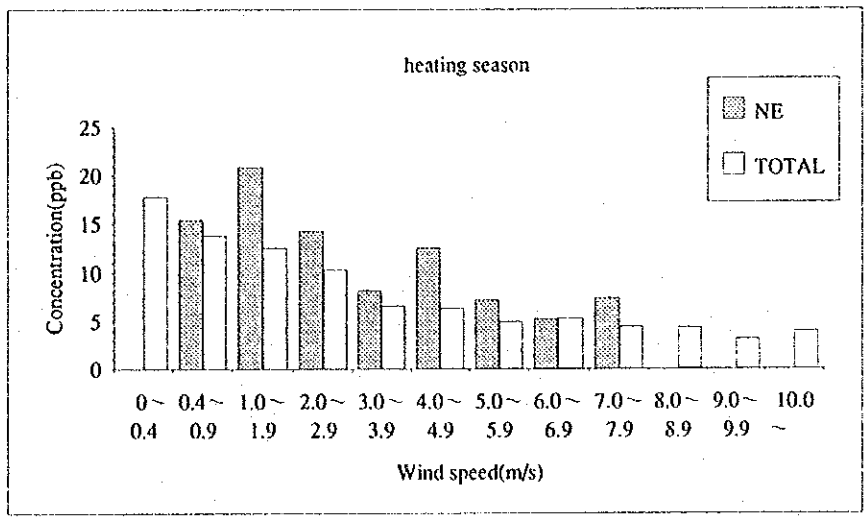


Figure 3.2.25 (1) Mean Concentration of SO_2 by Wind Direction (JF2)

Figure 3.2.25 (2) Mean Concentration of SO_2 by Wind Speed (JF2)

5) Station J7 (Figure 3.2.26 for NO_x and Figure 3.2.27 for SO_2)

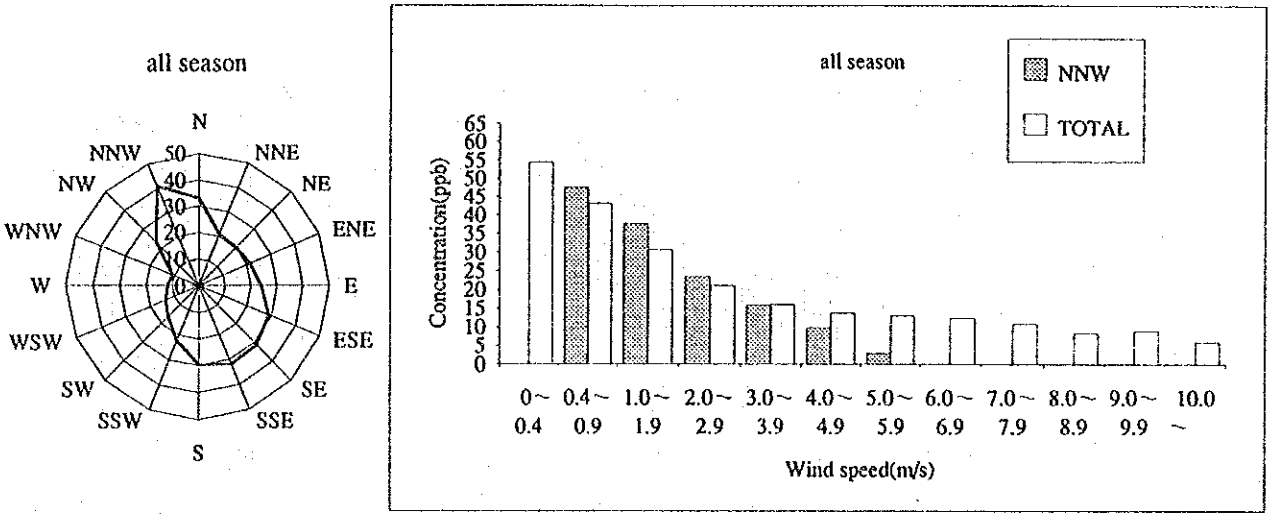
This monitoring station is located to the northeast of the junction of two national roads where Route No.3 runs in a north-south direction and Route 35 runs in an east-west direction. The station recorded the second highest NO_x concentration after Station J2.

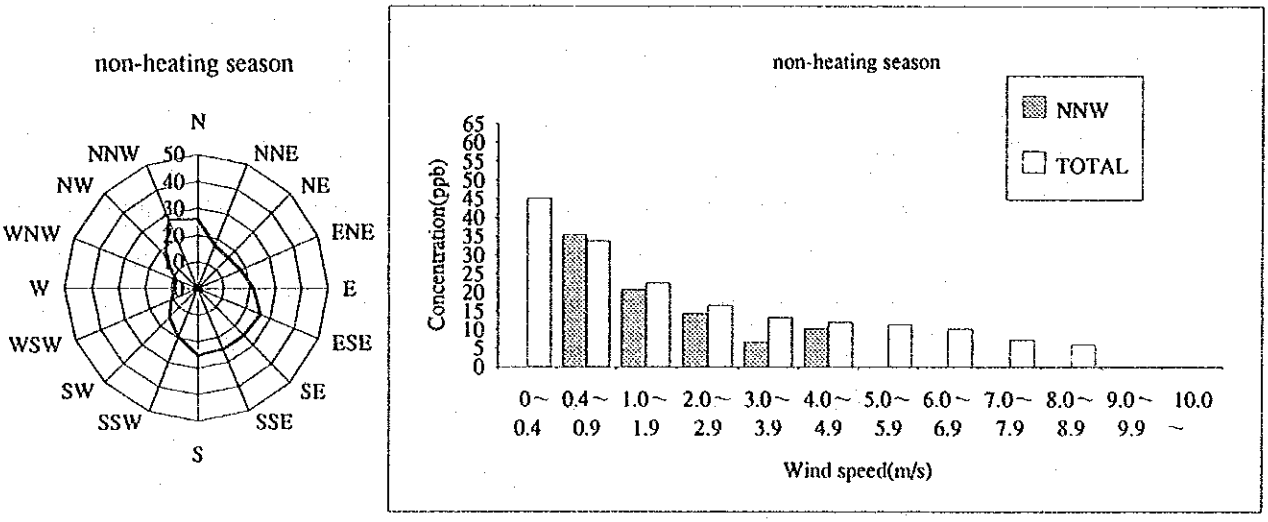
NO_x:

The NO_x concentration is higher when the wind is from the NNW and ESE to SSE directions during the heating and non-heating seasons. The highest concentration occurs under the CALM wind condition. The concentration decreases as the wind speed increases. These tendencies are the characteristics of low elevation pollutant sources, and the effect of automobiles in the nearby major roads is evident.

SO_2:

The SO_2 concentration difference between the heating and non-heating season is large. During the heating season a high concentration appears when the wind is from the NNW to SSE directions which corresponds to the directions of the housing areas. The effect of house heating is obvious. During the non-heating season, the SO_2 concentration is low and only slightly affected by the wind direction. A somewhat higher concentration appears when the wind is from the E to SE directions which is the direction of the oil refinery and petrochemical industry complex and the Tisza Thermal Power Station. When the speed of the SE wind is 4.0 to 4.9 m/s, an extraordinarily high concentration appears. It indicates the effects of specific pollutant sources.





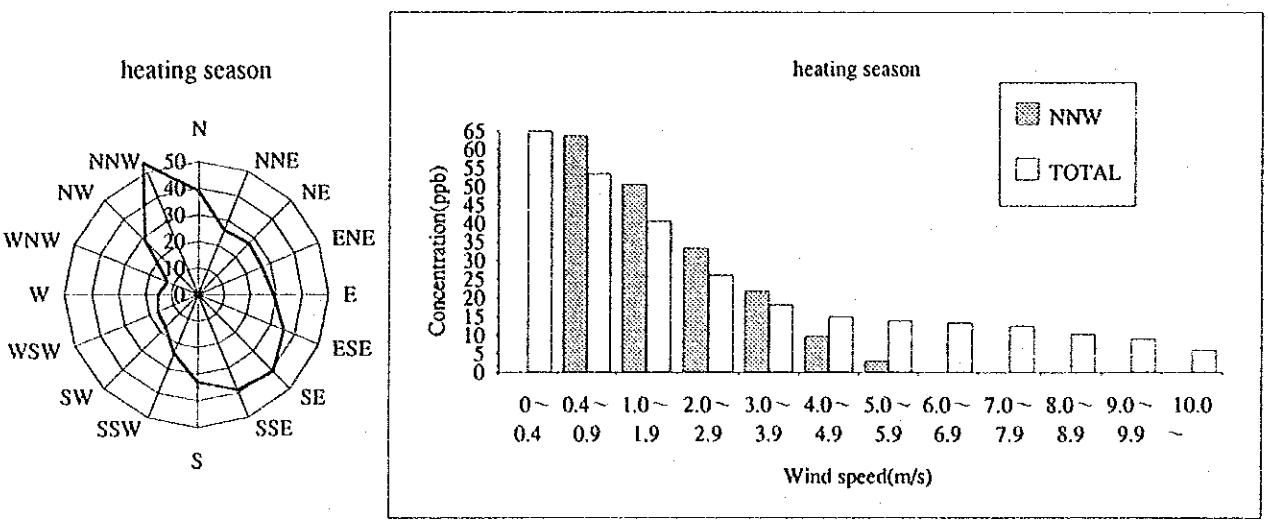
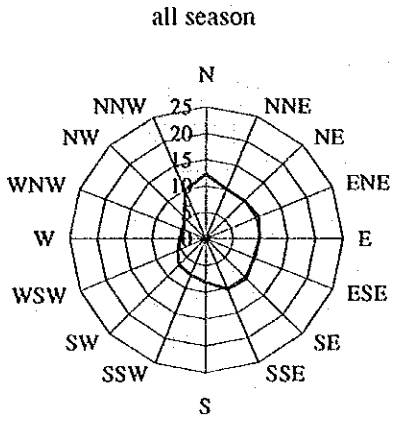


Figure 3.2.26 (1) Mean Concentration of NO_x by Wind Direction (J7)

Figure 3.2.26 (2) Mean Concentration of NO_x by Wind Speed (J7)



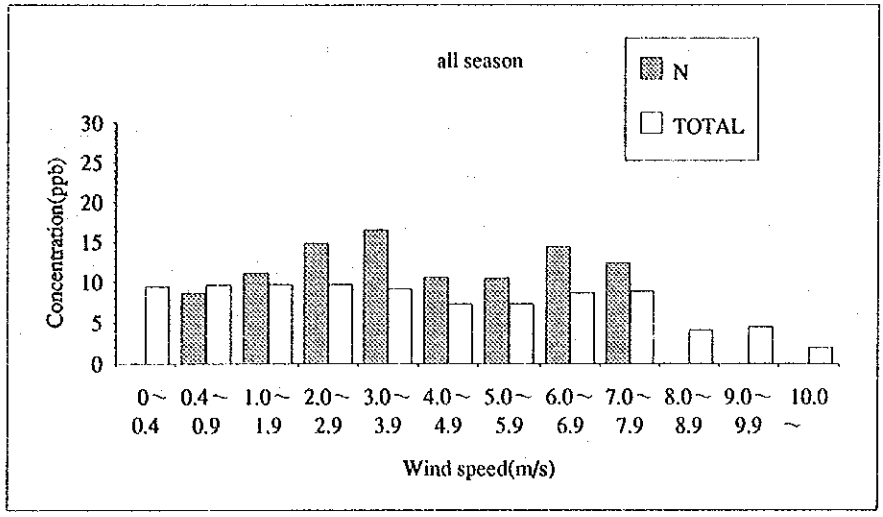
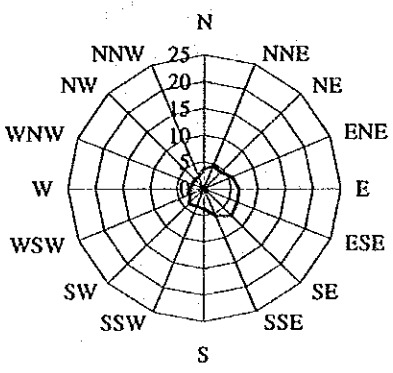
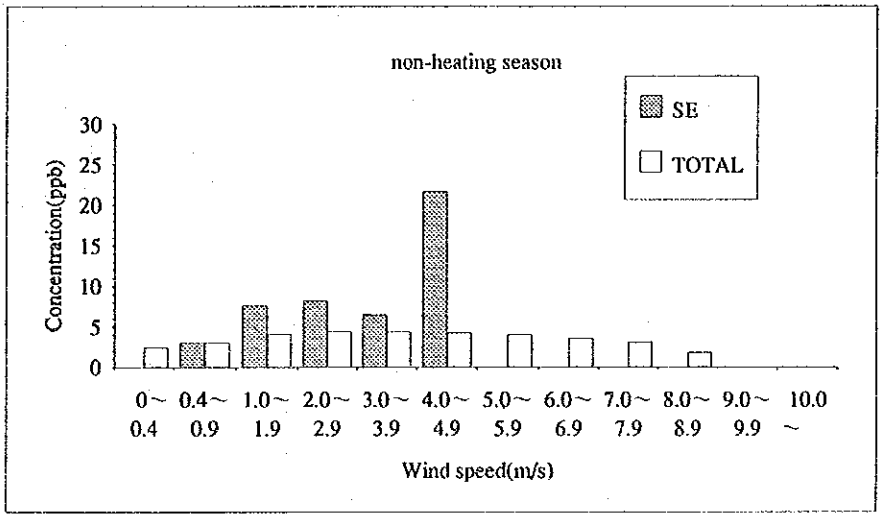
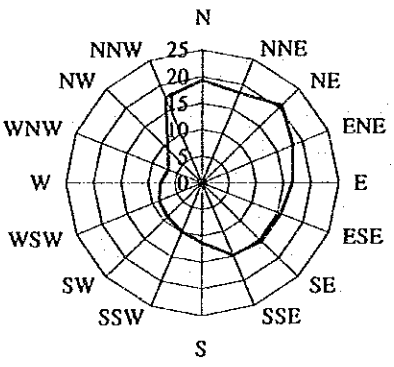


Figure 3.2.27 (1) Mean Concentration of SO_2 by Wind Direction (J7)







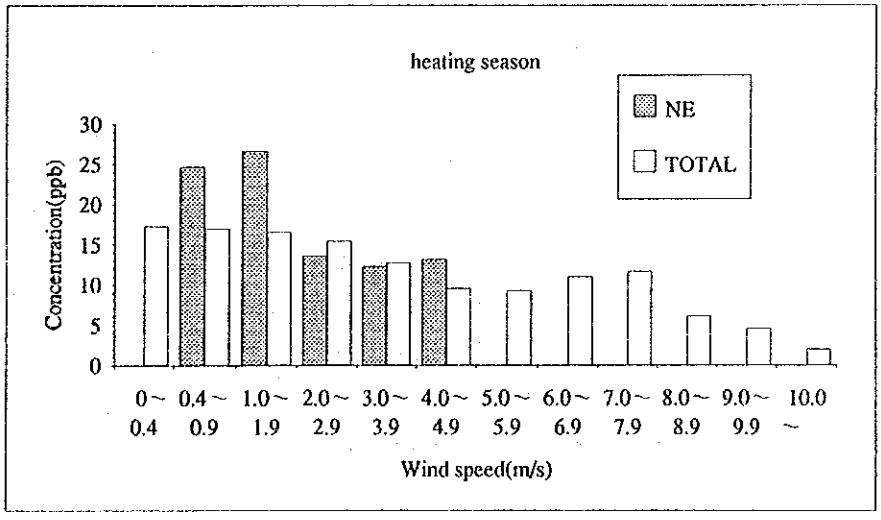


Figure 3.2.27 (2) Mean Concentration of SO_2 by Wind Speed (J7)

(2) Cumulative Appearance Frequencies of Concentration Levels by Wind Directions

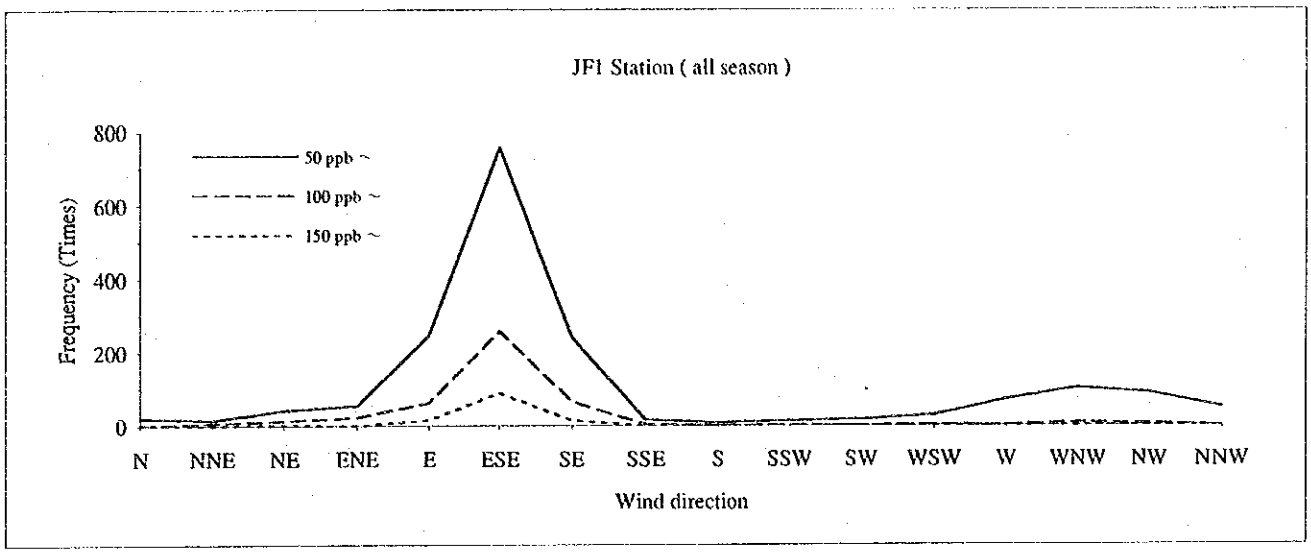
The annual average SO_2 concentration exceeded the ambient air quality standard only at Station JF1. However, as explained earlier, the variation of the SO_2 concentration was very large. High 30 minutes values in the range of 0.4 to 0.5 ppm sporadically appeared. Such variations characterize the air pollution in the Study Area.

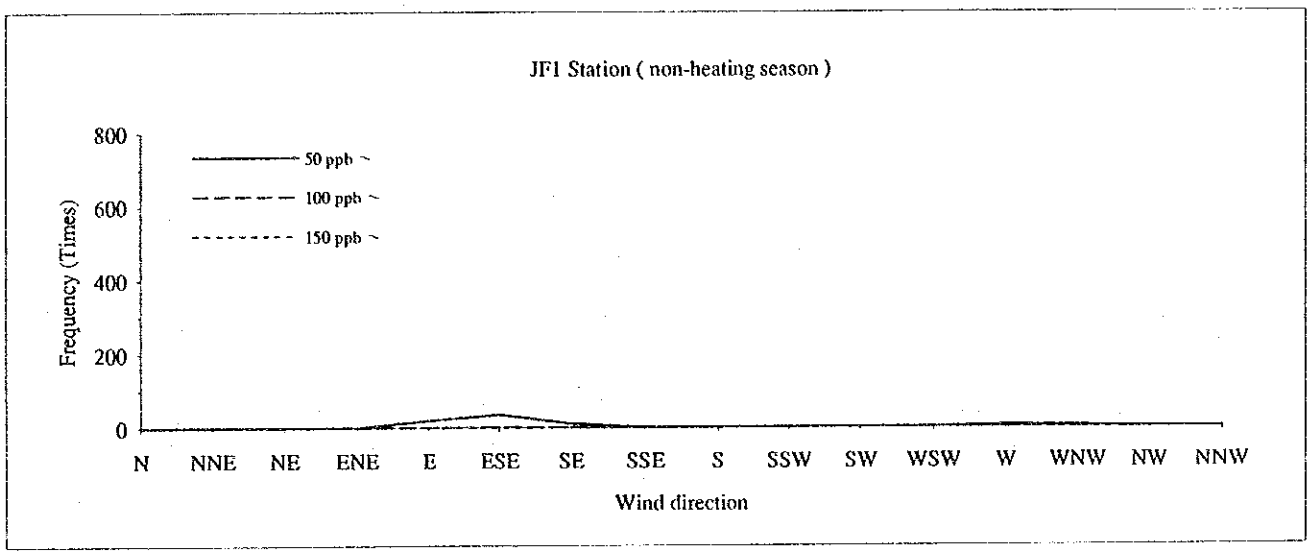
In order to understand the situations which caused such high SO_2 concentrations, an analysis was made on the cumulative appearance frequencies of 30 minutes concentration levels by wind directions for Stations JF1, J2, and JF2. The results are shown in Figures 3.2.28 through 3.2.30 and in Tables D3.2.14 through D3.2.16 in Data Book.

