2) HAMOR RT., DAV KFT., etc.

According to the survey of flue gas by the Study Team, the concentration of oxygen in exhaust gas, which is an indication of heat loss caused by exhaust gas, was 10% or more in almost all cases : only one sample showed 9.7% (DNM), and the maximum concentration was 17.6% (HAMOR). The temperature of exhaust gas was at higher levels with a maximum temperature of 415 °C (DAV). These findings indicate that large amounts of heat are being lost through exhaust gases.

When natural gas is used as fuel, normal oxygen concentrations in exhaust gas are 3 to 5% for small size furnaces of conventional type, or 1 to 2% for medium-to-large size furnaces, depending on the shape and type of the combustion facility.

3) SAGROCHEM KFT.

The survey, as mentioned above, indicated that the concentration of oxygen in exhaust gas was as high as 8.5 % and 7.6 % for P001 (20t/h) boiler that use heavy oil as fuel. Although a super heater had been installed, the temperature of the exhaust gas was measured to be 223°C and 194°C, indicating that heat recovery was insufficient.

4) Power Plant Company

Figure 7.2.2 shows electric energy loss in Hungarian power stations, and Table 7.2.5 shows efficiency of heat supply as steam and hot water in Hungarian power stations and amount of the heat sold.

Table 7.2.5 Heat Supply from Power Stations in Hungary

Power Station	Heat supply efficiency (%)	Sold heat (TJ)
Dunament No.1	83.33	7967.4
Dunament No.2	-	-
Matra	66.67	151.5
Tisza II	-	-
Tiszapalkonya	72.84	2414.8
Oroszlany	67.91	363.5
Banhida	69.02	63.5
Pecs	65.69	3380.6
Borsod	67.83	3129.7
Ajka	71.27	3351.3
Inota	57.80	657.6
Matravidek	58.13	17.2
Base load power stations	73.11	2149.0

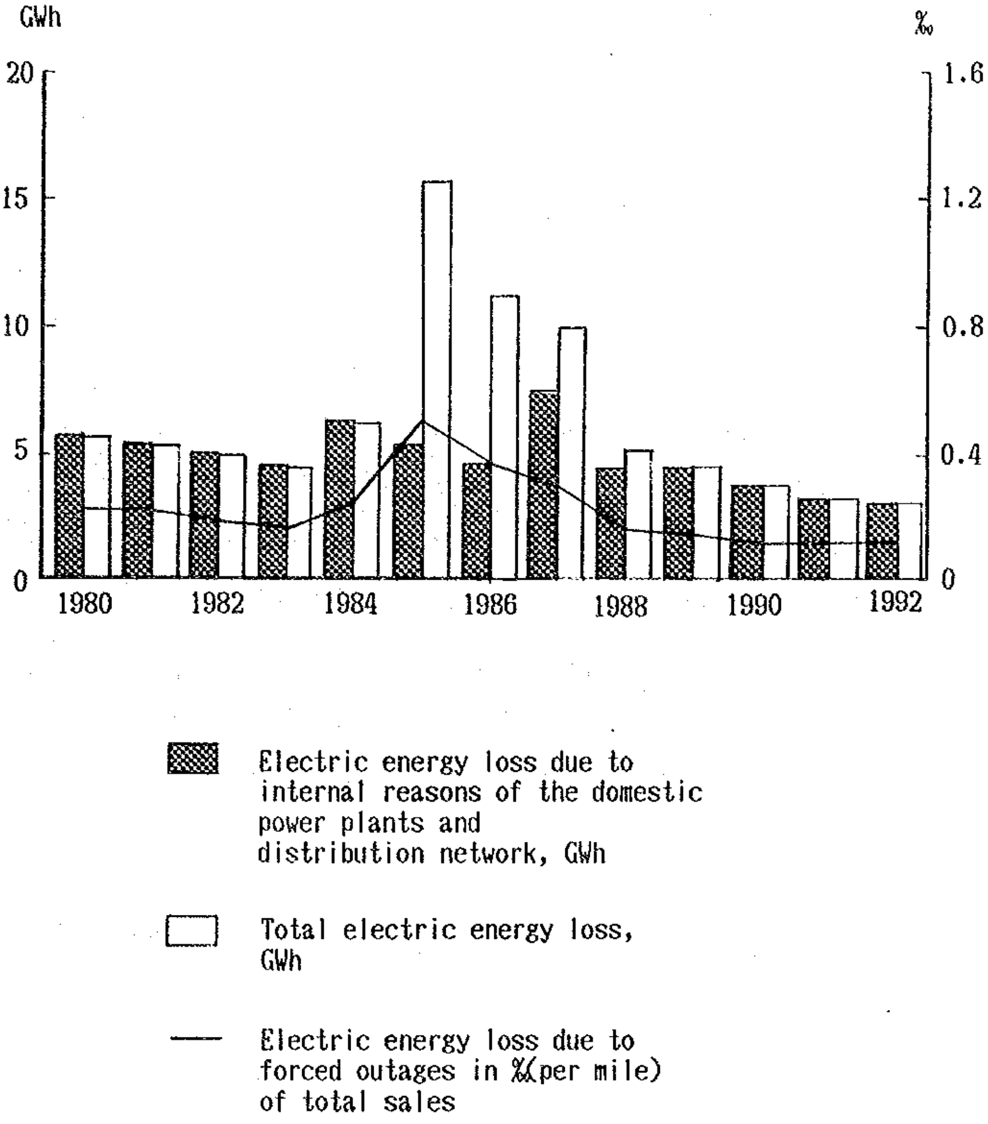


Figure 7.2.2 Electric Energy Loss in Hungarian Power Stations and on the Network

The electric energy efficiency and heat supply efficiency achieved by the Borsod, Tisza Palkonya, and Tisza II power plants in the period of January - August in 1993 are as follows:

Power Plants	Electric Energy Efficiency	Heat Supply Efficiency
Borsod	26%	67%
Tisza Palkonya	26%	73.4%
Tisza II	36%	-

The rates of electric energy efficiency achieved by the coal-fired plants (Borsod and Tisza Palkonya) are much lower than the average rate of 38 - 40% achieved by all coal-fired power plants in Japan, and even lower than the lowest level found in China (27%).

The lower rates of heat supply efficiency are attributable to the causes described below:

In the case of the Borsod power plant, steam of 75 bars and 495°C produced in the boilers is converted to steam of 29 bars, 15 bars, and 6 bars, or to hot water through steam cooling equipment before supply. Moreover, no hot water is fed back from the steam cooler directly to the boiler, and the heat loss from the generator is not utilized effectively.

The case of the Tisza Palkonya (Tisza I) power plant is similar. Generated steam of 98 bars and 520 °C is converted to steam of 17 bars, and to hot water through the steam cooler before supply. The boiler efficiency is less than 80%, which is much lower than the average for power plants.

In the case of the Tisza II power plant, the electric energy efficiency is 36% which is the average for power plants built in 1977, although much lower than that in Japan. More energy saving efforts should be made to improve energy efficiency.

Regarding steam and water supplied from by the Tisza Palkonya power plant, there had been no flow meters in consumers' houses in the town until the summer of 1992. In the winter of the same year, flow meters were installed in some residential areas in the town. The installation reportedly brought about a drastic decrease in the amount of heat supply. In the past, the lack of a flow meter monitoring system allowed consumers to continue to use heating resources wastefully. But now, consumers are making efforts to use less heating resources for saving utility bills, resulting in the drastic decrease of heat supply from the plant.

5) Abolition of State Subsidies

In Hungary, coal production has received no state subsidies since January 1992. On the other hand, gas and communal heating oil productions still receive state subsidies which are equal to 40 and 60 percent of their production costs, respectively. This is considered to be one of the main causes of the country's wasteful energy consumption habits.

After recommendations from the World Bank, the Government scheduled to abolish the subsidies of gas and oil in 1995. It is highly recommended to adopt a market pricing system in the country's energy sector.

7.3 Study on Pollution Control Technology for Stationary Sources

7.3.1 SO_2 Emission Control Technology

(1) Outline of SO_2 Emission Control Technology

Control measures for SO_2 pollution caused by burning coal are generally classified as shown in Figure 7.3.1. These are briefly explained below.

1) Preliminary Desulfurization Techniques

Physical removal:	30 - 90% of inorganic sulfur can be removed by the differences in specific gravity, degree of wetness by water and oil, and magnetization. However, little organic sulfur can be removed.
Chemical removal:	Organic sulfur can be removed by oxidation and substitution, however, the cost is higher than that of physical removal.
Biological removal:	Sulfur in coal can be removed using microorganisms. This takes longer time than other methods.

2) Simultaneous Desulfurization Techniques

In combustion of pulverized coal, desulfurization methods include a method of feeding limestone and coal sumultaneously into the furnace (blowing-into-furnace method) and a method of desulfurization using limestone as a fluidizing medium in fluidized bed combustion. Fluidized bed combustion does not achieve sufficient sulfur removal efficiency unless the Ca/S ratio is 2 - 3 or more since the grain size of limestone is comparatively large. Moreover, there is a problem of limestone wear. Pulverized coal firing has the problem of low desulfurization efficiency (about 40%). With some combustors as in a power plant, the grains stick to the wall of boiler, thereby possibly decreasing thermal efficiency.

3) Stack Gas Desulfurization Techniques

These techniques can be roughly divided into two kinds: dry process and wet process. In Japan, the wet process is mainly used. Recently, a method called semi-dry process has been studied.

i) Wet process

SO_2 is removed by absorption solution. This has a high efficiency of 90 - 99%. It also removes dust passing through the scrubber. However, it requires a large volume of blow

Technique	Process	Desulfurization process	By-product
Preliminary Desulfurization technique			
Simultaneous Desulfurization technique		Fluidized be combustion method	
Stack gas desulfurization technique	Dry process	Actived carbon absorption method	Sulfuric acid, Gypsum
		Activeted manganese oxide method	Ammonium sulfate
		Alkalized aslumina method	Sulfur
		Lime suction method	Gypsum
		Catalytic oxidation method	Sulfuric acid
		Fused carbonate method	Sulfur
	Semi-dry process	Two-stage method (furnace internal desulfurization + flue gas desulfurization)	Gypsum
		Spray dryer method	Gypsum
	Wet process	Sodium sulfite absorption method	Sulfur, Sulfuric acid, Gypsum
		Potassium sulfite absorption mehod	Sulfur, Sulfuric acid, Gypsum
		Ammonium hydroxide absorption method	Ammonium sulfate, Gypsum, Sulfur
		Lime absorption method	Gypsum
		Lime suction wet absoription method	Gypsum
		Magnesium absoription method	Sulfuric acid
		Dilute sulfuric acid absorption method	Gypsum

Figure 7.3.1 Various Desulfurization Method

water to be treated in wastewater treatment facilities, and the gas temperature drops to 50 - 60°C, which is near the dew point, causing heat loss. Running costs are high.

ii) Dry process

There are two desulfurization methods: absorption of exhaust gas SO2 using solid absorbent and absorption using activated carbon. These are suitable for mass treatment of exhaust gases. Since the exhaust gas temperature does not fall, dispersion of the stack exhaust gas is not hindered. Another advantage is that it uses little water. However, since the desulfurization percentage depends on the specific surface area of absorbent, a large amount of absorbent is required and the cost is high. Although, lime is cheap, it has a disadvantage of low reaction speed.

iii) Semi-dry process

This process increases the desulfurization efficiency of dry method by spraying water in the flue.

(2) Outline of Fluidized Bed Combustion Method

1) Basic Characteristics

Regarding the desulfurization process of SO2 in large-sized stationary sources, wet-type desulfurization process incorporating the wet-type limestone-gypsum method has been mainly used up to now in countries such as Japan, and it is well established technically. However with this method, although the desulfurization rate is very high, there are certain requirements such as large amount of water supply, wastewater treatment facilities and supplementary gas and gas heater facilities.

On the other hand, there is the fluidized bed combustion method for coal combustion. Its wide range applicability for various coals, in-furnace desulfurization and low pollution due to low temperature combustion (about 900°C) are advantages. The hot-dry desulfurization method is used for this fluidized bed combustion. A direct desulfurization agent (limestone, usually) is blown into the furnace, and as combustion continues, it removes SOx by absorbing it at the same time. There is almost no need for supplementary facilities, and there is no temperature decrease as occurs in the wet process, so it is thought to be a reasonable desulfurization process from the viewpoint of energy efficiency. Thus, including in-furnace desulfurization which accompanies fluidized bed combustion, hot-dry desulfurization is one process that can solve the above mentioned problem. However, the utilization rate of desulfurizing agent is low in fluidized bed in-furnace desulfurization. Because, this method is based on the reaction and absorption process which accompanies the increase of the specific molecular volume of desulfurizing solid particulate agent. Therefore, the major problem is that the Ca to S molar ratio of 2 - 4 is required in order to obtain a desulfurization rate greater than 80%.

The following are the basic characteristics of fluidized bed combustion:

- It can be applied to various kinds of coals.
- Low NOx combustion is possible due to combustion at low temperature.
- There are few problems with ash
- In-furnace desulfurization is possible.
- Heat transfer of the heat transfer pipe inside the bed is good and the heating area is smaller.

2) Types of Fluidized Bed Coal Combustion

By fluidized state of solid particulates, fluidized bed coal combustion is classified into the air bubbling fluidized bed combustion (BFBC) and the circulating fluidized bed combustion (CFBC). It is possible to further classify them into normal pressure type and the pressurized type. At first, studies and development of the fluidized bed were done using the normal pressure air bubbling fluidized bed type. However, with the aim of improving operation and combustion efficiency, research on various modifications is now under way. Moreover, in recent years, with the aim of increasing efficiency of electricity generation and making equipment more compact by incorporating the combined cycle with a gas turbine and steam turbine, studies and development of pressurized fluidized bed combustion (PFBC) have also been active. The Hungarian Institute of Electric Power Research (VEIKI) developed hybrid fluidized bed combustion (HFBC) for low calorie brown coal by modifying existing boilers.

(3) Circulating Fluidized Bed Combustion Process

The CFBC process uses the heat storage of the circulation material (bed ash) in the combustion chamber, and the heat from the fuel is transported from the suspended material (the flue gas generated and ash transported) to the heat absorption surface of the fluidized bed combustion chamber via convection and radiation. In this case, the low temperature of the combustion chamber can suppress NOx production to the lower level than the case of combustion of grained coal. Accordingly, desulfurization is achieved in the course of circulation fluidized bed combustion by means of the $CaCO_3$ additive. It is said that there is no particular need to add the equipment of desulfurization and denitrification.

Fine limestone grains for desulfurization is mixed into the combustion chamber from the furnace side, with desulfurization executed directly in the combustion chamber.

Combustion of sulfur in fuel: $S + O_2 \rightarrow SO_2$
Burning of limestone: $CaCO_3 \rightarrow CaO + CO_2$
Reaction: $CaO + SO_2 + 1/2O_2 \rightarrow CaSO_4$ (gypsum)

CFBC has the following features:

- Easy to prepare the fuel
- High combustion efficiency
- Low NOx generation rate due to low combustion temperature of about 850°C
- Substantial reduction of the SO_2 content in the flue gas through injection of limestone within an appropriate temperature
- Superior in correct load fluctuation and partial load change in operating conditions
- Higher operation reliability and applicability when compared with conventional equipment

Requirements to maintain these fundamental features are as follows:

- Combustion process (heat release) matched to appropriate combustion over the entire height of the combustion chamber
- Adequate grain size distribution for fuels, limestone and bed ash
- Well-matched relationship with internal and external circulation bed ash amount appropriate respectively to the fuel
- Effective introduction of required combustion air and additional flue gas circulation in the combustion chamber
- Step air supply
- Fly ash return in particular case
- Effective particle movement of individual grain pieces
- Sufficient reaction route and temperature
- Sufficient contact opportunity for each reactor

High-level technology to meet the above requirements will help achieve the high combustion quality and low pollutant generation.

(4) Hybrid Fluidized Bed Combustion Method

1) Development of Hybrid Fluidized Bed Combustion System

The Hungarian Institute of Electric Power Research (VEIKI) began research of BFBC in the middle of 1980s. They reconstructed the 47 t/h boiler at the Tatabanga thermal power plant and carried out experiments. In 1990, they reconstructed the old pulverized coal firing boiler for low caloric brown coal and developed hybrid fluidized bed combustion (HFBC) system. It is a combination of the conventional boiler for pulverized low-calorie brown coal and fluidized bed combustion.

Four of the 100 t/h boilers (12 through 9) at the Ajka thermal power plant were used for the reconstruction experiment, which was completed with the assistance of the PHARE Program of EC. This system is planned to be employed in the Borsod Power Plant as described in Section 7.2.3.

This system is relatively inexpensive and can be readily coupled with any existing boiler. Because of fluidized bed combustion, an air distributor is installed below a furnace. The fluidized bed is formed through utilization of the difference in the air flow rate jet out from this air distributor. (Three air boxes of the air distributor ensure forming of a main middle layer and layers on both ends circulating about two times.) The air distributor includes a membrane wall connected to a circulation system of the boiler. The air for fluidized bed is preheated (310°C) and supplied to air boxes through separate ventilators. Primary air and secondary air for grained coal injector are supplied by a forced draft fan.

Direct desulfurization directly in the combustion chamber proceeds as shown below :

Combustion of sulfur in fuel: $S + O_2 \rightarrow SO_2$
Burning of limestone: $CaCO_3 \rightarrow CaO + CO_2$
Reaction: $CaO + SO_2 + 1/2O_2 \rightarrow CaSO_4$ (gypsum)

The hybrid fluidized bed combustion has the following features:

- Applicable to combustion of coals with high ash content or coals differing in grade without help of oil
- Low-load stable combustion (40% of normal combustion)
- Decrease in SO2 generation and decrease in NOx generation by low-temperature combustion
- Satisfactory combustion efficiency

2) Combustion Test of HFBC Conducted by VEIKI

A combustion test of HFBC system was conducted by VEIKI at the Ajka Power Plant using 100 ton/h boilers. The results indicate the following problems:

i) The desulfurization rate is considerably high at 70 - 80 % under the combustion load with the evaporation rate at 60 - 70 t/h, but it decreases to 50 - 60% under the evaporation rate at 100 t/h. The reason is considered to be as follows. The combustion proceeds within the fluidized bed up to the evaporation rate of 60 - 70 t/h. However, since heat transfer tubes are not installed within the fluidized bed, additional pulverized coal burners installed above the fluidized bed are used, thereby ignoring desulfurization effect, in order to increase the evaporation rate to 100 t/h. (When heat transfer tubes are installed within the fluidized bed, solid particles are highly fluidized and the heat transfer efficiency is increased enabling reduction of heat transfer surface area, therefore reduction of the boiler size. However, troubles due to abrasion of heat transfer tubes are unavoidable.)

ii) Under the combustion load with the evaporation rate at 100 t/h, the denitration rate tends to decrease, besides the reduction of desulfurization rate, with the increased concentration of NOx in the flue gas to 300 - 350 ppm. This is due to the appearance of a peak of the combustion chamber temperature around the flame of the pulverized coal combustion above the fluidized bed.

3) Combustion Test of HFBC Conducted by the JICA Study Team

When HFBC boilers are introduced to the Borsod Power Station, the following problems arise because the brown coal used in the Borsod plant differs from that of the Ajka plant.

i) The desulfurizing agent has to be added

ii) The desulfurization ratio drops because pulverized coal burning must be made during high load operation to compensate for deficient heat value obtained solely from fluidized bed combustion and thus the study must be made concerning substitution of the deficient heat value with a high quality fuel with less sulfur content.

iii) Improvement of the combustion method must be made to use the low-grade coal.

In view of the situation, the Lyuko coal and limestone used in the Borsod power station was transported to the Ajka station for the demonstration test of HFBC.

The test result shows the following:

i) The desulfurization ratio was 42 - 45% (desulfurization ratio with added desulfurizing agent was 23 - 34%). The NOx concentration was lower by 40 - 80 ppm than that of the existing grained coal boilers.

ii) Though substituting the deficient heat value with the fuel with less sulfur content is technically possible, CaSO4 (gypsum) that has been subjected to desulfurization reaction in the fluidized layer combustion zone passes through the high-temperature combustion zone together with the flue gas, resulting in partial reduction and causing degradation of the desulfurization ratio.

iii) The desulfurization rate at 60% may be attainable if following measures are taken:

a) Increase the capacity of the coal feeder and dryer.

b) Ensure even temperature within the fluidized layer.

c) Study the grain size of desulfurizing agent (limestone) and loading method.

d) Install coal mill to finely purverize the Borsod coal.

e) Well mix coal and limestone.

f) Spray lime slurry into flue gas.

7.3.2 NOx Emission Control Technology

A Hungarian burner maker has developed a world high-ranking low-NOx burner, that has incorporated the advanced rocket combustion technology of the USA and former USSR, and is now marketing this product at a price far lower than the international level. In Sajó Valley area, however, the low-NOx combustion technology is not well disseminated. Twelve of 52 facilities surveyed appear to require introduction of a certain NOx reduction facility or denitrification equipment. They are two waste incinerators, one cement rotary kiln, two glass melting furnaces, one sintering furnace, two thermoelectric power stations, one soaking pit, one forging furnace, one heavy oil boiler for heating and one nitric acid plant.

An outline of NOx emission control technology and some of available methods that may be applied to above facilities are described below.

(1) Outline of NOx Emision Control Technology

1) Principles of NOx Generation

When a material is burnt, nitrogen (N_2) in the air and organic nitrogen in the material (fuel N) are bound with oxygen (O_2) to produce nitrogen oxides (NOx). NOx produced by binding between nitrogen in the air and oxygen is called thermal NOx and the other is called fuel NOx.

i) Thermal NOx

The factors in the generation of thermal NOx include: (1) O_2 concentration in the combustion zone, (2) combustion temperature (flame temperature), and (3) combustion gas detention time at high temperature.

NOx generation increases as the detention time at high temperature increases and the O_2 concentration increases.

ii) Fuel NOx

Fuel N in heavy oil or coal is incorporated into the complex aromatic nucleus in the forms of pyridine, quinoline, pyrol, indol, and carbazol. It is also contained in sludge or dust in the form of ammonium or protein.

Fuel N is considered to be more easily oxidized than N_2 in the air. But the oxidation process and natures of decomposed intermedite products are not well known.

Assuming that N contained in a fuel by 0.1% is totally converted into NO, its concentration under the condition of 0% O_2 becomes as follows:

heavy oil	approx. 155 ppm
coal	approx. 200 ppm
sludge (13,810 kJ/kg DS)	approx. 440 ppm
municipal wastes (7,120 kJ/kg)	approx. 755 ppm

The concentration becomes higher as the calorific value per unit weight of the fuel is smaller.

The fuel NOx actually generated occupies a certain percentage of the above values. This ratio is called the fuel NOx conversion ratio.

The generation of fuel NOx exhibits the following tendencies:

a) Under combustion conditions with air deficiency or low excess air ratio, the generation of fuel NOx is suppressed.

b) The fuel NOx conversion ratio decreases with increasing N content in fuel. But the amount of NO generated increases with the increasing N content.

c) The generation of fuel NOx is faster than that of thermal NOx. Moreover, the effect of temperature on the rate of fuel NOx generation is small, i.e. fuel NOx is generated even at relatively low temperature.

d) The amount of NOx generation varies with the state of air-fuel mixing. NOx generation increases with higher degree of mixing.