- Most of the high SO_2 concentrations at Station JF1 appeared during the heating season. During windy days higher concentrations were observed when the wind was from the ESE direction. However, the appearance frequency of high concentrations was highest under the CALM condition. Of the times the concentration exceeded the ambient air quality standard of 150 ppb in Protected Area II, the CALM condition occupied more than 50%. It should be mentioned also that the CALM condition appeared by 30.5% of the heating season period at this station.

- At Station J2, high concentrations were observed during both the heating and non-heating seasons. The high concentrations frequently appeared under CALM weather conditions during the heating seasons. However, when it was windy, high concentrations appeared more frequently during the non-heating season than during the heating season. The prevailing wind for high concentrations was from the SE to S centering on the SSE during the heating and non-heating seasons. It is believed that the high concentrations were caused by specific pollutant sources. During the heating season, the prevailing wind for high concentration was from the SE to S and from the NNW.

- Station JF2 is evidently affected by the Tisza I Thermal Power Station. High concentrations were observed when winds were from the direction of the power plant. The characteristic of the station is that high concentrations were observed more frequently during the non-heating season than during the heating season. As mentioned ealier, it is believed that the high concentrations are related to the distance from the station to the pollutant source and the meteorological conditions; in particular, the atmospheric stability.





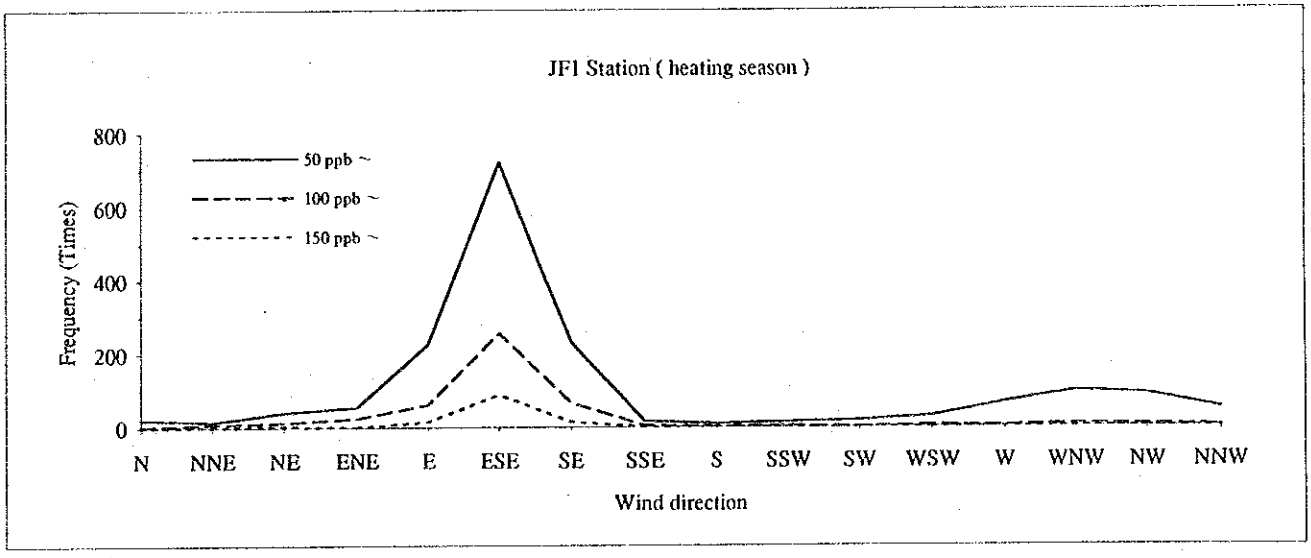
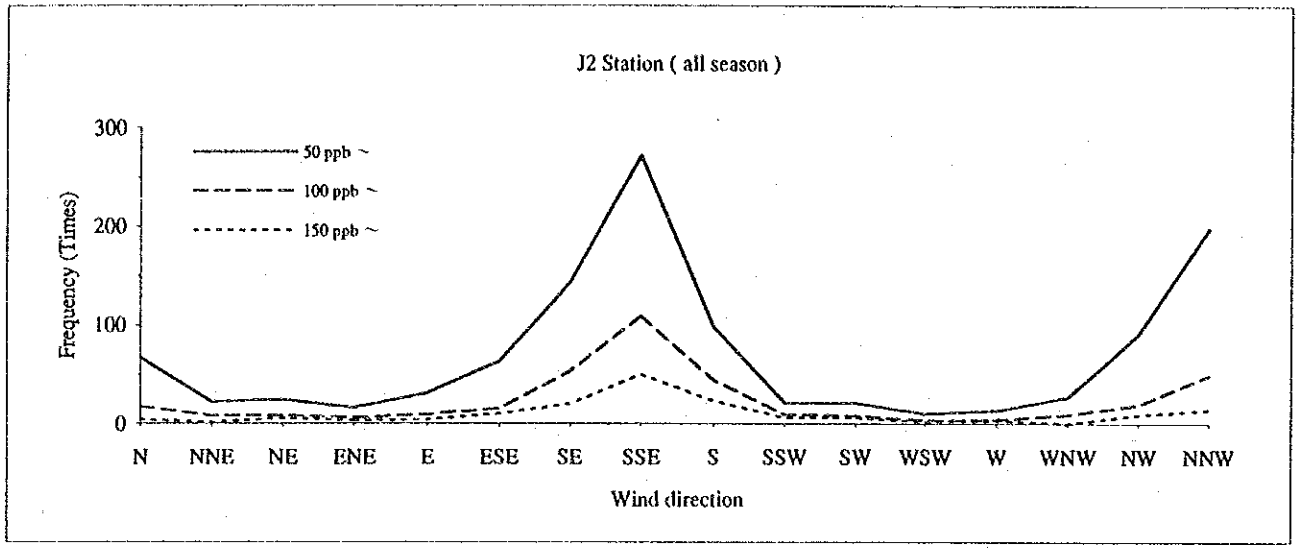
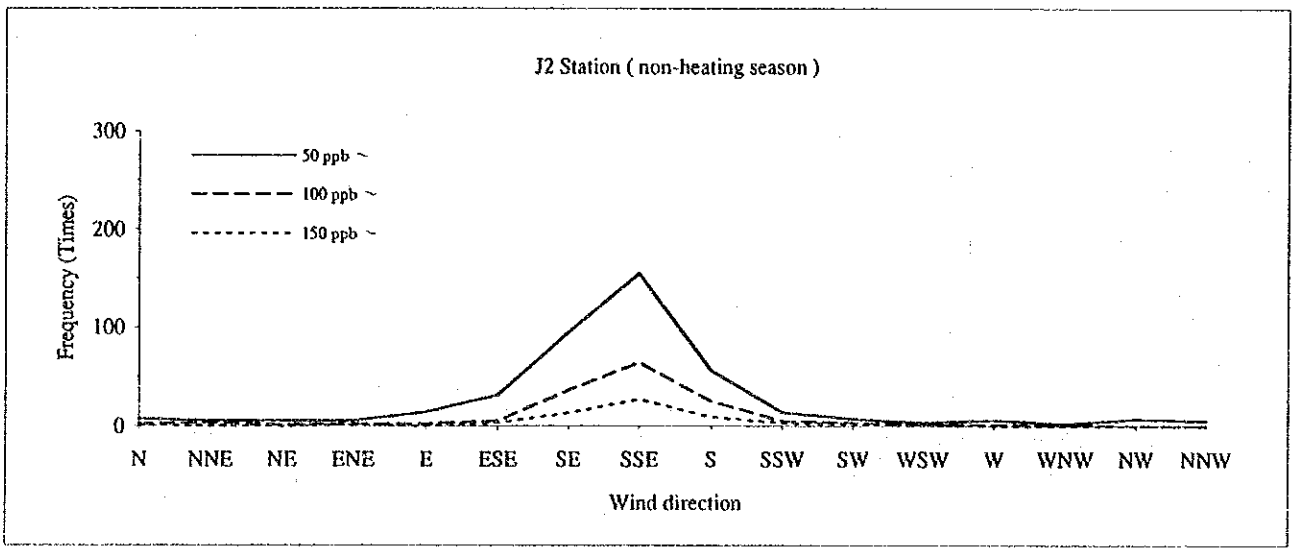


Figure 3.2.28 Cumulative Frequency of SO2 Concentration by Wind Direction (JF1)





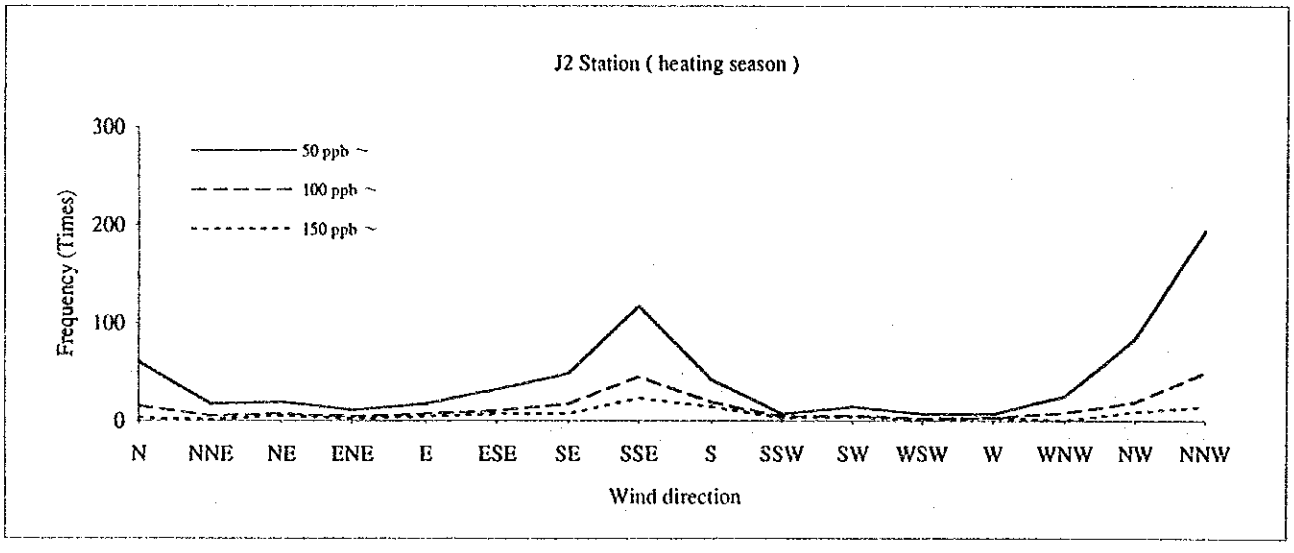
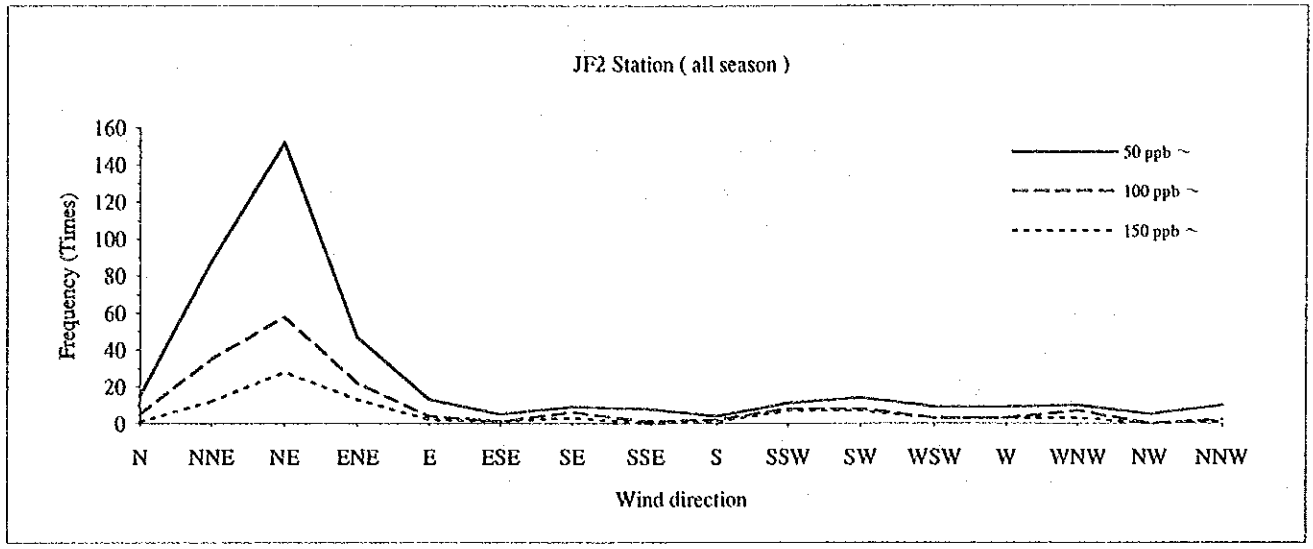
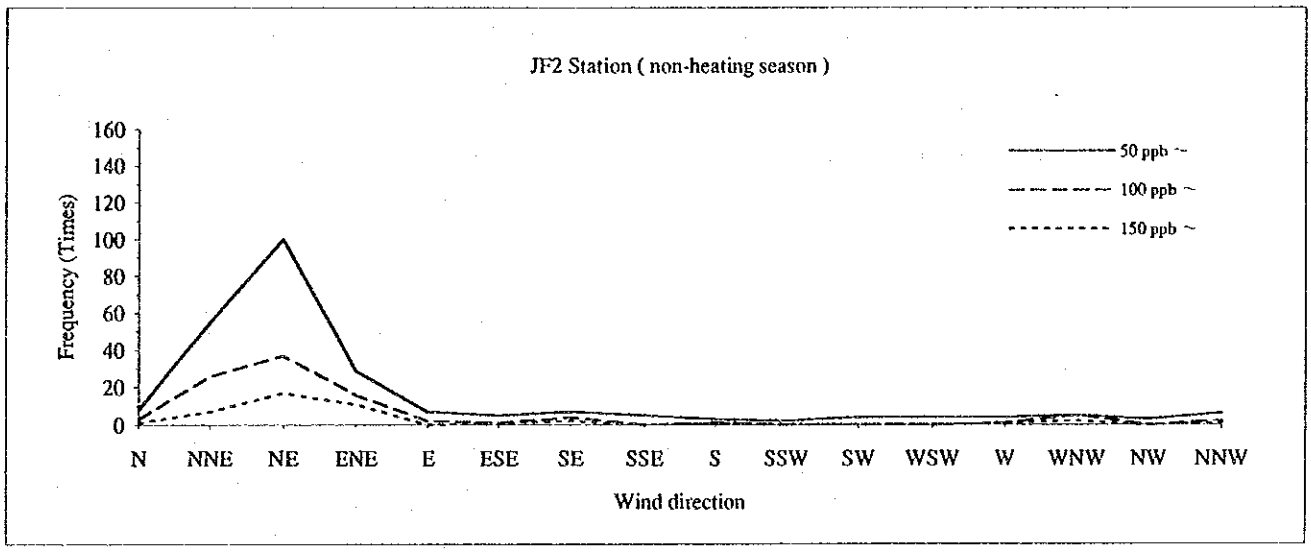


Figure 3.2.29 Cumulative Frequency of SO2 Concentration by Wind Direction (J2)





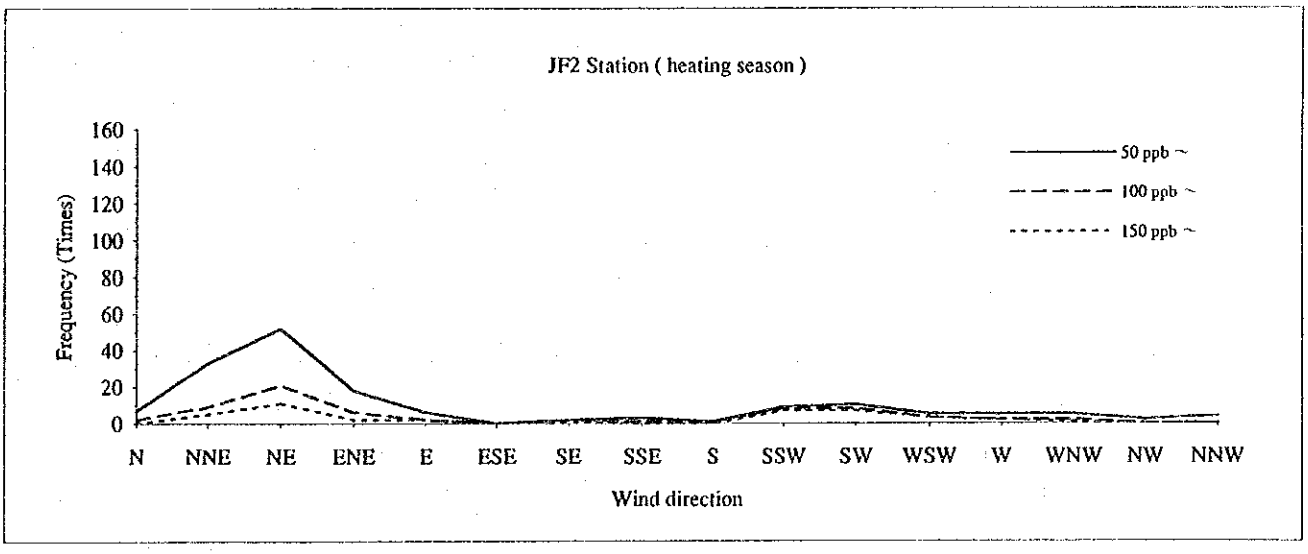


Figure 3.2.30 Cumulative Frequency of SO2 Concentration by Wind Direction (JF2)

During the heating season, high concentrations appeared also under the CALM condition and occasionally under the SSW to SW winds due to the effect of the surrounding housing area.

(3) Atmospheric Stability and Concentration

The relationships between the atmospheric stability and NO_x and SO_2 concentrations at Stations JF1, J2 and J3 in the northern part and Stations JF2 and J7 in the southern part are shown in Figures D3.2.54 through D3.2.63 in Data Book.

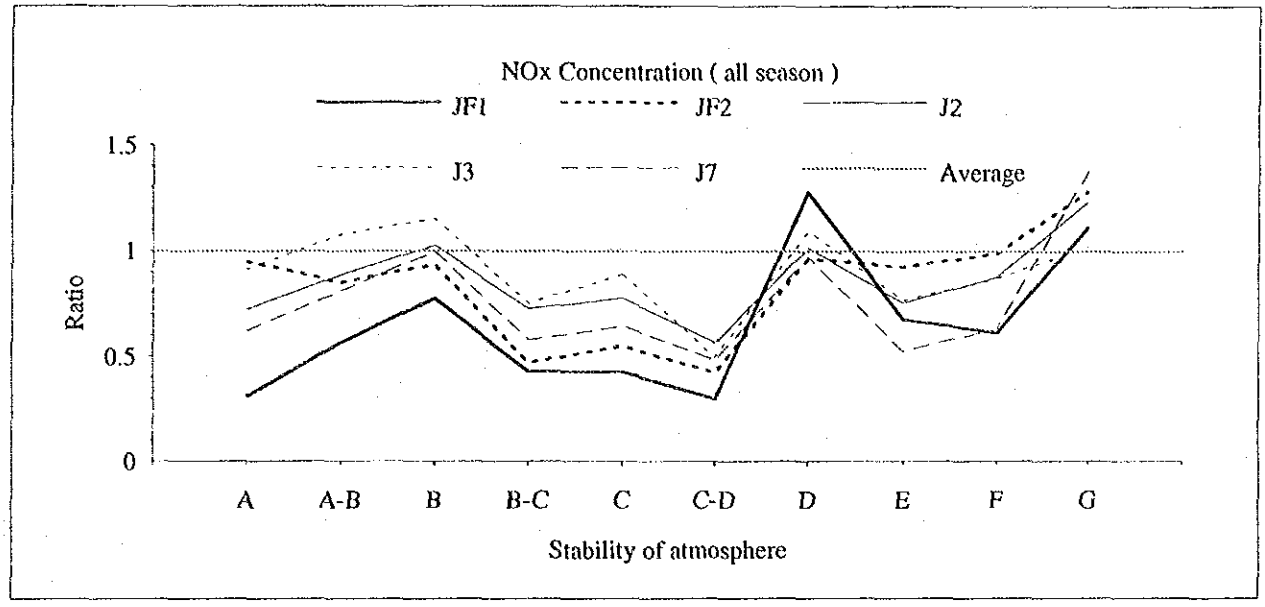
In order to compare concentration levels under different atmospheric stability classes, the concentration under each stability class was expressed by the ratio to the average concentration and is shown in Figures 3.2.31 (for NO_x) and 3.2.32 (for SO_2).