2) Methods for Reduction of NOx Emission

There are three basic methods for reducing NOx emission from a combustion facility:

- Control of NOx generation itself
- Reduction of exhaust gas volume by fuel saving (reduction of NOx amount)
- Removal of generated NOx (denitration)

i) Control of NOx Generation

Considering the principles of NOx generation, the generation can be suppressed by taking the following measures:

a) Keep the O_2 concentration low in the combustion reaction zone
(Low air-ratio combustion, two-stage combustion, off-stoichiometric combustion, emulsion combustion, etc.)

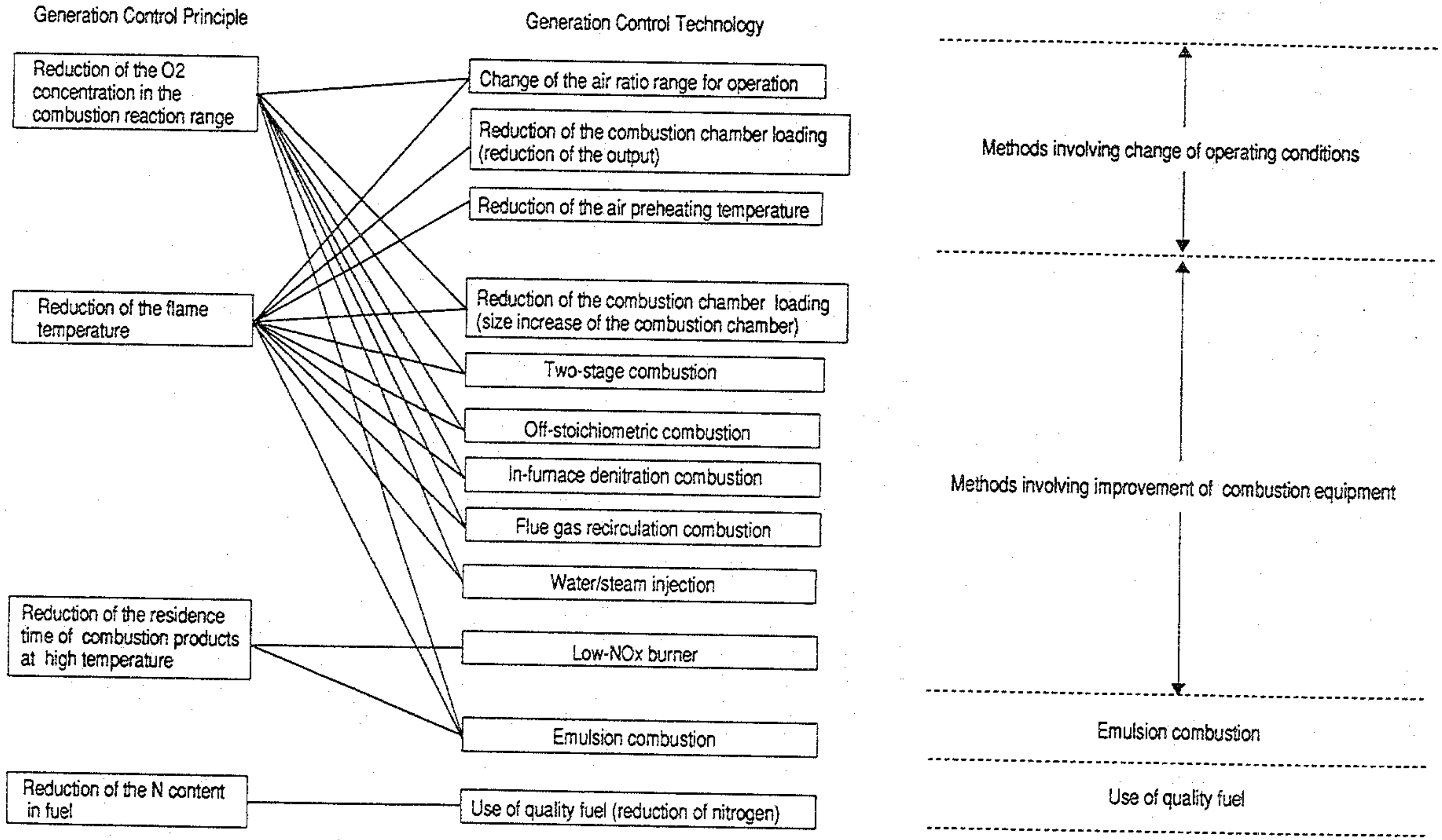
b) Keep the flame temperature as low as possible
(Exhaust gas recirculation, steam/water injection, emulsion combustion, etc.)

c) Reduce the detention time at high temperature
(Rapid mixed combustion, combustion with extremely fine atomization of oil-in-water type emulsion, high-speed heat transmission type low-NOx burner)

d) Reduce the N content in fuel
(Change to quality fuel)

Various NOx generation control technology may be classified in relation to above principles as shown in Table 7.3.1.

Table 7.3.1 NOx Generation Control Principles and Technology



ii) Reduction of NOx Emission by Energy Saving

The gross NOx emission amount is reduced by reducing fuel consumption thereby decreasing the amount of exhaust gas without increasing the NOx concentration through stabilization of furnace or boiler operation.

a) Energy Saving by Control of Furnace Operation

Energy consumption can be reduced by controlling the temperature of the material being heated (prevention of overheating, etc.) and by preventing air intrusion into the furnace.

b) Installation of Energy Saving Equipment

The waste heat can be recovered by installing an economizer (in case of a boiler) and an air preheater. In the case of ordinary burners, the NOx concentration will increase when air is preheated. Therefore, a low-NOx burner which does not cause increase of NOx concentration by air preheating needs to be used.

c) Low Air Ratio Combustion

The low air ratio combustion enables reduction in fuel consumption and resultant reduction of exhaust gas amount, leading to reduction of the NOx concentration itself.

iii) Denitration

Denitration is employed when control of NOx generation by changing combustion method is difficult or there are certain constraints to control NOx generation during combustion. For example, strengthening of NOx generation control may decrease NOx, but it may also hinder heat transmission to the material inside the furnace, thereby adversely affecting the quality of products or causing secondary pollution through generation of particulate matter (PM) or CO. In the case of solid waste incinerator, NOx generation control may cause incomplete combustion and unburnt materials may remain in the ash. This method should be considered in such cases, or when a high degree of reduction of NOx emission is required.

a) Non-catalytic Denitration

In this method, NH_3 or urea is blown into flue gas of around 900°C containing NOx in order to reduce NOx to N_2. The NOx reduction rate by this method is normally around 40 - 70%.

b) Simplified Denitration Method

The non-catalytic denitration method requires that a considerable amount of NH_3 be blown in order to increase the denitration rate. This is often associated with an increase in non-reacted NH_3. The simplified denitration method employs a simple catalytic layer in the flue so as to utilize such non-reacted NH_3 to enhance the denitration rate while preventing release of NH_3.

c) Flue Gas Denitration Method

Wet and dry methods are available, and the dry method is currently used in most cases. In the wet method, NO is oxidized to more reactive NO2 by ozone or other oxidizing agents, and then washed and absorbed by water or alkalis. In the dry method, reduction of NOx by NH_3 is enhanced by the use of a catalyst. The flue gas temperature is 200 - 300°C and the denitration rate is 90% or more.

In some cases, however, problems such as damaging of the catalyst by SOx or clogging of the catalystic layer with smoke and soot may occur.

(2) Two-stage Combustion Burner

Combustion by the two-stage combustion burner consists of the first and the second stages. In the first-stage of combustion, the air ratio is set far below (around 0.5 - 0.7 though varying depending on the fuel) the level of the conventional combustion method and the fuel is decomposed to generate a combustion gas consisting mainly of CO and H_2. This gas is completely burnt with secondary air in the second stage.

For waste liquid incineration, there is a type of burner with two-stage combustion.

Primary air is introduced in two steps : 1) near the burner nozzle, and 2) into the flow at a right angle halfway within a primary combustion chamber. The gross flow is set at a standard value of 0.7 of the theoretical air flow. The residual air flow necessary for combustion is introduced, as secondary air, into a secondary combustion chamber. Waste liquid is sprayed into the secondary combustion chamber via two atomizers provided in the middle portion of the secondary air nozzle. When the air ratio is appropriately adjusted, the NOx concentration may be reduced to 150 ppm or less.

(3) Oxygen Burner and Oxygen Production Method

The glass melting furnace requiring a temperature as high as 1500°C or more to melt the raw materials generates the thermal NOx (500 - 1500 ppm) in large quantity because of high-temperature combustion even when natural gas is burnt.

For natural gas combustion without Fuel N, a method to reduce NOx substantially by an oxygen burner has been developed. By using only the O2 gas without N content, instead of the combustion air, generation of the high-concentration thermal NOx can be suppressed. Moreover, the fuel can be saved by 5% due to the high-temperature combustion effect with O2.

However, when O2 is to be supplied in a cylinder from a gas maker, the running cost for the combustion becomes higher. Recently, a new process of oxygen production has been developed.

This process, called Lindox process, separates the oxygen in air by means of a pressure swing adsorption system. The process is simple without particular equipment for heating and dehumidification. Though three or four adsorption towers are used mostly, there is no difference in the principle between them. The raw air is passed through the filter by a forced draft fan (FDF) to remove mist and drain, then supplied to one of adsorption towers. In the tower, the moisture, CO2, HC and N2 are adsorbed and O2 is separated.

After a certain period of time, air feed is switched to another adsorption tower automatically and the pressure of the previous tower is reduced slightly by a vacuum pump to fall off the adsorbed materials and to release and regenerate the absorption tower. The unit is compact and easy to start/stop with only one pushbutton. The purity of the product oxygen can be adjusted in the design conditions but is limited to maximum 95% (normally 93%) because argon existing in 0.93% in the air is mixed. The gas composition is as follows:

O2 :	95 vol%
Ar :	4.5 vol%
N2 :	0.5 vol%

The N2 content at this level produces only a few ppm of NOx.

Conventionally, O2 has been produced in a large scale by a super-low temperature air separator. This unit separates the air through liquefaction and distillation at super-low temperature. The product has been transported in a form of liquefied oxygen for applications of a small scale. The above Lindox process, however, is more compact than the super-low temperature air separator and enables easy and safe oxygen production on site at normal temperature and low pressure. The process is best suited for applications with the oxygen consumption of about 1 - 30 t/day for which there has been no appropriate oxygen supply method in the past. When O2 is used instead of an air for various applications which have relied conventionally on an air as an O2 source, substantial energy saving effects can be expected. They include increase in the reaction rate, improved yield, compact unit size, decrease in the heat loss, and substantial reduction of the flue gas amount.

Apart from the above, the Lindox process may be applied in the wide field, such as kiln, sintering furnace, metal smelting, chemical industry, fermentation industry, paper making industry, and wastewater treatment, which could only rely on the air.

(4) Internal Denitration Process of Vertical Water-tube Boiler Burning Pulverized Coal

The process utilizes the NOx reducing function of hydrocarbon fuels, in which a part of main fuel is bypassed to be used as a denitration fuel. The denitration reaction is completed wholly within a furnace. There are some variations in internal denitration technology. These processes are said to be able to reduce the NOx generation substantially in the purverized coal burning boilers.

(5) Denitration Process in Ammonia Oxidation Furnace

This process (Pura Siv N process) is to eliminate and recover NOx contained in the flue gas from a nitric acid plant. A molecular sieve is provided with a catalytic capacity of NO + 1/2O2 => NO2 and NO in NOx reacts with the oxygen remaining normally in about 3% in the flue gas and turns into NO2, then adsorbed. The concentration of NOx left un-adsorbed is 10 ppm or less. This process is therefore extremely superior to various NOx eliminating processes that have been made available to data.

Regeneration is made at about 300°C and the nitric acid undertakes recovery to plant. The nitric acid yield can be enhanced by about 2.5%. When this process is compared with the NOx contact reducing process for flue gas treatment of a 300 t/day nitric acid plant, the equipment cost is higher by about 28%, but the total treatment cost is lower by 20%. Due to this cost merit and the superior treatment result of 10 ppm of NOx, this process is reported to be favorable for application. The life of molecular sieve is calculated to be two years in this case.

7.3.3 Energy Saving Measures and Organization

To propel energy saving, the enterprises will be required to establish such organization. Also, energy diagnosis procedures and decision criteria for rationalizing energy consumption should be established.

These measures practiced in Japan are outlined below.

(1) Organization to Implement Energy Saving Measures

Each plant should be organized to implement energy saving as described below.

i) Has a director for the implementation energy saving been appointed? Which section is responsible for energy calculations? How the effects of efforts and improvements and their results are reported to the president ?

ii) Are methods of improvement planning and evaluation appropriate? The following items require attention as a basis for selecting check items:

a) Are control criteria for each process prepared? Are manuals prepared for maintenance of measuring instruments and measuring procedures? Are forms for recorded data established?

b) Are items of maintenance and checking of facilities and machines in each process written as manuals? Are forms to show the results established?

c) Are the above forms translated into data forms allowing analysis?

These and other items must be confirmed in advance.

iii) Energy saving goals and check points requiring special attention

a) Decision on energy saving goals

b) Elimination of wastefulness of entire plant

To decide an energy saving campaign on goals to be tackled everyday, such as unit energy consumption requirement, prevention of idled operation by employee, and turning lights off when not necessary.

c) Energy saving by process rationalization

To analyze work movements for each process and to decide energy saving goals.

d) Energy saving by heat insulation and heat recovery

To study types and effect (economical efficiency) of heat-insulation materials, as well as heat recovery means and methods, and to decide energy saving goals, using a heat balance sheet as a reference.

e) Energy saving by installing energy saving equipment

To decide energy saving goals by installing new equipment, for example, high-efficiency burners, electric arc furnaces, high-efficiency ganged crucibles, high-performance slow cooling furnaces and heating furnaces.

Views will be coordinated with line operators and necessary training will be provided to accomplish the foregoing energy saving goals.

(2) Procedure for Energy Diagnosis

Procedure for energy diagnosis is shown in Figure 7.3.2.

(3) Decision Criteria for Rationalizing Energy Consumption

An outline of decision criteria for rationalizing energy consumption is shown in Table 7.3.2.

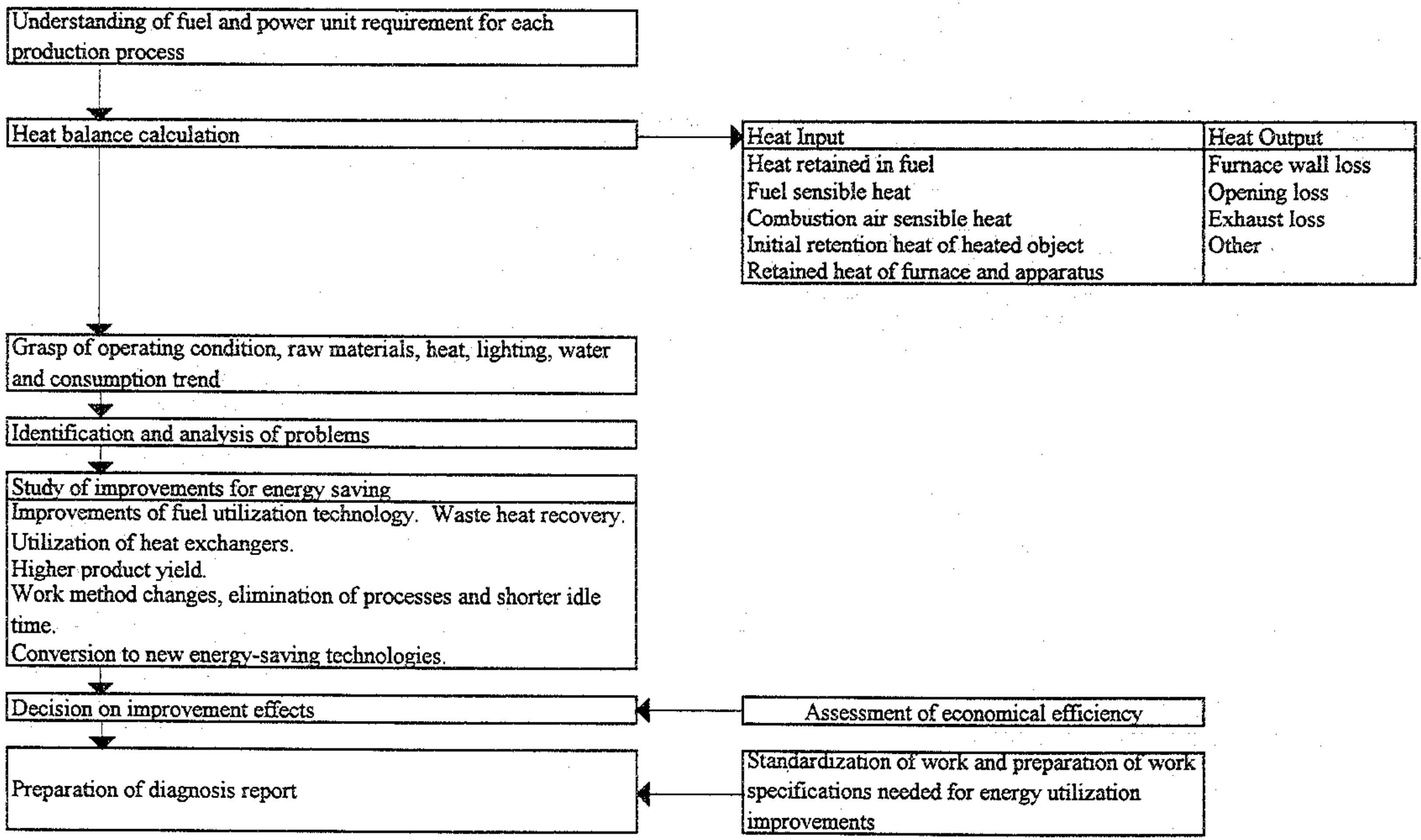


Figure 7.3.2 Procedure for Energy Diagnosis

Table 7.3.2 Outline of Decision Criteria for Energy Consumption Rationalization by Plant

(Based on article 4 of Japanese Law Concerning Rationalization of Energy Consumption)

	Fuel Combustion Rationalization	Heating, Cooling and Heat Transfer Rationalization	Prevention of Heat Loss by Radiation and Thermal Conduction	Waste Heat Recovery and Utilization	Rationalization by Converting Heat into Motive Power, etc.	Prevention of Power Loss by Resistance, etc.	Rationalization of Conversion of Power to Motive Power, Heat, etc.
Setting Standard for Improving Control Standards	Control standard for excess air ratio	Standards for temperatures of articles to be heated and cooled, of heat transfer medium, for pressure, flow and other parameters, and for air conditioning temperature and humidity.	Standard for heat-insulation works.	Standard for waste heat recovery utilization	Standard for load adjustment among boilers and turbines. Standard for minimum allowable pressure for exhaust and back pressure turbines.	Control standard for voltage, current, power factor, load factor and demand factor of incoming, transforming and distribution equipment.	Standards, etc. for voltage, current, power factor and demand factor on electric-motor applied, electric heating and lighting equipment.
Measurement and Recording	Measurement and recording of fuel supply quantities, emission gas temperature, amount of residual oxygen in emission gases and other parameters.	Measurement and recording to understand heat transfer conditions such as temperature, pressure and flow. Measurement and recording of air conditioning temperature and humidity.	Heat balance analysis.	Measurement and recording of items to understand waste heat condition. Study of effective waste heat utilization method.	Measurement and recording of heat efficiency of main boilers and turbines. Operation at minimum allowable pressure.	Measurement and recording of values listed above.	Measurement and recording of values listed above. (Coefficient of utilization also measured for lighting)
Maintenance and Checks	Maintenance and checks of combustion facilities.	Prevention of deterioration of heat transfer performance, control of boiler water quality, and maintenance and checks of air conditioning facilities.	Prevention of heat transfer medium leaks due to damaged or missing parts, maintenance of heat-insulation parts, maintenance and checks of steam traps.	Clean dirty heat transfer surfaces of waste heat recovery facilities. Prevention of heat transfer medium leaks from facilities.	Maintenance and checks of boilers and turbines. Maintenance and checks of turbine blades and other components in operation at minimum allowable pressure.	Maintenance and checks of incoming, transforming and distributing facilities.	Reduction of machine damage such as friction. Prevention of fluid leaks in fluid machines. Maintenance and checks of other electric heat, electrolytic and lighting
Improvements and Facility Installation for Rationalization	Adjustment of combustion load, selection of appropriate burners, improvements in ventilators and installation of combustion controllers and heat storage systems.	Review of heat consumption and supply conditions. Improvements in heat patterns, adjustment of loads and other improvements in direct heating. Installation of high-thermal efficiency facilities such as multi-stage use of heat. Continuation, integration, shortening and omission of processes.	More effective heat insulation, reduction in size of openings, installing covers on open-type facilities and rationalization of supply pipes.	Prevention of temperature loss during waste heat transport process. Improvements in heat transfer surfaces of waste heat recovery facilities, installation of recovery and utilization facilities suiting waste heat use.	Remodeling of turbines to lower minimum allowable pressure. Utilization of surplus steam, which has value for use, to power generation and work motive power.	Operation of transformers at appropriate load, optimization of transformer capacity, load leveling, optimal incoming and transforming equipment layout, improvements in power factor and imbalance among three phases.	Prevention of motor idling, appropriate distribution of loads, review of pump heads, speed control, installation of motors with appropriate capacities and other facility improvements and installation.

7.4 Air Pollution Control of Mobile Source

The major mobile source of air pollution in Sajó Valley Area is motor vehicles.

In general, control measures for mobile sources are roughly divided into two groups. One is to reduce the number of motor vehicles and the other is to improve motor vehicles technologically. However, since the reduction of motor vehicles as a control measure against air pollution is difficult, the improvement of motor vehicles has been applied generally.

7.4.1 Present State

Prior to the study of control measures for motor vehicles, it is useful to take a look at the current situation which will help to determine appropriate actions. In Hungary, the Ministry of Transport, Communication and Water Management (KHVM) has taken action to regulate air pollution from motor vehicles.

1) Number and Age of Registered Motor Vehicles

In 1990 , 2.2 million vehicles in Hungary, 0.13 million vehicles in BAZ county and 45,000 vehicles in Miskok were registered, respectively, as shown in Table 7.3.1. With regard to the ratio of vehicle types, passenger cars account for County 80 - 87%, buses account for 1.2 - 3.1%, and trucks account for 12 - 16% of the total number. The ratios of buses and trucks in Miskolc are somewhat higher than those in the country and BAZ County.

Table 7.4.1 Number of Registered Motor Vehicles by Type (in 1990)

	Ps. Cars	Buses	Trucks	Sum
Hungary	1,944,553	26,121	262,445	2,233,119
%	87.1	1.2	11.8	100.0
BAZ. country	109,674	2,180	17,093	128,947
%	85.1	1.7	13.3	100.0
Miskolc	35,928	1,401	7,226	44,555
%	80.6	3.1	16.2	100.0

The distribution of passenger cars in Hungary by manufacturers is illustrated in Figure 7.4.1. Only three manufacturers in Eeastern European countries i.e., Lada, Travant and Wartburg account for more than 60% of the total number of passenger cars in Hungary. Figure 7.4.2 indicates that 30 - 40% of all categories of motor vehicles in Hungary are 10 years or more of the age. This raito is highest for passenger cars.

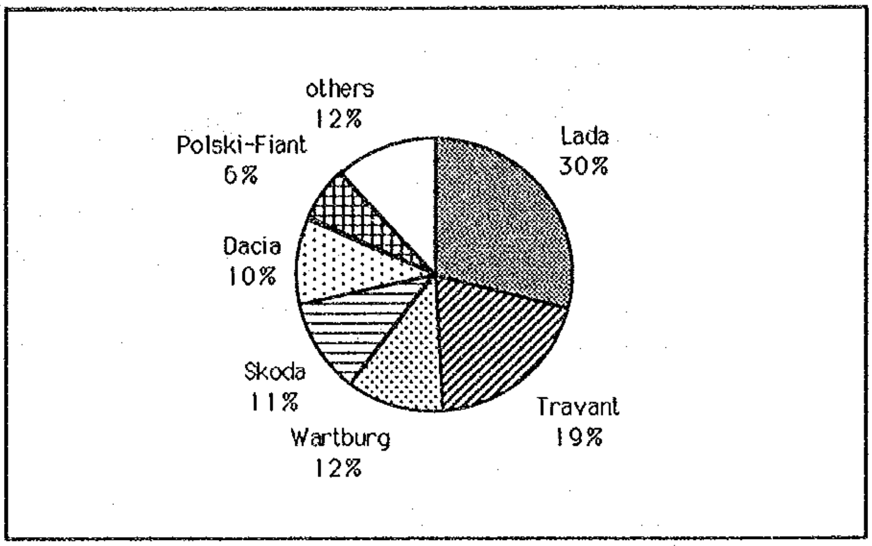


Figure 7.4.1 Shares of Passenger Cars by Manufactures

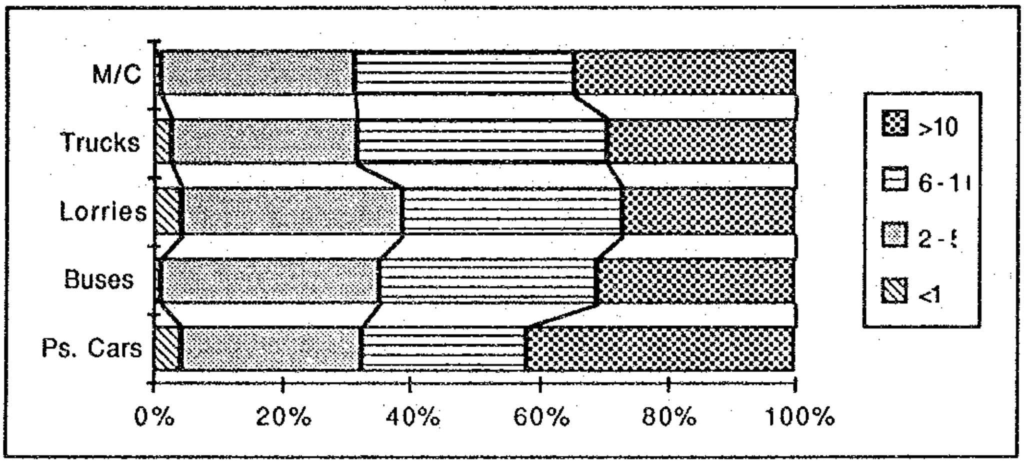


Figure 7.4.2 Age of Registered Motor Vehicles in Hungary (1990)

2) Engine Type of Motor Vehicles

It is considered that most passenger cars in the study area are equipped with gasoline engine. Concerning engine types, the existence of large number of two-stroke engine vehicles such as Trabant in the study area should be noted, because they emit much more pollutants than four-stroke engine vehicles.

From January 1, 1992, the use of two-stroke engine motor vehicles for public and commercial transport is banned if they are not equipped with catalytic converters.

3) Fuel Type of Motor Vehicles

Since many passenger cars in the study area were produced in the Eastern European countries or are highly aged, leaded gasoline is mostly used in the study area. Leaded gasoline should be gradually replaced by unleaded gasoline to facilitate use of motor vehicles equipped with catalytic converters.

7.4.2 Existing Motor Vehicle Pollution Control Plan

Hungarian government has established a five year plan for the air pollution control. The plan is named as "Government Resolution No. 1079/1993 (dated: December 23.); The improvement of the air quality in highly endangered geographical regions for period 1994-1998", and its content consists of 22 items as summarized in Table 7.4.2. The circled figures in the table are related to measures against mobile sources. The reduction volume of pollution load by this plan is expected to be about 13% for SO_2, 10% for Nox and 12% for CO.

Moreover, the government has been preparing "Governmental Decree on Air Pollution Abatement". According to a draft version of the new decree, the government mainly plans to replace the present vehicles to the new vehicles equipped catalytic converter gradually to control the air pollution caused by motor vehicles. The anti-pollution vehicles are conformable to EC's future exhaust emission regulations. The decree contains technological or institutional regulations in order to conduct that countermeasure.

Table 7.4.2 Summary Table of Hungarian Action Plan for the Period 1994 - 1998

○ : for the mobile sources

No.	Task Short identification	In charge first identified	Deadline
1.	Development of a technical and economic action plan for the seriously polluted regions with the inclusion of the local self-governments and ensuring their support	Minister for the Environment and Regional Policy	30th June 1994
2.	Provision of professional support to the local self-government	Minister for the Environment and Regional Policy	continuous
③	Provision of methodology for introducing traffic organisation and traffic restricting measures in the polluted settlements	Minister of Transport, Telecommunication and Water Management	30th June 1994
④	Preparation of a city public transport development program	Minister for the Environment and Regional Policy	30th September 1994
5.	Reduction in emission of carbo-hydrogens at fuel filling stations	Minister for the Environment and Regional Policy, Minister of Industry and Trade	31st May 1994
⑥	Increase in spot-checks of vehicles on the road	Minister of Transport, Telecommunication and Water Management	continuous
7.	Incentives to promote environmental protective heating methods	Minister for the Environment and Regional Policy	continuous
8.	Laying down the quality requirements of residential heating fuels	Minister for the Environment and Regional Policy	31st May 1994
9.	Identification of polluted areas, continuous monitoring	Minister of Welfare	31st March 1994
10.	Preparation of the implementation of air quality monitoring network concepts in and out of settlements	Minister for the Environment and Regional Policy	30th June 1994
11.	Securing the finances for the support of execution of clean air tasks	Minister for the Environment and Regional Policy	continuous
12.	Securing priority of Central Environmental Protection Funds to the implementation of the program	Minister for the Environment and Regional Policy	continuous (at the time of judging the applications)
13.	Development of the regulating system for Environment Loading Charge	Minister for the Environment and Regional Policy	31st August 1994
14.	Harmonising the reduction in emission with regional demand and international obligations	Minister for the Environment and Regional Policy	continuous (according to the execution of international obligations)
15.	Moderation of cross-border air pollution through bi-lateral agreements	Minister for the Environment and Regional Policy	continuous (dependent on the execution of bi-lateral agreements)
⑯	Preparation of a support program to help the establishment of a more up to date vehicle fleet	Minister of Transport, Telecommunication and Water Management Minister of International Trading Relations	31st March 1994 30th April 1994
⑰	Introduction of domestic application of EC regulations	Minister of Transport, Telecommunication and Water Management	30th June 1994 31st January 1995
⑱	Securing the finances for the implementation of the catalyst program	Minister for the Environment and Regional Policy	30th June 1994
⑲	Further restriction of two-stroke cars in non-personal use	Minister for the Environment and Regional Policy	30th June 1994
⑳	Incentives, execution of equipping two-stroke engines with catalysts	Minister for the Environment and Regional Policy	31st October 1994 1st January 1995
21	Preparation of environmental requirements, supervision system of low power domestic heating appliances	Minister for the Environment and Regional Policy	31st October 1994 1st January 1995
22.	Preparation of mid-project and concluding reports on the execution of the program's tasks	Minister for the Environment and Regional Policy	31st December 1995 30th June 1999

Chapter 8 PREDICTION OF FUTURE AIR QUALITY

8.1 Target Year

Generally, a target year for a regional air pollution control plan should be determined considering various factors including the following :

1) Target years of upper-ranked plans such as urban development plan and regional development plan.

2) Urgency of the plan, i.e. time allowed for a substantial improvement of air quality.

3) Future years for which projected figures for basic social and economic parameters are available.

4) Size of the planning area and scale of pollution sources in the area.

Considering above factors, the target year for the present study has been determined to be the year 2005.

8.2 Basic Future Conditions of Pollutant Sources

8.2.1 Power Stations

MVM Rt. has specific plans for the existing 3 thermal power stations for electricity and heat energy production. Their plans are shown in Tables 8.2.1 through 8.2.3.

Table 8.2.1 Energy Production and Fuel Consumption Planned for Borsod Power Station

Year		1992	1993	1995	2000	2005
Production of Electiricy (GWh)		599.3	424.6	380	780 HFBC : 120 CFBC : 660	970 HFBC : 70 CFBC : 900
Production of Heat Energy of (TJ)		3,168	3,056	3,200	2,870 HFBC : 870 CFBC : 2,000	2,870 HFBC : 870 CFBC : 2,000
Fuel Consumption (TJ)	Coal	10,785	8,226	8,120	9,500	11,230
	N. Gas	1,080	1,199	900	185	160
	Oil	5	3	-	-	-
	Total	11,870	9,428	9,020	9,685	11,390

Table 8.2.2 Energy Production and Fuel Consumption Planned for Tisza I Power Station

Year		1992	1993	1995	2000	2005
Production of Electiricy (GWh)		932.4	794.8	450	120	35
Production of Heat Energy of (TJ)		2,422	2,232	1,800	1,700	1,700
Fuel Consumption (TJ)	Coal	12,756	10,987	6,650	2,620	2,300
	N. Gas	1,333	1,364	750	300	250
	Oil	20	19	-	-	-
	Total	14,109	12,370	7,400	2,920	2,550

Table 8.2.3 Electricity Production and Fuel Consumption Planned for Tisza II Power Station

Year		1992	1993	1995	2000	2005
Production of Electiricy (GWh)		2,615.6	3,008	3,300	3,805	1,581
Fuel Consumption (TJ)	N. Gas	17,564	19,711	31,710	36,600	15,210
	Oil	7,293	8,925			
	Total	24,857	28,636	31,710	36,600	15,210

8.2.2 Major Factories

For the industrial sector, IKM projected that the energy consumption in 2000 would increase from the 1992 level by 5 - 7 % (annual rate at 0.61-0.85%) which accounts for reduction of energy intensity by about 10% toward future as a result of energy saving.

The Study team adopted the upper limit of above growth rate band as the industry-average growth rate of fuel consumption because it is safer to use higher rate for air pollution control planning. The team also assumed that this growth rate would continue up to 2005, i.e. increase of energy consumption by 11.6% from the 1992 level as the industry average.

However, since the growth rate will be different depending on the types of industry, major factories in the study area were divided into the four groups based on the industrial trends in Hungary as follows:

1) Types of industry whose growth rates are expected to be above the average

- manufacture of agricultural machine, equipment and materials
- manufacture of construction materials
- engineering and manufacturing of household appliances
- pharmaceutical industry
- printing
- construction
- petrochemical industry
- oil refining

2) Types of industry whose growth rates are expected to be about the average

- textile and clothing
- steel rolling

- chemical industry
- wire industry

3) Types of industry in which no growth is expected

   - iron manufacturing
   - mining

4) Types of industry to be phased out

   - blast furnace
   - ore preparing

The following growth rates for energy consumption are assumed for above groups of industry 1) through 3):

Group 1)	annual 1.0 - 1.5 %
Group 2)	annual 0.85 %
Group 3)	annual 0 %

When the future operation rate of a factory indicated by the estimated fuel consumption exceeds 100%, i.e. more than the rated capacity of the factory, the estimated fuel consumption is adjusted by assuming 100% operation rate.

8.2.3 Communal Facilities

(1) Heating Centers

Generally, district heating is made to provide the heat to a well-urbanized area, particularly a densely built-up housing complex. In the housing areas in the study area not covered by the district heating, it is said that heating of individual houses is more economical than constructing new district heating system. In view of expected population decrease in the future, expansion of district heating is not expected, and the fuel consumption in heating centers are assumed to be the same at the present level.

(2) Household Fuel

1) Natural Gas

According to the gas distribution company, the number of households using natural gas in the study area is about 57% of the total number of households. Dissemination of the use of natural gas will proceed further in the future in the Study Area, since the gas supply company plans to expand supply pipes covering almost all of the Study Area by 2005 as shown in Figure 8.2.1.

According to ÉKF, out of the households in the Sajó Valley area not having natural gas supply at present, 75% desire the gas supply even though they have to bear the cost for individual pipe connection. However, since the price of natural gas is scheduled to be doubled by the end of the year 1996, ÉKF expects that this percentage will be decreased to 50 - 60% in the future. The annual consumption per household is 2000 - 3000 m^3 (34 MJ/m^3) according to the gas company, and it is considered to be in the similar range in the future.

2) Coal and Firewood

According to the result of the questionnaire survey on home heating, houses using coal are found around the coal mines while those using firewood are in mountainous areas. Dissemination of the natural gas will cause decrease in the use of coal and firewood in these areas.

3) Light Oil

Houses using light oil are very few (from the questionnaire on home heating), and light oil consumption is not expected to grow in the future.

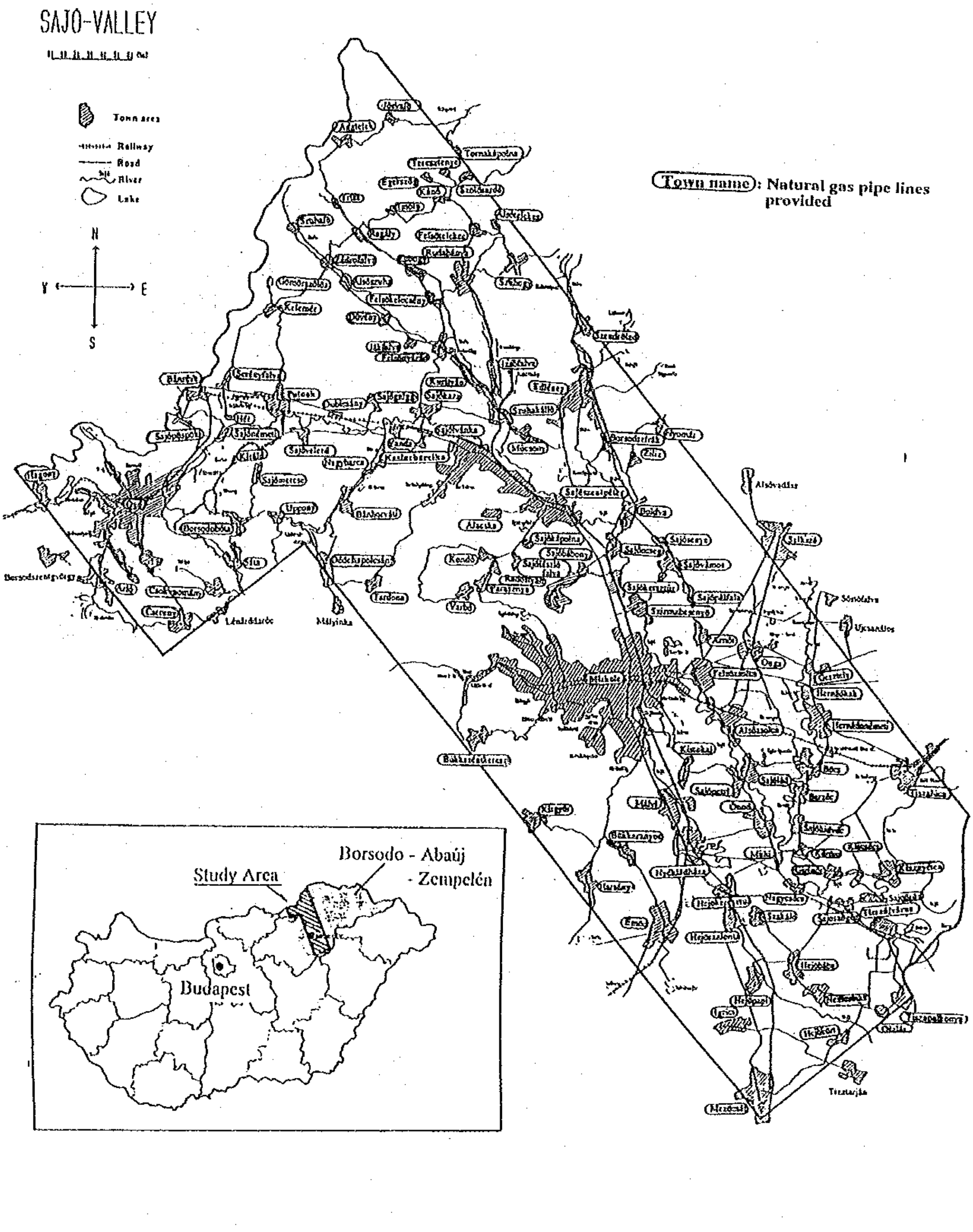


Figure 8.2.1 Towns and Villages Where Natural Gas Pipe Lines Will Have Been Laid by the Year 2005

8.2.4 Motor Vehicles

(1) Future Traffic Volume

A growth rate of traffic volume is one of the principal elements to estimate the future pollutant load from motor vehicles in the study area. Since the increase of traffic volume seems to be determined by many socio-economic factors affecting each others with complicated relations, it is difficult to predict the future traffic volume rationally. In this study, it is assumed that the traffic volume is proportional to the number of registered motor vehicles.

Figure 8.2.2 shows the regression curve for the number of registered motor vehicles in Hungary. The regression was made by the polynomial expression using the statistic data from 1976 to 1990 and the predicted data for 1991, 1995 and 2000 given in "The Long-term Development Program of the National Public Road Network, Oct. 1991". The number of motor vehicle to be registered in Hungary in the target year 2005 is estimated to be 2,850,000 by this regression equation. The growth rate of registered motor vehicles in the country will be also applied to the study area.

The traffic volume thus estimated may be somewhat greater than the actual one. However, it is considered to be permissible for the purpose of this study since the estimate will be on the safety side for planning air pollution control.

(2) Emission Factor of Motor Vehicles

According to the information from BAZKF, the number of motor vehicles registered in BAZ County including the study area was 106,344 in 1993. Among them, approximately 2,400 vehicles or 2.3% are equipped with a catalytic converter. Ages of these motor vehicles are considered to be less than 5 years. The ratio of such relatively new cars to all the registered cars in BAZ County is assumed to be the same as that of the country in 1990 shown in Table 8.2.4, i.e. 33%. Then, the number of vehicles not older than 5 years is: 106,344 x 33% = 35,094 (Vehicles).

The number of motor vehicles in BAZ County equipped with catalytic converter (2,400) is 6.8% of 35,094. It is assumed that all vehicles older than 5 years are replaced by new vehicles by 2005, and in the no pollution control case, 6.8% of the total vehicles are equipped with a catalytic converter.

Year	A.D.	Vehicles
0	1976	630,000
1	1977	720,000
2	1978	800,000
3	1979	880,000
4	1980	970,000
5	1981	1,060,000
6	1982	1,146,000
7	1983	1,223,000
8	1984	1,308,000
9	1985	1,399,000
10	1986	1,500,000
11	1987	1,619,000
12	1988	1,760,000
13	1989	1,850,000
14	1990	1,944,000
15	1991	2,000,000
16	1992	
17	1993	
18	1994	
19	1995	2,200,000
20	1996	
21	1997	
22	1998	
23	1999	
24	2000	2,500,000
25	2001	
26	2002	
27	2003	
28	2004	
29	2005	**2,847,470**

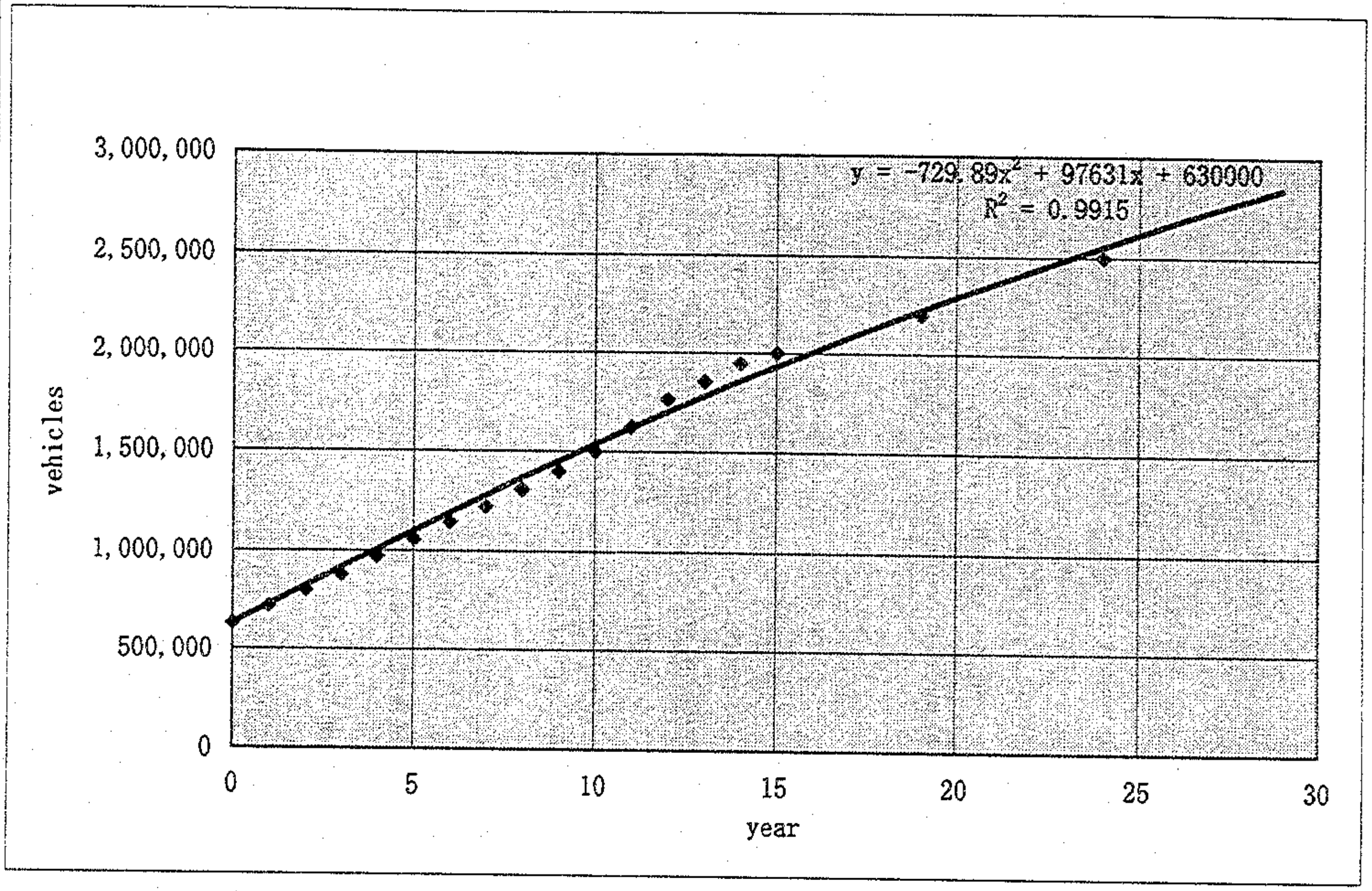


Figure 8.2.2 Projection of Number of Motor Vehicles in Hungary in 2005

Table 8.2.4 Age Distribution of Registered Motor Vehicles in Hungary (1990)

Unit : %

Age (year) / Car type	< 1	2 - 5	6 - 10	10 <	Total
Passenger Car	4.3	27.8	25.9	42.0	80.6
Buse	1.2	33.7	34.0	31.1	3.1
Truck	4.3	33.2	34.9	27.6	16.2
Weighted Average	4.2	28.8	27.6	39.4	100

Since motor vehicles equipped a catalytic converter are considered to satisfy the EC regulation concerning emission standard, the emission factors of (2) shown in Table 8.2.5 can be applied to such vehicles, and those of (1) to older vehicles.