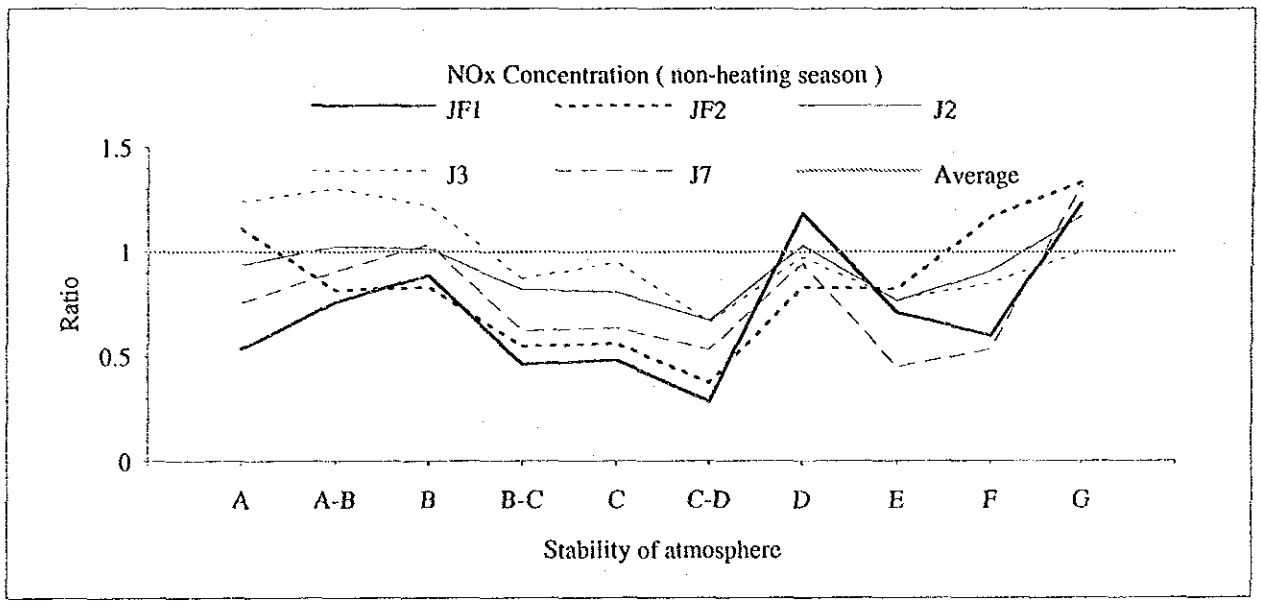
- The NO_x concentration was generally higher under the stability class G (extremely stable). Higher-than-average concentrations appeared also under class D (neutral) at Station JF1, and A-B and B (unstable side) at Station J3.

  High NO_x concentrations appear under class G in both the heating and non-heating seasons. However, during the heating season as compared to the non-heating season, the NO_x concentration also tends to become high under the unstable side (A-B and B).

- Compared to the NO_x concentration, the SO_2 concentration becomes lower under class G. According to the concentration distribution under the unstable side (A, A-B, and B) of the stability, the monitoring stations can be classified into two groups: one group (Stations JF1 and J7) receive a strong effect of low elevation pollutant sources such as house heating and the SO_2 concentration at these stations becomes lower when the atmospheric stability is on the unstable side; the other group (Stations JF2, J2, and J3) receive a strong effect from stationary pollutant sources of industries and the SO_2 concentration at these stations becomes higher under the unstable side of atmospheric stability, in particular, during the non-heating season. In these stations, the SO_2 concentration increases under the stable side of atmospheric stability D (neutral) or G (extremely stable) in the heating season since they are also affected by house heating.

Figure D3.2.64 and Table D3.2.27 in Data Book show the cumulative appearance frequencies of the different concentration levels under each atmospheric stability class at Station JF2. High concentrations during the non-heating season appeared only under unstable classes of A and A-B.





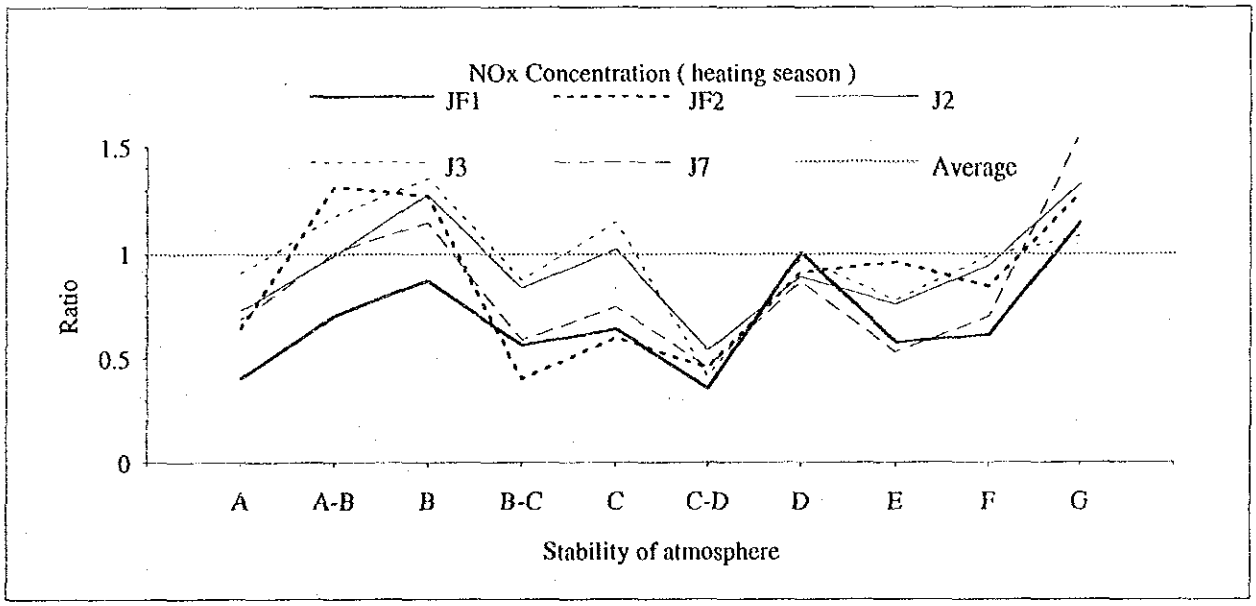
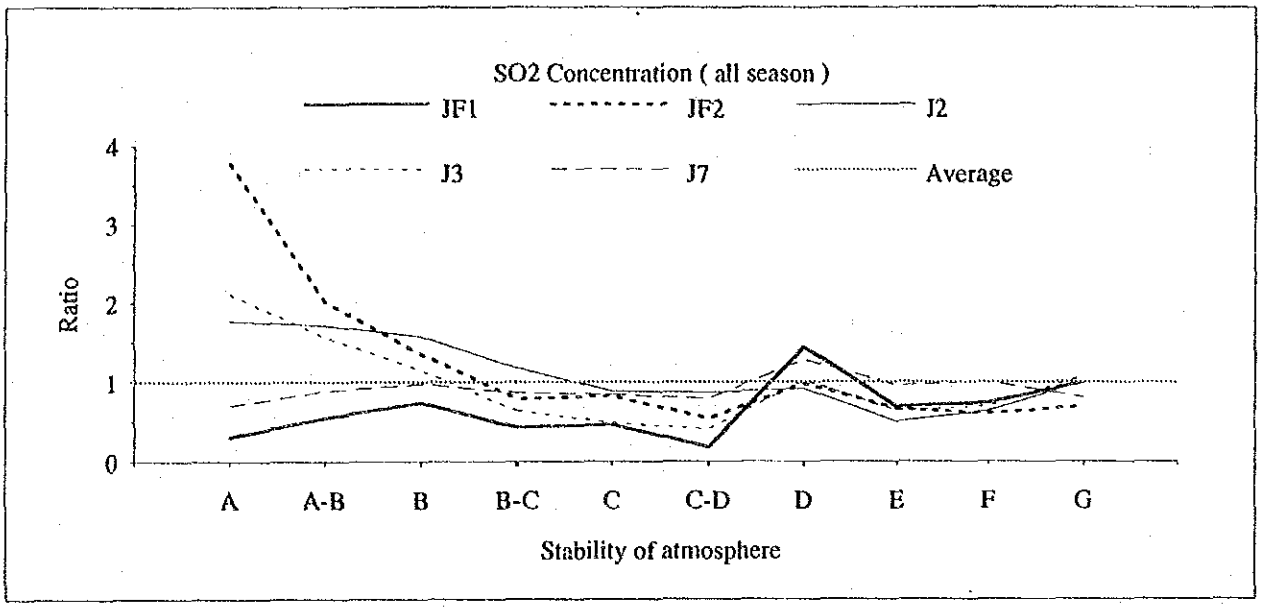
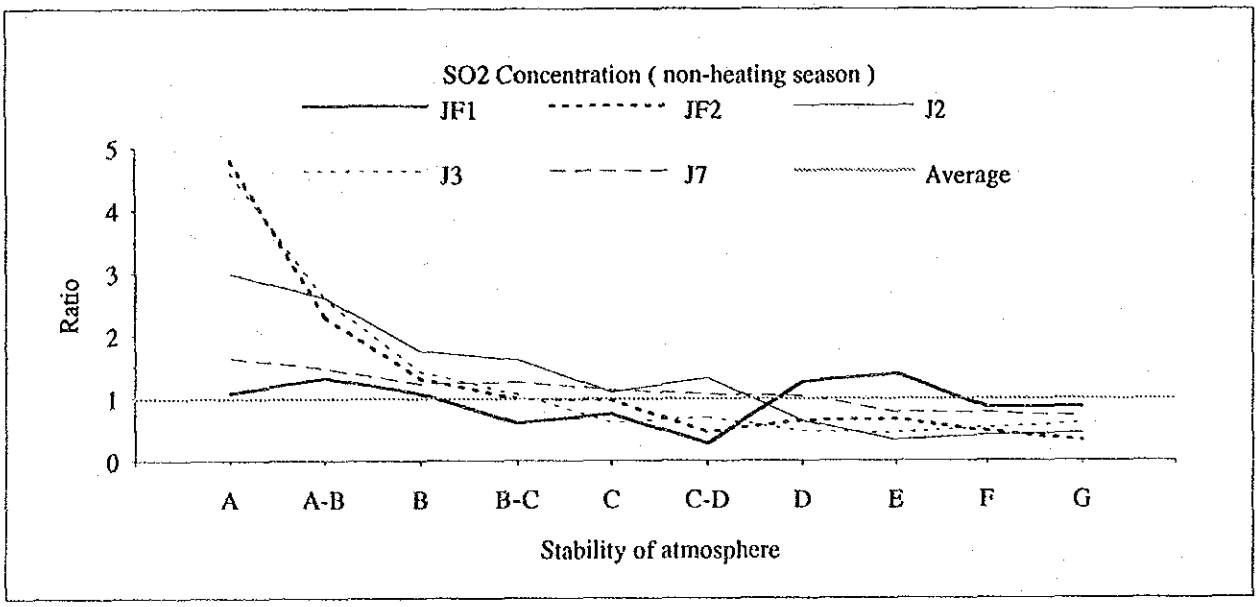


Figure 3.2.31 Ratio of Concentration of NOx by Stability of Atmosphere





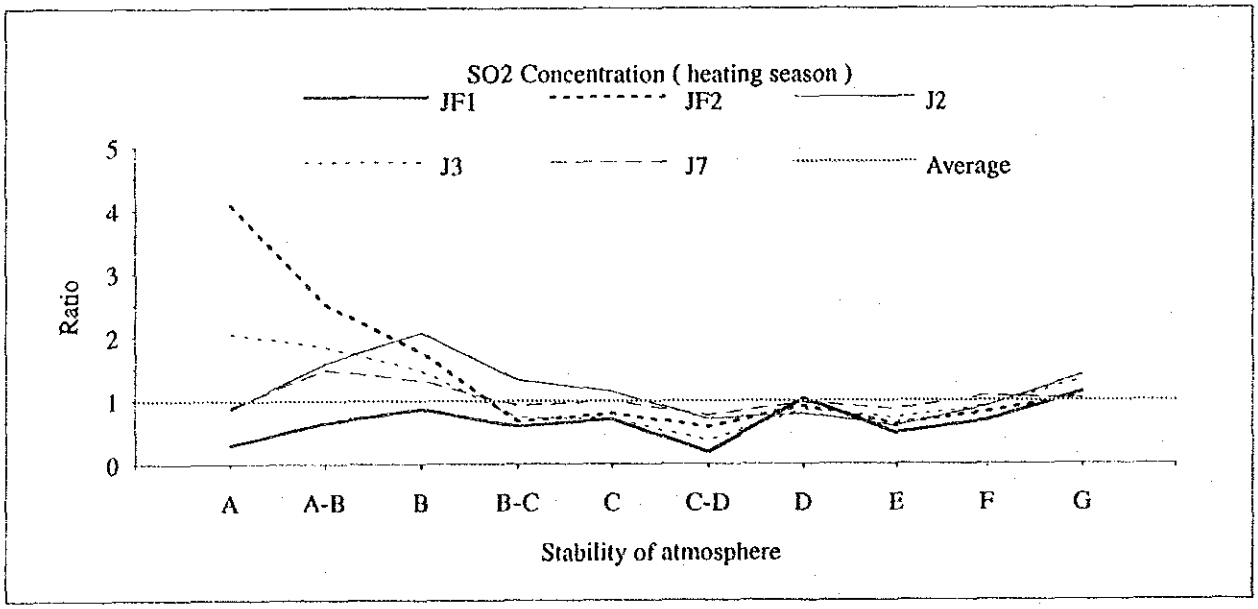


Figure 3.2.32 Ratio of Concentration of SO2 by Stability of Atmosphere

During the heating season, high concentrations were prevalent under classes D (neutral) and G (extremely stable). This tendency is very distinctive compared to that of the non-heating season. However, during the heating season also, high concentrations appeared under unstable classes of A-B and B.

(4) Analysis of High Concentration Appearance Days

Table 3.2.19 shows the appearance of high pollutant concentration days (top 30 daily average concentrations during the year) at each station.

The entire Study Area had high pollutant concentrations during the periods of November 1 through 4, November 22 through 30, January 8 through 12, February 1 through 10 and February 18 through 28. The appearance tendency of high concentration was such that a high SO_2 concentration did not appear when the NO concentration was high (the periods of November 1 through 4 and January 8 through 12). On the other hand, the NO_2 concentration became high when the SO_2 concentration was high, but the NO concentration did not become so high (the period of February 18 through 28).

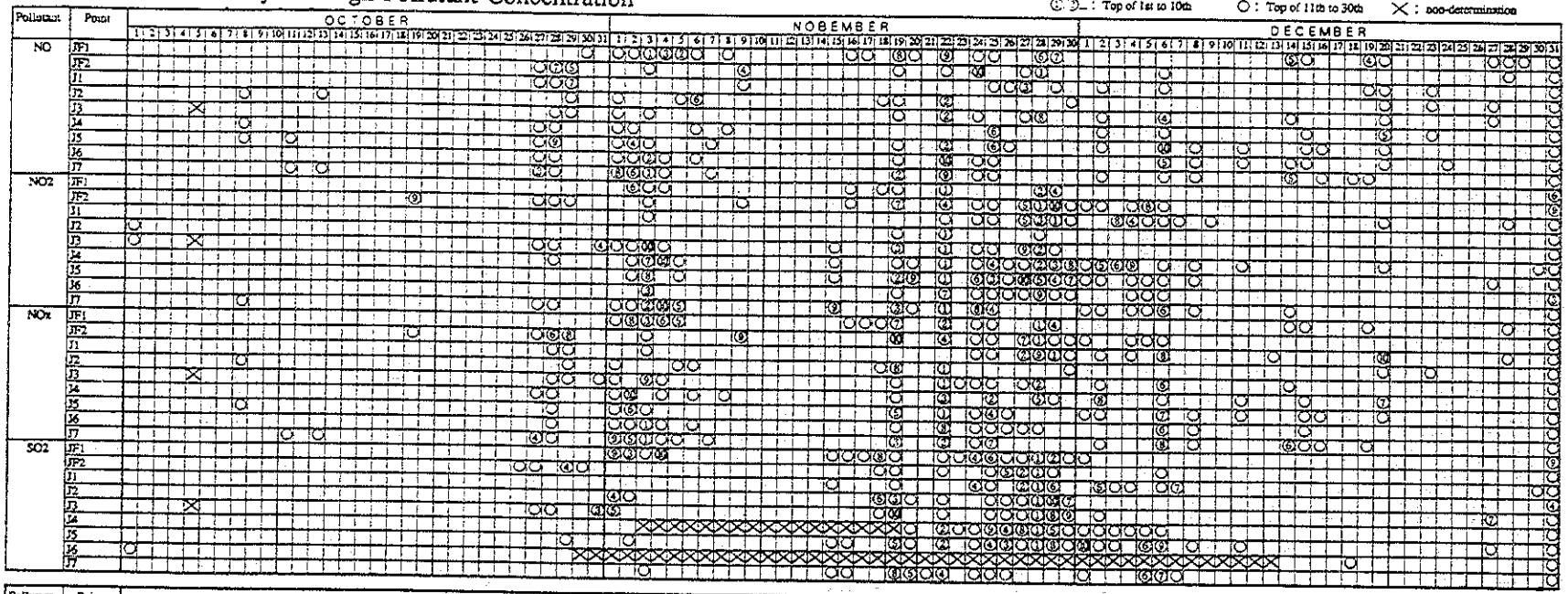
Figures D3.2.65 through D3.2.70 in Data Book show the changes of the daily average NO_x and SO_2 concentrations together with the changes of wind speed and temperature that were observed during the November 1 through January 31 period at Stations JF1, J2, and JF2.

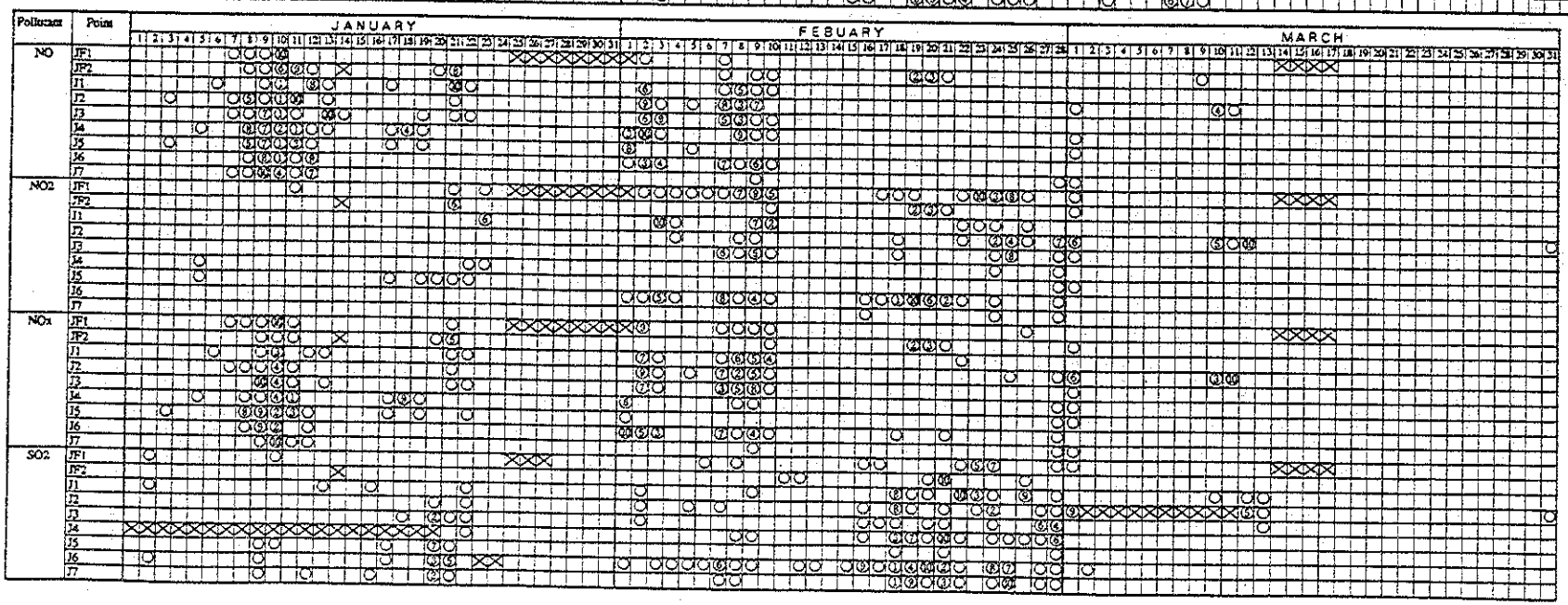
The NO_x concentration tends to become high when the wind speed is low. The change of the SO_2 concentration corresponds well to the air temperature change, and the concentration becomes higher when the air temperature becomes lower.

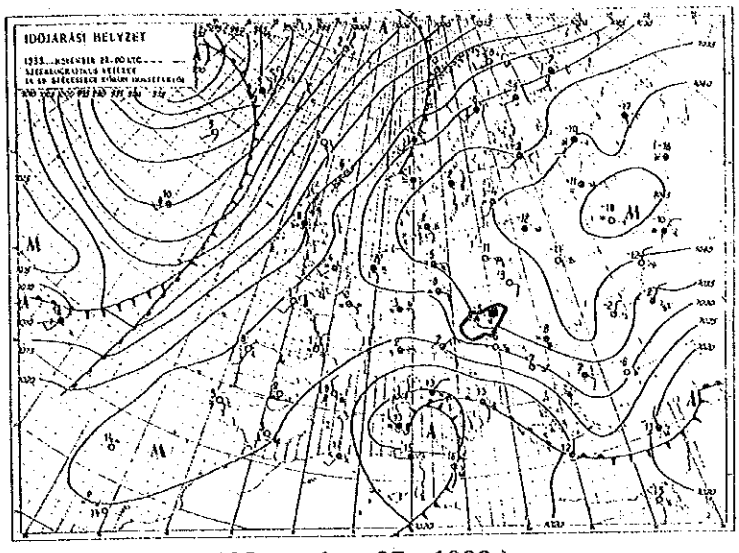
At Station JF1, the NO_x concentration also corresponds well to the change of air temperature. It is considered that the NO_x concentration is affected by the same pollutant source that affects the SO_2 concentration, i.e., house heating.

Figure 3.2.33 shows the weather maps for November 28 when a high SO_2 concentration appeared, and Figure 3.2.34 shows those for January 10 when NO_x concentrations (particularly NO concentration) were high. During both time periods there was a strong low pressure air mass above the Atlantic Ocean to the west of Ireland and a weak low pressure air mass covering Sicily in the Mediterranean Sea. The Eastern European area, including Hungary, was covered by a strong continental high pressure mass that emanated from east of Moscow. The density of the isobars covering Hungary was so coarse that the wind speed was low.

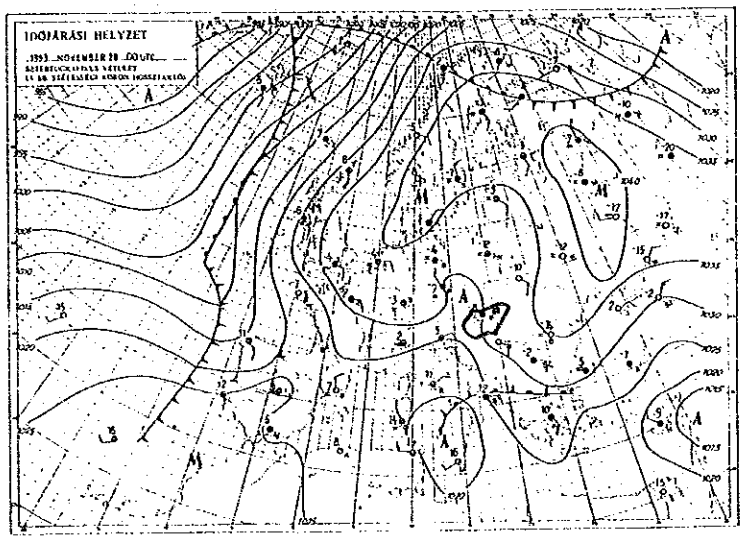
Table 3.2.19 Days of High Pollutant Concentration



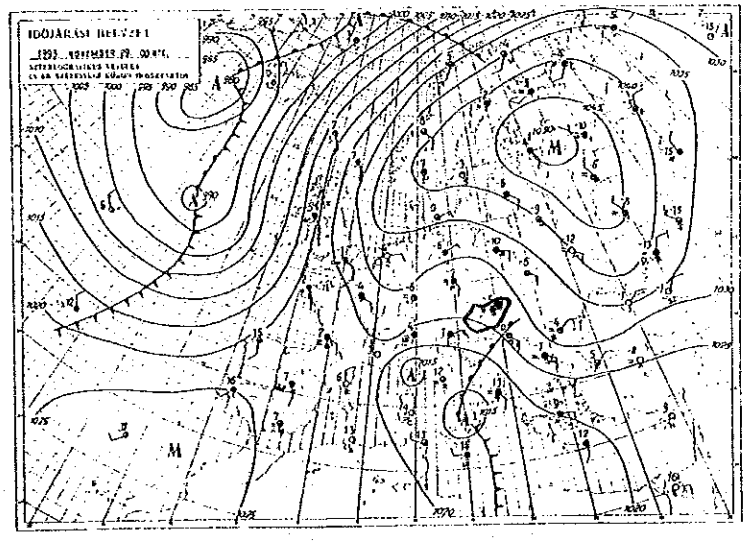




(November 27 , 1993)

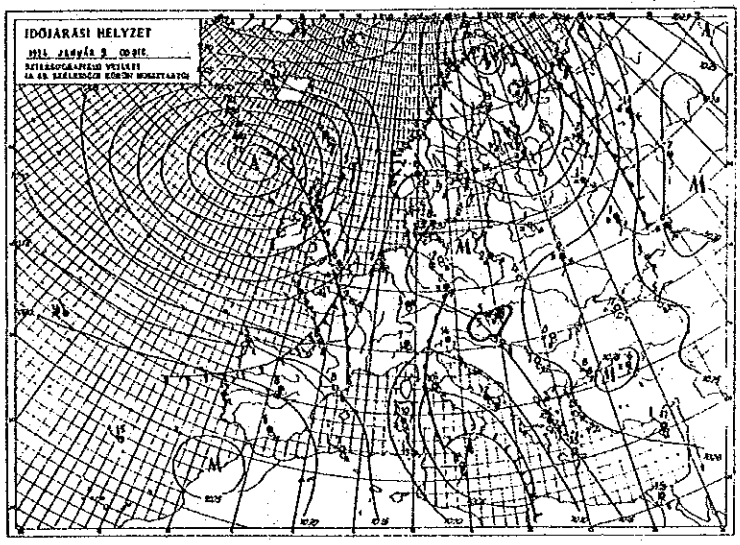


(November 28 , 1993)

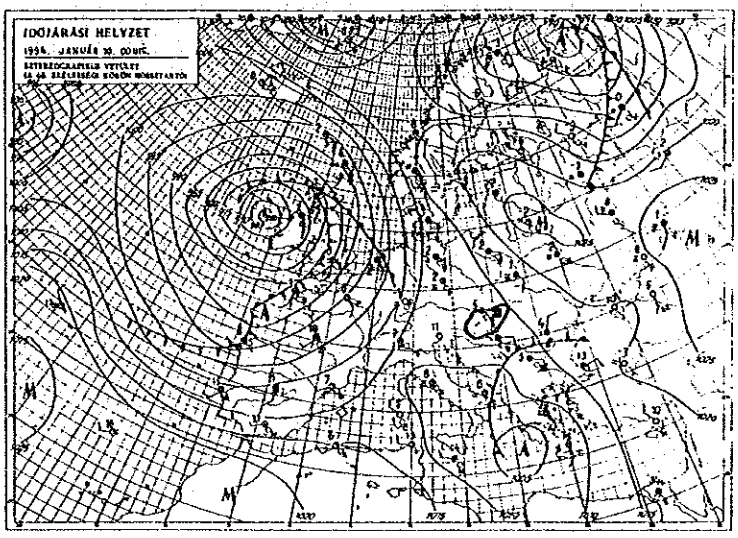


(November 29 , 1993)

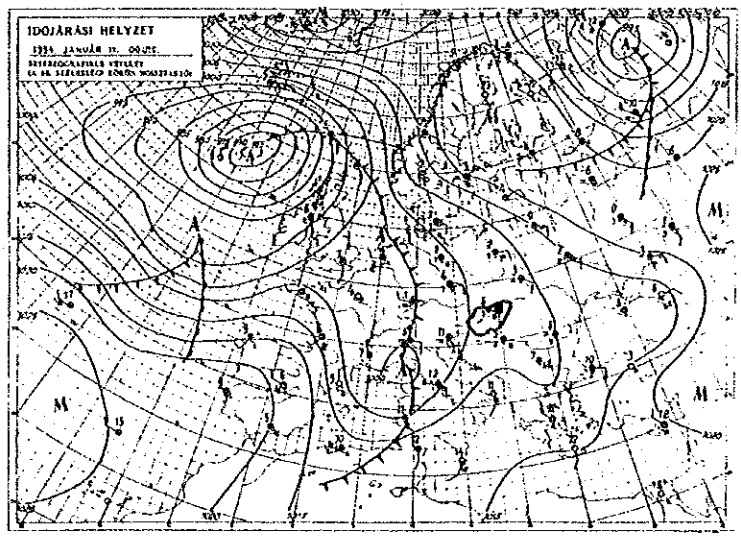
Figure 3.2.33 Weather Map of Heavily Polluted Day (11/27 ~ 11/29)



(January 9 , 1994)



(January 10 , 1994)



(January 11 , 1994)

Figure 3.2.34 Weather Map of Heavily Polluted Day (1/9 ~ 1/11)

3.2.5 Summary

The results of above analyses are summarized as follows:

(1) Air Pollutant Concentration Analyses

1) Comparison to the Ambient Air Quality Standards

i) Nitrogen Oxides (NO_x, and NO_2,)

- A high concentration of NO_x was observed at Stations J2, J5, and J7. The annual average value at Station J2, the station observed to have the highest concentration, was 0.033 ppm. The observed annual average concentrations satisfied the ambient air quality standards at all stations. The annual 98% values of the daily average NO_x concentrations at Stations J5 and J7 exceeded the ambient air quality standards. The 98% values of the 30 minutes average at Stations J5 and J7 also exceeded the ambient air quality standards.

- The highest annual average value of NO_2 concentration (0.020 ppm) was observed at Station J2 followed by Station J5 (0.016 ppm). But both values satisfied the ambient air quality standard. The 98% values of both the daily average and 30 minutes average also satisfied the ambient air quality standards at all stations.

ii) Sulfur Dioxide (SO_2)

- The highest SO_2 concentration was observed at Station JF1 that is 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 also exceeded the ambient air quality standards at this station.

- The next highest SO_2 concentrations were observed at Stations J2 and J3 that are located in industrial areas and at Station J5 in a housing area. However, the annual average and the 98% values of both the daily average and the 30 minutes average at these stations satisfied the ambient quality standards.

iii) 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 is below the ambient air quality standard of 8.6 ppm in Protected Area I. Thus, there is no CO problem.

iv) Others (O_3, SPM, and HC)

- Ozone (O_3) concentration was monitored at Stations JF1, JF2, and J6. The 98% values of the daily average were in the range of 0.029 to 0.030 ppm which is 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 exceeds the ambient air quality standard.

- Suspended particulate matter (SPM) concentration was measured at Stations JF1, JF2, and J6. The annual average concentrations were in the range of 0.022 to 0.026 mg/m^3, the 98% values of the daily average were in the range of 0.062 to 0.072 mg/m^3, and the 98% values of the 30 minutes average were in the range of 0.065 to 0.087 mg/m^3. These values are below the ambient air quality standards.

- Hydrocarbons (HC) concentration was measured at Stations JF1 and JF2. High concentrations of non-methane hydrocarbon (NMT), that is normally emitted at man-made sources, were observed at Station JF2 which is 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 values are far below the ambient air quality standards of 3.0 ppmC for the daily average and 10.0 ppmC for the 30 minutes average for Protected Area I.

2) Variation Characteristics of Air Pollutant Concentrations

i) Characteristics of Hourly Variation

- Concentrations of major pollutants (NO_x, SO_2, CO, O_3, and SPM) increase during the heating season. The high concentrations are mainly caused by seasonally variable pollutant sources, such as house heating. It is considered that atmospheric stability conditions also affect the concentrations.

- The daily variation of SO_2 well corresponds to the temperature variation. When the daily average temperature is lower than 0°C, a high concentration of SO_2 appears. It is believed that the SO_2 concentration is greatly affected by house heating.

- The hourly variation of NO concentration was very large at Stations J2, J5, J6, and J7 that 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 peaks at 6:00 a.m. and 6:00 p.m.

- The hourly variation pattern of SO_2 concentration differs from station to station. The variation pattern at Station JF1 (located in a housing area) has two distinct peaks. Those at Stations J2 and J3 (located in industrial areas) and JF2, which is affected by the large pollutant source (thermal power station), have two different patterns: the non-heating season with one peak from morning to noon and the heating season with two peaks with the second peak occurring around 17:00 and continues throughout the night.

ii) Appearance Frequency Distribution of Concentration

- The variations of 30 minutes average of NO and SO_2 concentrations are greater than those of NO_x and NO_2.

- At all stations, the variation of the SO_2 concentration is large in the high concentration zone. This tendency is clearer during the non-heating season and shows the characteristics of the hourly variation of the high concentration that is instantaneously caused by certain meteorological factors such as particular wind directions, while the concentration is usually low.

- The SO_2 concentration at Station JF2, which is considered to be affected by specific stationary pollutant sources, has a very characteristic appearance distribution. The cumulative frequency curve of the SO_2 concentration has a bend to separate into two different appearance distribution patterns during both the heating and non-heating seasons. These patterns indicate the strong effects of stationary pollutant sources throughout the year. Furthermore, the appearance frequency of the high concentration is higher during the non-heating season than during the heating season. The reason for this can be attributed to the meteorological conditions, in particular, to the atmospheric

stability.

iii) Correlation Analysis of Pollutant Concentrations

- The coefficients of correlation between concentrations of nitrogen oxides (NO, NO_2, NO_x) themselves are large at all monitoring stations. However, except Station JF1, the correlation between NO_x and SO_2 concentrations is weak. It is considered that the main pollutant sources of NO_x are different from that of SO_2.

- On the other hand, at Station JF1, the coefficients of correlation between each others of SO_2, NO_x, and CO exceed 0.8 and those between SPM and each of SO_2, NO_x, and CO exceed 0.7 throughout the year. As this tendency is not seen at all during the non-heating season, it is considered that Station JF1's main pollutant source during the heating season is house heating and the source greatly affects not only the SO_2 concentration, but also the NO_x, CO, and SPM concentrations.

iv) Correlation Analysis of Monitoring Stations

- As for NO_x and SO_2 concentrations, the correlations between Stations J4, J5 and J6, that are located relatively close to each other, are high. Of the nine stations, Stations J1 and JF2 have small correlation with other stations. This fact indicates that Stations J1 and JF2 have relatively independent dispersion fields or governed by characteristic pollutant sources.

(2) Meteorological Conditions and Pollutant Concentration

1) Meteorological Conditions

i) Wind Directions and Speed

- The appearance frequencies of different wind directions at the four surface meteorological stations (JF1 and JM1 in the northern part, and JF2 and J7 in the southern part) indicate that the prevailing wind direction corresponds to the area topography at each station. The seasonal and hourly variations of the appearance frequency of wind directions are relatively small.

- The average wind speeds at Station JF1 are the lowest; they are in the range of 1.2 to 1.3 m/s. The average wind speeds at other stations are in the range of 2.0 to 2.4 m/s. The average wind speeds at the southern two stations during the heating season are greater than those during the non-heating season.

- 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 average nighttime wind speed is greater during the heating season than during the non-heating season.

ii) Atmospheric Stability

- The atmospheric stability classes of D (neutral) and G (extremely stable) are prevalent at each station. The frequencies of these two classes were 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 and classes A through D (unstable side) appear more frequently. The frequency of G (extremely stable) is also high.

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

iii) Occurrence of Inversion Layer

- From the result of the upper-layer meteorological observation at Stations JF1 and JF2, 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. Near the ground surface, a relatively strong air temperature inversion continues throughout the night. This 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 from 100 to 400 m is frequently seen. In particular, during the winter season, the upper-layer inversion occasionally lasts for an entire day.

2) Meteorological Conditions and Pollutant Concentration

i) Wind Direction / Speed and Pollutant Concentration

- It is possible to presume the directions 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'sfactory'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 elevation, 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.

- The cross analysis was conducted using the meteorological data and pollutants (NO_x and SO_2) concentration data that were monitored at the same time at Stations JF1, J2, J3, JF2, and J7.

- As a whole, there was a tendency to appear high SO_2 concentrations under certain wind directions during the non-heating season. Under the wind directions to cause high SO_2 concentration, the concentration does not decrease in accordance with the increase of wind speed. Thus, the high SO_2 concentration during the non-heating season is considered to be caused by certain high elevation pollutant sources.

- During the heating season, the SO_2 concentration becomes higher under the wind from the direction in which a housing area is located. SO_2 concentration distribution in different wind speed levels shows the characteristics of low elevation pollutant sources. These tendencies are evidently caused by house heating.

- It is considered that the NO_x concentration is generally attributed to the low elevation pollutant source of automobiles. However, at all stations except J7, although the NO_x concentration generally decreases as the wind speed increases, there is no such tendency under certain wind directions that cause high concentration. Thus, the NO_x concentration may be also affected by medium to

high elevation pollutant sources.

- At Station J7, the pollutant concentration becomes higher under the wind from the direction of nearby major roads. The pollutant concentration distribution under different wind speed levels show the characteristics of low elevation pollutant sources. Thus, it is evident that the concentration is affected by automobiles on the major roads.

ii) Atmospheric Stability and Pollutant Concentration

- The NO_x concentration was generally higher under the atmospheric stability class G (extremely stable) during both the heating and non-heating seasons. However, during the heating season as compared to the non-heating season, the NO_x concentration also tends to become high under the unstable side (classes A-B and B).

- Compared to the NO_x concentration, the SO_2 concentration becomes lower under the stability class G. According to the concentration distribution under the unstable side (A, A-B, and B) of the stability, the monitoring stations can be classified into two groups: one group (Stations JF1 and J7) receive a strong effect of low elevation pollutant sources such as house heating and the SO_2 concentration at these stations becomes lower when the atmospheric stability is on the unstable side; the other group (Stations JF2, J2, and J3) receive a strong effect from stationary pollutant sources of industries and the SO_2 concentration at these stations becomes higher under the unstable side of atmospheric stability, in particular, during the non-heating season.

iii) Inversion Layer and Pollutant Concentration

- During the spring and summer seasons, very strong surface inversions were observed from midnight through dawn. The SO_2 concentration was low, therefore the relationship between the surface inversion and the SO_2 concentration is not 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 SO_2 occurred.

3) Conditions for Occurrence of High Pollutant Concentration

- Occurrence of high pollutant concentrations (Top 30 daily average concentrations during the year) are as follows.

- The entire Study Area had high pollutant concentrations during the periods of November 1 through 4, November 22 through 30, January 8 through 12, February 1 through 10 and February 18 through 28. A high SO_2 concentration did not appear when the NO concentration was high. On the other hand, the NO_2 concentration became high when the SO_2 concentration was high, but the NO concentration did not become so high.

- The NO_x concentration tends to become higher when the wind speed is low. The change of the SO_2 concentration corresponds well to the change of air temperature, and the concentration becomes higher when the air temperature becomes lower.

- Whether maps for the days of high pollutant concentrations indicate the following. There was a strong low pressure air mass above the Atlantic Ocean to the west of Ireland and a weak low pressure air mass covering Sicily in the Mediterranean Sea. The Eastern European area, including Hungary, was covered by a strong continental high pressure mass that emanated from east of Moscow. The density of the isobars covering Hungary was so coarse that the wind speed was low.

3.3 Results of Other Measurements

3.3.1 Air Quality at Roadside

As a result of simplified measurement of NO, NO_2 and NO_x at roadside, Figure 3.3.1 shows changes of concentration by distance from the road edge.

Table D3.3.1 in Data Book shows measured values of NO, NO_2 and NO_x concentrations, and Table D3.3.2 shows the comparison of measured values between the automatic measuring method and the simplified measuring method.

The concentrations are higher in the winter than in the summer : about five times higher for NO_x, and two to three times higher for NO_2.

Although the measurement points were located along the road, the concentration levels of NO_2 and NO_x were generally low. Even in the winter, they were below the ambient air quality standard value for the daily average for residential areas (Protected Area I).

The concentration profiles across the road show that high attenuation took place within 20 meters from the road edge, and concentration levels became almost constant beyond 40 meters from the edge.

Comparison of measure data of the simplified and automatic measuring methods showed that they are on a one-to-one correspondence, and the correlation coefficient is high at 0.99. In view of this fact, it is considered that the simplified method is also useful, because the sampler is easy to handle requiring no special sampling techniques.