Table 8.2.5 Emission Factors of NOx for Motor Vehicles

Car Type	Emission Factor (g/km)		(2) / (1)
	(1) Uncontrolled	(2) Controled	
Passenger Car	0.80	0.21	0.26
Small Truck	0.92	0.42	0.46
Bus	16.6	9.70	0.58
Large Truck	14.7	8.60	0.56

The emission factor of SO_2 largely depends on the sulfur content of fuels. The Hungarian authorities plan to improve sulfur content of diesel and gasoline as follows:

Fuel	Sulfur Content	
	Present	Future
Diesel	0.2 %	0.05 %
Gasoline	0.05 %	0.04 %

Accordingly, the emission factors shown in Table 8.2.6 can be used.

Table 8.2.6 Emission Factors of SO_2 for Motor Vehicles

Car Type	Emission Factor (g/km)		(2) / (1)
	(1) No fuel Improvement	(2) Fuel improvement	
Passenger Car	0.05	0.04	0.80
Small Truck	0.07	0.056	0.80
Bus	1.55	0.39	0.25
Large Truck	1.37	0.34	0.25

8.3 Future Cases for Prediction of Air Quality

For prediction of future air quality, the following 3 cases are considered:

(1) No air pollution control measures are taken (Case F-0).

(2) Air pollution control measures already planned by the Hungarian authorities and individual enterprises are taken (Case F-1).

(3) Some air pollution control measures in addition to Case F-1 are taken (Case F-2).

Since the Hungarian authorities and individual enterprises are already planning various air pollution control measures, above case (1) is not realistic. However, it is included for analysis since the effects of air pollution control measures in other cases can be more clearly demonstrated in comparison to this case.

Conditions of above 3 cases are explained below.

8.3.1 Case of No Air Pollution Control (Case F-0)

(1) Power Stations

1) Borsod Power Station

It is assumed that the productions of electricity and heat energy in 2005 are 970 GWh and 2,870 TJ, respectively, as shown in Table 8.2.1.

However, it is also assumed that the productions are carreid out by using the present facilities and the same fuels as the present. Fuel consumption in this case is as follows:

Brown coal (S : 2.2%)	1,557,545 ton/y	(8.5 MJ/kg)
Natural gas	39,116,000 Nm^3/y	(34.0 MJ/m^3)
Oil (S : 2.9%)	145 ton/y	(42.0 MJ/kg)
Total heat value	14,575 TJ	

2) Tiszapalkonya (Tisza I)

It is assumed that the productions of electricity and heat energy in 2005 are 35 GWh and 1,700 TJ, respectively, as shown in Table 8.2.2. The present facilities and the same fuels as the present are assumed to be used. Fuel consumption is as follows:

Brown coal (S : 1.875%)	270,588 ton/y	(8.5 MJ/kg)
Natural gas	7,205,000 Nm^3/y	(34.0 MJ/m^3)
Oil (S : 3.45%)	125 ton/y	(41.0 MJ/kg)
Total heat value	2,550 TJ	

3) Tisza II Power Station

It is assumed that the electricity production in 2005 is 1,581 GWh as shown in Table 8.2.3. Present facilities and the same fuels with the same ratio of gas/oil as that of the present are assumed to be used. Fuel consumption in 2005 is as follows:

Natural gas	172,620,000 Nm^3/y	(34.0 MJ/m^3)
Inert gas	300,918,000 Nm^3/y	(16.2 MJ/m^3)
Oil (S : 3.73%)	110,889 ton/y	(40.2 MJ/kg)
Total heat value	15,210 TJ	

(2) Major Factories

Conditions of major factories in 2005 is assumed to be basically the same as that described in Section 8.2, but energy saving by about 10% is excluded.

(3) Communal Facilities

Population and the number of households in 2005 are assumed to be the same as the present. Fuel consumption in the heating centers (except power stations) is assumed to be the same as that of the present both in quantity and quality of fuels. Household consumption of natural gas and other fuels is also assumed to be the same as the present.

(4) Motor Vehicles

As described in Section 8.2.4, the traffic volume in the target year 2005 would increase by 40% in comparison with the present, and the ratio of anti-pollution motor vehicles would be 6.8% of the future traffic volume. The emission factors of NOx for the anti-pollution vehicles and others is shown in Table 8.2.5. The sulfur contents of diesel and gasoline are assumed to be the same as the present.

8.3.2 Case of Existing Air Pollution Control Plan (Case F-1)

This case largely corresponds to the basic future conditions described in Section 8.2. Air pollution control measures planned by the Hungarian authorities and enterprises are included.

(1) Power Stations

1) Borsod Power Station

CFBC and HFBC systems are introduced as shown in Table 8.2.1. Fuel consumption and energy production by these facilities in 2005 are as shown below:

		CFBC	HFBC	Total
Production of electricity	(GWh)	900	70	970
Production of heat energy	(TJ)	2,000	870	2,870
Brown coal (S : 2.2%)	(ton)	1,108,302	212,874	1,321,176
Natural gas	(1,000 m^3)	3,943	765	4,708
Load (%)		100	60	-
Annual operation rate (%)		79	25	-

2) Tisza I Power Station

Fuel consumption and energy production of Tisza I Power Station is assumed to be the same as that in the no pollution control.

3) Tisza II Power Station

Electricity production and fuel consumption are the same as that in the no pollution control case. But low sulfur oil (S : 1.0%) is to be used in place of the oil used at the present (S : 3.73%).

(2) Major Factories

The conditions of major factories in fuel consumption are basically the same as that described in Section 8.2 that account for energy saving by about 10%.

In addition, emission control measures planned in 4 factories shown in Table 8.3.1 are included. These measures are explained below.

Table 8.3.1 Factories Having Pollutant Emission Control Plan

R/N	Name of Factories	Type of Industry	Source No. and Facility	Item for Control Measures	Fuel
03/0	EMO. TEGLA ES CSEREPIPARI VALLALAT PUTNOKI TEGLAGYAR	Brick	P-014 Tunnel kiln	SO2	Coal
15/1	HAMOR RESZVENYTARSASAG	Iron Casting	P-009 etc. 8 Forge furnaces	NOx	Natural gas
15/2	DIOSGYORI ACEL ES VASONTO KFT	Iron Casting	E-001 3 Electric furnaces	Dust	
23/1	TISZAI VEGYI KOMBINAT	Chemical	P-002 3 Nitric acid production lines	NOx (*)	

(*) : The emission standard value is not exceeded, but the emission is still high.

1) EMO. TEGLA ES CSEREPIPARI VALLALAT PUTNOK TEGLAGYAR (R/N : 03/0)

Bricks are formed by uniformly pulverizing clay and coal and mixing them with water and a combustible material such as sawdust. Green bricks are dried by hot air from a tunnel kiln in which the coal and sawdust in the raw material are burnt. The tunnel kiln in question is old. The factory intends to change fuel from coal to natural gas.

2) HAMOR RESZVENYTARSASAG (R/N: 15/1)

In this iron casting plant, there are 8 old forge furnaces of the age between 30 to 60 years. Natural gas is used as the fuel. They cause large energy losses, and NOx emissions from some furnaces exceed the standard level.

Remodeling of the furnaces into the Rath type is planned in the plant to yield energy saving by 30 to 35% as achieved in a past experience. However, revamping of the eight furnaces will require HUF 160 million. One alternative considered in the plant is to change energy source from natural gas to electricity. NOx will not be generated and it is said that some of the new products can only be produced by electric arc furnaces.

3) DIOSGYORI ACEL. ES VASONTO KFT (R/N : 15/2)

A large amount of dust is generated in the electric arc furnaces when pig iron and ingots are produced by melting scrap iron and alloys. Dust emissions from the furnaces amount to 40kg per hour.

The following control measures are being planned by the plant.

The E-001 building houses two 17.5t and one 2.5t units. Umbrella-type suctions are installed on the furnaces and exhaust gases are released from the stacks after passing through these suctions and outdoor dust collectors.

4) TISZAI VEGYI KOMBINAT (R/N: 23/1)

There are nine production lines in total in the TVK nitric acid plants. Of them, four lines are actually operated.

In 1993, TVK installed de-NOx equipment to one line with good test results. The remaining three lines are planned to have similar de-NOx equipment installed. The process is as follows :

$$NO + NO_2 + 2NH_3 \xrightarrow{230 \text{ to } 300\ ^\circ C} 2N_2 + 3\ H_2O$$

The catalyst used : $V_2\ O_5/Al_2\ O_3$ (imported)
Amount of emission gases: 18,000 to 20,000 Nm^3/h
NOx concentration reduced : from 0.2% to 0.05% (75% reduction)

5) Other

Measures to control air pollution were needed for the DNM steel mills in Miskolc City. However, the blast furnace, LD converters in the combined steel works, and other equipment have been decided to close by the Government. When the operation of the blast furnace stops by 1996, sintered products from BEM will not be required and air pollutants emitted by BEM will be also eliminated.

(3) Communal Facilities

1) Heating Centers

Conditions of heating centers are assumed to be the same as that of the present.

2) Households

It is assumed that the natural gas supply is expanded to 55% of the households not having the supply at present. Areas to be supplied are in accordance with the plan of the gas company (Tigaz). As a result, 78% of the total number of households are supplied with the natural gas in comparison to 57% at present.

(4) Motor Vehicles

The government has introduced a preferential tax system for import of new vehicles equipped with a catalytic converter, and plans to adopt emission standards that are almost the same levels as that of EC's.

Age of registered motor vehicle in Hungary is generally high. The average life of the motor vehicle is about 16 years, and the ratio of vehicles aged more than 10 years is approximately 40%. This means that almost all of the motor vehicles used at present would be replaced in 2005. In this case, it can be assumed that all motor vehicles would be replaced with anti-pollution vehicles in 2005 by the existing control plan as mentioned above.

The sulfur contents of diesel and gasoline will be improved as described in Section 8.2.4.

8.3.3 Case of Additional Pollution Control Measures (Case F-2)

This case corresponds to the situation where pollution control measures recommended by the Study Team for some factories are added to the existing air pollution control plan, and natural gas supply for household heating is further expanded.

(1) Major Factories

Factories shown in Table 8.3.2 were selected by the Study Team to recommend emission control measures since pollutant emissions exceeded the emission standard values. These measures are explained below.

Table 8.3.2 Factories Selected for Emission Control Measures

R/N	Name of Factories	Type of Industry	Source No. and Facility	Item for Control Measures	Fuel
02/1	OZD KOHASZATI UZEMEN	Iron and Steel	P-036 2 Boilers	SO_2	Natural gas Brown coal
03/0	EMO. TEGLA ES CSEREPIPARI VALLALAT PUTNOKI TEGLAGYAR	Brick	P-014 Tunnel kiln	SO_2	Coal
04/1	BORSODCHEM	Chemical	P-062 Incinerator	NOx	Waste solvent
09/2	SAGROCHEM KFT.	Chemical	P-055 Incinerator	NOx	Waste solvent and solid
15/2	DIOSGYORI ACEL ES VASONTO KFT	Iron Casting	P-014-1 Heating furnace	NOx	Natural gas
17/1	HEJOCSABA CEMENT-ES MESZIPARI RT	Cement	P-010 Cement kiln	NOx	Natural gas

1) OZD KOHASZATI UZEMEM (R/N : 02-1)

As the service sector of the Ozd metallurgical plant, the company is currently supplying steam and hot water to part of the Ozd City housing complex. The company has eight boilers in total. The source P-036 has two boilers of 30t/h (max) and 28bar (max) used for heat supply. The boilers are multi-fuel firing boilers, using natural gas (40%) and brown coal (60%).

The emission standard of SOx is 8.2 kg/h for P-036, and the brown coal contains sulfur by 0.85 %. It means that the brown coal can be used by 536 kg per hour (8.2 x 100 / 2 / 0.85 / 0.9 = 536 kg) for the emission standard of SOx to be satisfied.

The amount of natural gas required is as follows :

At present,

Coal : 4,000 kg/h (20 MJ/kg)	(59.5 %)
Natural Gas : 1,600 m3/h (34 MJ/m3)	(40.5 %)

For the emission standard to be satisfied, the use of the fuels should be changed as follows:

Coal : 536 kg/h	(8%)
Natural Gas : 3,638 m3/h	(92 %)

There is a possibility that above two boilers will be out of the service in the future. In this case, above measure will not be necessary.

2) EMO. TEGLA ES CSEREPIPARI VALLALAT PUTNOK TEGLAGYAR (R/N : 03/0)

In addition to changing fuel from coal to natural as planned by the plant, increased use of low-sulfur coal as raw material is recommended so that the average sulfur content is decreased to 1.5% against 3% at present.

3) BORSODCHEM RT. (R/N : 04/1)

The NOx concentration of the exhaust gas from a small waste solvent incinerator (60 kg/h) was as high as 4,028 ppm (at 4% O2 conversion). This may be due to presence of N containing matters in the waste for incineration. By the employment of a two-stage combustion type burner, the NOx concentration can be reduced to 150-200 ppm (at 4% O2).

4) SAGROCHEM KFT. (R/N : 9/2)

P-055 is a small incinerator for waste oil (100 kg/h) and solid waste (60 kg/h). The NOx concentration was 813 ppm (at 4% O2) also indicating the presence of N containing matters in the incinerating wastes. The same measure as that for BORSODCHEM is recommended. The NOx concentration can be reduced to 150 - 200 ppm (at 4% O_2).

5) DIOSGYORI ACEL. ES VASONTO KFT (R/N : 15/2)

The source P-014 in question is in the casting fabrication process and is a wheel-type heat treatment furnace which uses natural gas. The old equipment has been in use for 29 years. Retrofitting of this furnace and installation of a recuperator (for energy saving by 10%) are recommended.

6) HEJOCSABA CEMENT-ES MESZIPARI RT (R/N: 17/1)

P-010 is a cement rotary kiln with a suspension preheater (SP).

In the manufacture of cement, the raw material temperature must be maintained at higher than 1,450 °C during the calcination process. A flame temperature of about 1800 °C has to be maintained in the kiln in order to meet this condition. The generation of thermal NOx is therefore unavoidable in the kiln.

One possible measure for this kiln will be employment of oxygen burners as describle in Section 7.3.2 (3). However, since natural gas consumption is 10,000m3/h and O2 consumption will be about twice this amount, availability of oxygen supply equipment will be limited.

The exhaust gas oxygen concentration measured in the kiln stacks was as high as 14.5%. Low air ratio combustion and the use of low-NOx burner are recommended. Reduction of NOx emission up to 30% is possible by selecting an appropriate burner.

(2) Household

As described in Section 8.2.3, almost all towns and villages in the Study Area will be covered by the natural gas supply by the year 2005. Since home heating by brown coal is a significant cause of SO_2 pollution in the heating season, it is recommended that the use of coal be replaced by the natural gas as far as the planned supply network allows. As a result, 86% of the total number of households are supplied with the natural gas.

There are two major economic obstacles to spread the use of the natural gas:

1) Individual households have to bear the costs for the pipe connection and new equipment for heating. These costs are estimated to be HUF 150,000 to 200,000.

2) Price of natural gas is scheduled to be doubled by the end of 1996 making it considerably higher than the price of brown coal as shown below:

a) Natural gas

Assuming annual consumption of 2,000 m^3 per household,
Annual expense is :
$2,000(m^3) \times 34(MJ / m^3) \times 0.53(HUF / MJ) \times 1.1(VAT) \cong 40,000HUF$

b) Brown coal

Assuming annual consumption of 6,600 kg per household,
Annual expense is :
$6,600(kg) \times 14(MJ / kg) \times 0.3234(HUF / MJ) \times 1.1(VAT) \cong 30,000HUF$

Since the use of natural gas is much more convenient than the use of coal, it is considered that many households wish to use the natural gas if the facility costs of HUF 150,000 - 200,000 can be afforded. To promote dissemination of the use of the natural gas, some measures such as the following to support the facility costs are considered to be necessary.

- low-interest, long-term loans
- subsides
- preferential taxation

There exist some financial supporting systems for the purpose of environmental protection. Therefore existing support system such as Central Environmental Protection Fund should be utilized.

8.3.4 Amount of Pollutant Emission in the Future Cases

Based on the future conditions of pollutant sources described for above 3 cases, the emission quantities of SO_2 and NOx were estimated. The annual amount of SO_2 emission for the three cases are summarized in Table 8.3.3 and Figure 8.3.1, and the same for the NOx are summarized in Table 8.3.4 and Figure 8.3.2.

Table 8.3.3 Amount of SO_2 Emission by Sources and Cases (ton/y)

	Present	Case F-0	Case F-1	Case F-2
Borsod P.S.	31,259	40,636	9,690	9,690
Tisza I. P.S.	34,808	6,962	6,962	6,962
Tisza II. P.S.	15,036	9,172	2,406	2,406
Major Factories	3,350	2,192	1,996	1,804
Communal Facilities	13,084	13,084	4,564	2,963
Motor Vehicles	261	367	105	105
Total	97,798	72,413	25,723	23,930

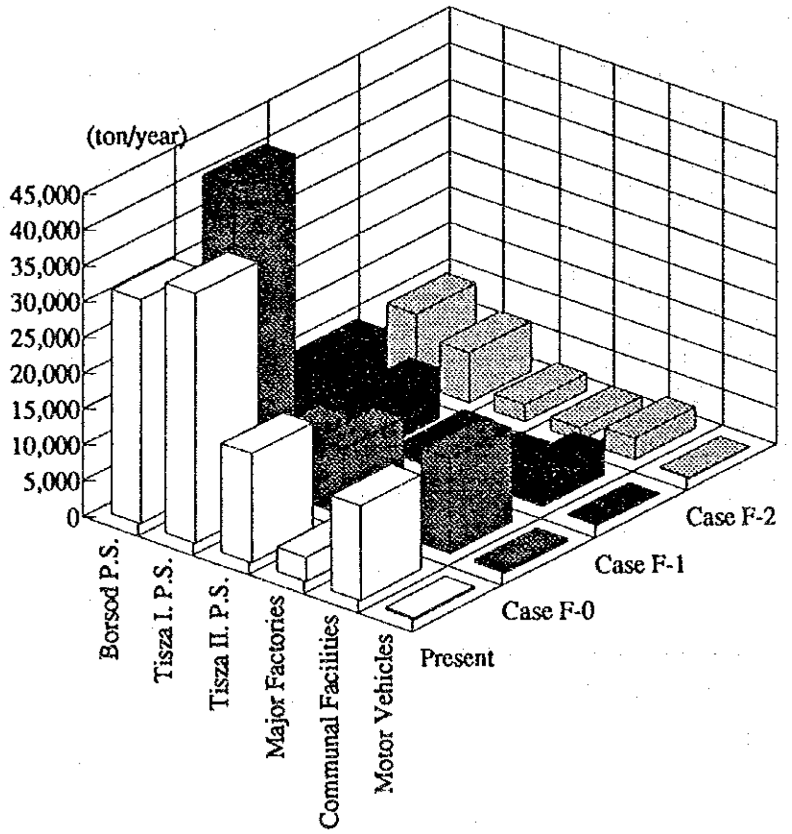


Figure 8.3.1 Amount of SO_2 Emission by Sources and Cases (ton/y)

Table 8.3.4 Amount of NOx Emission by Sources and Cases (ton/y)

	Present	Case F-0	Case F-1	Case F-2
Borsod P.S.	2,135	2,776	1,708	1,708
Tisza I. P.S.	2,882	576	576	576
Tisza II. P.S.	3,148	1,920	1,920	1,920
Major Factories	2,867	2,837	1,571	1,499
Communal Facilities	2,484	2,484	1,435	1,240
Motor Vehicles	2,976	4,098	2,243	2,243
Total	16,492	14,691	9,453	9,186

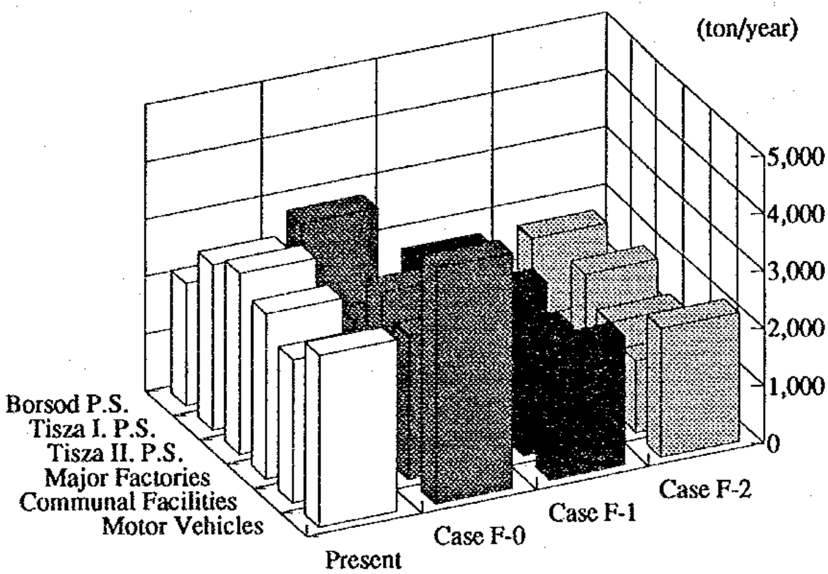


Figure 8.3.2 Amount of NOx Emission by Sources and Cases (ton/y)

8.4 Prediction of Future Air Quality

Based on the amount of pollutant emissions for the future cases described in Section 8.3.4, ambient air quality of each case was predicted by the simulation model. Since future ambient air quality standards have been proposed by KTM, "long time limit values" in the new standards will be used for discussion of the predicted air quality, and the limit values will be referred to as "the new standards".

8.4.1 No Air Pollution Control (Case F-0)

The annual average and the heating season average concentration distributions of SO_2 are shown in Figures 8.4.1 and 8.4.2, and the same for NO_2 are shown in Figures 8.4.3 and 8.4.4, respectively.

(1) SO_2

Since the distribution of SO_2 emissions is similar to that of the present, the concentration distributions are also similar to those of the present. The areas where the annual average concentration exceeds the new standard (50 $\mu g/m^3$) are:

- The area along Route 3 and Route 26 from the southern edge of Miskolc to the noth of Kazincbarcika

- Ozd

In the heating season, the areas exceeding the new standard occupy 70 - 80% of the Study Area.