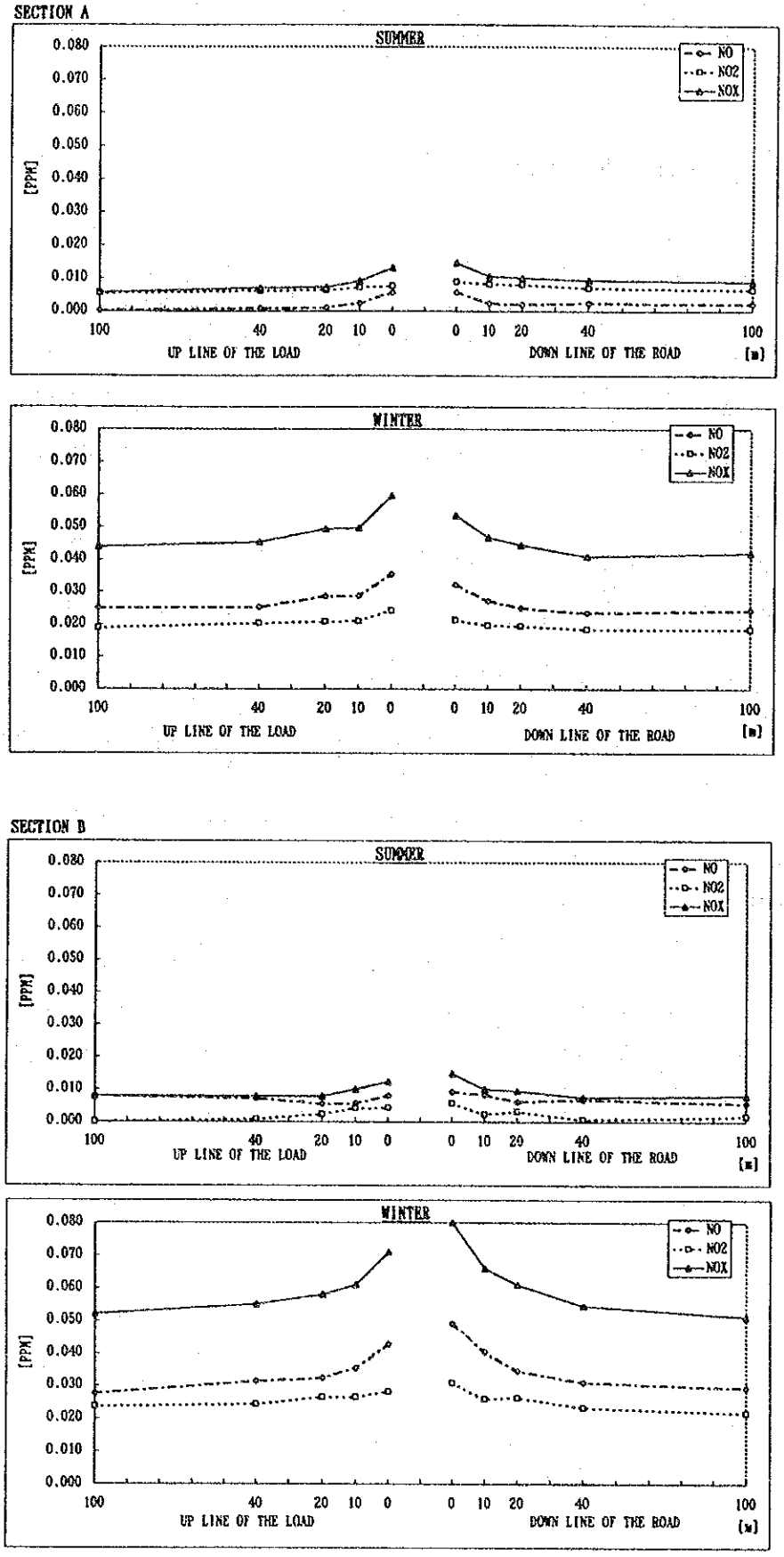


Figure 3.3.1 Attenuation of NO, NO_2 and NOx Concentrations by Distance from the Road Edge

3.3.2 Ambient Concentration of Mercury

Measurements of the concentration of mercury in the ambient air were made once per month over the one-year period.

Initially, measurements were made at seven measuring points located at automatic monitoring stations, but another point was added at Berente (J3) from November of 1993. Additional measurement was also made at a background point (Szentlelek) once each in the summer and the winter.

Results of the measurements are shown as 24-hour average values in Table 3.3.1. Figure 3.3.2 shows the annual average concentrations. The mercury concentration levels over the one-year period indicate that there are no abnormally high concentrations at any of the measuring points. However, at J2, J3 and EC2 measuring points near the Borsod chemical complex and the Borsod Thermal Power Station, higher concentrations were observed sometimes as compared to other points, causing the annual average value to be high.

Looking at concentration levels by month, the level in the April to June period is slightly higher than those in other months.

Comparing the annual average concentration levels in the study area with that in Japan, the concentrations at Stations J2, J3 and EC2 are at the same level as or slightly higher than those in the large metropolitan areas in Japan. At other measuring points, the levels are the same as those in the regional cities in Japan. The high concentration levels occasionally found at Station EC2 closely match the concentration levels found in areas near volcanoes or geothermal development sites in Japan.

The concentrations around 3 ng/m^3 at the background point are considered to be due to the presence of a restaurant (guest house) nearby which uses coals.

Table 3.3.1 Concentration of Vapor Hg in Ambient Air

(Unit:ng/m3)

Year	Month	Measuring Points							
		Rudabanya (J1)	Kazincbarcika (J2)	Berente (J3)	Kazincbarcika (EC2)	Szirmabesenyo (J4)	Martintelep (J5)	Goromboly (J6)	Nyekladhaza (J7)
1993	May	4.1	14.5	-	38.8	6.6	6.0	3.3	4.8
	Jun	3.5	9.9	-	7.6	10.7	16.2	6.2	3.8
	Jul	3.3	8.3	-	8.8	6.4	5.3	4.3	3.0
	Aug	5.2	9.8	-	5.1	7.9	8.4	1.5	6.9
	Sep	2.9	9.1	-	2.3	5.6	5.8	6.1	3.1
	Oct	3.8	15.5	-	23.5	3.3	2.6	1.9	2.3
	Nov	1.7	5.6	6.1	5.3	2.8	2.5	2.8	3.0
	Des	2.4	9.2	15.9	6.2	2.9	3.8	3.4	2.6
1994	Jan	1.9	10.1	6.2	3.8	2.2	1.8	1.1	2.1
	Feb	2.6	8.0	11.1	3.7	3.8	3.1	2.3	2.0
	Mar	2.0	4.5	7.0	1.9	1.8	1.3	0.9	1.8
	Apr	2.0	2.3	5.5	7.4	9.5	4.3	13.7	4.1
	May	3.7	11.4	10.2	4.2	11.2	8.3	7.7	3.3
Average		3.0	9.1	8.9	9.1	4.9	5.3	4.2	3.3

Note: Measurement time : Once per month for 24 hours
Sampling method : Collected in a form of silver amalgam
Measuring method : Flameless atomic absorption photometory
B.G. Point (Szentlelek) : Sep. 30, 1993 Hg 3.3ng/m3
Jan. 27, 1994 Hg 3.0ng/m3
BVK, Inert gaz uzem : Sep. 30, Hg 27.0ng/m3

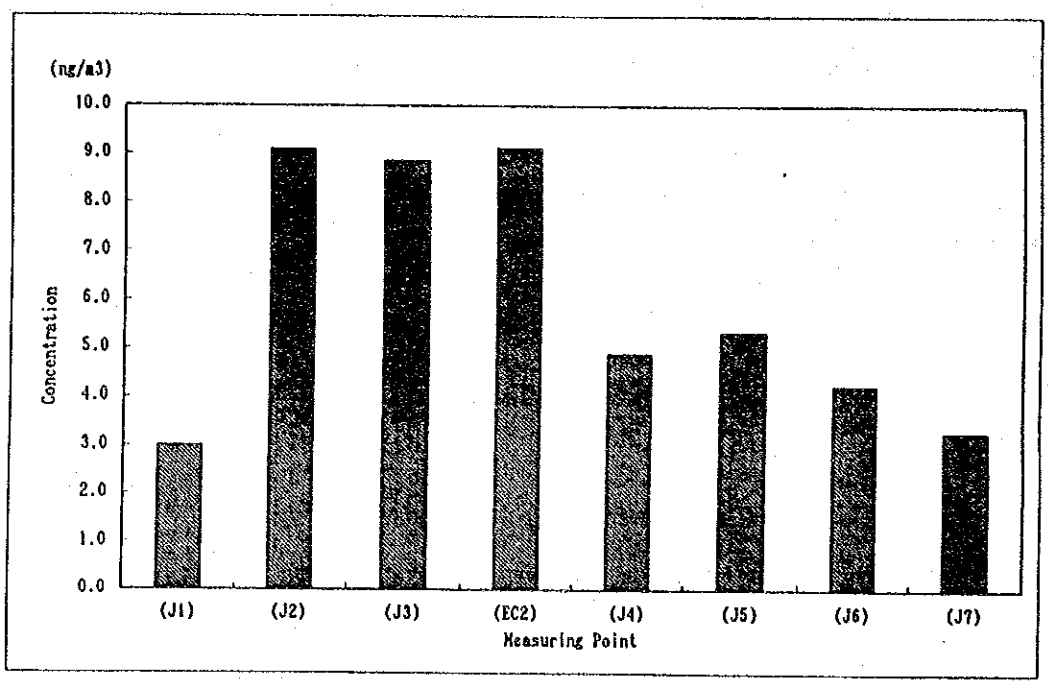


Figure 3.3.2 Annual Average of Hg Concentration

3.3.3 Falling Dust

Measurements of the amount of falling dust in the study area were made monthly from April 1993 to April 1994. The results are shown in Table D3.3.3 in Data Book. The monthly variations are presented in Figures 3.3.3 (1) through 3.3.3 (3).

The amount of falling dust was largest in the Ozd area, in the range of approximately 6 to 19 g/m^2/month (t/km^2/month). In other areas, the amount varied with month, but the average was around 6 g/m^2/month, or about one half the level in the Ozd area.

Looking at seasonal variation, in the Ozd area the amount of falling dust was larger in the autumn to winter period, and decreased to about half in the spring to summer period. By contrast, in the Kazincbarcika area, the amount was largest in the summer and smallest in the winter. The level in Sajoszentpeter, in the south of Kazincbarcika, was extremely low from May to July. The aforementioned variations are considered to be related to the presence of the coal thermal power station and the ash disposal center near these areas and seasonal changes of the wind conditions.

In Miskolc, which is urbanized, the level of falling dust does not undergo such large variations as found in the other areas.

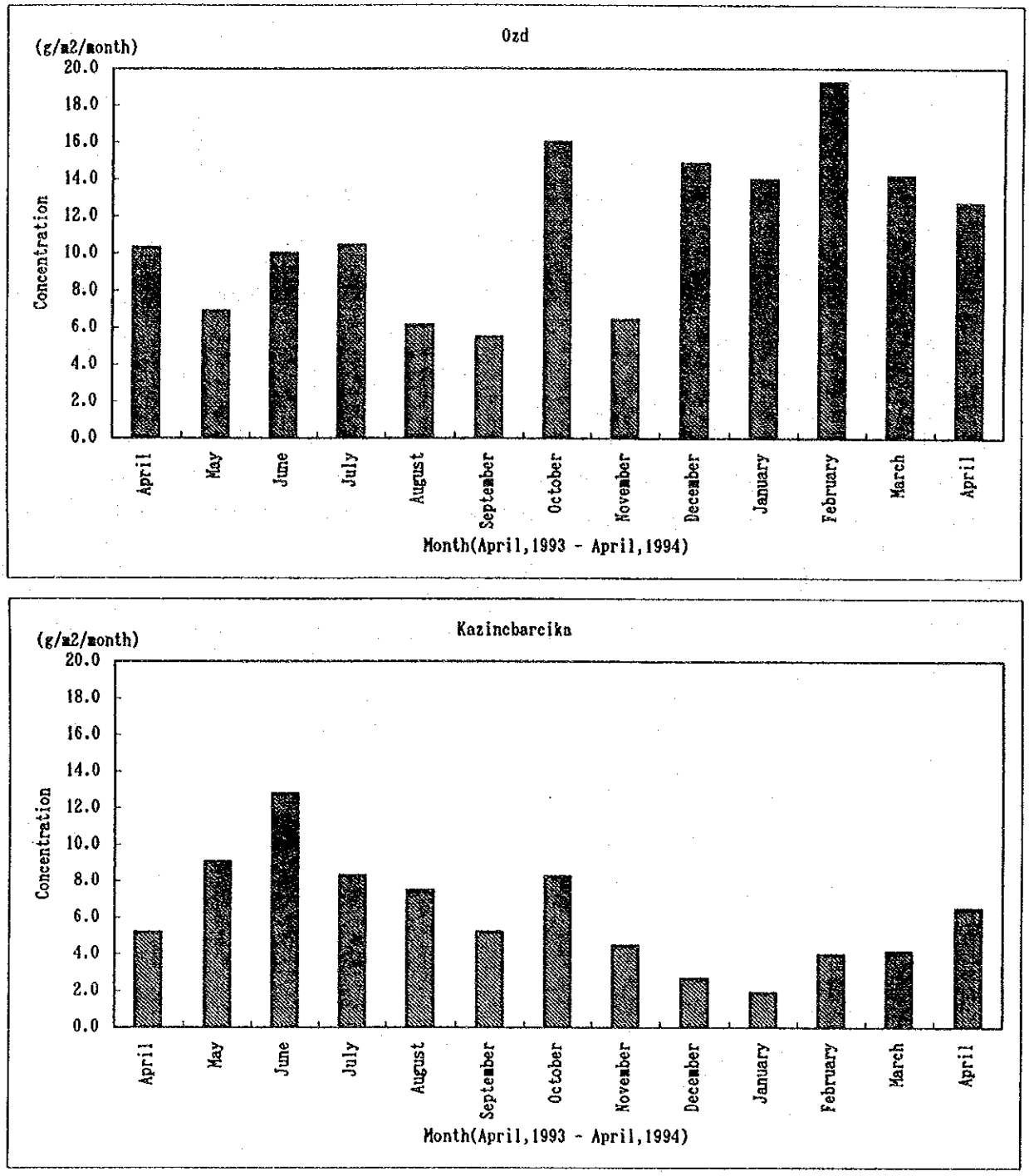
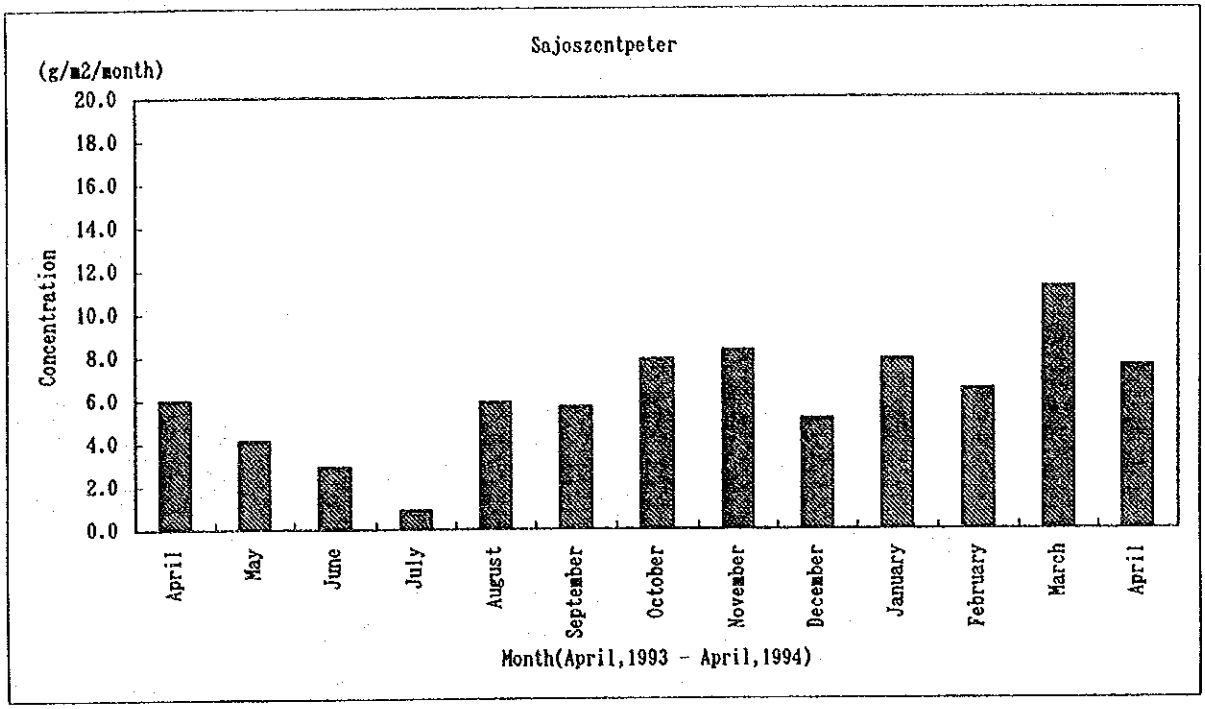


Figure 3.3.3 (1) Monthly Variation of Falling Dust in Sajo Valley Area (Ozd and Kazincbarcika)



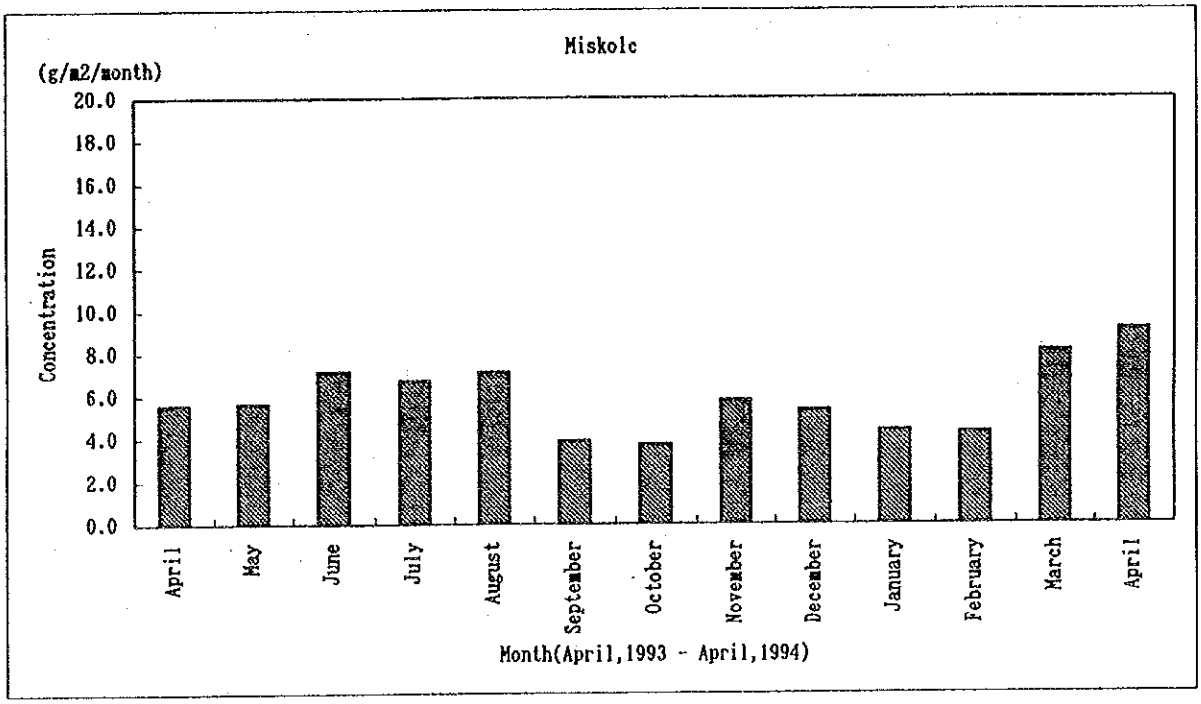


Figure 3.3.3 (2) Monthly Variation of Falling Dust in Sajo Valley Area (Sajoszentpeter and Miskolc)

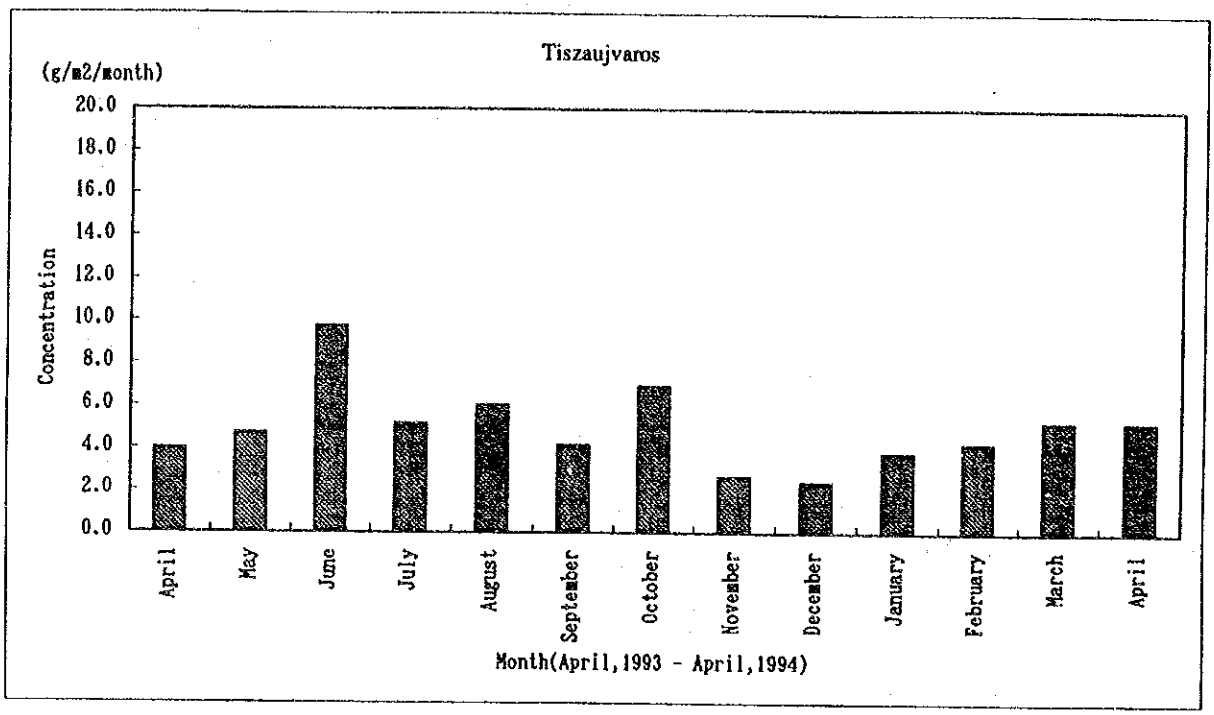


Figure 3.3.3 (3) Monthly Variation of Falling Dust in Sajo Valley Area (Tiszaújváros)

CHAPTER 4

Chapter 4 PRESENT STATE OF AIR POLLUTION SOURCES

4.1 Survey of Stationary Pollution Sources

4.1.1 Questionnaire and Visiting Surveys on Factories

(1) Location of Major Stationary Pollution Sources and Heating Centers

Among stationary pollution sources in the Sajo Valley area that were surveyed through questionnaire and visits, there are 35 major factories (including power stations) and 19 heating centers that are or were emitting air pollutants from combustion and/or production processes. Locations of these sites are shown in Figures 4.1.1 and 4.1.2.