(2) NO_2

The NO_2 distribution pattern is similar to that of the present, but the concentration is slightly lower.

The annual average concentration satisfies the new standard (70 $\mu g/m^3$) in the whole area. In the heating season, however, the new standard is exceeded in the center of Miskolc.

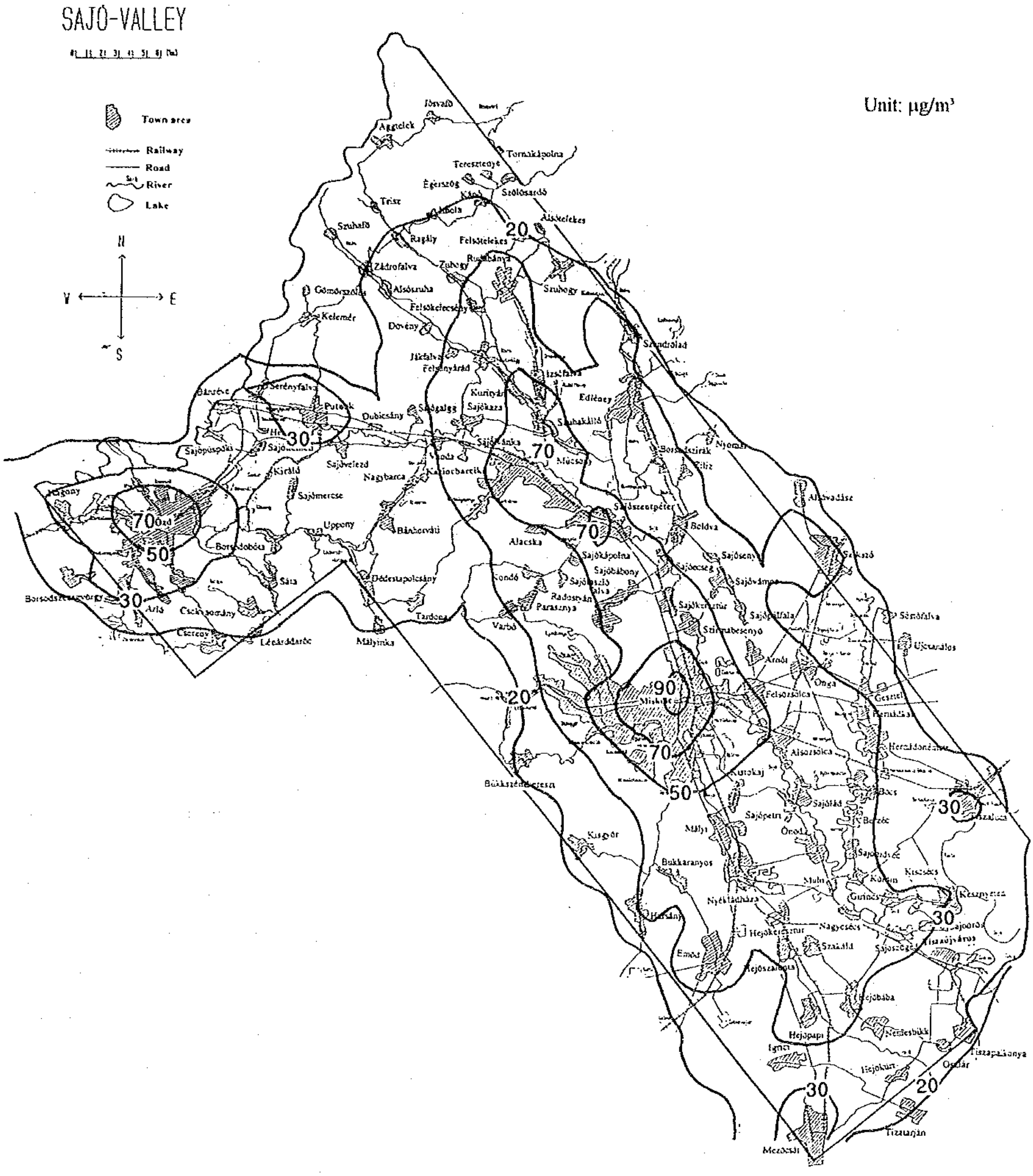


Figure 8.4.1 Annual Average Concentration Isopleth for SO2 (Case F-0, All Sources)

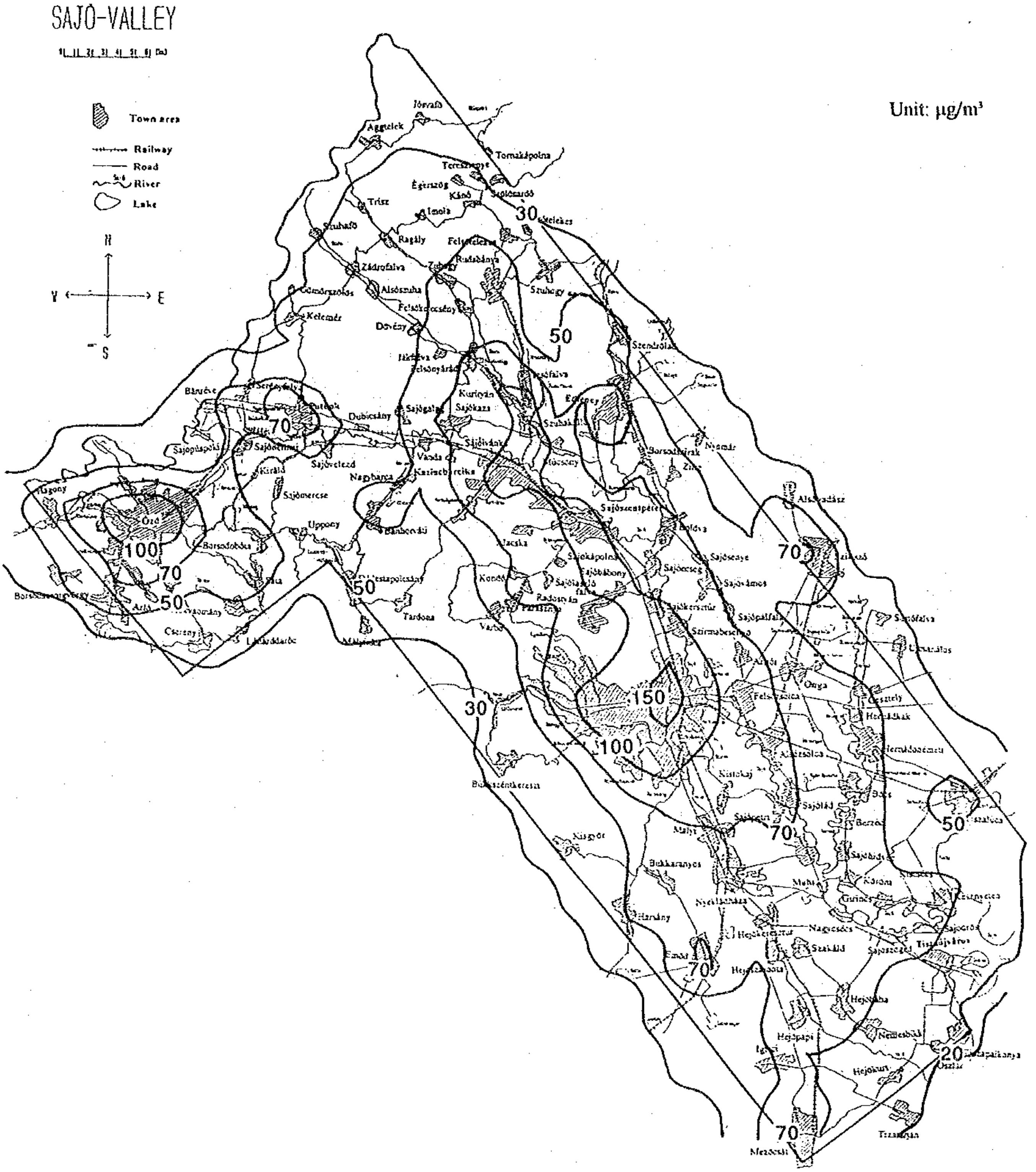


Figure 8.4.2 Average Concentration Isopleth for SO2 in Heating Season (Case F-0, All Sources)

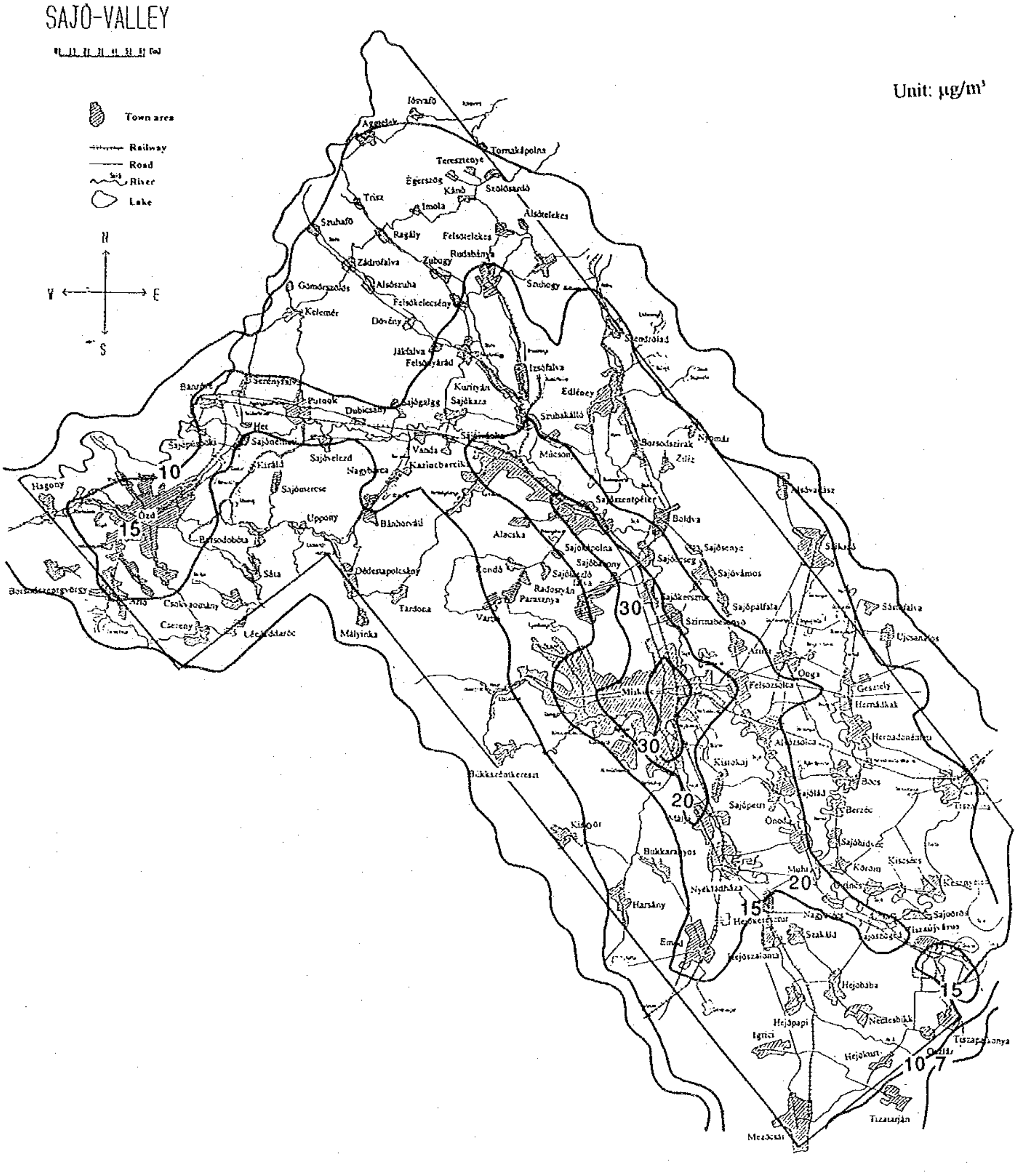


Figure 8.4.3 Annual Average Concentration Isopleth for NO2 (Case F-0, All Sources)

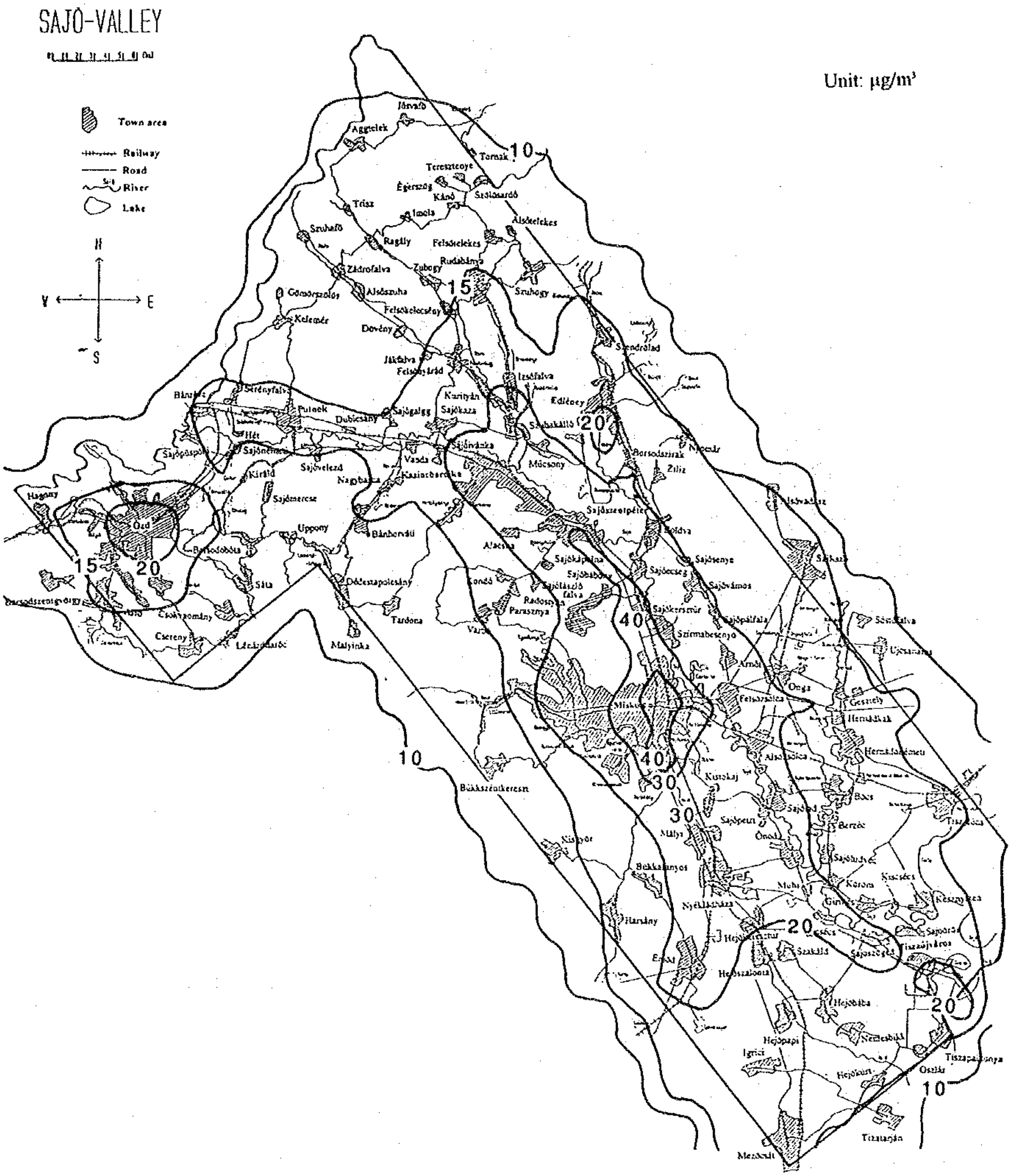


Figure 8.4.4 Average Concentration Isopleth for NO2 in Heating Season (Case F-0, All Sources)

8.4.2 Existing Air Pollution Control Plan (Case F-1)

The annual average and the heating season average concentration distributions of SO_2 are shown in Figures 8.4.5 and 8.4.6, and the same for NO_2 are shown in Figures 8.4.7 and 8.4.8, respectively.

(1) SO_2

The SO_2 concentration is decreased to the level of 1/2 - 1/3 of that of the no pollution control case (Case F-0).

The annual average concentration satisfies the new standard (50 $\mu g/m^3$) in the whole area. In the heating season, however, the new standard is exceeded in the central part of Miskolc.

(2) NO_2

The NO_2 concentration decreases to the level of about 2/3 of that of the no pollution control case. The annual and the heating season average concentrations satisfy the new standard (70 $\mu g/m^3$) in the whole area.

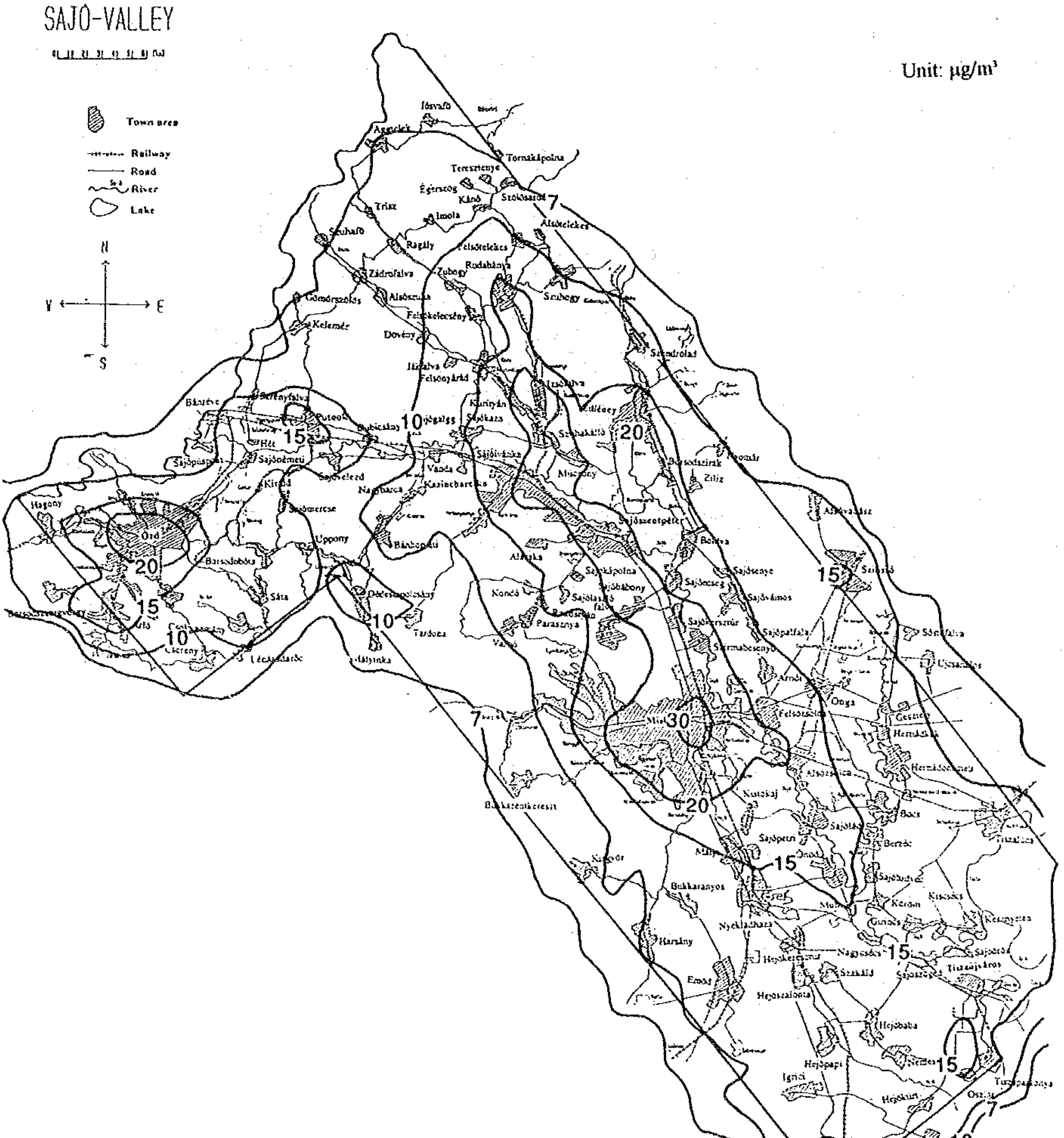


Figure 8.4.5 Annual Average Concentration Isopleth for SO2 (Case F-1, All Sources)

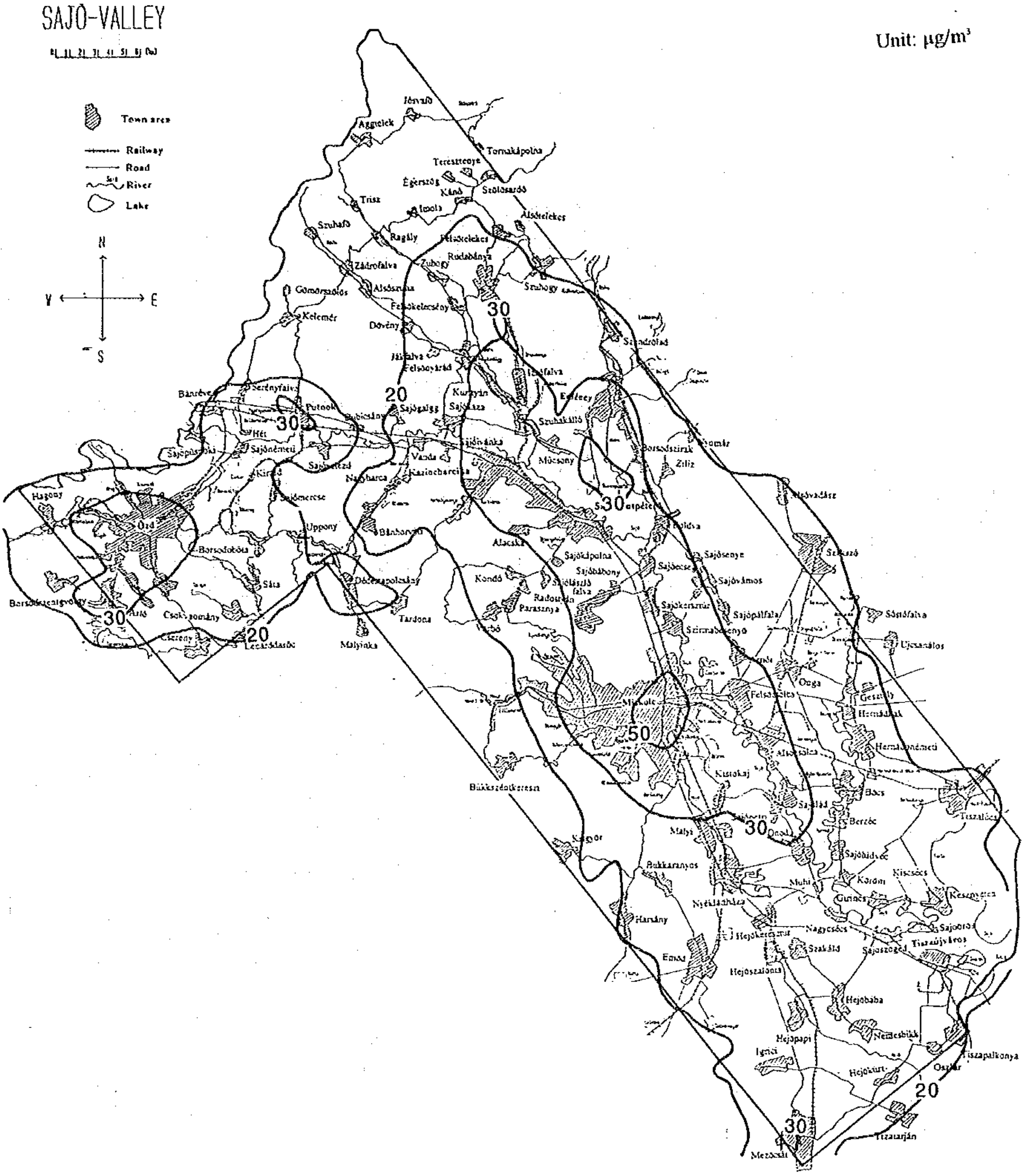


Figure 8.4.6 Average Concentration Isopleth for SO2 in Heating Season (Case F-1, All Sources)

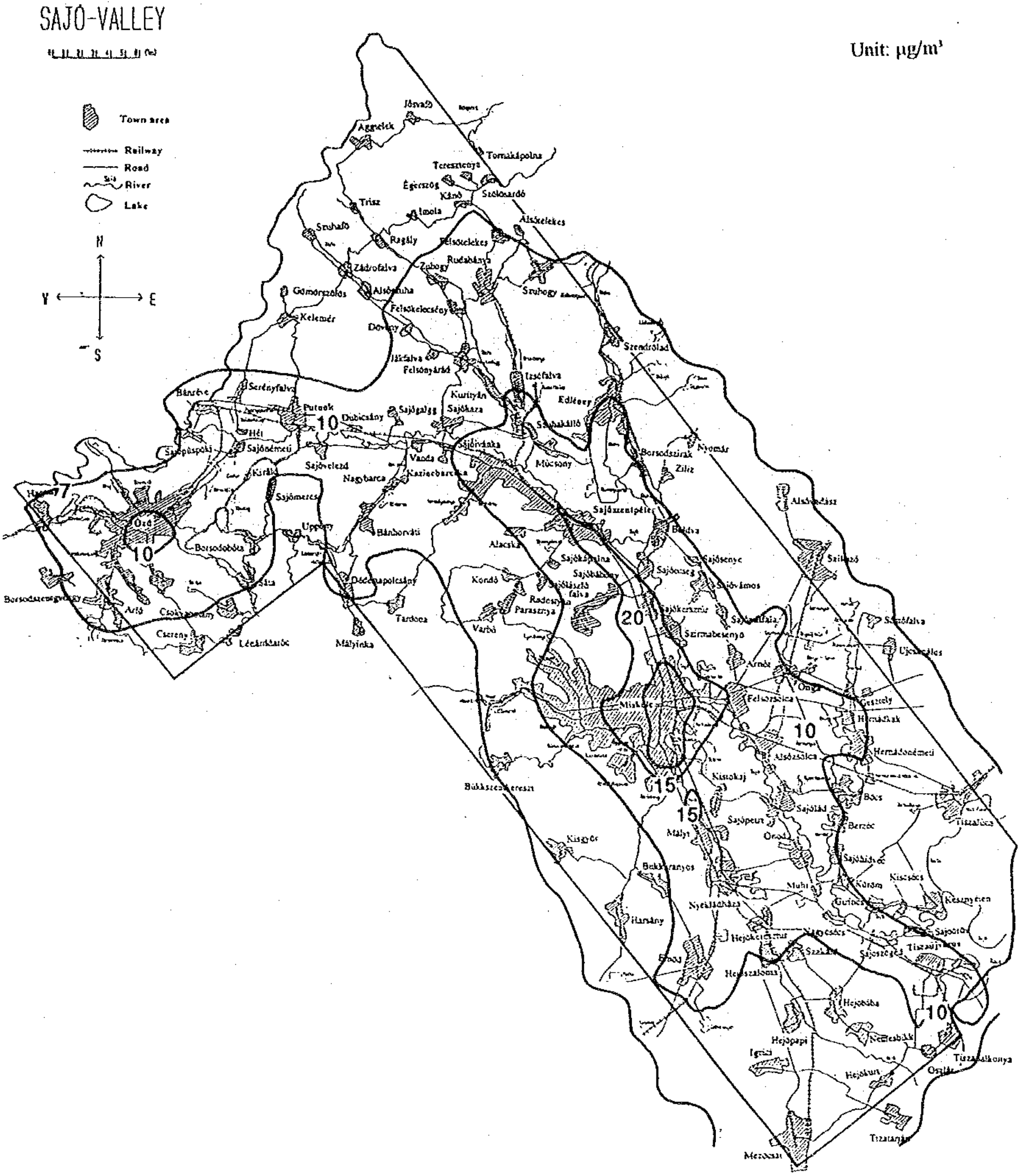


Figure 8.4.7 Annual Average Concentration Isopleth for NO2 (Case F-1, All Sources)

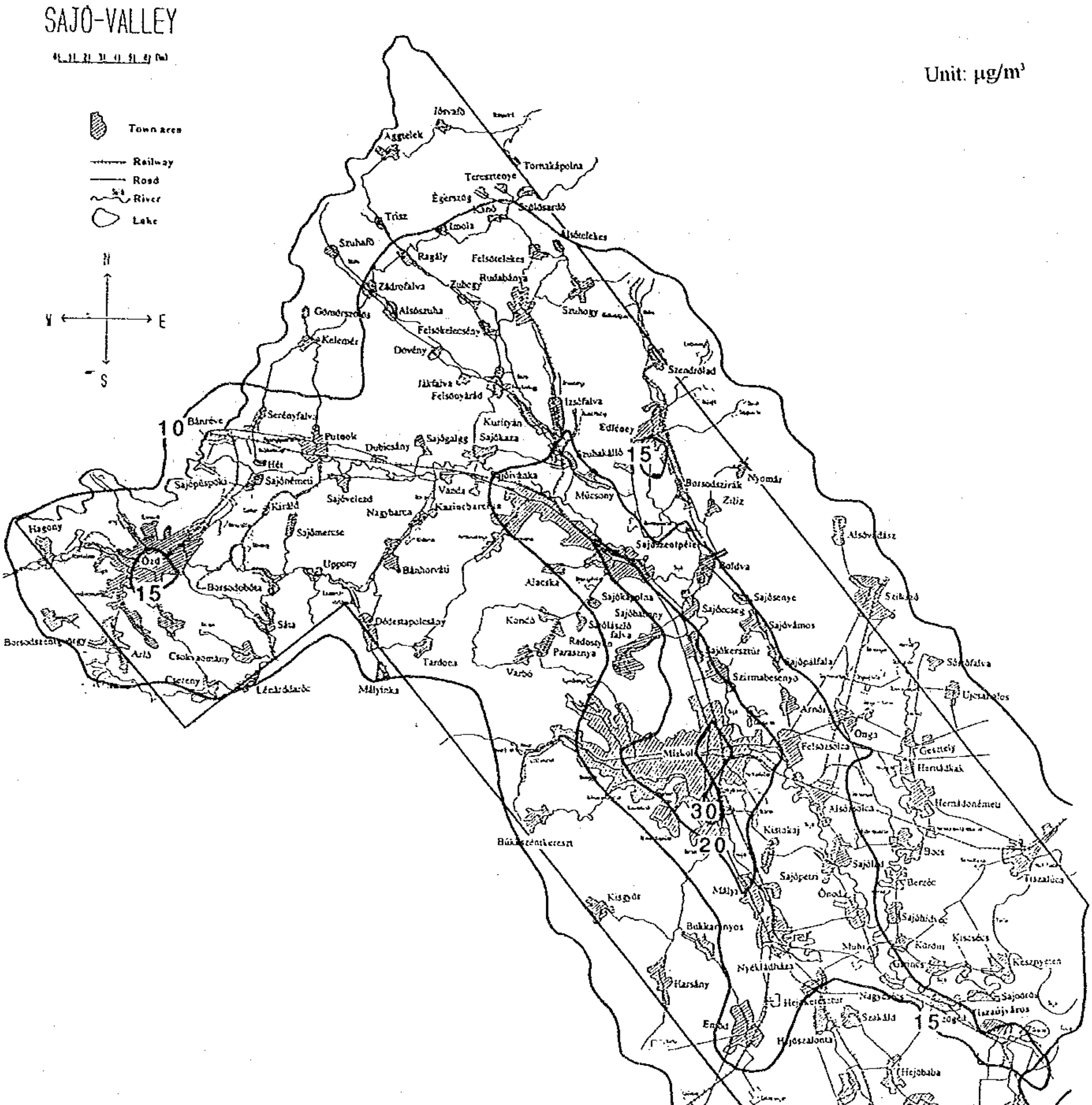


Figure 8.4.8 Average Concentration Isopleth for NO2 in Heating Season (Case F-1, All Sources)

8.4.3 Additional Air Pollution Control (Case F-2)

The annual average and the heating season average concentration distributions of SO_2 are shown in Figures 8.4.9 and 8.4.10, and the same for NO_2 are shown in Figures 8.4.11 and 8.4.12.

(1) SO_2

The SO_2 concentration is further improved beyond the level of Case F-1. The annual and the heating season average concentrations satisfy the new standard (50 $\mu g/m^3$) in the whole area.

(2) NO_2

The NO_2 concentration is further improved beyond the level of Case F-1. There is no problem of NO_2 pollution.

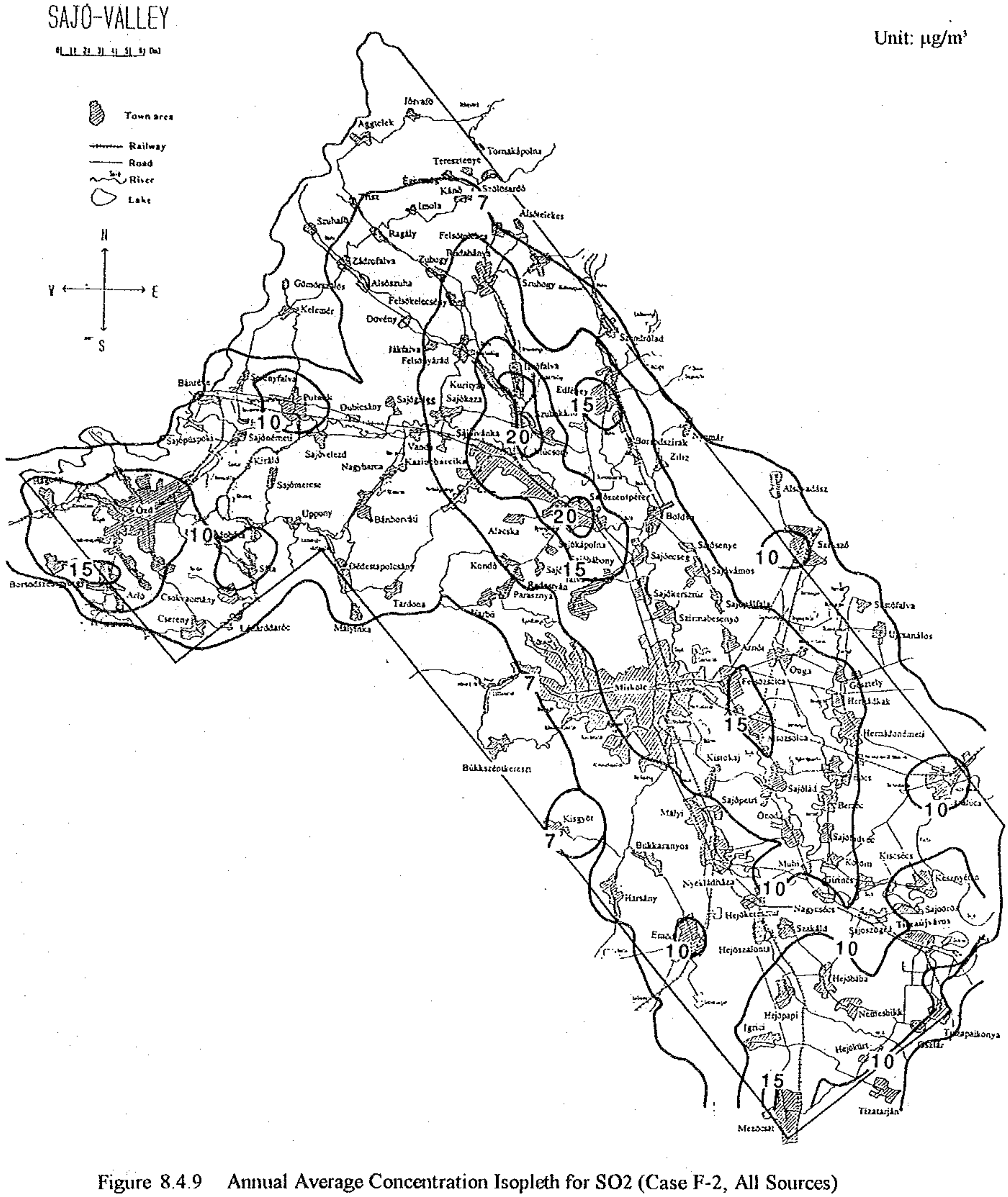


Figure 8.4.9 Annual Average Concentration Isopleth for SO2 (Case F-2, All Sources)

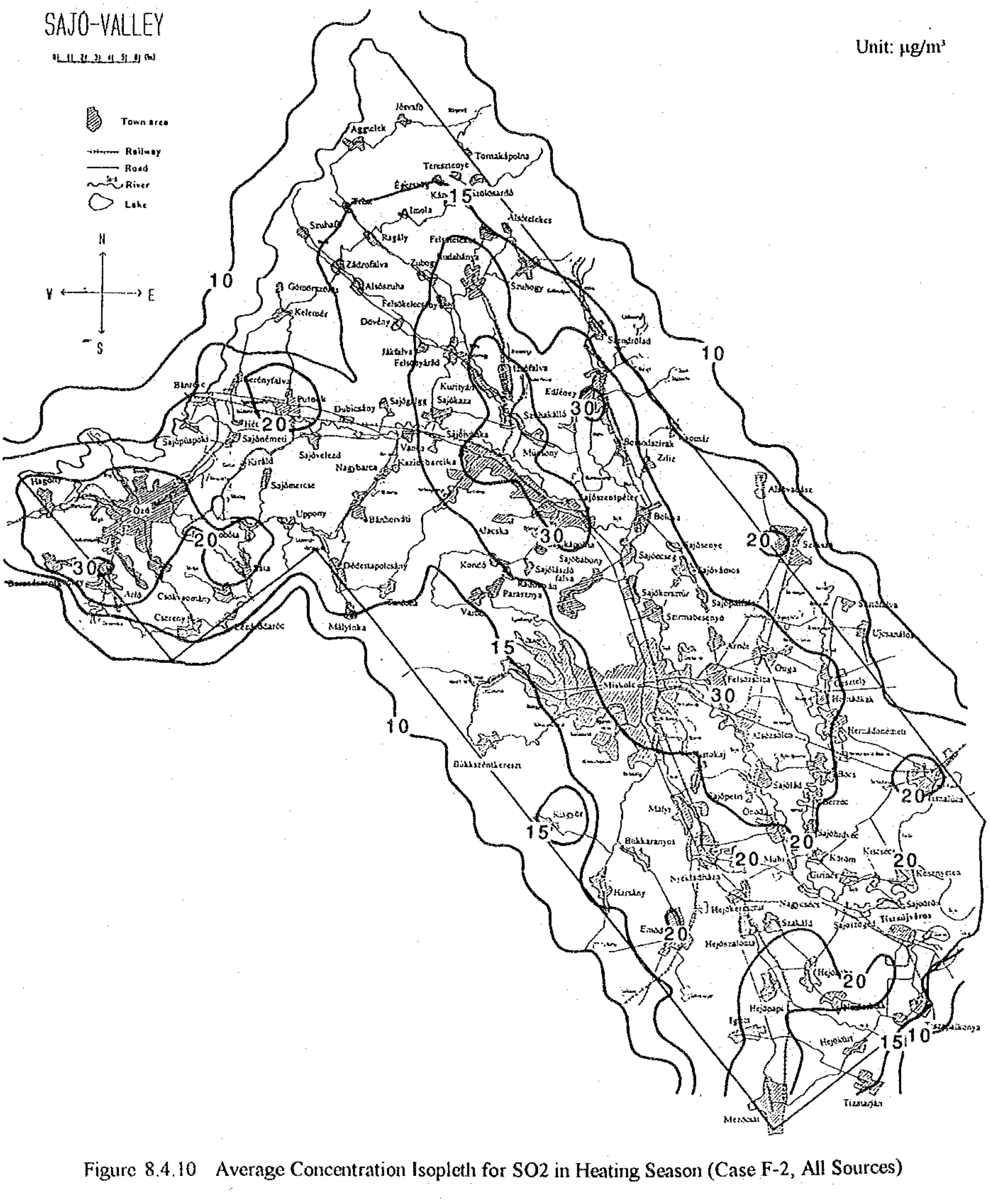


Figure 8.4.10 Average Concentration Isopleth for SO2 in Heating Season (Case F-2, All Sources)

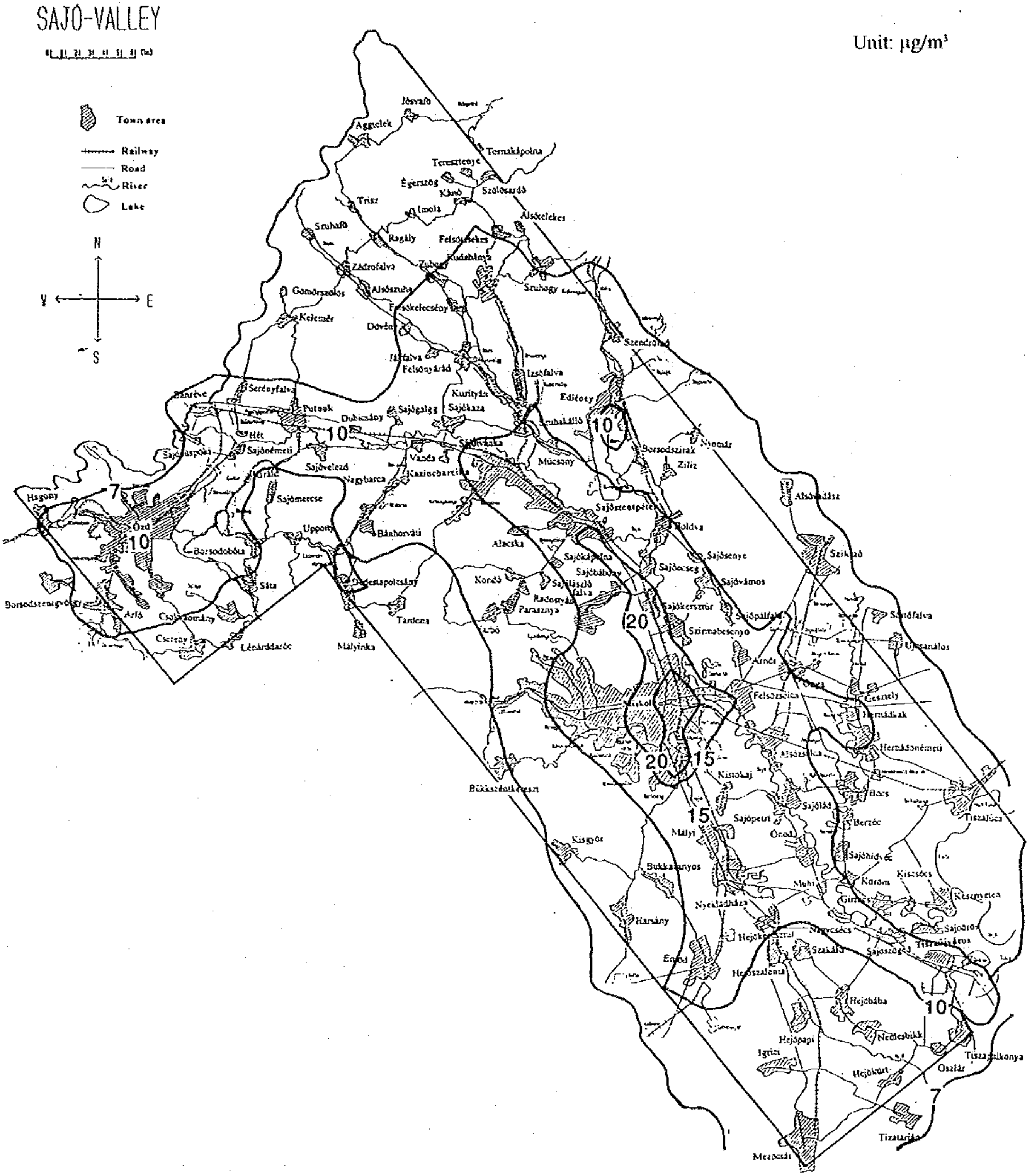


Figure 8.4.11 Annual Average Concentration Isopleth for NO2 (Case F-2, All Sources)

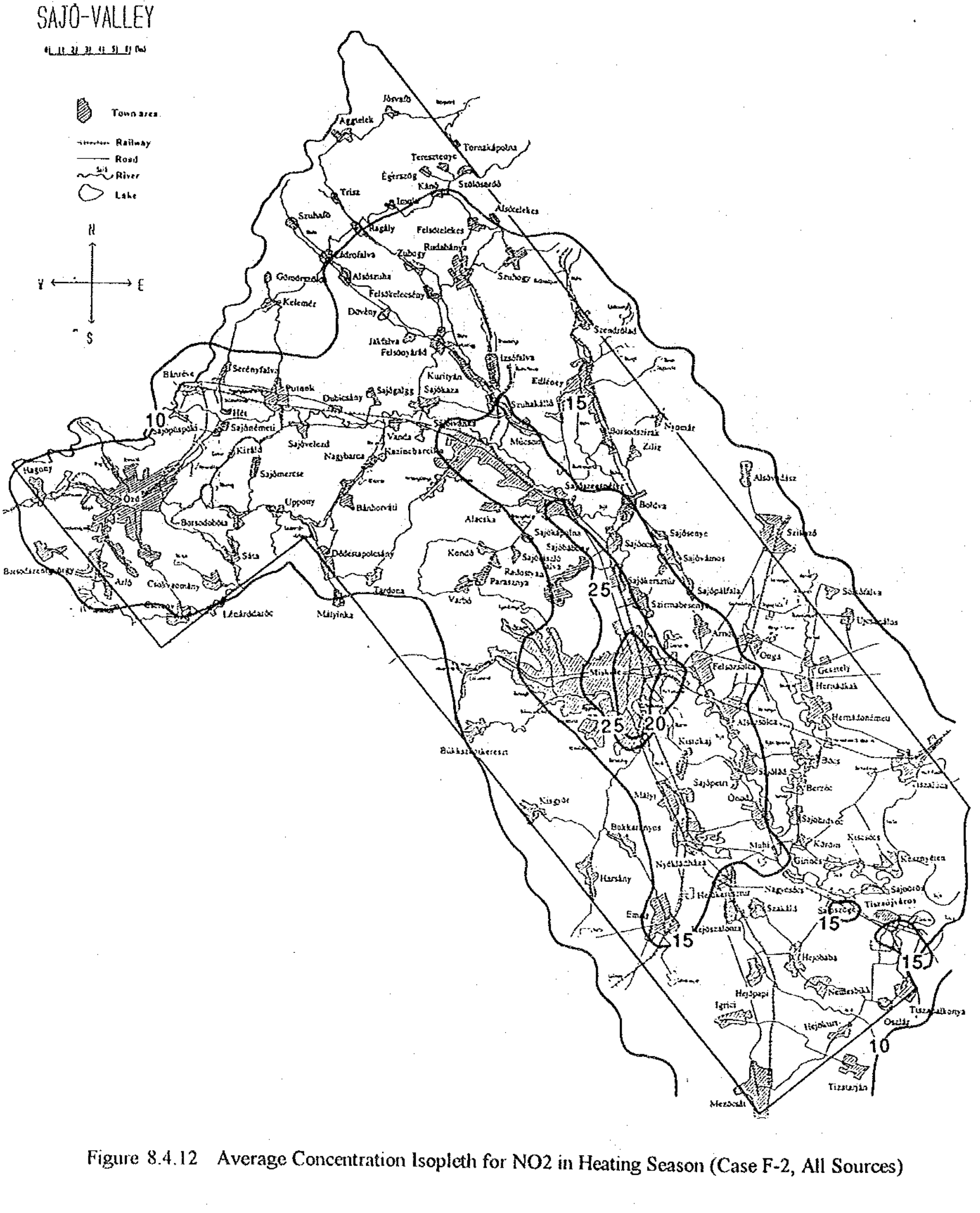


Figure 8.4.12 Average Concentration Isopleth for NO2 in Heating Season (Case F-2, All Sources)

8.4.4 Quantitative Comparison of Air Quality of the Future Cases

In the analysis described above, the differences in air quality between three future cases have been demonstrated by the concentration isopleth figures. In this section, these differences are tried to be quantified. An index of expressing the person-average exposure concentration is introduced as follows:

$$Cp = \sum_{i=1}^{n} (Ci \times Pi) / \sum_{i=1}^{n} Pi$$

where,
- Cp : Person-average exposure concentration
- Ci : Concentration in grid element i
- Pi : Population of grid element i
- n : Number of grid elements

When the cooncentration decreases in densely populated areas, Cp decreases rapidly.