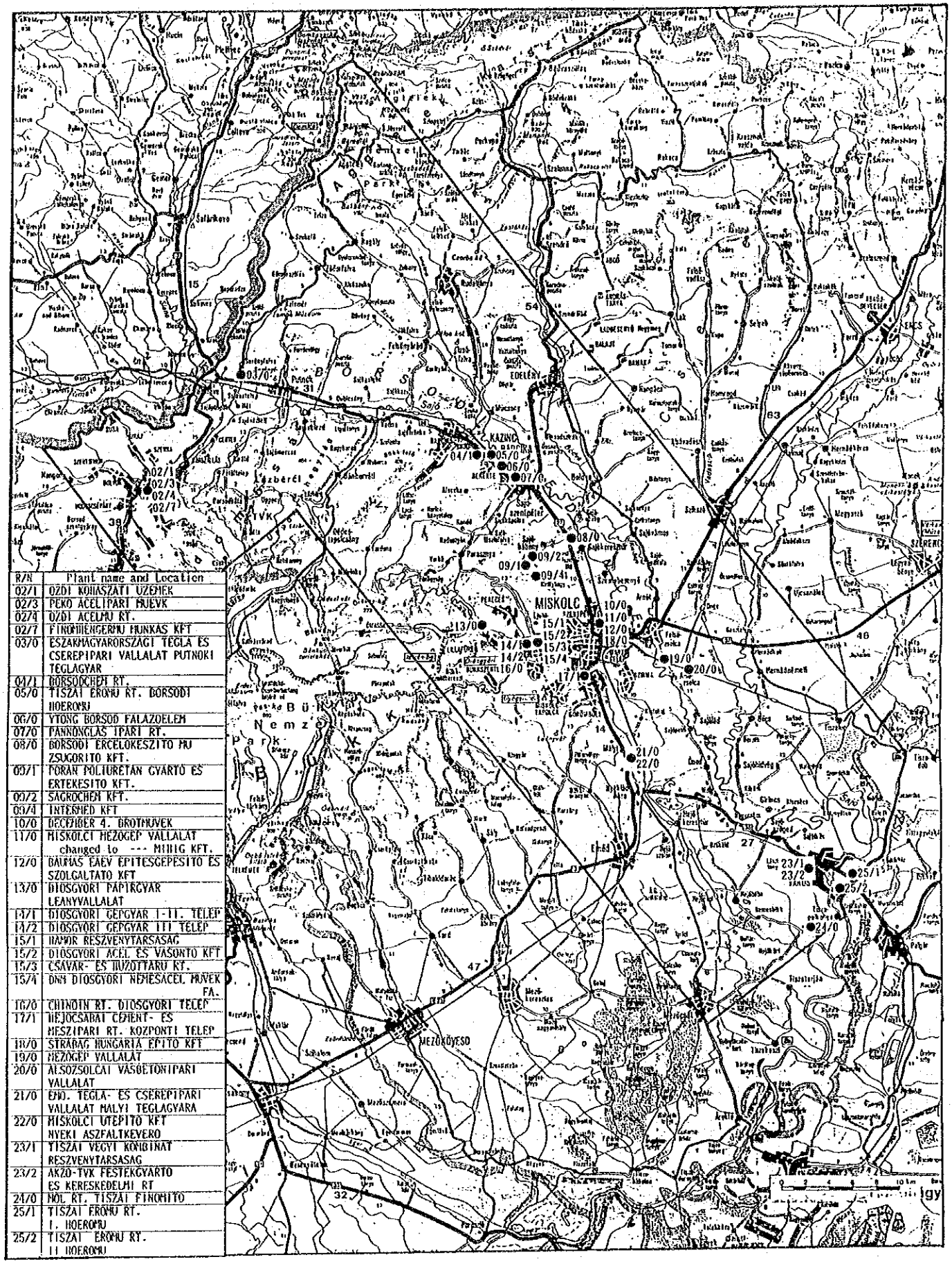
(2) Questionnaire and Visiting Surveys

A questionnaire survey was conducted on large to medium-size plants among representative types of industry using a questionnaire form shown in Table D4.1.1 in Data Book which inquires about various items including the following:

- Plant outline, age and capacity of facilities
- Fuel consumption
- Operation and management
- Type of combustion equipment
- Combustion mode
- Pollutant emission rate
- Management of pollution control equipment

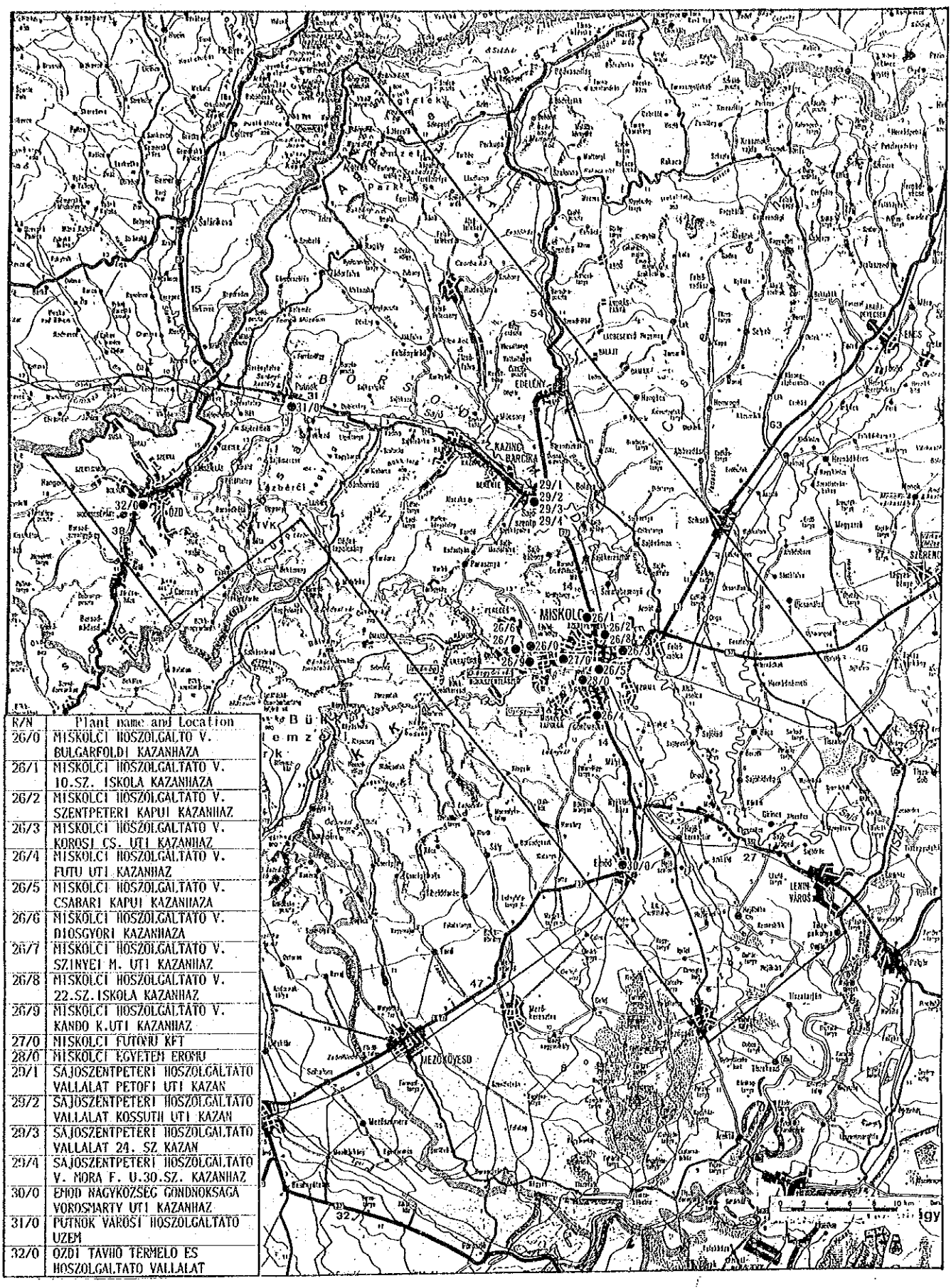
The questionnaire form was distributed by EKF to responsible persons of the plants. Out of the plans to which the questionnaire was sent, responsible persons of 24 major enterprises owning 35 plants were asked to attend the explanation meeting for the visiting survey. The background and purpose of the survey and the contents of the questionnaire were explained. In addition to the plants mentioned above, heating centers were also visited. The visiting survey was conducted by the member(s) of the Study Team and EKF's officials.

Results of the questionnaire and visiting surveys are summarized in Tables D4.1.2 (1) through D4.1.2 (5) in Data Book, and discussed in Section 7.2.2. More details on each plant are given in the last part of "Data for Chapter 4" in Data Book.



R/N	Plant name and Location
02/1	OZDI KOHASZATI UZEMEK
02/3	PEKO ACELIPARI MUEVK
02/4	OZDI ACELMU RT.
02/7	FINOMHENGERMU MUNKAS KFT
03/0	ESZAKMAGYARORSZAGI TEGLA ES CSEREPIPARI VALLALAT PUTNOKI TEGLAGYAR
04/1	BORSODCHEM RT.
05/0	TISZAI ERONU RT. BORSODI HOEROMU
06/0	YTONG BORSOD FALAZOELEM
07/0	PANNONGLAS IPARI RT.
08/0	BORSODI ERCELOKESZITO MU ZSUGORITO KFT.
09/1	PORAN POLIURETAN GYARTO ES ERTEKESITO KFT.
09/2	SAGROCHEM KFT.
09/4	INTERMED KFT
10/0	DECEMBER 4. GROTMUVEK
11/0	MISKOLCI HEZOGEP VALLALAT changed to --- MIHIG KFT.
12/0	BAUMAS EAEV EPITESGEPESITO ES SZOLGALTATO KFT
13/0	DIOSGYORI PAPIRGYAR LEANYVALLALAT
14/1	DIOSGYORI GEPGYAR I-II. TELEP
14/2	DIOSGYORI GEPGYAR III TELEP
15/1	HAMOR RESZVENYTARSASAG
15/2	DIOSGYORI ACEL ES VASONTO KFT
15/3	CSAVAR- ES RUGOTTARU KT.
15/4	DNH DIOSGYORI NEMESACEL MUVEK FA.
16/0	CHINOIN RT. DIOSGYORI TELEP
17/1	HEJOCSABAI CEMENT- ES MESZIPARI RT. KOZPONTI TELEP
18/0	STRABAG HUNGARIA EPITO KFT
19/0	HEZOGEP VALLALAT
20/0	ALSOZSOLCAI VASBETONIPARI VALLALAT
21/0	ENO. TEGLA- ES CSEREPIPARI VALLALAT HALYI TEGLAGYARA
22/0	MISKOLCI UTEPITO KFT NYEKI ASZFALTKEVERO
23/1	TISZAI VEGYI KOMBINAT RESZVENYTARSASAG
23/2	AKZO-TVK FESTEKGYARTO ES KERESKEDELMI RT
24/0	NOL RT. TISZAI FINOMITO
25/1	TISZAI ERONU RT. I. HOEROMU
25/2	TISZAI ERONU RT. II HOEROMU

Figure 4.1.1 Location of Major Stationary Pollution Sources



R/N	Plant name and Location
26/0	MISKOLCI HOSZOLGALTATO V. BULGARFOLDI KAZANHAZA
26/1	MISKOLCI HOSZOLGALTATO V. 10.SZ. ISKOLA KAZANHAZA
26/2	MISKOLCI HOSZOLGALTATO V. SZENTPETERI KAPUI KAZANHAZ
26/3	MISKOLCI HOSZOLGALTATO V. KOROSI CS. UTI KAZANHAZ
26/4	MISKOLCI HOSZOLGALTATO V. FUTU UTI KAZANHAZ
26/5	MISKOLCI HOSZOLGALTATO V. CSABAI KAPUI KAZANHAZA
26/6	MISKOLCI HOSZOLGALTATO V. DIOSGYORI KAZANHAZA
26/7	MISKOLCI HOSZOLGALTATO V. SZINYEI M. UTI KAZANHAZ
26/8	MISKOLCI HOSZOLGALTATO V. 22.SZ.ISKOLA KAZANHAZ
26/9	MISKOLCI HOSZOLGALTATO V. KANDO K.UTI KAZANHAZ
27/0	MISKOLCI FUTOMU KFT
28/0	MISKOLCI EGYETEM EROMU
29/1	SAJOSZENTPETERI HOSZOLGALTATO VALLALAT PETOFI UTI KAZAN
29/2	SAJOSZENTPETERI HOSZOLGALTATO VALLALAT KOSSUTH UTI KAZAN
29/3	SAJOSZENTPETERI HOSZOLGALTATO VALLALAT 24. SZ KAZAN
29/4	SAJOSZENTPETERI HOSZOLGALTATO V. MORA F. U.30.SZ. KAZANHAZ
30/0	EMOD NAGYKOZSEG GONDNOKSAGA VOROSMARTY UTI KAZANHAZ
31/0	PUTNOK VAROSI HOSZOLGALTATO UZEM
32/0	OZDI TAVHO TERMELO ES HOSZOLGALTATO VALLALAT

Figure 4.1.2 Location of Heating Centers

4.1.2 Survey of Combustion Facilities and Exhaust Gas Measurement

Measurements of exhaust gas were made at 22 major factories and 10 heating centers having combustion facilities. The types and number of facilities for the measurement are shown in Table 4.1.1.

Table 4.1.1 The Types and Number of Facilities for Exhaust Gas Measurement

Category	Type	Number
Power generation boiler	Pulverized coal combustion boiler	8
	Natural gas & heavy oil mixture boiler	2
Process boiler	Smoke tube boiler	2
	Flue and smoke tube boiler	5
	Locomotive boiler	1
	Marine boiler	1
	Heating medium boiler	1
Metal heating furnace	Truck type heat treating furnace	2
	Box type soaking pit	2
	Underground soaking pit	1
Waste incinerator		5
Brick burning furnace	Hoffman type ring kiln	2
	Truck type heat treating furnace	1
Aggregate drying furnace	For producing asphalt mix	2
Glass melting furnace	Tank furnace	2
Iron ore sintering furnace	DL type sintering furnace	1
Cement burning furnace	Rotary kiln	1
Lime burning furnace	Shaft kiln	1
Nitric acid production plant	Ammonia oxidation furnace	1
Sub-total		41
Boiler for heating	Water tube type boiler	4
	Flue and smoke tube boiler	4
	Cast iron boiler	3
Sub-total		11
Total		52

In conducting measurements, active cooperation was extended by EKF so that the survey proceeded as scheduled for all the targeted facilities.

The measurement items were SO2, NOx, CO, dust, O2, CO2, HC and exhaust gas temperature. In some cases, combustion efficiency was also measured.

Outlines of stationary emission sources subjected to measurement of flue gas and results of the measurement are presented in Table D4.1.3 and Table D4.1.4 in Data Book, respectively.

Detailed result for each of all 52 facilities are shown in Tables D4.1.5 (1) through D4.1.5 (52) in Data Book. Each table presents an outline of the facility, measurement data, measurement locations, and a brief summary of problems and countermeasures. When the effects of countermeasures could be represented, their values were posted.

Major problematic points in the survey results are as follows.

1) Facilities in most plants in the Study Area have deteriorated. Nearly all of combustion facilities were built according to design standards of former Czechoslovakia, former East Germany and former Soviet Union, and it is very difficult to obtain components or necessary materials for improvement of these facilities.

2) Of the 52 facilities, 19 or 36.5% did not have flow meters, weighing equipment or other types of meters necessary for accurately determining fuel consumption volumes, the most important factor in combustion control. Energy saving is one of the most important subjects to be promoted for the future. Hence it is undesirable that the fuel consumption is not being measured at many facilities. It was often found that a flue gas measuring port was placed at the rear of the electric precipitator (E.P.) or the induced draft fan, or on the smokestack used jointly with other combustion facilities. Accordingly, there were many cases in which the concentration of oxygen in the combustion exhaust gas, a key indicator of the quality of the combustion state, could not be determined because of air intake. In order to achieve energy saving in the future, efforts should be made to measure exhausts at locations where there is no air intake (for example, at boiler outlets), in order to determine accurately the relationship between the O_2 concentration in the exhaust gas and the fuel consumption volume, to practice combustion at low air ratio, and to minimize loss of heat from exhaust gases.

3) The major sources of air pollution in the Study Area are blast furnaces and sintering furnaces of steel plants and thermal power stations at three locations. Of these facilities, the government resolved to abolish the blast furnaces and sintering furnaces at steel plants in the near future and replace them with electric furnaces. Accordingly, countermeasures against dust from electric furnaces will become a major issue, but for the present, the boilers at the three thermal power stations are the major facilities that require exhaust gas control measures.

4.1.3 Questionnaire Survey on Home Heating

(1) Outline of the Survey

A questionnaire survey was conducted to investigate fuel consumption for home heating in the Study Area. The survey items were as follows:

1) Questions regarding building

a) type of building, b) number of story, c) floor area of the household, d) building structure, e) number of families in the household, f) number of occupants of the household

2) Questions regarding heating devices

a) individual heating or central heating, b) type of heating devices, c) kinds of fuel, d) fuel consumption volume during the period of November 1992 through March 1993, e) time period of use, f) firing time

As shown in Figure 4.1.3, the questionnaire sheets were distributed widely to cover the Sajó Valley area since heating methods vary by areas. Therefore, the distribution of the samples does not necessarily agree with the distributions of population and fuel consumption amount.

From 33 towns or villages in the Study Area, 159 samples were obtained.

(2) Results of the Survey

Breakdowns of the 159 samples by the question items regarding building are shown in Table D4.1.6 in Data Book. The amount of fuel consumption by heating device and by fuel type is shown in Table D4.1.7 in Data Book. The types of heating consist mostly of centralized heating by boiler and single-unit heating by stove. The types of fuel used vary by area: firewood is widely used in the mountainous regions, and coal is used extensively in areas around coal-mining sites. With respect to natural gas, although its use is expanding, there are many households which do not use natural gas even though it is available because of the cost for new installation of the gas heating system.

Per capita consumption of primary fuel is shown in Table 4.1.2 and that of sub-fuel is shown in Table 4.1.3. Sub-fuel refers to that other than the primary fuel when plural kinds of fuel are used. Firewood as sub-fuel is used for firing coal.

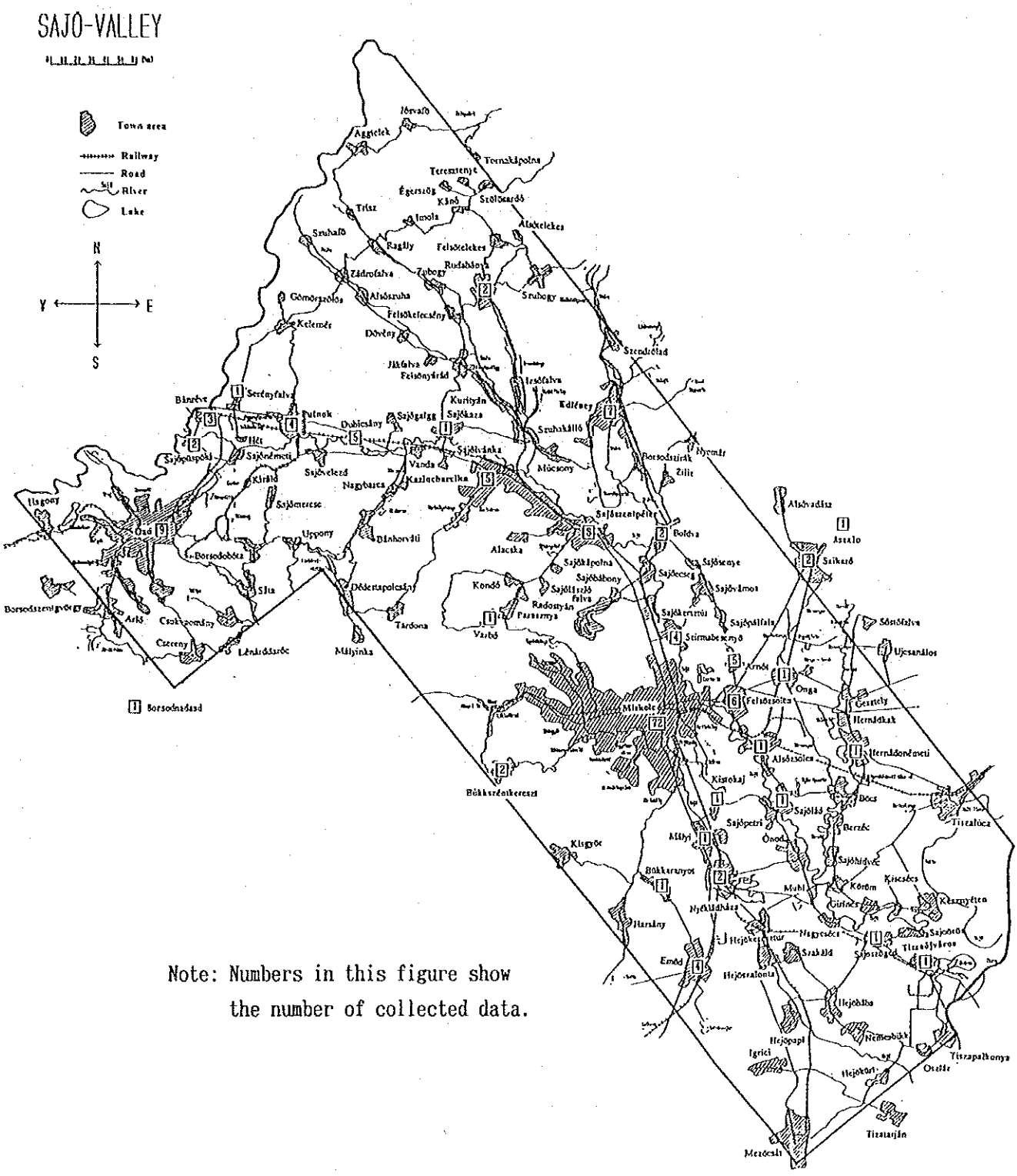


Figure 4.1.3 The Area of Questionnaire Survey on Home Heating

Table 4.1.2 Amount of Primary Fuel Consumption per Person
(November 1992 - March 1993)

	Average	Maximum	Minimum	Standard Deviation	Number of Samples
Natural gas (m^3)	614	2,000	84	316	79
Coal (kg)	2,233	8,000	188	1,441	65
Firewood (kg)	1,791	4,000	270	1,230	9
Electric power (KWh)	4,634	5,786	2,386	1,947	3
Diesel (l)	428	500	355	103	2
LPG gas (m^3)	405	405	405	405	1

Table 4.1.3 Amount of Sub-fuel Consumption per Person
(November 1992 - March 1993)

	Average	Maximum	Minimum	Standard Deviation	Number of Samples
Firewood (kg)	846	5,000	73	596	44
Natural gas (m^3)	466	730	330	229	3
Diesel (l)	579	1,000	158	596	2
Electric power (KWh)	1,217	1,217	1,217	1,217	1
Wood dust (kg)	3,000	3,000	3,000	3,000	1

Note : Sub-fuels are those other than primary fuel when plural kinds of fuel are used.

4.1.4 Fuel Analysis

(1) Sample Taking

Fuel analysis was carried out for the following numbers of samples:

- solid : 85 samples
- liquid : 8 samples
- gas : 3 samples

Sample taking of solid fuels was carried out partially from stationary grain piles and partially from conveying belts having stopped then while loading the fuel on transporting vehicles. In the latter case samples were taken from the whole range of the fuel in determined circles (distances).

Sampling of imported coals was made from piles. Local coals were also sampled in the latter way at coal preparatory works in cases if they had grain dimension of +20 mm. Coals with dimension range of 0 - 20 mm were sampled by automatic sample taking equipment from moving material flow when loading it on transporting vehicles or when emptying railway carriages at the power stations.

Taken samples were reduced in several steps, then underwent so called laboratory sample preparation (grinding, repeated reduction).

Sample taking of liquid fuels was carried out from fuel tanks by descending sample taking equipment.

Sample taking of gases was not necessary because gas analyzing equipment was directly connected to gas pipes.

During sample taking, tools and methods regulated by Hungarian standards were used.

(2) Place and Method of Analysis

Analyses of fuels were made in credible laboratories selected according to the places of sample taking and also specialization of the laboratory.

Among solid fuels domestic coals were analyzed at the places of production - with the exception of coals used in power stations that were analyzed at the places of utilization. Majority of domestic coals and all imported coals were analyzed at the Berente Laboratory.

Analysis of liquid fuels was made at the Tiszaújváros Laboratory of MOL RT.

Analysis of gas fuels was carried out at the Eger and Hajduszoboszlo Laboratories of MOL RT.

Methods of analyses are detailed in the regarding regulations of Hungarian Standards (MSz).

Analyses of mercury in coal sample were made in the ÁNTSZ-BAZ laboratory by vaporization by heating and atomic absorption photometry method.

(3) Results of Analysis

The results of the fuel analyses are shown in Tables D4.1.8 through D4.1.10 in Data Book.

Characteristic features of fuel quality in terms of air pollution control is discussed in Section 7.2.1.

4.2 Survey of Mobile Pollution Sources

4.2.1 Traffic Volume Survey

(1) Traffic Volume According to Existing Data

The road network in the Study Area is shown in Figure 4.2.1.

Main roads in the Study Area are : Route No.3 (Budapest ~ Tornyosnémeti), Route No.25 (Kerecsed ~ Bánréve), Route No.26 (Miskolc ~ Bánréve), Route No.27 (Sajoszentpeter ~ Tornanadaska), Route No.35 (Nyékladhaza ~ Debrcen), and Route No. 37 (Arnót · Felsözsoka ~ Satorljaújhely).

The points of the traffic volume survey regularly conducted by the Miskolc Rood Management Office (MKI) are shown in Figure D4.2.1, and the results of the 1990 survey are shown in Table D4.2.1 in Data Book.

Table 4.2.1 and Figure 4.2.2 show the trends in the traffic volume at representative survey points. The maximum daily traffic volume is observed at point 3 (Route No.3) in Miskolc being about 21,000 units/day in 1990.

Figure.4.2.3 shows the trends in the share of automobile types. The traffic volumes of buses and trucks have not been changed remarkably, but those of passenger cars have been increasing.

(2) Traffic Volume Survey

To supplement the existing traffic volume data, especially regarding hourly changes of the traffic volume, a survey was conducted as described below.

1) Location

Locations of the survey are shown Figure 4.2.4 and Table 4.2.2.

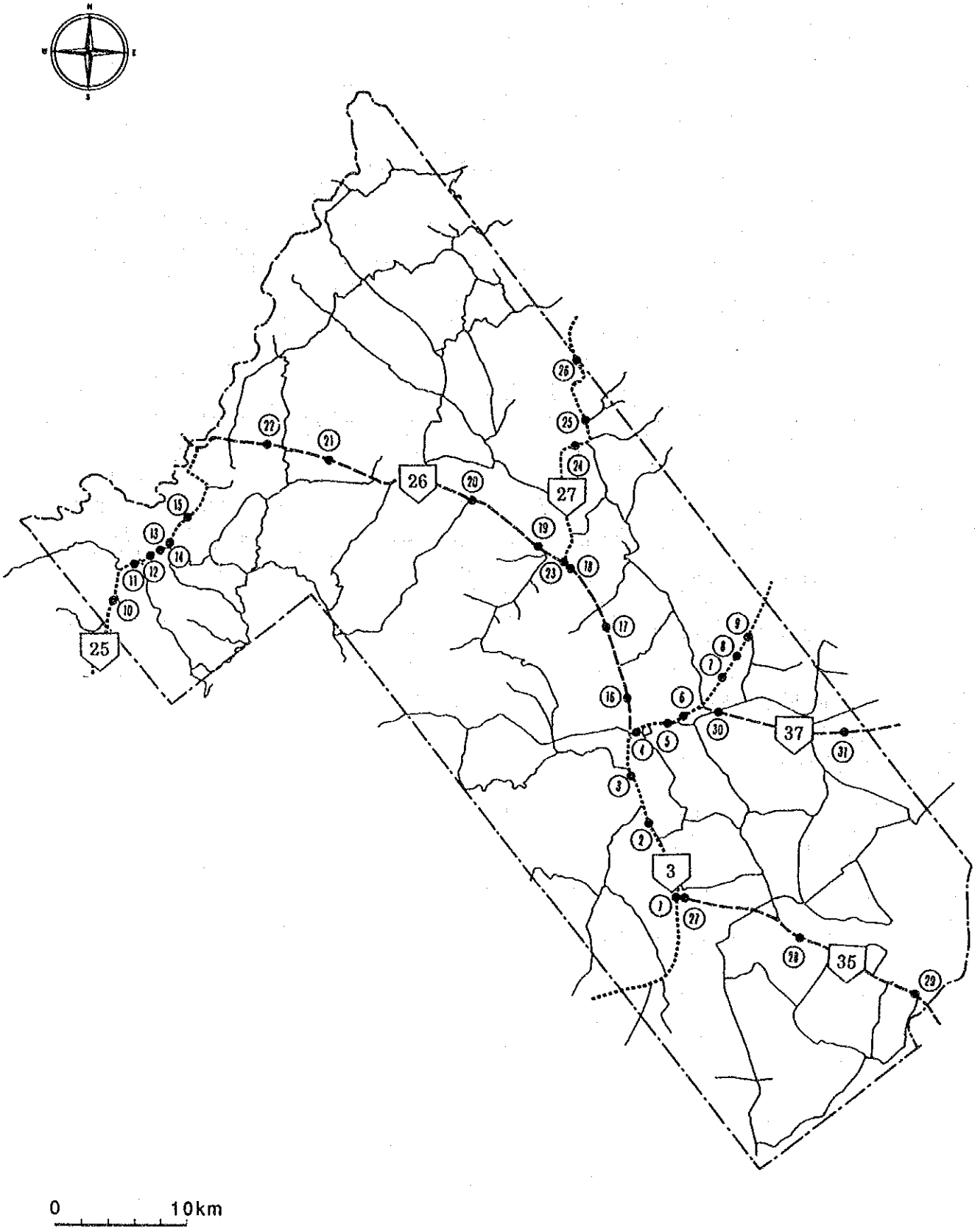


Figure 4.2.1 Road Network and Existing Traffic Survey Points in the Study Area

Table 4.2.1 Trends in Traffic Volume by Car Type

(units/day)

Type	point	Year 1980	1985	1990
Passenger Car	3	8,107	13,241	16,413
	12	2,049	1,803	2,640
	20	2,028	2,685	3,957
	24	1,732	2,172	2,080
	28	2,917	3,008	6,730
	31	2,660	2,812	4,401
Bus	3	720	939	571
	12	289	194	130
	20	113	223	284
	24	208	225	279
	28	217	188	159
	31	180	107	85
Truck	3	3,368	4,381	4,306
	12	643	862	448
	20	1,039	1,228	1,502
	24	663	1,113	820
	28	2,460	2,473	2,823
	31	1,883	1,678	1,433
Total	3	12,195	18,561	21,290
	12	2,981	2,859	3,218
	20	3,180	4,136	5,743
	24	2,603	3,510	3,179
	28	5,594	5,669	9,712
	31	4,723	4,597	5,919

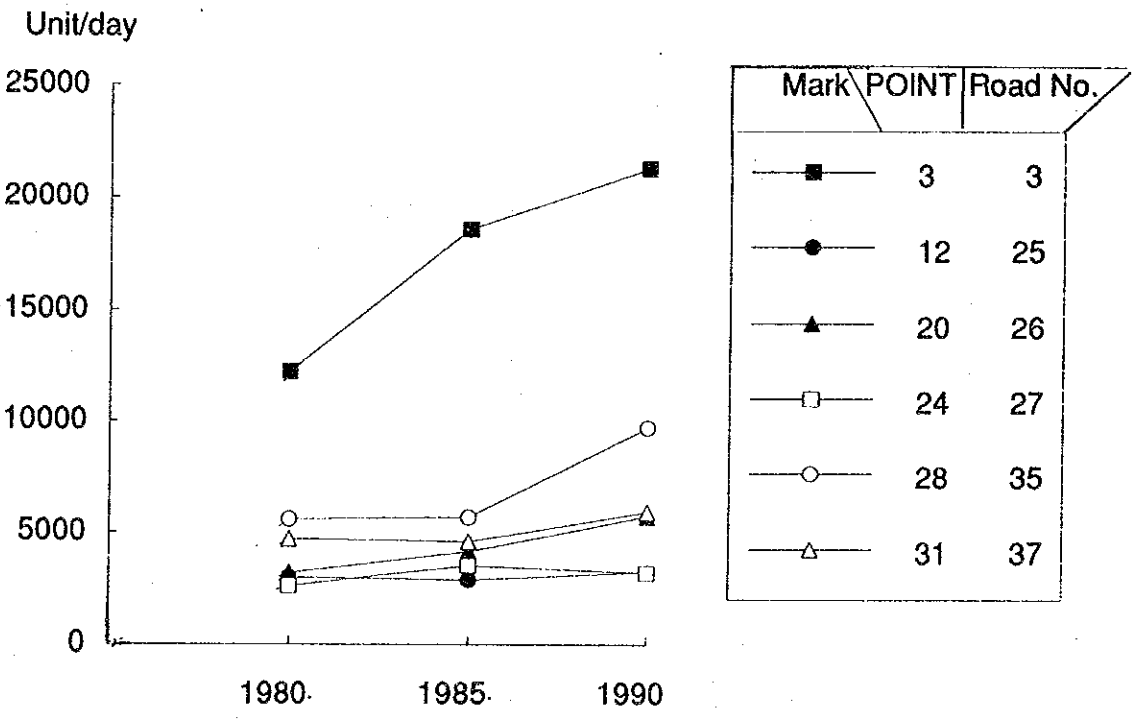


Figure 4.2.2 Trends in Traffic Volumes

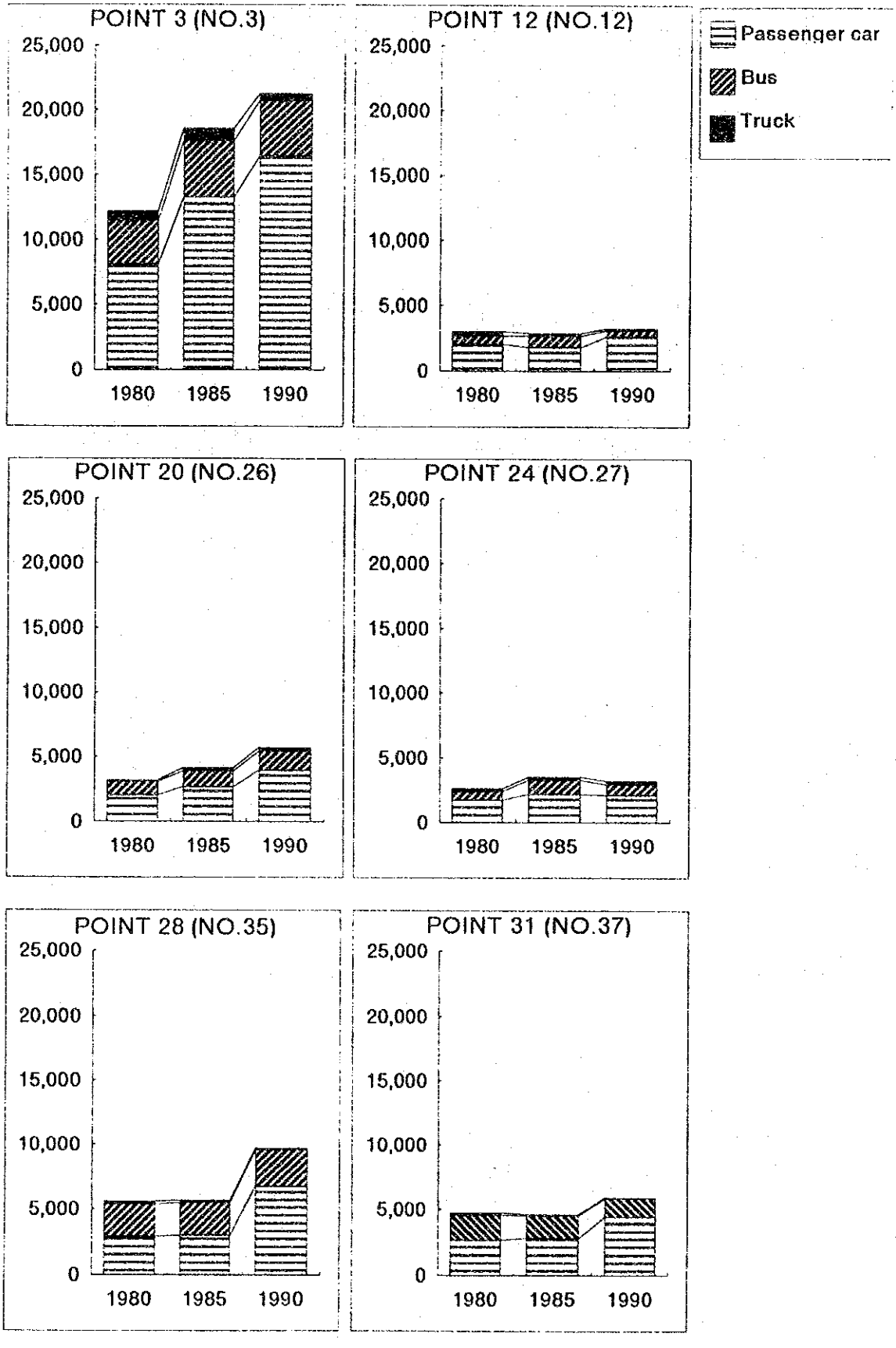


Figure 4.2.3 Trends in Traffic Volumes by Car Type

Figure 4.2.4 Locations of Traffic Volumes Survey

Table 4.2.2 Locations of Traffic Volume Survey

No	Road Name	Section	Code	Direction
a) Trunk road				
1	Route 3	172 + 500 km	1026 2026	Budapest → Miskolc Miskolc → Budapest
2	Route 3	180 + 820 km	1463 2463	Miskolc → Szikszó Szikszó → Miskolc
3	Route 26	1 + 800 km	4469 6469	Sajoszentpéter → Miskolc Miskolc → Sajoszentpéter
4	Rout 35	10 + 00 km	3119 6119	Miskolc → Debrecen Debrecen → Miskolc
b) Alleys				
5	Route 2050	55 + 316 km	1001 2001	Lillafüred → Miskolc Miskolc → Lillafüred
6	Route 3604	0 + 600 km	1002 2002	Miskolc → Kistokoj Kistokoj → Miskolc
7	Inner Miskolc	Bessenyöi út.	1003 2003	To Reptér From Reptér
8	Inner Miskolc	Tronyalija ut.	1004 2004	To Diósgyör From Diósgyör

2) Periods of the Survey

Weekday: 6:00 a.m., June 17 - 6:00 a.m., June 18, 1993 (Thursday - Friday)
Weekend: 6:00 a.m., June 20 - 6:00 a.m., June 21, 1993 (Sunday - Monday)

3) Survey Method

24-hour traffic volumes in two directions at each location were counted in each hour by 9 types of automobiles. These types were categorized into 3 groups as follows:

- Passenger car
- Small truck
- Large vehicle

Driving speed was also measured by stop watches for about 10 vehicles at each point.