Table 8.4.1 shows the peerson-average exposure concentrations (PAEC) of SO_2 and NO_2 for the thre future cases obatained by the above equation and their percentages to the no pollution control case.

Table 8.4.1 Person-average Exposoure Concengtration (PAEC)

Period	Case No.	SO_2		NO_2	
		PAEC ($\mu g/m^3$)	Ratio (%) F-0 = 100	PAEC ($\mu g/m^3$)	Ratio (%) F-0 = 100
Whole year	F-0	52.8	100	18.1	100
	F-1	19.4	36.7	13.1	72.4
	F-2	11.8	22.3	12.5	69.1
Heating season	F-0	93.1	100	25.1	100
	F-1	35.5	38.1	18.3	72.9
	F-2	22.4	24.1	17.3	68.9

As can seen from Table 8.4.1, effects of Cases F-1 and F-2 are particularly large in the reduction of the person-average exposure concentration of SO_2. The reduction of PAEC of SO_2 in Case F-1 from the level of Case F-0 is more than 60%, and that in Case F-2 is nearly 80%.

The reduction of PAEC of NO_2 in Case F-1 is about 27%, and that in Case F-2 is over 30%.

Chapter 9 INTEGRATED AIR POLLUTION CONTROL PLAN

9.1 Cost Estimation

Costs for implementation of air pollution control measures were estimated under the following conditions.

1) Exchange rate

1USD = 100.19 HUF
1USD = 109.35 Japanese Yen
(as of December 15, 1993)

2) Interest rate

The annual interest is assumed to be 5% as employed in direct loans of Japanese government funds. Commissions and an additional interest of an undertaking bank in Hungary is excluded.

Costs for implementation of control measures for motor vehicles are excluded.

Cost estimates already made by Hungarian enterprises are used whenever available.

9.1.1 Existing Control Plan

(1) Borsod Power Station

a) Initial costs

CFBC system	:	HUF 14,740 million
HFBC system	:	HUF 1,330 million
Ash disposal site for HFBC	:	HUF 1,670 million
Total		HUF 17,740 million

b) Operation costs (exchange losses excluded)

CFBC system (6,920 hr/year)	:	HUF 2,976 million
HFBC system (2,210 hr/year)	:	HUF 282 million
Total		HUF 3,258 million/year

(2) Major Factories

R/N	Factory Name	Object Facility	Control Measure	Initial Cost (million HUF)
03/0	EMO	Tunnel kiln	Fuel change from coal to natural gas	-
15/1	HAMOR	Forge furnace	Improvement of 8 furnaces to the Rath type	160
15/2	DAV	Electric furnace	Suction devices and dust collectors	62
23/1	TVK	Nitric acid production line	Denitration equipment using ammonia	31
Total				253

(3) Households

The costs for house connection of gas pipe and gas-burning equipment are assumed to be HUF 175,000/household.

37,600 households x HUF 175,000 = HUF 6,580 million

(4) Total Initial Cost

The total initial cost for above measures : HUF 24,573 million

9.1.2 Additional Measures

Costs to be added to those of the existing plan are estimated.

(1) Major Factories

R/N	Factory Name	Source No.	Control Measure	Initial Cost (million HUF)
02/1	OZD K.U.	Boiler	Fuel change	-
03/0	EMO	Tunnel kiln	Quality coal as raw material	-
04/1	BORSODCHEM	Incinerator	2-stage combustion	1.65
09/2	SAGROCHEM	Incinerator	2-stage combustion	2.20
15/2	DAV	Heating furnace	Furnace retrofitting Recuperator	60.0 1.65
17/1	HEJOCSABA	Cement kiln	Low-NOx burner	32.1
		Total		97.6

(2) Households

Additional 14,800 households are supplied with natural gas. Pipe connection and equipment costs are:

14,800 x HUF 175,000/household = HUF 2,590 million

(3) Total Initial Cost for Additional Measures

The total initial cost for above measures : HUF 2,688 million

(4) Grand Total Initial Cost

Grand total initial cost for the measures in the existing plan and the additional measures is as follows (million HUF):

Borsod Power Station	:	17,740
Major Factories (8 plants)	:	351
Gas supply (52,400 households)	:	9,170
Grand Total		HUF 27,261 million

9.2 Proposed Air Pollution Control Plan

Conditions of pollution sources, control measures, and predicted air quality (SO_2 and NO_2) are summarized in Table 9.2.1 for the present and the three cases of the year 2005.

In Case F-0, the no pollution control case, the predicted concentration of SO_2 seriously exceeds the new ambient air quality standard (50 $\mu g/m^3$ as the long time limit value). The maximum heating-season average concentration occurring in the center of Miskolc is 173 $\mu g/m^3$ which is over 3 times of the new standard.

In Case F-1, the case of existing plans of the Hungarian authorities and enterprises, major air pollution control measures are as follows:

(1) Introduction of CFBC and HFBC systems to Borsod Power Station
(2) Drastic reduction of electricity production in Tisza I Power Station
(3) Use of low-sulfur fuel oil (S : present 3.73% to 1.0%) in Tisza II Power Station
(4) Increase of the natural gas supply covering 78% of all households (57% at present)
(5) Fuel saving by about 10% in major factories and some measures to reduce pollutant emissions in 4 factories

By above measures, the amount of SO_2 emission will be reduced to 26% of the present level, and that of NO_x will be reduced to 57% of the present level. The annual average concentration of SO_2 satisfies the new standard in the whole area. However, the heating-season average concentration of SO_2 does not satisfy the new standards at the central part of Miskolc.

In Case F-2, the additional measures case, the following measures are added to Case F-1:

(1) Further increase of the natural gas supply covering 86% of all households
(2) Some measures to reduce pollutant emissions in 6 factories

These measures reduce the SO_2 emission by 1,700 ton/y, and the NOx emission by 300 t/y. As a result, the heating-season average concentration of SO_2 satisfies the new standard in the whole area with the highest concentration being 41 $\mu g/m^3$ (the standard : 50 $\mu g/m^3$).

The NO_2 concentration satisfies the new standard (70 $\mu g/m^3$) in all three future cases, and is the lowest in Case F-2.

In view of air quality improvement in the Sajó Valley area, implementation of the air pollution control measures included in Case F-2 is proposed.

Table 9.2.1 Summary of Air Pollution Control Measures and Simulation Results

	Present (1992)	Case F-0 (2005) Without Measure	Case F-1 (2005) With Existing Measures	Case F-2 (2005) With Additional Measures
Borsod P.S.	· Pulverized Coal -Fired Boiler 100t/h x 10 · 600GWh · Pollutant Emission : SO2 31,300t/y (1.0) NOx 2,100t/y (1.0)	· Same Facilities and Fuel as Present · 970GWh (1.62times) · Pollutant Emission : SO2 40,600t/y (1.30) NOx 2,800t/y (1.30)	· Circulation Fluidized Bed Combustion + Hibrid Fluidized Bed Combustion · 970GWh · Pollutant Emission : SO2 9,700t/y (0.31) NOx 1,700t/y (0.80)	Same as Case F-1 · Pollutant Emission : SO2 9,700t/y (0.31) NOx 1,700t/y (0.80)
Tisza I P.S.	· Pulverizes Coal -Fired Boiler 125t/h x 8 (in 1992 6 boilers operated) · 932GWh (1.0) · Pollutant Emission : SO2 35,000t/y (1.0) NOx 2,900t/y (1.0)	· Same Facilities and Fuel as Present · 35GWh (0.04) · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)	Same as Case F-0 · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)	Same as Case F-1 · Pollutant Emission : SO2 7,000t/y (0.20) NOx 600t/y (0.20)
Tisza II P.S.	· Oil & Gas Mixed Fired Boiler 4 Blocks (670t/h x 4) · 2,616GWh (1.0) · Pollutant Emission : SO2 15,000t/y (1.0) NOx 3,100t/y (1.0)	· Same Facilities and Fuel as Present · 1,581GWh (0.60) · Pollutant Emission : SO2 9,200t/y (0.61) NOx 1,900t/y (0.61)	· Same Facilities as Present · 1,581GWh (0.60) · "S" Contents 3.73% to 1.0% · Pollutant Emission : SO2 2,400t/y (0.16) NOx 1,900t/y (0.16)	Same as Case F-1 · Pollutant Emission : SO2 2,400t/y (0.16) NOx 1,900t/y (0.16)
Major factories	· Fuel Consumption Solid 92,000t/y, Liquid 120,000t/y Gas 1,080Mm3 · Pollutant Emission : SO2 3,400t/y (1.0) NOx 2,900t/y (1.0)	· Fuel consumption increases 28.5% from the present · Pollutant Emission : SO2 2,200t/y (0.64) NOx 2,800t/y (0.99) · Some factories close down	· Fuel save by about 10% from case F-0 · Measures to reduce SO2, NO2 or Dust in 4 factories · Pollutant Emission : SO2 2,000t/y (0.59) NOx 1,600t/y (0.25)	· Measures to reduce SO2 or NO2 in 6 factories in addition to Case F-1 · Pollutant Emission : SO2 1,800t/y (0.53) NOx 1,500t/y (0.23)
Communal Facilities	· 178,000 Households · 57% of Households Supplied with Natural Gas · Pollutant Emission : SO2 13,100t/y (1.0) NOx 2,500t/y (1.0)	· 178,000 Households · 57% of Households Supplied with Natural Gas · Pollutant Emission : SO2 13,100t/y (1.0) NOx 2,500t/y (1.0)	· 178,000 Households · 78% of Households Supplied with Natural Gas · Pollutant Emission : SO2 4,500t/y (0.34) NOx 1,400t/y (0.56)	· 178,000 Households · 86% of Households Supplied with Natural Gas · Pollutant Emission : SO2 3,000t/y (0.23) NOx 1,200t/y (0.48)
Motor Vehicles	· 106,300 Vehicles Registered in Baz County · 2.3% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 260t/y (1.0) NOx 3,000t/y (1.0)	· 40% of Traffic Volume Increase Over Present · 6.8% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 370t/y (1.42) NOx 4,100t/y (1.37)	· 40% of Traffic Volume Increase Over Present · 100% of Motor Vehicles Equipped with Catalytic Converter · Pollutant Emission : SO2 110t/y (0.42) NOx 2,200t/y (0.73)	Same as Case F-1 · Pollutant Emission : SO2 110t/y (0.42) NOx 2,200t/y (0.73)
Air Pollution Condition	SO2: A.A.C. Max:100>70 (NS) Total Emission 98,000t/y (1.0) NO2: A.A.C. Max.: 38<70 (S) Total NOx Emission 16,500t/y (1.0)	SO2: A.A.C. Max:100>50 (NS) A.C.H. Max:173>50 (NS) Total Emission 72,400t/y (0.74) NO2: A.A.C. Max:45<70 (S) A.C.H. Max:53<70 (S) Total NOx Emission 14,700t/y (0.89)	SO2: A.A.C. Max:34<50 (S) A.C.H. Max:59>50 (NS) Total Emission 25,700t/y (0.26) NO2: A.A.C. Max:31<70 (S) A.C.H. Max:37<70 (S) Total NOx Emission 9,500t/y (0.57)	SO2: A.A.C. Max:25<50 (S) A.C.H. Max:41<50 (S) Total Emission 24,000t/y (0.24) NO2: A.A.C. Max:29<70 (S) A.C.H. Max:34<70 (S) Total NOx Emission 9,200t/y (0.56)

A.A.C : Annual Average Concentration (unit: $\mu g/m^3$) 、A.C.H. : Average Concentration in Heating Season (unit: $\mu g/m^3$) 、NS : Not Stisfying Standard、S : Satisfying Standard, P.S.: Power Station

9.3 Institutional Measures

9.3.1 Legal Control Measures

It may be stated that the slow progress of air pollution abatement in Hungary partly has originated in the gaps of legislation but has been mainly caused by the lack of coordination and insufficiency in the implementation. Air pollution abatement is the responsibility in common and separately of more than one ministry, however such shared organization and responsibility hinders the efficiency of actions taken in air pollution abatement. The obligatory data declaration serves as a basis for the emission inventories and other control measures. However, in the early years the system functioned with difficulties due to different understanding of regulatory measures by the authorities and polluters. These difficulties were reflected in the problems accompanying the implementation of the mechanism of fining to achieve the reduction or elimination of harmful air pollution. In many cases, the emission limit values and the possibilities in emission reduction determined by the actually available technology are in a discrepancy to a greater extent. The legislation concerning traffic generated air pollution was introduced with delay and up to the present there are gaps in the legislation. In practice, the implementation of qualification (quality control) of the mobile sources and the development of the highway system taking into consideration environmental aspects was not performed coherently and consistently. Emission limit values for major polluting sources are specified in a separate way by a transmission model and by an environmental impact assessment, however such method results in inadequate accuracy because of the lack of ambient air quality monitoring/measurement.

Hungarian government is preparing new legal systems on air pollution abatement to settle the above-mentioned problems. The draft decree and regulations proposed adopts new ideas which seems to be more effective for an air pollution control and more flexible to execute them. Almost all important principles that are indispensable for air pollution abatement and that can be accepted internationally, have been described in the draft act and regulations. Therefore, enactment and enforcement of them are expected as the most probable legal control measures. Remarkable differences between the present legal systems and the proposed ones are as follows:

1) specifying the jurisdiction and the roles of governmental organizations and their administrative tasks in air pollution abatement;
   (Certain administrative bodies will be empowered to coordinate the relating organizations not to hinder the efficiency of actions taken in air pollution abatement.)

2) introduction of "fee for using environment" instead of the present basic fine system concerning stationary air polluting sources;
(By an introduction of "fee for using environment", all operators/owners of air polluting sources shall be liable to pay a "fee for using environment" depending on the total mass of air pollutant emissions. A fee will be paid voluntarily or without a sense of guilty like a tax by the polluter.)

3) modifications of ambient air quality standards and zoning system for their application;
(Modification of ambient air quality standards makes the limit values of SO_2 stricter than present ones.)

4) introduction of concrete technological emission standards (limit values) to certain industries instead of present regional emission standards;
(Polluting sources as thermal power plant and cement industry will be controlled with special care according to the concrete technological emission standards.)

5) stricter emission limit values concerning mobile air polluting sources based on a EC regulation; and
(New regulation concerning mobile air pollution control will encourage the replacement of traditional high-emission motor vehicles by low-emission vehicles equipped with catalyzer.)

6) emphasizing an effective utilization of environmental impact/status assessment for the air pollution abatement.

Gaps and insufficiencies might still remain to some extent even if new act and regulations come into force. Because lots of well-trained talents and optimum executing systems would be needed to realize the objectives of the regulations.

9.3.2 Reinforcement of the Organizations

One of the draft regulations emphasizes that operator/owner of air polluting sources shall appoint an official who is responsible for air pollution protection and is enough educated to direct and control the activity professionally. The other draft regulations emphasize that operator/owner of air polluting sources shall make self-declaration of air pollution data based on the measurement and technical calculation to the competent environmental authority, and that the state and the trend of ambient air quality shall be regularly measured and kept with the help of suitable measuring network. To perform these obligations, qualified talents shall be provided within a short term by the appropriate training or education. Therefore it is necessary to establish a training systems inside or outside of competent environmental authorities in the Study Area.

The draft governmental decree emphasizes an importance of emission/immission monitoring for air pollution control and an effective utilization of environmental impact/status assessment for the air pollution abatement. The draft regulation on emission limit values of stationary air polluting point sources says that the operators of the polluting sources are obliged to measure the emission or to commit the measurement to professional organizations, and that the special emission limit values shall be imposed on the basis of air quality control and environmental impact assessment of spread of pollution. Therefore it is necessary to establish systems which can provide standardized measuring or processing methodology and can provide suggestions and recommendations by an assessment based on the reliable data.

(1) Training Center for Air Pollution Control

One example of the training systems is a regional/local training center as shown in Figure 9.3.1. It might be better from the view point of effective administration that the training center belongs to a certain competent environmental authority like EKF. However it should be operated in cooperation with other organizations and with academic institutions, such as KTM, KHVM, IKM, NM, BAZKF, ANTSZ, University of Miskolc and so on. Because specialists and experts of several fields are needed for trainers. The training center consists of five major sections which roles are as follows.

1) Combustion control section

The section develops a knowledge and a technical skill of the administrative officer/engineer to promote an optimum combustion control and an energy saving in industry. Items to be instructed are technical skill to operate and maintain the combustion equipment, quality control of fuels and methodology for energy saving.

2) Section of air pollution control concerning stationary sources

The section develops a knowledge and a technical skill of the administrative officer/engineer to promote an air pollution control measures for stationary sources. Items to be instructed are legal systems on air pollution control, technical skill to operate and maintain the control equipment and to prepare necessary emergency measures for preventing the dangerous state of air pollution, and methods to report the data concerning air pollution and to train the workers.

3) Section of air pollution control concerning mobile sources

The section develops a knowledge and a technical skill of the administrative officer/engineer to promote an air pollution control measures for mobile sources. Items to be instructed are legal systems on air pollution control, technical skill to install and maintain the control equipment of motor vehicles, and methods to report the data concerning air pollution and to train the manufacturers and the users.

4) Section of measurement and data processing

The section develops a knowledge and a technical skill of the administrative officer/engineer to ensure an accuracy of the measurements and technical calculations of air pollutants. Items to be instructed are legal systems on air pollution control and on quality control of measurement/inspection, technical skill to operate and maintain the measuring equipment and to process the data, and methods to report the data concerning air pollution and to train the workers.

5) Registration section

The section issues a certificate/license for trainees who can accomplish the whole courses and can pass the qualifying examination, and registers their names, registration numbers and biodata. The section also recommends the registered persons by request for the qualified officials/engineers according to their specialties.

(2) Air Pollution Monitoring and Assessment Center

One example of data measuring and processing systems is a regional/local unified center of monitoring and assessment as shown in Figure 9.3.2. It might be better that certain divisions of EKF are developed into the center under the control of EKF. Because difficulty of coordination will affect the efficiency of its operation as shown in the past experience, if the center is an inter-organizational body. The monitoring and assessment center consists of five major sections whose roles are as follows.

1) Ambient air quality monitoring section

Parts of existing division such as Air Cleanness Protection Division of EKF can be developed into this section. The main tasks are monitoring ambient air quality, operation/maintenance of monitoring equipment and processing of measured data. The ambient air quality data from monitoring stations are gathered by a central data acquisition system like a telemeter system. The gathered data are processed and transmitted to the Central Environmental Information System in Budapest. After that, the data are stored in the Data Administration Section in the center and are informed to regional air pollution protection authorities and to local governments.

2) Emission monitoring section (Stationary sources, Mobile sources)

Part of existing division such as Emission Monitoring Division and Information Division of EKF can be developed into the section. The main tasks are emission measurement of both stationary and mobile sources, operation/maintenance of measuring equipment and data processing/storing. The gathered data are processed and transmitted to the Central Environmental Information System in Budapest. Emission data of stationary sources are gathered by the self-declaration system, by the direct measurement and by surprise measurement, and those of mobile sources measured by car inspection systems are informed by BAZKF. After that , the data are stored in the Data Administration Section in the center and are utilized by the competent environmental authorities and local government.

3) Assessment section

Part of division such as Environmental Assessment Division of EKF can be developed into this section. The section conducts environmental impact assessment by request of regional or local governments (BAZ county, city mayor offices) and private sectors with the help of the air pollution simulation models such as the model introduced in this Study. Results of the assessment would be useful information for the environmental protection authorities who need to make a policy, a strategy and a decision on air pollution abatement.

4) Public awareness development section

The section periodically notifies the state of ambient air quality to the public through mass communication or by street display boards to promote public awareness to air pollution problems. It would be helpful for getting the consensus of public opinion on the obligations concerning air pollution abatement, in other words, it would help the public to understand an importance of "fee for using environment" (air pollution fee), vehicles equipped with catalyzer and so on.

5) Data administration section

The section compiles all data measured and keeps them for certain period (10 years). Restored data should be freely utilized for air pollution protection activities by regional or local governments at any time.

9.3.3 Financial Measures for Executing the Control Measures

CEPF (Central Environmental Protection Fund) is expected to be expanded by the newly proposed system of "fee for using environment". CEPF can support not only control measures of industrial polluting sources but also those of domestic sources. According to the annual program for support in 1993, projects for reduction of domestic emissions are selected as high-priority tasks and can be funded by CEPF sources. The projects include building up or extending medium or low pressure gas network, which may extend up to joining individuals into the network. It is predicted that reduction of domestic emissions will contribute to improvement of air quality in the Study Area to a greater extent. Therefore, the project of expanding natural gas supply area for domestic use in the Study Area can be supported by CEPF.

Preferences and tax allowances for activities and products concerning air pollution abatement should be strengthened by some modifications in present taxation system, and should be widely noticed to the public.

All or part of expenses for emission measurement should be paid by the polluters who ask to measure it or who have to be inspected according to the regulation, and should be filled up for a replacement of the measuring equipment or for purchasing articles like standard gases or spare parts.