4) Results

Results of the traffic volume survey are shown in Data Book in Tables D4.2.2 through D4.2.17 and Figures D4.2.2 through D4.2.17 for each location, and results of the driving speed measurement are shown in Tables D4.2.18 and D4.2.19.

4.2.2 Travel Speed and Mode Survey

Travel speed survey was conducted using a test car. The purpose of this survey is to investigate driving modes in Miskolc city as the basic data for chassis dynamometer tests.

1) Method of Survey

Test Route

The tests were carried out in the following 4 routes (see Figure 4.2.5).

No.1 (trunk road):	Route 26, Reptéri Street junction - Ady bridge - Route 3, Harsány junction (No.1a: 8,830 m, and No.1b: 8648 m)
No.2 (sub-trunk):	City center Zsolcai gate - Gyôri gate - Diósgyôr Blaha L. Street (No.2a: 8,196 m, and No.2b: 8,192 m)
No.3 (secondary):	Route 26, Reptéri Street junction - Bessenyôi Street - overpass of Route 3 (No.3a: 3,394 m, and No.3b: 3,390 m)
No.4 (secondary):	Kistokaj Street bus terminal - Kisfaludy Street - Tutto Mobile (No.4a: 6,919, and No.4b: 6,907 m)

Test Method

A video camera was installed on the test car, and driving speed, distance and elapsed time were recorded. The video tape was replayed and the driving speed was read at every 5 seconds.

Time Periods and Number of Tests

Three time periods : morning (6:00 - 8:00), daytime (10:00 - 12:00), and evening (16:00 - 18:00) were selected. Test run was made 3 times for each direction.

2) Result and Analysis

Examples of the result of the speed test are shown as time-speed charts in Figures D4.2.18 and D.4.2.19 in Data Book.

The data were analyzed to obtain following parameters:

1. Average traveling speed
2. Maximum speed
3. Idling time
4. Number of stops
5. Number of acceleration
6. Number of deceleration
7. Distribution of speed class frequency

From the result of these analyses, two driving modes were obtained as follows:

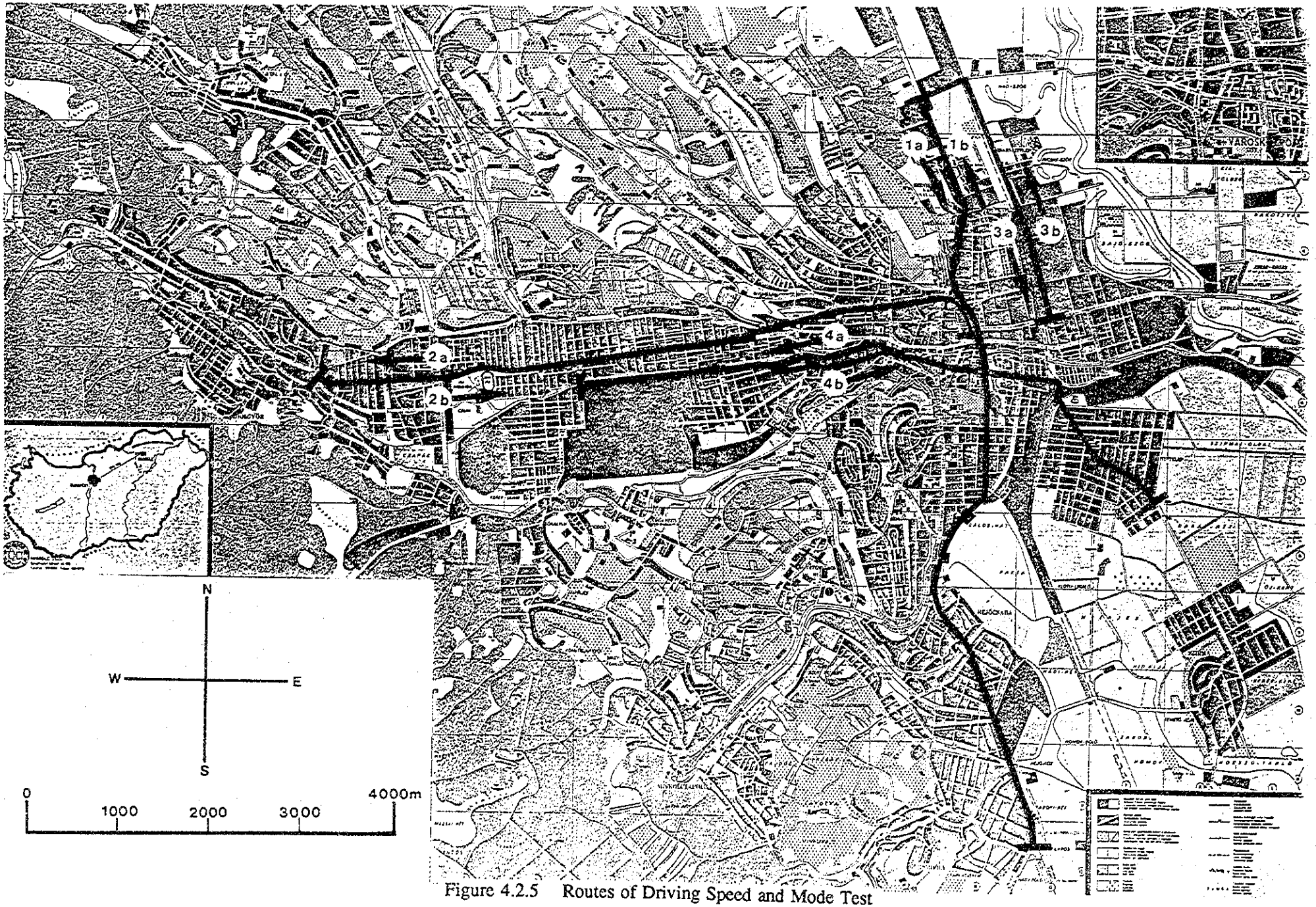


Figure 4.2.5 Routes of Driving Speed and Mode Test

- Mode 1: Trunk road
- Mode 2: Sub-trunk road and secondary (results of analyses including distribution of speed class frequency in routes No.2, No.3, and No.4 were found to be similar)

Distributions of speed class frequency for above two modes are shown in Figures D4.2.20 and D4.2.21, and those for routes 2, 3 and 4 are shown in Figures D4.2.22 through 4.2.24 in Data Book.

Parameter values of above two modes are shown in Table 4.2.3.

Table 4.2.3 Parameters of Traffic Flow for Emissions Mode

Term	unit	Mode No.1	Mode No.2
Average traveling speed	(km/h)	46.1	39.1
Maximum speed	(km/h)	92	78
Time at idle	(%)	3.2	8.0
Number of stops	(number/km)	0.22	0.36
Number of acceleration	(number/km)	0.42	0.75
Number of deceleration	(number/km)	0.47	0.79

Figure D4.2.25 in Data Book shows the time-speed diagrams of these two modes to be used in the chassis dynamometer test.

4.2.3 Emission Factor Test by Chassis Dynamometer

Chassis dynamometer test was conducted at the Institute for Transport Sciences. It was carried out as a series of tests for the determination of emission factors serving for estimating the amount of air pollutants emitted by the motor vehicles running in the Sajó Valley Area.

(1) Passenger Cars

The tests of 9 passenger cars, whose main technical data are shown in Table 4.2.4, were conducted to determine emission factors (g/km) of HC, NOx, CO, CO_2 and particulate matter, as well as fuel consumption rate. The test modes are as follows.

- European urban driving cycle (UN/ECE 15.04)
- Extra urban driving cycle (90 EUDC)
- Driving cycles characteristic in Miskolc (Miskolc Mode 1 and Mode 2)

Table 4.2.4 Technical Data of Tested Passenger Cars

No.	Car Name	Engine Type	Engine Capacity(cc)	GVW (kg)	Age (years)	Mileage (km)
1	Travant 601	2-stroke	600	1,000	4	77,900
2	Wartburg 353W	2-stroke	992	1,320	6	117,800
3	Dácia 1310	4-stroke	1,289	1,300	5	71,800
4	Lada 21053	4-stroke	1,452	1,440	0.3	2,300
5	Wartburg 1.3	4-stroke	1,272	1,320	3	28,200
6	Skoda 105	4-stroke	1,046	1,255	5	32,500
7	Opelastra 1.4i	4-stroke	1,389	1,455	0.5	6,700
8	Ford Escort	Diesel	1,608	1,300	8	128,000
9	Lada 2104	4-stroke	1,294	1,460	7	150,300

GVW;Gross vehicle weight

(2) Small Commercial Vehicles

Two small commercial vehicles whose gross vehicle weight (GVW) is 3.5 ton or less were tested. Their technical data are shown in Table 4.2.5. The tests were conducted in the same manner as that for passenger cars for two loading conditions : with load and without load.

Table 4.2.5 Technical Data of Tested Small Commercial Vehicles

No.	Car Name	Engine Type	Engine Capacity(cc)	GVW(kg)	Age(years)	Mileage(km)
1	Barkas	2-stroke	992	2,050	13	78,800
2	Mazda E 2200	Diesel	2,184	2,794	0.5	13,500

GVW;Gross vehicle weight

(3) Large Vehicles

Emissions from diesel-powered engines for large vehicles were tested using an engine test bench. Test engines are as follows :

RABA-MAN D2156 : truck and bus engine made in Hungry
KAMAZ 740 type : truck engine made in USSR

Emission factors of CO, HC and NOx were determined according to the UN/ECE regulation No. 49.

(4) Test Result

The results of the chassis dynamometer test are shown in Table D4.2.25 in Data Book.

4.3 Air Pollutant Emission

4.3.1 Stationary Sources

Air pollutant emissions from stationary sources in the Study Area in 1992 were estimated on the EKF data and the results of the investigations by Study Team described earlier. The result is shown in Table 4.3.3 in Section 4.3.3 together with the pollutant emissions from motor vehicles. Table 4.3.3 indicates the following.

- SO_2

  Three power stations account for approximately 80% of the annual total amount of SO_2 emissions from stationary sources, and particularly Tisza I power station emits 36% of the total. They are followed by communal facilities of 13%. The SO_2 emission from communal facilities in the heating season is about 4 times as much as that of the non-heating season. The SO_2 emission from major factories accounts for only 3.4%.

- NOx

  Three power stations account for 60% of the annual total amount of NOx emissions from stationary sources. The stationary source that emits the largest amount of NOx is Tisza I power station, and its ratio is 23%. The NO_2 emission from major factories is 21% and that from communal facilities is 18% of the total of the stationary sources.

4.3.2 Mobile Sources

(1) Determination of Emission Factors by Car Type

Emission factors of several car types were obtained through the chassis dynamometer test and the engine test. When the emission factors were used for the estimation of pollutant emissions, it is necessary to sort the factors into four types of automobiles categorized in the traffic volume survey, i.e. passenger car, small truck, bus and large truck. Methods of determining the representative emission factors for four types are described below.

1) Passenger Car

The number of the registered passenger cars in BAZ County was classified by car types used for the chassis dynamometer test. All emission factors obtained through the test were weighted by these vehicle numbers, and the weighted means of emission factors were estimated. The weighted means are used as the representative emission factors of passenger cars.

Emission factors (SO2, NOx, CO) of the cars used for the chassis dynamometer test and the weighted means are shown in Tables D4.3.1(1) through D4.3.1(3) in Data Book. The numbers of the registered passenger cars in BAZ county classified by car type, and the standards of fuel quality used for the estimation of SO_2 emission factors are shown in Tables D4.3.2 and D4.3.3 in Data Book, respectively.

2) Small Truck

Two types of small truck were selected for the chassis dynamometer test, however, the number of the registered MAZDA E2200D is not known. Therefore, BARKAS B1000 was selected as the representative car type and GVW = 2,040kg was applied. Emission factors (SO_2, NO_X, CO) of small trucks obtaimed by the chassis dynamometer test are also shown in Table D4.3.1 in Data Book.

3) Large Truck and Bus

The representative emission factors were defined as the weighted means which were determined by the results of the engine test and by the numbers of RABAMAN-engined vehicles and KAMAZ-engined vehicles. The emission factors determined by the engine test were given in the unit of g/kWh, but the unit of the representative factors were translated into g/km/ton(vehicle weight). Emission factors in the unit of g/km/ton are shown in Table D4.3.4 in Data Book.

Referring to the average weights of buses and trucks of Hungarian and Japanese, the equivalent inertial weights (ton) were determined: bus (9 ton) and large truck (8 ton).

4) Emission Factors by Car Type for the Estimation of Pollutant Emission

The determined emission factors are shown in Table 4.3.1. For passenger cars and small trucks, Miskolc 1 and Miskolc 2 modes were applied.

Table 4.3.1 Emission Factors for Estimation of Pollutant Emissions

Unit :g/km

Pollutant	Kind of Cars	Test Modes		
		MISKOLC1	MISKOLC 2	ECE NO.49
SO2	Passenger car	0.044	0.047	-
	Small truck	0.068	0.073	
	Bus	-	-	1.546
	Large truck			1.374
NOx	Passenger car	0.797	0.802	-
	Small truck	0.855	0.992	
	Bus	-	-	16.585
	Large truck			14.742
CO	Passenger car	6.99	7.76	-
	Small truck	7.94	8.41	
	Bus	-	-	7.39
	Large truck			7.57

(2) Estimation of Daily Pollutant Emission From Motor Vehicles

Table 4.3.2 shows the annual average daily amount of pollutant emission in major roads by car type.

Large trucks account for 75% of the total SO_2 load from motor vehicles and 70% of the total NOx load from the same.

Table 4.3.2 Annual Average Daily Pollutant Emission in Major Roads by Car Type

Unit : kg/day

Pollutant	Car Type	Quantity	%
SO2	Passenger car	47.4	9.3
	Small truck	4.4	0.9
	Bus	76.7	15.0
	Large truck	380.3	74.8
Total	-	580.7	100.0
NOx	Passenger car	832.6	14.4
	Small truck	57.1	1.0
	Bus	822.5	14.2
	Large truck	4,080.5	70.4
Total	-	5,792.6	100.0

4.3.3 Total Amount of Pollutant Emission

Table 4.3.3 shows the total amounts of SO_2 and NOx emissions. Shares of the source categories in the total emissions of SO_2 and NOx are shown in Figures 4.3.1 and 4.3.2, respectively. Motor vehicles account for 18% of the annual NOx emission and only 0.3% of the annual SO_2 emission.

Table 4.3.3 Total Emissions of SO_2 and NOx (Present)

Source Category		Heating Season				Non-heating Season				Whole Year			
		SO2		NOx		SO2		NOx		SO2		NOx	
		(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)	(t/y)	(%)
Stationary Sources	Borsod P.S.	20,570	38.1	1,481	15.4	10,689	24.4	654	9.5	31,259	32.0	2,135	12.9
	Tisza I. P.S.	17,698	32.8	1,662	17.3	17,110	39.1	1,220	17.8	34,808	35.6	2,882	17.5
	Tisza II. P.S.	3,000	5.6	1,742	18.1	12,036	27.5	1,406	20.5	15,036	15.4	3,148	19.1
	Major Factories	1,795	3.3	1,387	14.4	1,555	3.6	1,480	21.6	3,350	3.4	2,867	17.4
	Communal Facilities	10,851	20.1	2,021	21.0	2,233	5.1	463	6.7	13,084	13.4	2,484	15.1
	Sub total	53,914	99.8	8,293	86.1	43,623	99.7	5,223	76.1	97,537	99.7	13,516	82.0
Mobile Sources	Motor Vehicles	117	0.2	1,339	13.9	144	0.3	1,637	23.9	261	0.3	2,976	18.0
Total		54,031	100	9,632	100	43,767	100	6,860	100	97,798	100	16,492	100

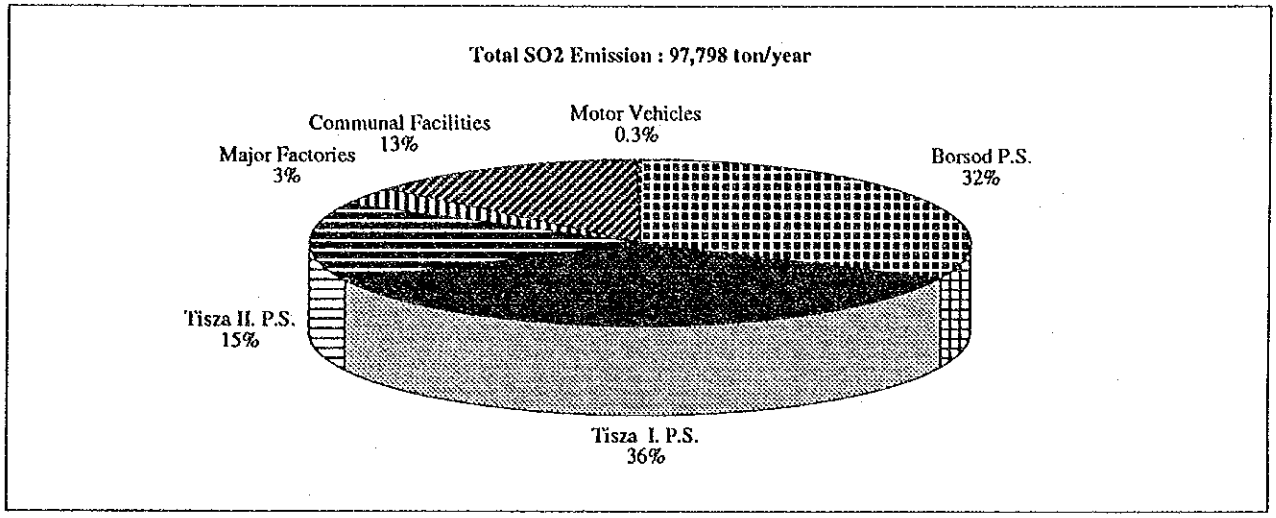


Figure 4.3.1 Shares of Source Categories in the SO2 Emission

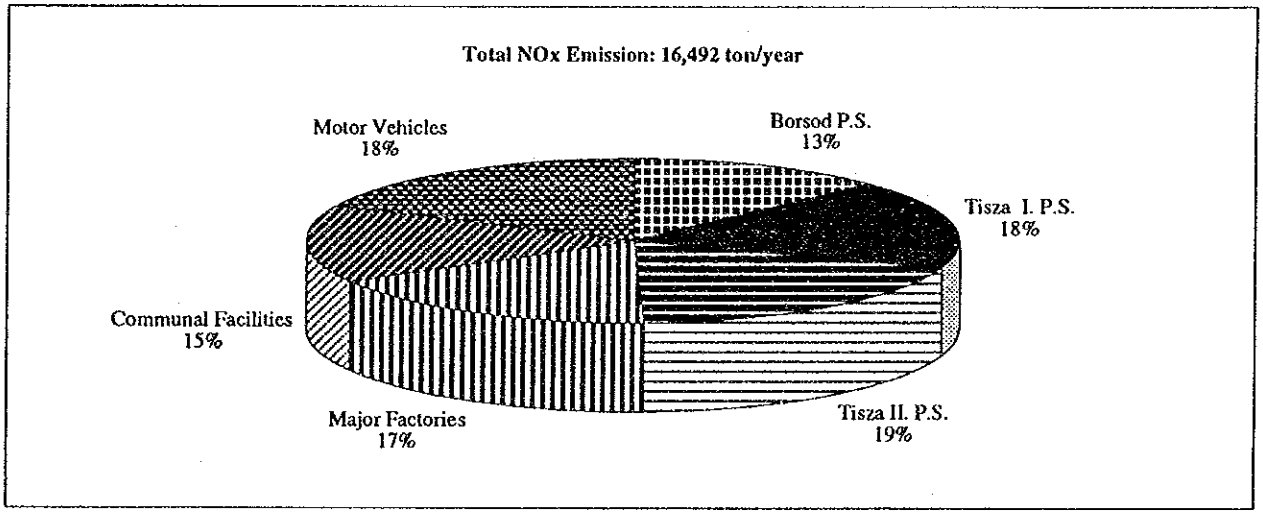


Figure 4.3.2 Shares of Source Categories in the NOx Emission