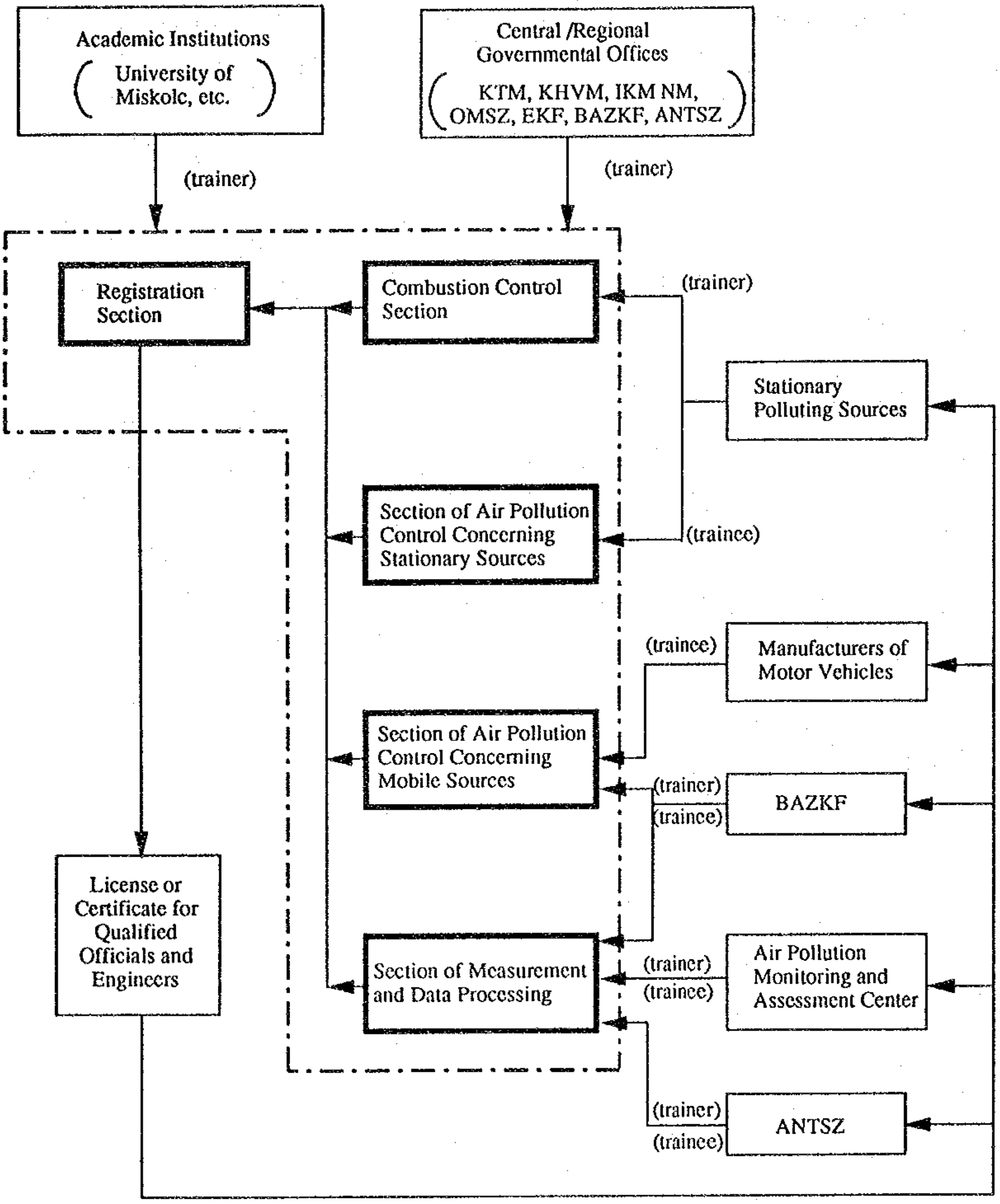


Figure 9.3.1 Conceptual Structure of Training Center for Air Pollution Control

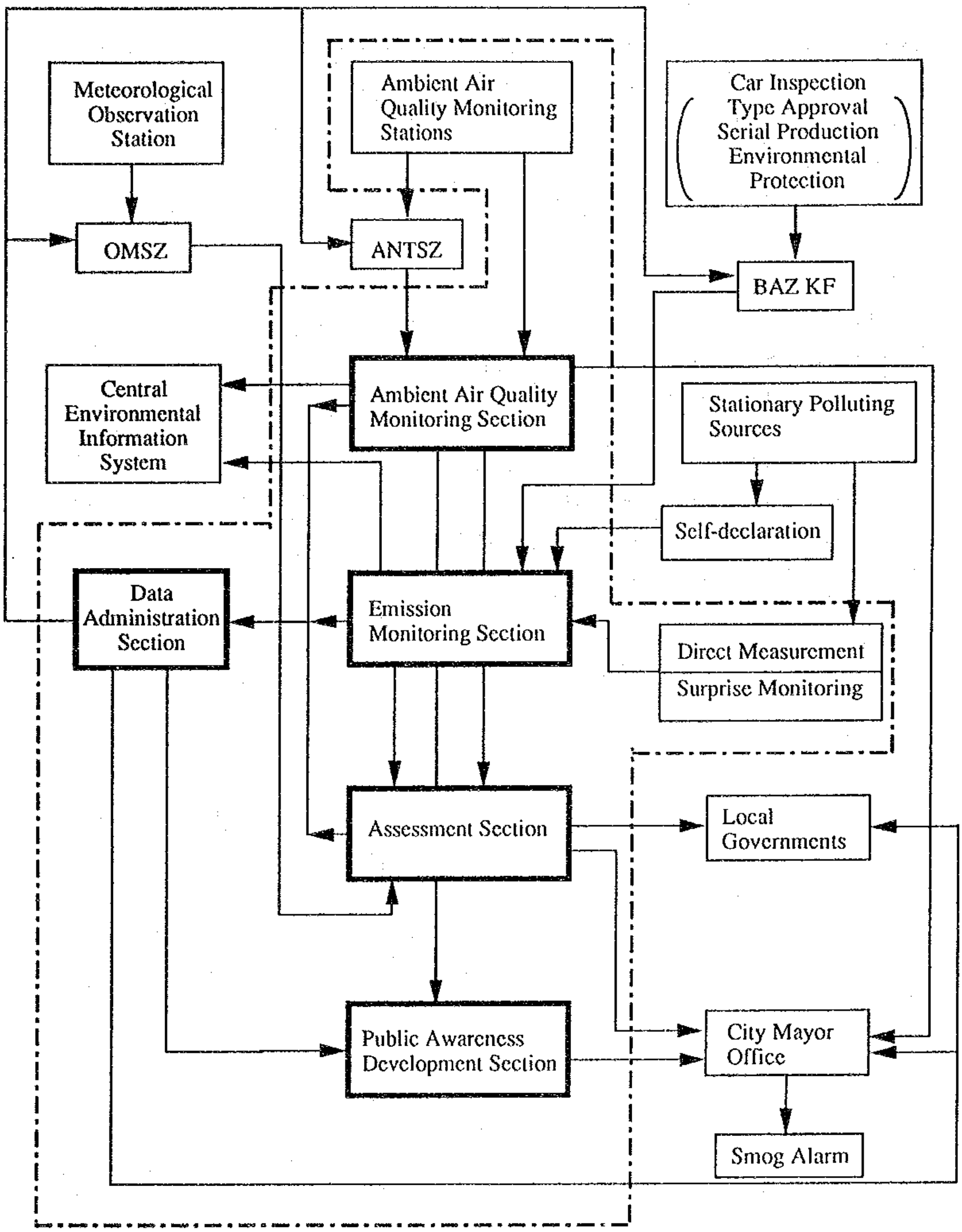


Figure 9.3.2 Conceptual Structure of Air Pollution Monitoring and Assessment Center

9.4 Implementation Program

The structural measures described earlier and the non-structural measures presented in Section 9.3 which support the former should be implemented to improve the air quality in the Sajó Valley area by the target year of 2005. In this Section, an implementation program will be proposed considering the priority of above measures.

(1) Structural Measures

One of the methods to determine the priority of implementing structural measures is to consider the amount of pollutant emission from the sources. Figure 9.4.1 shows the shares of the sources in the total amount of SO_2 emission, and Figure 9.4.2 shows the same for the NOx emission.

In the no pollution control case (Case F-0), the power stations account for 78% of the total SO_2 emission, communal sources account for 18%, major factories 3%, and motor vehicles less than 1%. In this respect, the power stations (especially Borsod P.S.) should be given a high priority in the SO_2 pollution control.

In the case of NOx, the power stations account for 36%, major factories 19%, motor vehicles 28%, and communal sources 17% of the total NOx emission.

Another method to determine the priority is to consider the contribution of each source to the ground-level concentration of the pollutant which is more important in terms of health of the people in the area concerned. The contributing concentrations of the sources at a typical point in Miskolc, Kazincbarcika, Putnok, and Ozd, where population is concentrated, is shown in Table 9.4.1.

The contribution ratio of communal sources in the SO_2 concentration is over 80% at all the points. The ratio particularly increases in the heating season. In this regard, the supply of natural gas to the households should be given a high priority.

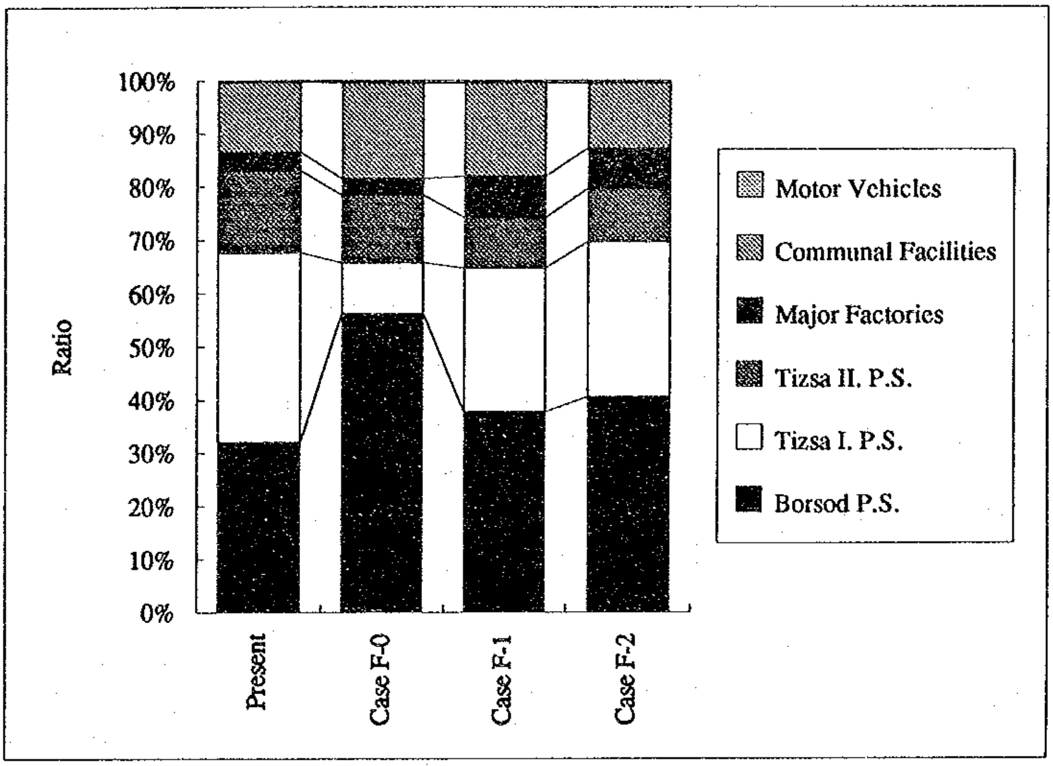


Figure 9.4.1 Shares of Sources in SO_2 Emission

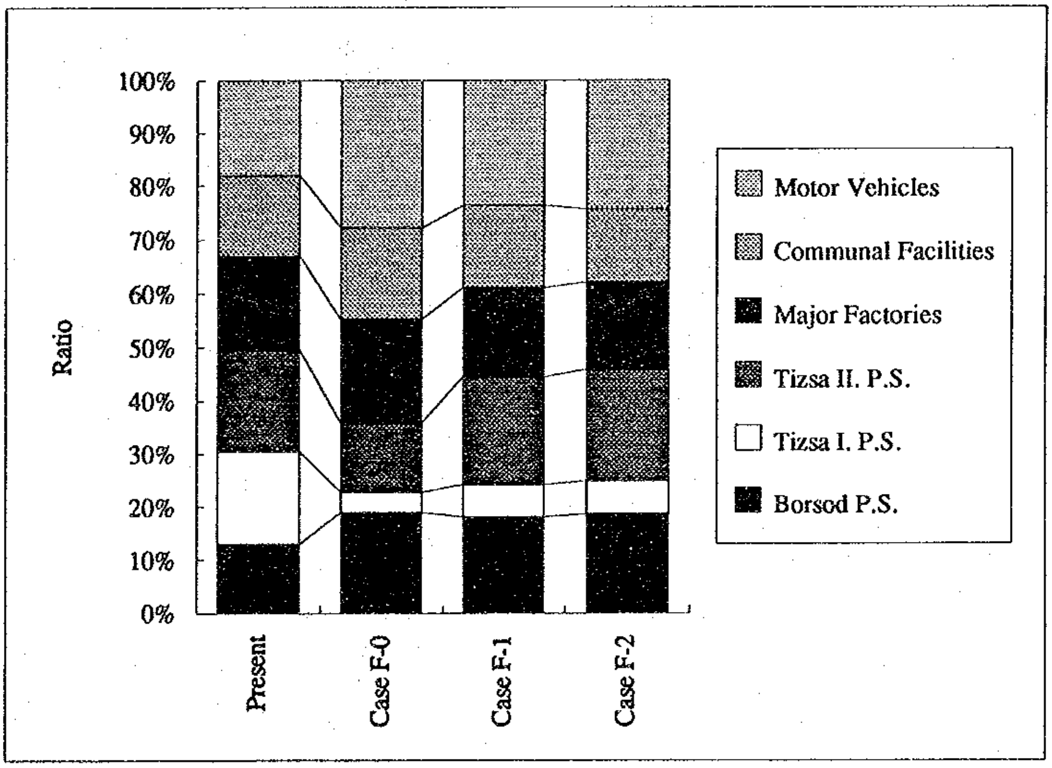


Figure 9.4.2 Shares of Sources in NOx Emission

Table 9.4.1(1) Contribution Concentration and Its Ratio by Sources in Major Cities of The Study Area

SO2

		Present						Case F-0						Case F-1						Case F-2					
		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year	
		mg/m^3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m	(%)	mg/m3	(%)
Miskolc	Industries	8	27	14	9	11	11	6	20	14	8	10	10	2	20	5	10	3	10	2	50	5	36	3	33
	Communal Sources	19	63	146	90	82	85	19	63	146	88	82	85	7	70	45	88	26	87	1	25	8	57	5	56
	Motor Vehicles	3	10	3	2	3	3	5	17	5	3	5	5	1	10	1	2	1	3	1	25	1	7	1	11
Kazinbarcika	Industries	9	47	10	10	9	15	9	45	10	10	10	16	2	33	3	10	3	17	2	40	3	12	3	19
	Communal Sources	10	53	90	89	50	83	10	50	90	89	50	82	4	67	27	90	15	83	3	60	23	88	13	81
	Motor Vehicles	0	0	1	1	1	2	1	5	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0
Putonok	Industries	3	30	3	4	3	8	2	22	3	4	3	8	1	33	1	5	1	8	1	33	1	6	1	10
	Communal Sources	7	70	67	96	37	93	7	78	67	94	37	93	2	67	20	95	11	92	2	67	17	94	9	90
	Motor Vehicles	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ozd	Industries	2	13	3	2	2	3	2	13	2	2	2	3	1	17	1	3	1	5	0	0	1	5	1	8
	Communal Sources	13	87	123	98	68	97	13	87	123	98	68	97	5	83	37	97	21	95	2	100	19	95	11	92
	Motor Vehicles	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9.4.1(2) Contribution Concentration and Its Ratio by Sources in Major Cities of The Study Area

NO2

		Present						Case F-0						Case F-1						Case F-2					
		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year		Non-heating		Heating		Whole Year	
		mg/m^3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m3	(%)	mg/m	(%)	mg/m3	(%)
Miskolc	Industries	1	4	1	3	1	3	1	3	1	2	1	3	1	5	1	4	1	4	1	5	1	4	1	4
	Communal Sources	3	12	16	44	10	31	3	9	16	36	10	26	3	14	11	41	7	29	3	14	9	36	6	26
	Motor Vehicles	22	85	19	53	21	66	30	88	27	61	28	72	17	81	15	56	16	67	17	81	15	60	16	70
Kazinbarcika	Industries	1	20	1	7	1	11	1	17	2	13	1	9	0	0	1	11	1	17	0	0	1	11	1	17
	Communal Sources	1	20	9	64	5	56	1	17	9	56	5	45	1	33	5	56	3	50	1	33	5	56	3	50
	Motor Vehicles	3	60	4	29	3	33	4	67	5	31	5	45	2	67	3	33	2	33	2	67	3	33	2	33
Putonok	Industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Communal Sources	1	50	6	75	3	60	1	33	6	67	3	60	0	0	2	67	1	50	0	0	2	67	1	50
	Motor Vehicles	1	50	2	25	2	40	2	67	3	33	2	40	1	100	1	33	1	50	1	100	1	33	1	50
Ozd	Industries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Communal Sources	1	33	11	85	7	78	1	33	11	79	7	70	1	50	5	71	3	75	1	50	4	67	2	67
	Motor Vehicles	2	67	2	15	2	22	2	67	3	21	3	30	1	50	2	29	1	25	1	50	2	33	1	33

(2) Non-structural Measures for Air Pollution Control

Non-structural measures are very important as the support to implement the structural measures.

Main non-structural measures proposed are as follows.

(1) Tax finance allowance system
(2) Financial measures
(3) Establishment of air pollution monitoring and assessment center
(4) Establishment of training center for air pollution control
(5) Enforcement of "Govemmental Decree on Air Pollution Control"

Enforcement of "Governmental Decree on Air Pollution Control" is most important, because the decree is the foundation of all measures.

(3) Implementation Program

On the basis of above considerations and mutual relation between structural and non-structural measures, an implementation program is proposed as shown in Table 9.4.2.

Table 9.4.2 Implementation Program of Air Pollution Control for Sajo Valley Area

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
1. Stationary Sources														
(1)Power Station														
1) Borsod Thermal Power Station Pulverized Coal-fired Boilers (100t/h x10) 600GWh in 1992	425GWh		380GWh Introduction of CFBC +HFBC					780GWh					970GWh	17,740million HUF
2) Tisza I. Thermal Power Station Pulverized Coal-fired Boilers (125t/h x 8) 932GWh in 1992	795GWh		450GWh					120GWh					35GWh	-
3) Tisza II. Thermal Power Station Oil & Gas Mixed Fired Boiler 4 Blocks(670t/h x 4) 2,616GWh in 1992	3,008GWh		3,300GWh					3,805GWh Fuel Control: Sulfur Cont.3.73% to 1.0%					3,581GWh	-
(2)Major Factories							4 factories: Fuel conversion etc.				6 factories: Low NOx burner etc			351million HUF
(3) Communal Facilities Fuel Conversion (to natural gas)	57% households supplied with natural gas										86% of households supplied with natural gas			9,170million HUF
2. Mobile Sources														-
(1) Emission Control Application of EC Regulation							Promotion of new motor vehicles equipped with catalytic converter							-
(2) Fuel Control														-
1) Unleaded fuel							Promotion of new motor vehicles equipped with catalytic converter							-
2) Low Sulphur Fuel		Sulphur content 0.2%					Sulphur content 0.05%							-
3. Institutional Measures (Non-srtuctural measures)														
(1) Tax Allowance System	Existing system						Strengthen System							-
(2) Central Environmental Protection Fund (CEPF)	Existing system						Enlargement of fund							-
(3) Training Center for Air Pollution Control						Establishment				Operation				-
(4) Air Pollution Monitoring & Assessment Center			Establishment					Operation						-
(5) "Governmental Decree on Air Pollution Abatement"				Enforcement										-
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate

Chapter 10 RECOMMENDATIONS

(1) Implementation of New Legal Systems for Air Pollution Control

The Hungarian Government is preparing new legal systems for air pollution control. Implementation of the new regulations and standards would undoubtedly contribute to improvement of air quality in Hungary including the Sajó Valley area. For the successful implementation, the following is recommended.

1) Fostering qualified persons in appropriate institutions in various areas including combustion control, air pollution control, air quality measurement and data processing, air quality assessment, public awareness development, and environmental data administration.

2) Effective utilization of the Central Environmental Protection Fund (CEPF) and strengthening the preferential taxation system to promote air pollution abatement measures including gasification of home heating and energy saving.

(2) Air Quality Monitoring

Ambient air quality monitoring is the foundation of air pollution control management. The Sajó Valley area is now covered by the monitoring network of 16 automatic measuring stations for air quality and meteorology. Important tasks for maximization of functions of the existing monitoring network and for effective utilization of the monitored data include the following:

1) Proper operation and maintenance of measuring equipment and data transmission devices

2) Data examination and processing for evaluation of the air quality

3) Data management for utilization in various works concerning air pollution control

4) Preparation of monthly summary and annual report of the monitoring data

5) Publicity of the state of air quality for stimulating public awareness towards air quality improvement

For strengthening the capability of performing above tasks, close cooperation of the institutions involved in the monitoring and adequate allocation of human resources and budget are recommended.

(3) Energy Saving

Energy consumption per unit output in Hungary is generally much higher in comparison to other developed countries. It also applies to many plants in the Sajó Valley area. To promote energy saving in plants, the following are recommended:

1) Actual status of energy efficiency should be evaluated in each plant. For this purpose, key combustion parameters such as fuel consumption rate and oxygen concentration of combustion gas have to be measured accurately. A fuel flow meter or an appropriate device for determining the fuel consumption rate should be installed on combustion facilities that do not have one currently. Since flue gas measuring ports for number of combustion facilities are provided at inappropriate positions where actual oxygen concentration of the combustion gas is not possible to measure due to air intrusion, the port should be provided at an appropriate place such as the boiler outlet.

2) The oxygen concentration and the temperature of exhaust gas were found to be high at number of combustion facilities, indicating dissipation of heat energy into atmosphere. Amount of air supply should be controlled at an appropriate level, and air intrusion into combustion chamber should be prevented. Waste heat of flue gas should be utilized as much as possible by employing appropriate energy saving devices.

3) Each plant should have an organization to pursue maximum energy utilization efficiency under a director who takes full responsibility in energy saving. It is desirable that the Government prepare guidelines for energy diagnosis and rationalization of energy utilization to be implemented by plants.

(4) Improvement of Borsod Power Plant

Borsod Power Plant is a large pollutant emission source at present with out-dated facilities, but its importance as an energy supplier in the Sajó Valley area will be increased in the future. Therefore, substantial improvements of this power plant in pollution control and energy efficiency are indispensable. An improvement plan has been prepared by the Hungarian Electricity Companies (MVM Rt.) on the basis of the energy policy of the Government in which utilization of the local coal is intended for Borsod Power Plant. Implementation of the improvement plan should be promoted by paying attentions to the following: