9.3 Prediction and Assessment of Environmental Impacts

9.3.1 Air Pollution

To predict the degree of the impact of pollutants emitted from the Maritsa East No.1 Power Plant exerting upon the surrounding environment, atomospheric dispersion analysis of air pollutants has been carried out. With the prediction items comprised of the short and long term dispersion of air pollutants, this prediction has been carried out over a radius range of 30km.

The pollutants consisting of sulfur oxides (SO_x), nitrogen oxides (NO_x) and dust are predicted to be diffused where these pollutants are assumed to behave equally. The meteorological conditions used herein are those described in "Meteorological Conditions".

Althought the short term dispersion conditions calculated herein are only those after completion of the reconstruction project, the long term diffusion conditions are calculated with regard to the following three cases: namely, the diffusion conditions during operation of Maritsa East No.1 Power Plant Units 1~6, present dispersion conditions and those after implementation of the reconstruction project.

The impact at pollutants from Maritsa East Nos.2 and 3 Power Plant exerting upon the surrounding environment is also considered very serious. An integrated assessment of environmental impacts including these power plants is, therefore, expected to be made separately. The following study is made in relation to Maritsa East No. 1 Power Plant only.

(1) Prediction of Short Term Dispersion

Calculation for prediction of short term dispersion is performed by using the Bosanquet Satten formula.

(a) Formula of The Effective Height of Stack (Bosanquet Formula- I)

$$H_e = H_o + \alpha (H_m + H_t)$$

$$H_m = \frac{4.77}{1+0.43U/V} \cdot \frac{\sqrt{Q \cdot V}}{U}$$

$$H_t = 6.37g \cdot \frac{Q(T-T_1)}{U^3 \cdot T_1} (\log_e J^2 + \frac{2}{J} - 2)$$

$$J = \frac{U^2}{\sqrt{Q \cdot V}} \left(0.43 \sqrt{\frac{T_1}{g \cdot G}} - 0.28 \cdot \frac{V}{g} \cdot \frac{T_1}{T - T_1}\right) + 1$$

where;

H_e	:	Effective height of stack (m)
H_o	:	Actual height of stack (m)
α	:	Flue gas ascending coefficient (= 0.65)
H_m	:	Rising height by momentum (m)
H_t	:	Buoyant height by temperature (m)
U	:	Wind velocity (m/s)
V	:	Leaving velocity of flue gas (m/s)
Q	:	Amount of flue gas at ambient temperature (m^3/s)
T	:	Temperature of flue gas (°K)
T_1	:	Ambient temperature (°K)
g	:	Acceleration of gravity (m/s^2) ($g = 9.8\ m/s^2$)
G	:	Temperature gradient of atmosphere (°C/m)

(b) Formula for Dispersion Calculation (Sutton's Formula)

$$c(x) = \frac{2q \cdot \eta}{\pi \cdot Cy \cdot C_z \cdot U \cdot X^{2-n}} \cdot \exp\left(- \frac{1}{x^{2-n}} \cdot \frac{H_e^2}{C_z^2}\right)$$

$$C_{max} = 0.234 \cdot \frac{C_z}{C_y} \cdot \frac{q}{U \cdot H_e^2} \cdot \eta$$

$$X_{max} = \left(\frac{H_e}{C_z}\right)^{\frac{2}{2-n}}$$

where;

C(x)	:	On-ground concentration at leeward distance X from pollutant emission source
x	:	Leeward distance from pollutant emission source (m)
α	:	Maximum density of on-ground concentration
C_{max}	:	Maximum density of on-ground concentration
X_{max}	:	Distance to maximum density of on-groun concentration from pollutant emission source (m)

q	:	Amount of pollutant emission
Cy	:	Dispersion variable (Vertical) (=0.07)
Cz	:	Dispersion variable (Horizontal) (=0.07)
V	:	Wind velocity (m/s)
n	:	Atmospheric disorder coefficient (=0.25)
He	:	Effective height of stack (m)
		Time correction coefficient (1 hour: 0.15, 24 hour: 0.15 x 0.59)

(c) Calculation Conditions

The constant used for this calculation are as given Table 9-3-1-1. As the dimensions of the smoke sources are indicated in Table 9-3-1-2 are adopted herein.

(d) Calculated Results

Calculated maximum on-ground concentration and distance of maximum on-ground concentration are presented in Table 9-3-1-3. The on-ground concentration curve in Figure 9-3-1-1,2.

The maximum on-ground concentrations distances is 14.7km down the wind. The maximum on-ground concentrations of air pollutants all satisfy the environmental standards of Bulgaria.

(2) Prediction of Long Term Dispersion

CONCAWE Formula and Briggs' Formula are adopted for prediction of the effective height of stack. For calculation of dispersion, Plume and Puff Formulae are adopted.

(a) Formula of the effective height of stack

① Windy condition : CONCAWE Formula

$He = Ho + \Delta H$

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

② Windless condition : Briggs' Formula

$He = Ho + \Delta H$

$\Delta H = 1.4 \cdot Q_H^{1/4} (dQ/dz)^{-3/8}$

$QH = \rho \cdot Q \cdot Cp \cdot (T - T_1)$

where:

He	:	Effective height of stack (m)
Ho	:	Actual height of stack (m)
ΔH	:	Exhaust gas rising height (m)
Q_H	:	Exhaust calorie (cal/s)
ρ	:	Density of flue gas at 0°C (= 1,293 g/m³)
Q	:	Amount of flue gas (m³N/s)
Cp	:	Specific heat (= 0.24 cal/kg)
T	:	Flue gas temperature (°C)
T_1	:	Ambient temperature (°C)
U	:	Wind velocity (m/s)

(b) Formula for dispersion calculation

① Windy condition : Plume Formula

$$C(X) = \frac{2Q}{\sqrt{2\pi}\cdot\frac{\pi}{8}\cdot X\cdot\sigma z\cdot U}\exp\left(-\frac{1}{2}\cdot\frac{He^2}{\sigma z^2}\right)$$

② Windless condition : Puff Formula

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

Where:

C(X)	:	On-ground concentration at leeward distance X(m) from pollutant emission source (m^3/m^3)
C(R)	:	On-ground concentration at distance R(m) from pollutant emission source (m^3/m^3)
Q	:	Amount of pollutant emission (N m^3/s)
U	:	Wind velocity (m/s)
X	:	Leeward distance from pollutant emission source (m)
R	:	Distance from pollutant emission source (m)
He	:	Effective height of stack (m)
σ z	:	Dispersion width in vertical direction at leeward distance X(m) (m)
α	:	Dispersion variable (Horizontal) (m/s)
γ	:	Dispersion variable (Vertical) (m/s)

Regarding dispersion variables, the following are adopted.

Windy condition: Approximate function of Pasquill - Gifford, Chart (Refer to Table 9-3-1-4.)

Windless condition: Dispersion variable at no wind condition using the Pasquill's stability (Refer to Table 9-3-1-5.)

(c) Conditions of Pollutant Sources

As the dimensions of the smoke sources are indicated Table 9-3-1-6.

(d) Results of Calculation and Assessment

The annual mean concentration values are based on the prediction Figures9-3-1-3~9-3-1-11. The Maximum on-ground concentrations are as follows.

① Case I (The Past)

(I) SO_x

The maximum on-ground concentration is 165 μ g/m3 (yealy mean).

(II) NO_x

The maximum on-ground concentration is 5 μ g/m3 (yealy mean).

(III) Dust

The maximum on-ground concentration is 48 μ g/m3 (yealy mean).

The maximum SO_x. above-ground concentration substantially exceed the environmental standards of Bulgaria (50 μ g/m^3). Therefore, the atmospheric air quality during operation of Units 5 and 6 of Maritsa East No.1 Power Plant is not deemed to have been so desirable.

② Case II (The Present)

(I) SO_x

The maximum on-ground concentration is 100 μ g/m3 (yealy mean).

(II) NO_x

The maximum on-ground concentration is 5 μ g/m3 (yealy mean).

(III) Dust

The maximum on-ground concentration is 31 μ g/m3 (yealy mean).

The maximum SOx. above-ground concentration exceed the environmental standards of Bulgaria. Consequently, the atmospheric air quality during operation of Units 5 and 6 of Maritsa East No.1 Power Plant is not deemed to have been so desirable.

③ Case III (The After Replacing)

(I) SO_x

The maximum on-ground concentration is 16 μ g/m3 (yealy mean).

(II) NO_x

The maximum on-ground concentration is 4 μ g/m3 (yealy mean).

(III) Dust

The maximum on-ground concentration is 0.6 μ g/m3 (yealy mean).

The concentration of sulfur oxides (SO_x), nitrogen oxides (NO_x) and dust all satisfy the environmental standards of Bulgaria.

Now, Since the existing Units 1～6 boilers and coal drying equipment (the units 7～10 boilers have already been demolished) in the Maritza East No.1 Power Plant will not be used and demolished upon completion of this replacement project. Consequently, the total amount of SO_2 emission will be reduced ultimately by as much as 50.9t/h (=54.4ton/hour - 5.3ton/hour), hence reduction ratio is about 90 %. (Refer to Table 9-3-1-7).

In addition, the amount of dust emissions will also be reduced by as much as [8.28 ton/hour - 0.20ton/hour=8.08ton/hour.]or reduction ration of about 98 %. (Refer to Table 9-3-1-8).

Consequently, the contribution degree of this reconstruction project for improving the environment can be regarded of vital significance.

Table 9-3-1-1 Calculation Constant

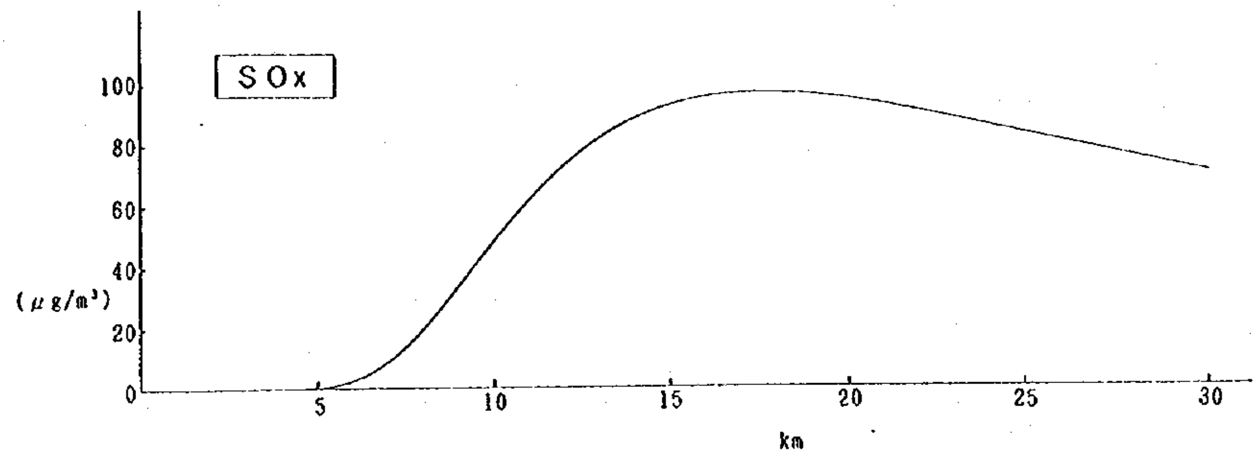
Item		Unit	1 Hour Value	24 Hour Value
On-ground Concentration		—	Sutton's Formula	
Effective Height of Stack		—	Bosanquet's I Formula	
Ambient Condition	Temperature	℃	15	15
	Wind velocity	m/s	6	6
	Dispersion Variable	—	Cy=Cz=0.07	Cy=Cz=0.07
	Atmospheric Disorder Coefficient	—	n=0.25	n=0.25
	Temperature Gradienrt	℃/m	G=0.0033	G=0.0033
	Flue Gas Ascending Coefficient	—	α=0.65	α=0.65
Time Correction Coefficient		—	η=0.224	η=0.046

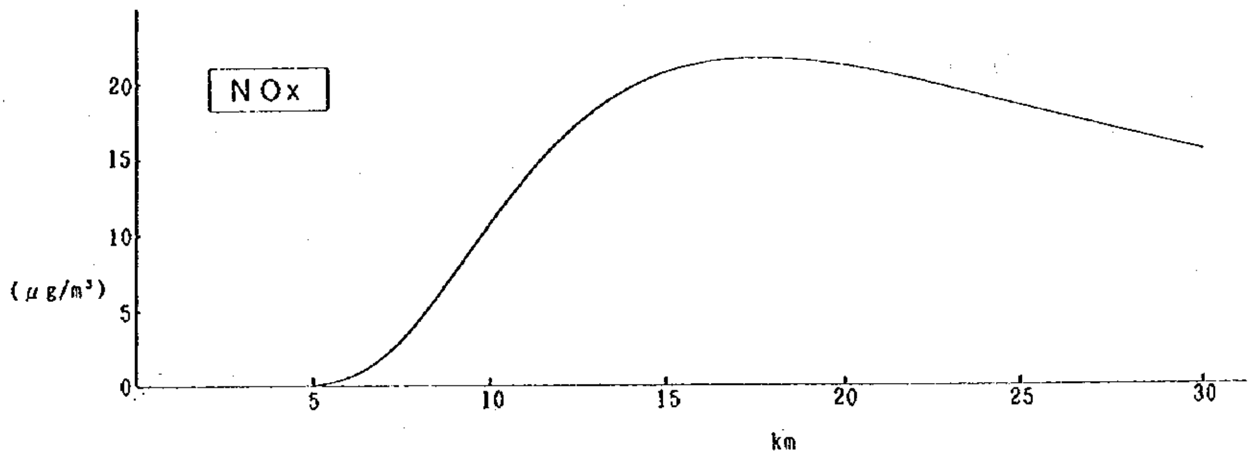
Table 9-3-1-2 Data/Specification of Pollutant Emission Sources

		Unit	Maritsa East # 1 (After Replacing)	
Plant Specification Unit NO.			R1 (230MW)	R2 (230MW)
Stack Height		m	180	180
Stack Inner Diameter at the Top		m	4.8	4.8
Flue Gas Flow		$10^3 m^3N/h$	1,297	1,297
SOx Conc.		ppm	940	940
NOx Conc.		ppm	292	292
Dust Conc.		mg/m^3N	100	100
Stack outlet gas	Temp.	°C	170	170
	Velocity	m/s	30	30

Tablre 9-3-1-3 Maximum On-ground Concentration and Distance of Maximum On-ground Concentration with reference Environmental Standards

Item		Unit	Maximum On-ground Concentration	Bulgarian Standard
SOx	1 hour value	$\mu g/m^3$	97	254
	24 hour value	$\mu g/m^3$	20	150
NOx	1 hour value	$\mu g/m^3$	21	102
	24 hour value	$\mu g/m^3$	4	60
Dust	1 hour value	$\mu g/m^3$	4	424
	24 hour value	$\mu g/m^3$	1	250
Distance to Maximum On-Ground Concentration Position		km	17.6	—





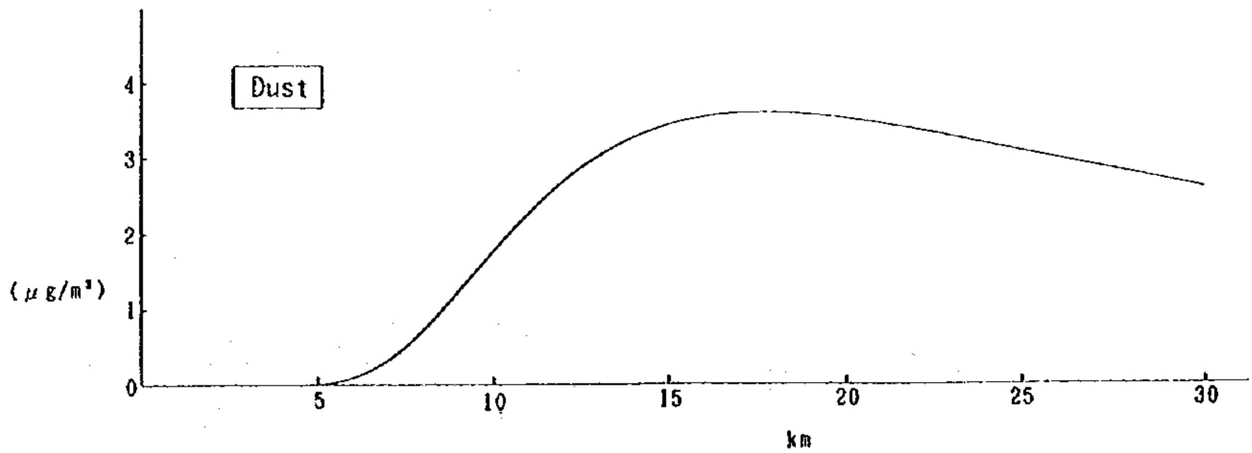


Figure 9-3-1-1 On-ground Concentration Curve for 1 Hour Value

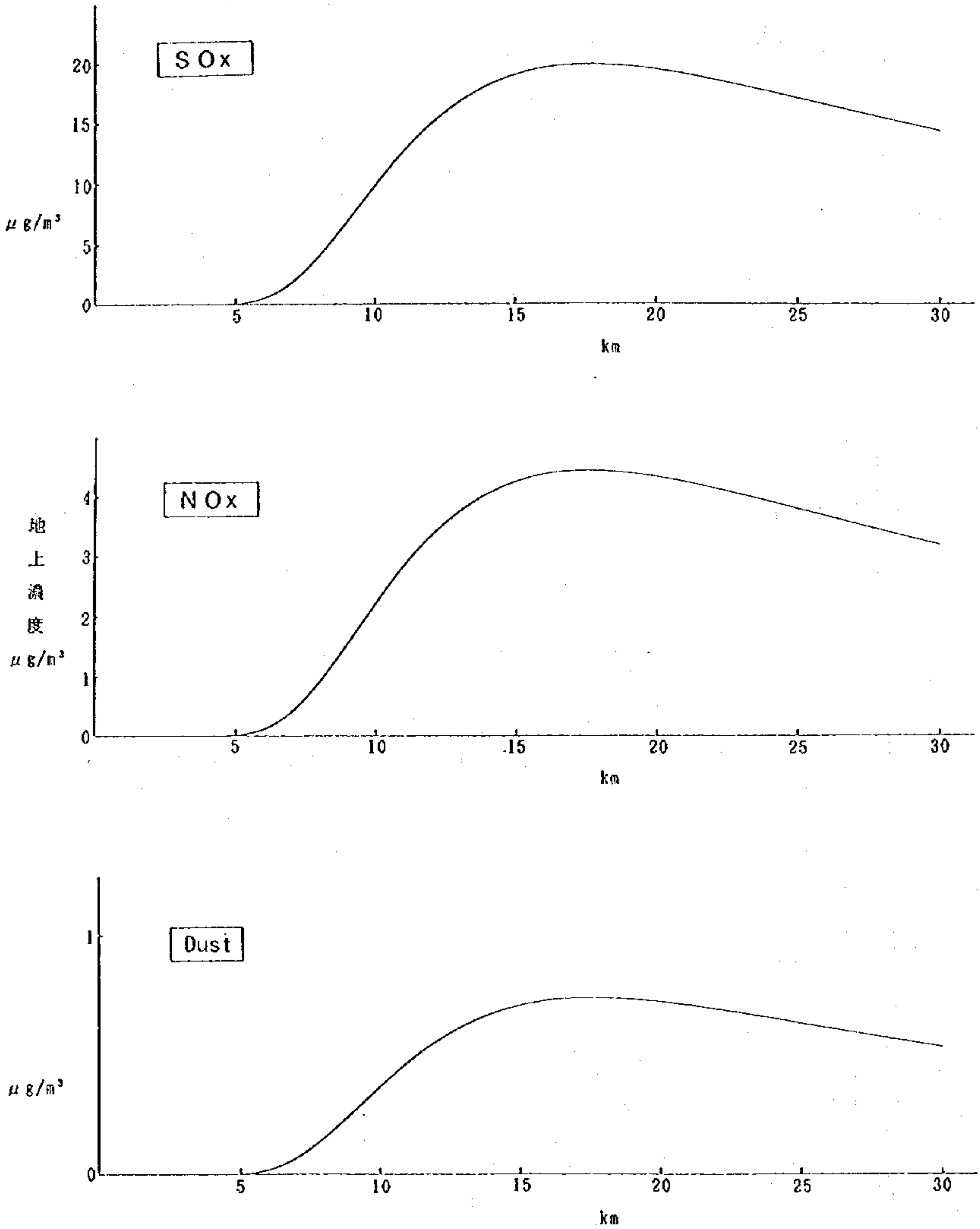


Figure 9-3-1-2 On-ground Concentration Curve for 24 Hour Value

Table 9-3-1-4 Dispersion Variable (Windy condition)
(Approximate function of Pasquile.Gyford Figure)

$\sigma_z : (x) = b \cdot x^a$

Atmospheric Stability	a	b	Leeward distance X (m)
B	0.964	0.1272	0 - 500
	1.094	0.0570	500
C	0.918	0.1068	0 -
CD	0.872	0.1057	0 - 1,000
	0.775	0.2067	1,000 - 10,000
	0.737	0.2943	10,000 -
D	0.826	0.1046	0 - 1,000
	0.632	0.400	1,000 - 10,000
	0.555	0.811	10,000 -
E	0.788	0.0928	0 - 1,000
	0.565	0.433	1,000 - 10,000
	0.415	1.732	10,000 -
F	0.784	0.0621	0 - 1,000
	0.526	0.370	1,000 - 10,000
	0.323	2.41	10,000 -

Table 9-3-1-5 Dispersion Variable (Windless condition)

Atmospheric Stability	α	γ
B	0.781	0.474
C	0.635	0.208
CD	0.542	0.153
D	0.470	0.113
E	0.439	0.067
F	0.439	0.048

Table 9-3-1-6 Data/Specification of Pollutant Emission Sources

	Unit	Maritsa East #1					
		Case I (The Past)			Case II (The Present)		Case III (After Replacing)
Plant Specification Boiler No.		1~6 (210t/h×6)	7~10 (250t/h×4)	Dryer 1~14	1~6 (210t/h×6)	Dryer 1~7	R1,2 (740t/h×2)
Stack Height	m	150	180	120	150	120	180
Stack Inner Diameter at the Top	m	6	6	5	6	5	4.8
Flue Gas Flow	$10^3 m^3N/h$	2,316	1,448	806	2,316	403	2,594
SOx Conc.	ppm	5,000	5,000	5,000	5,000	5,000	940
NOx Conc.	ppm	240	240	97	240	97	292
Dust Conc.	mg/m^3N	200	200	15,000	200	15,000	100
Stack Outlet Gas Temp.	°C	190	190	92	190	92	170
Stack Outlet Gas Velocity	m/s	12.0	12.0	11.0	12.0	11.0	30

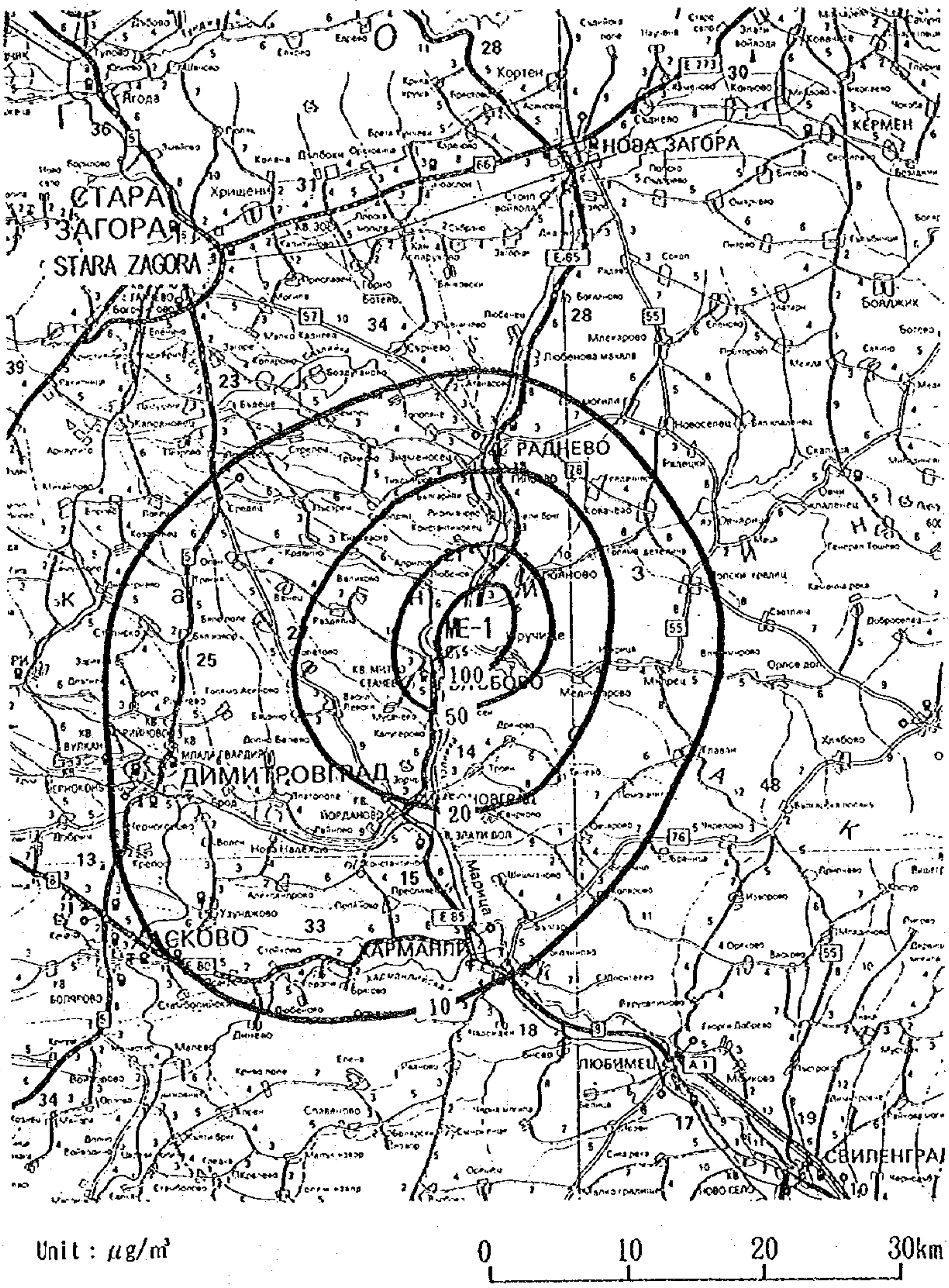
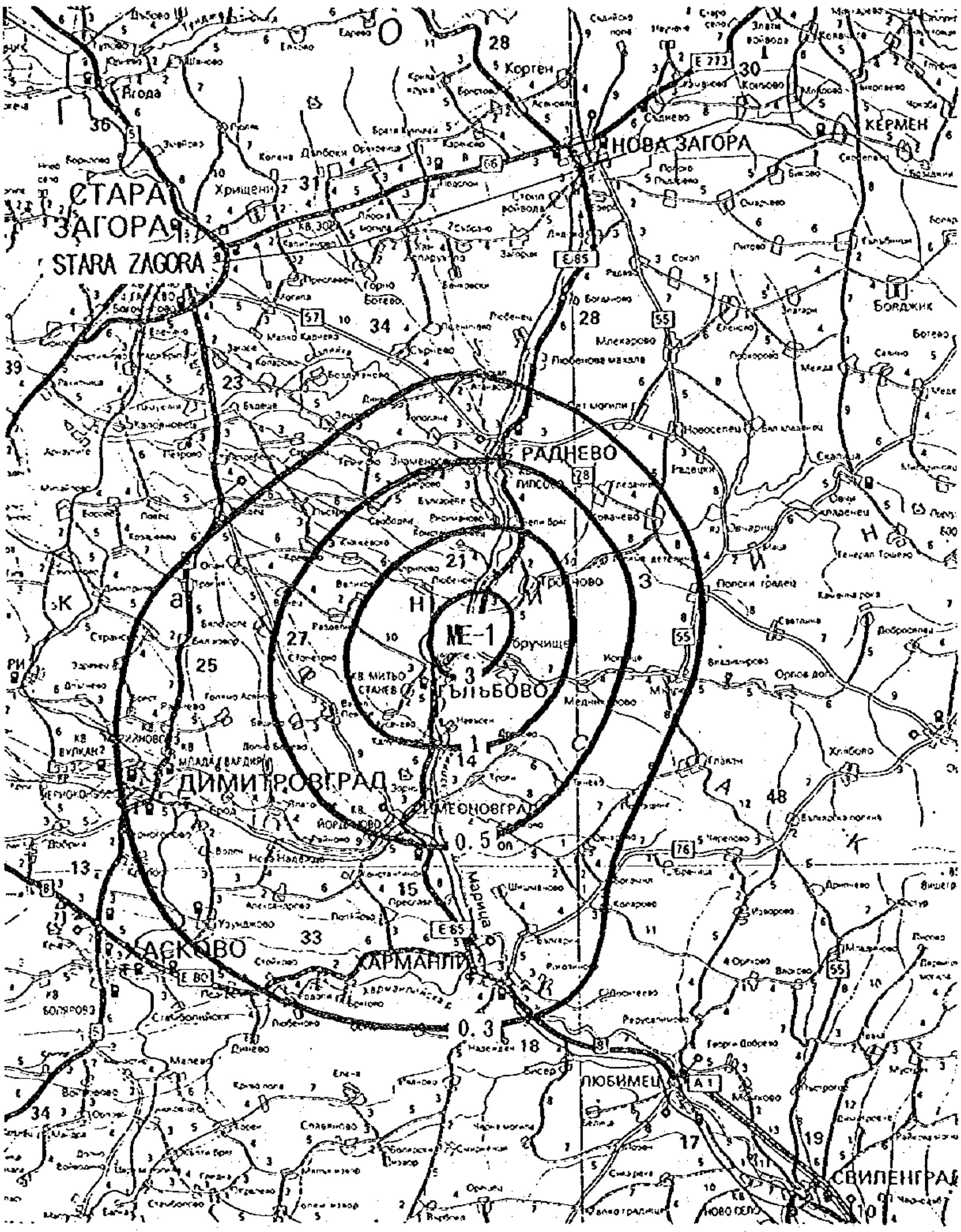


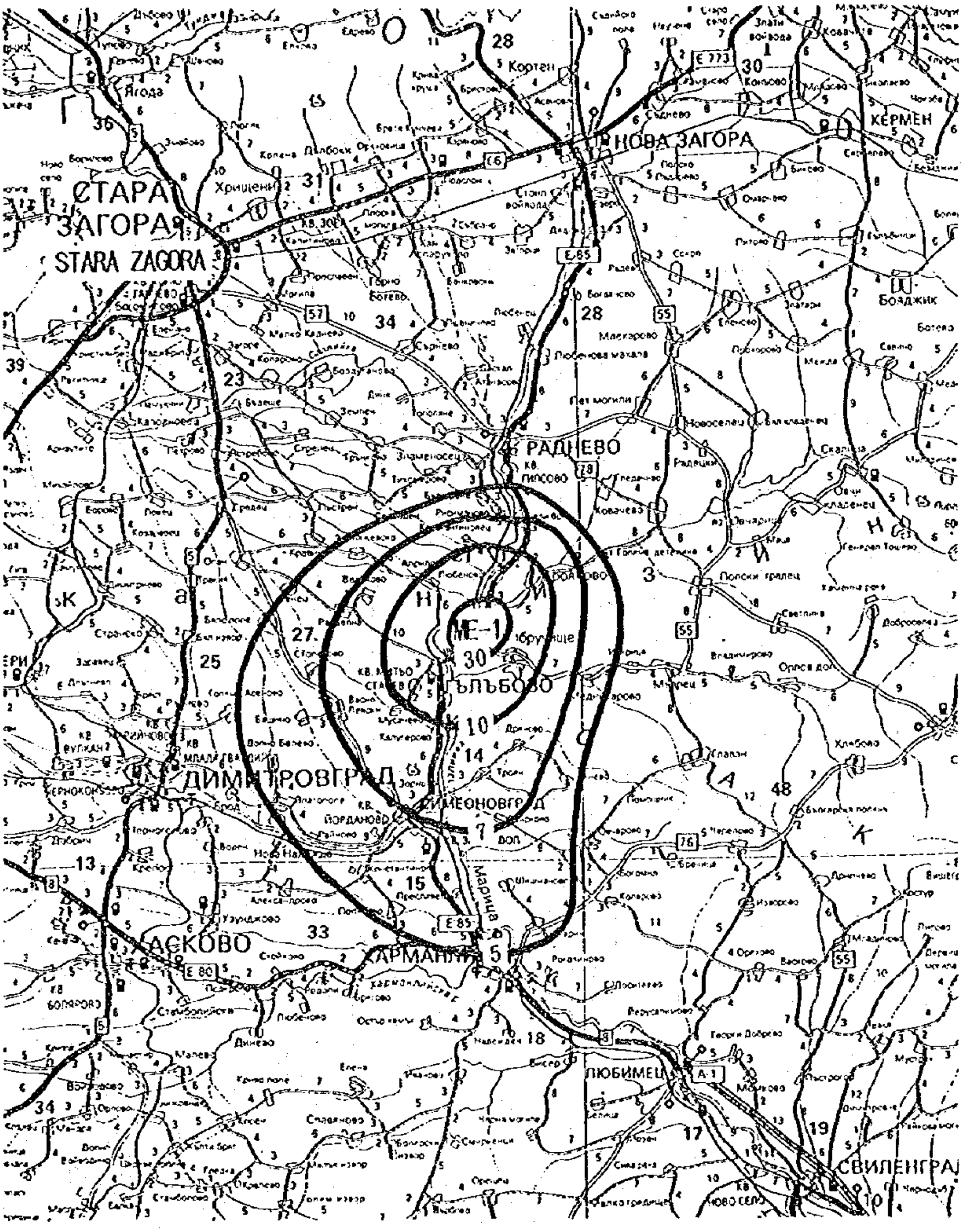
Figure 9-3-1-3 Annual Mean Concentration(CASE- I, SOx)



Unit : $\mu g/m^3$

0 10 20 30km

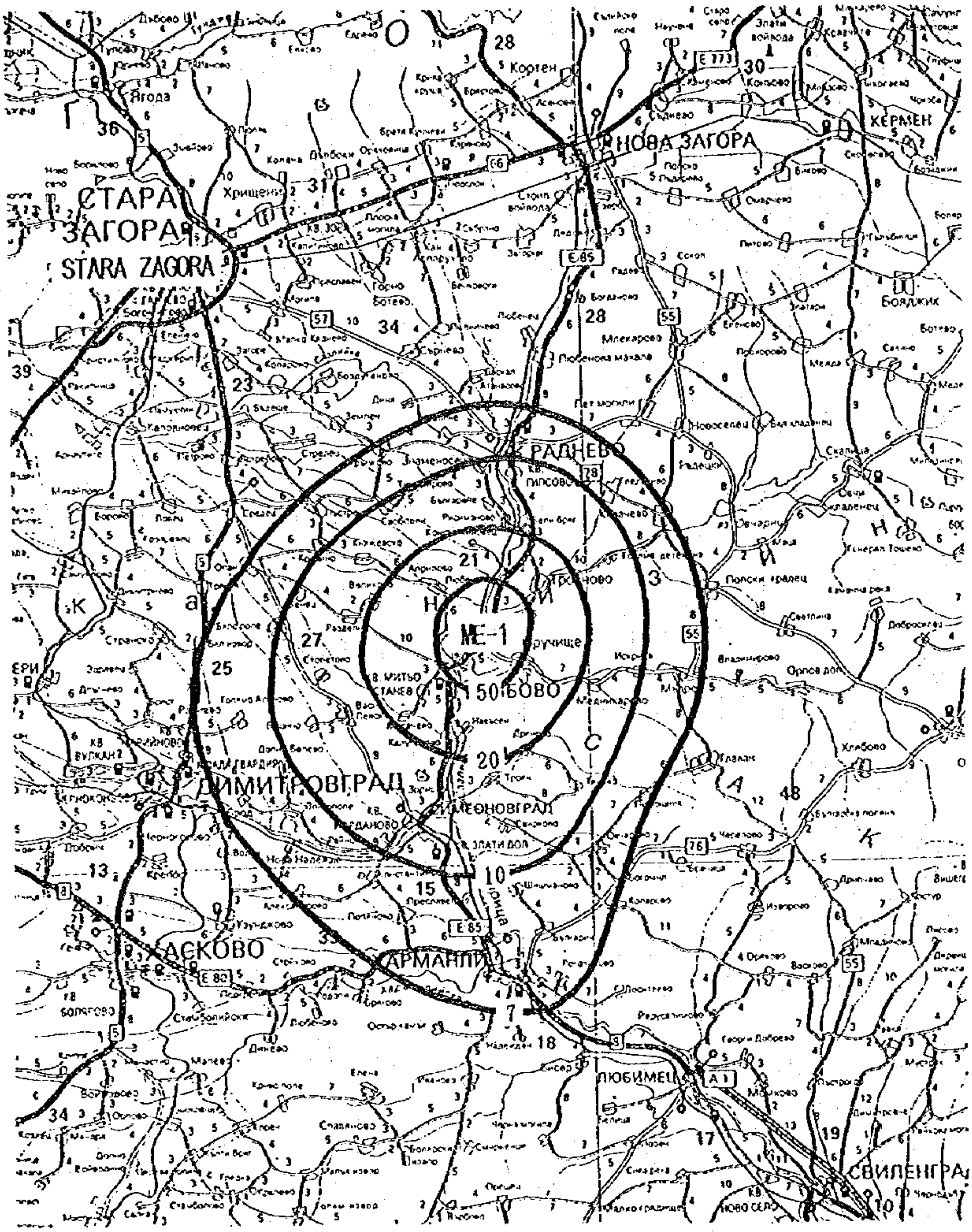
Figure 9-3-1-4 Annual Mean Concentration(CASE－Ⅰ, NOx)



Unit : $\mu g/m^3$

0 10 20 30km

Figure 9-3-1-5 Annual Mean Concentration(CASE- I, Dust)



Unit : $\mu g/m^3$

0 10 20 30km

Figure 9-3-1-6 Annual Mean Concentration(CASE－II, SOx)

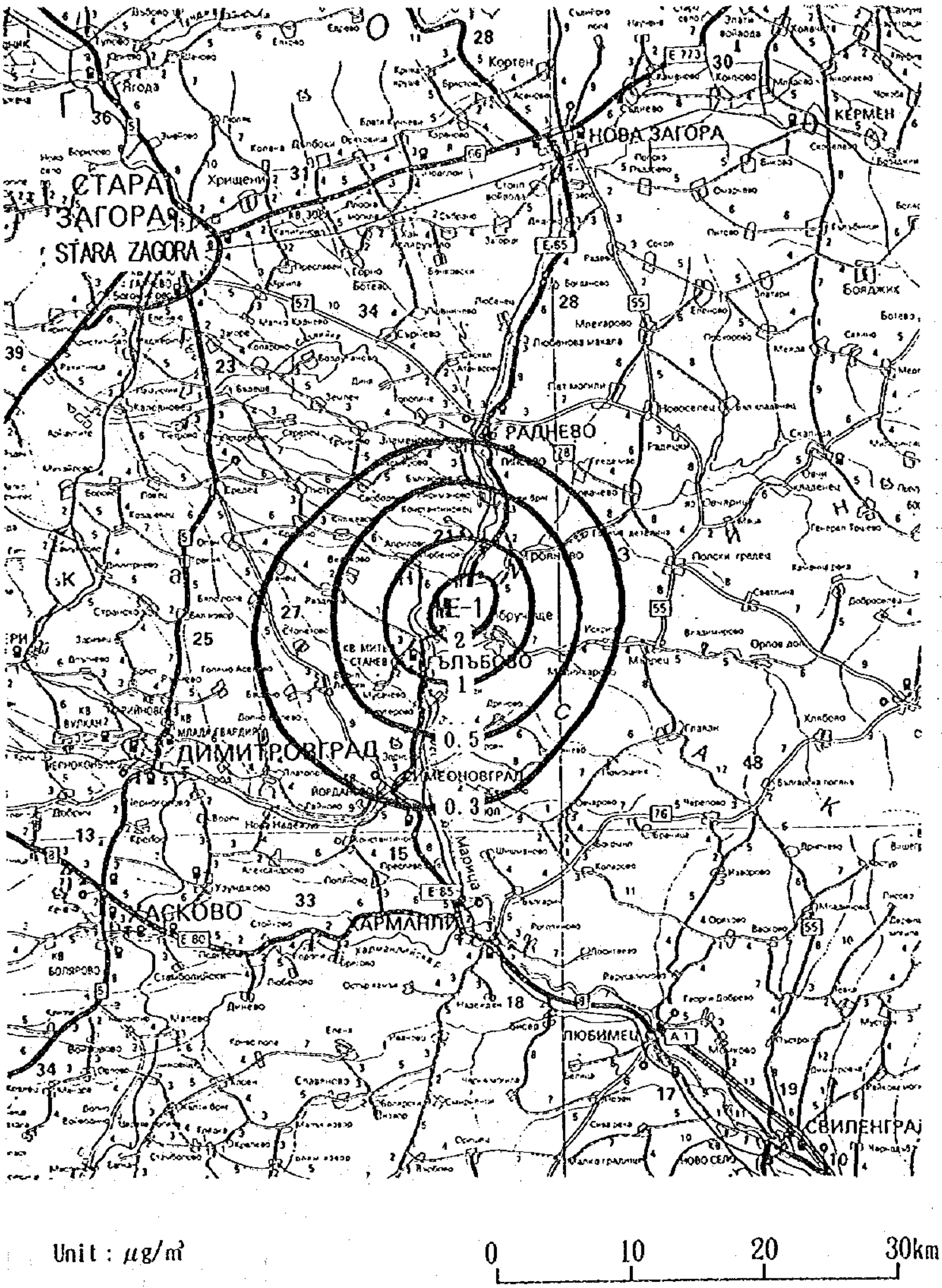
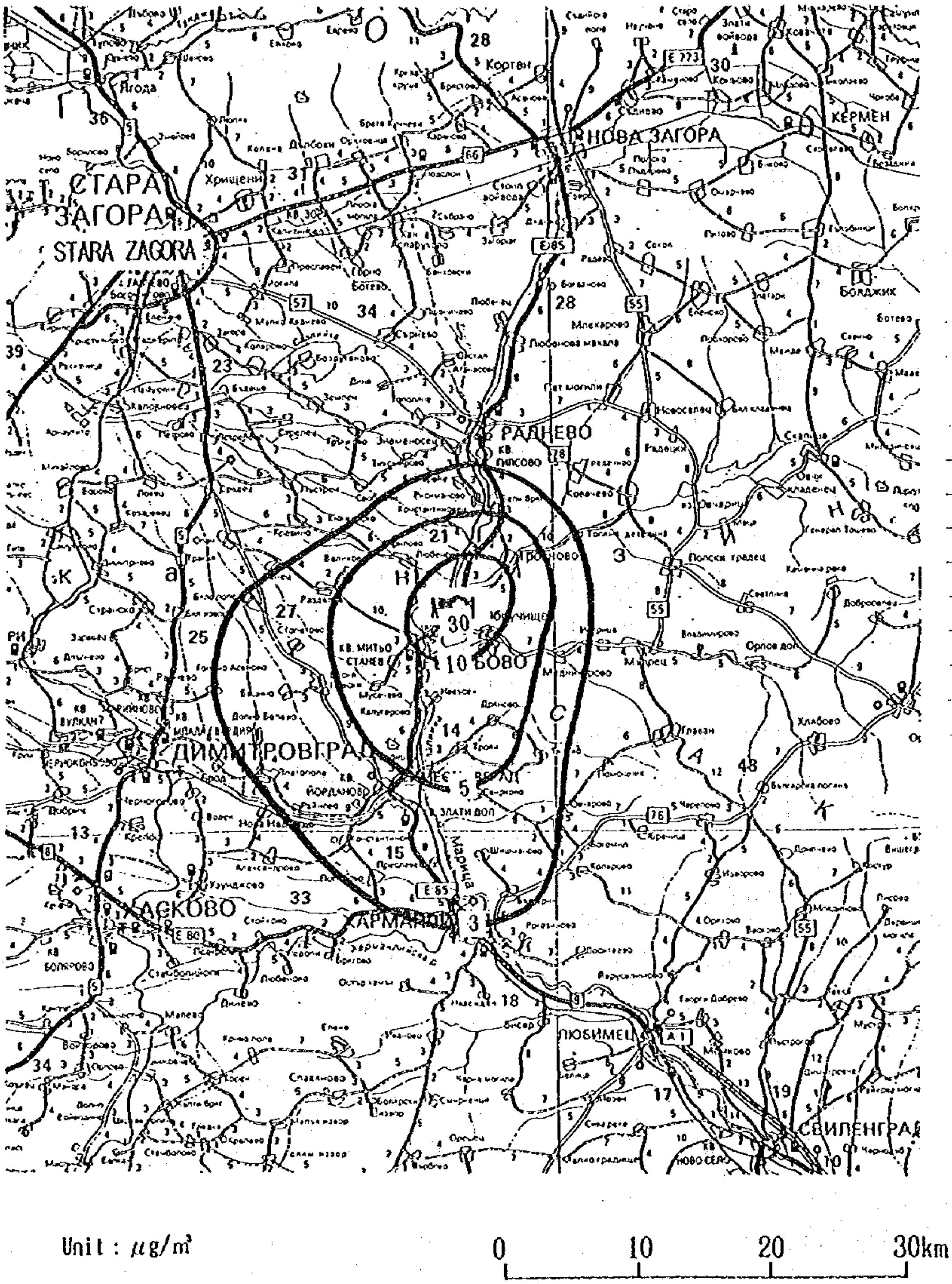
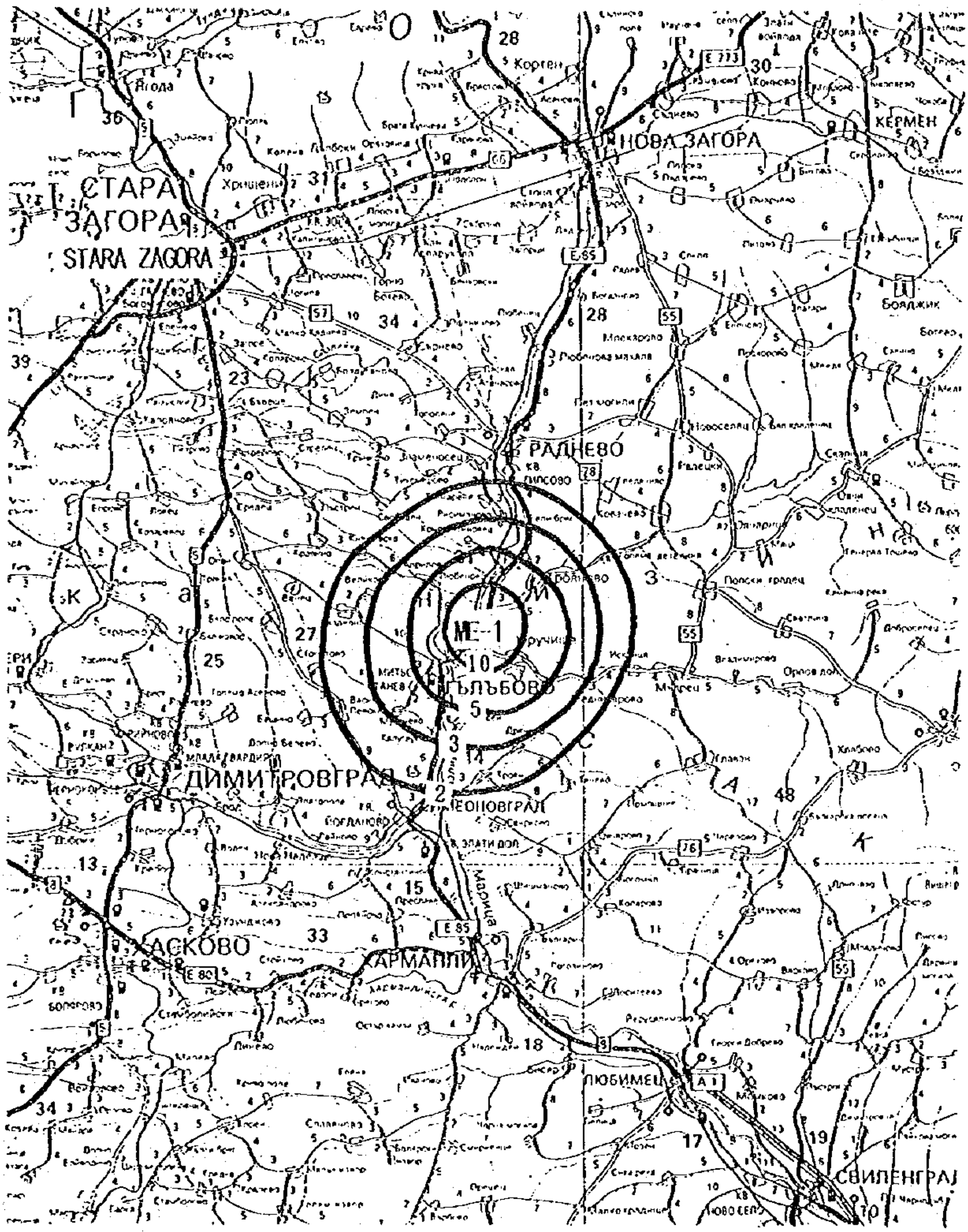


Figure 9-3-1-7 Annual Mean Concentration(CASE－II, NOx)



Unit : μg/m³

Figure 9-3-1-8 Annual Mean Concentration(CASE- II, Dust)



Unit : $\mu g/m^3$

0 10 20 30km

Figure 9-3-1-9 Annual Mean Concentration(CASE－III, SOx)

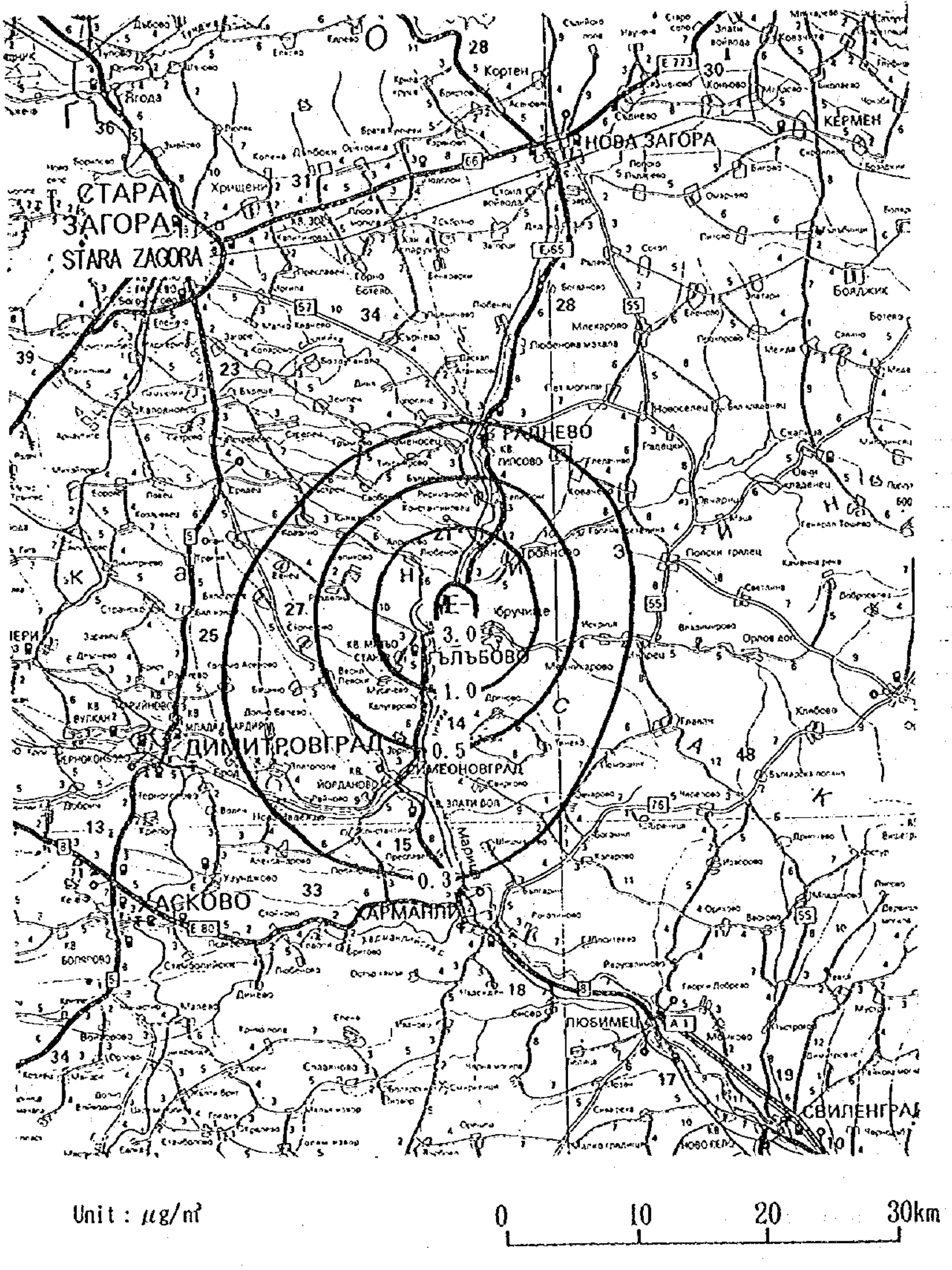
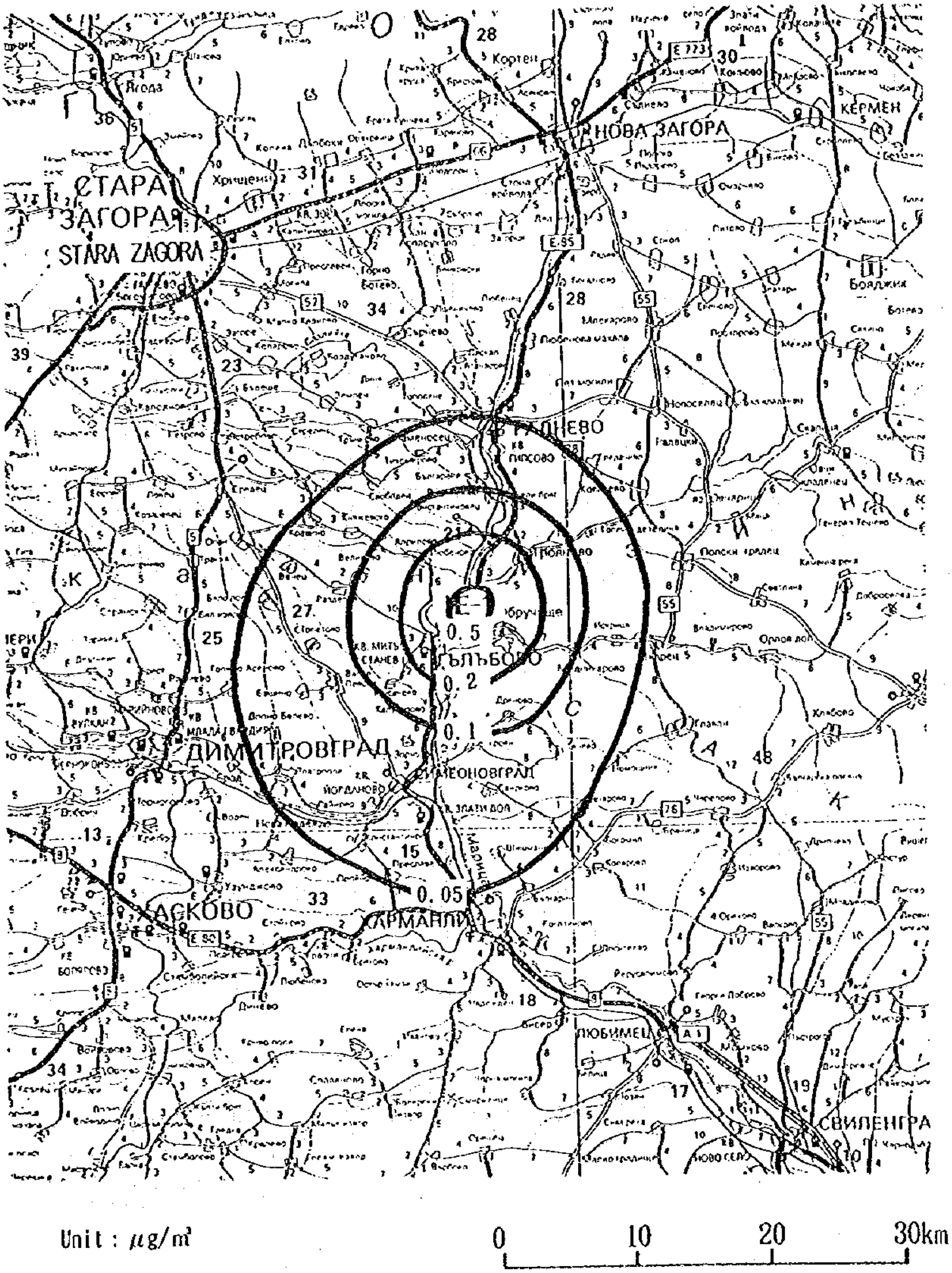
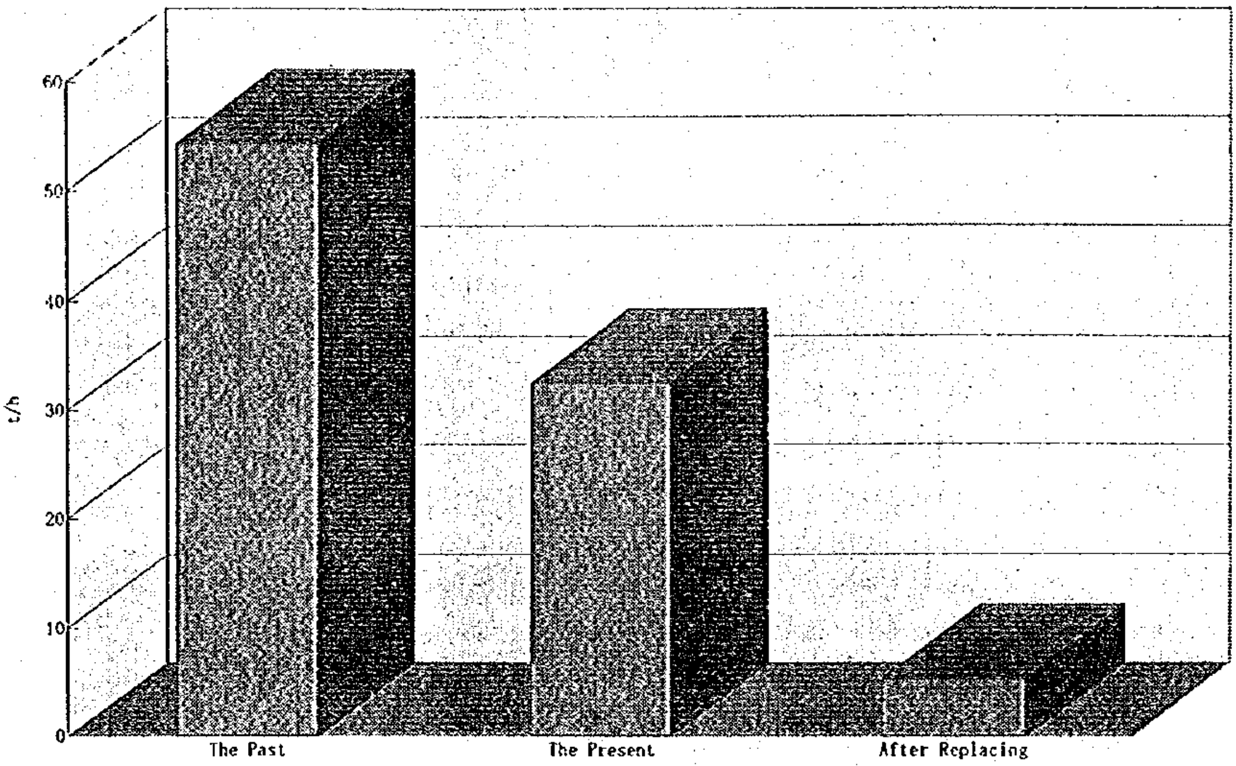


Figure 9-3-1-10 Annual Mean Concentration(CASE－III, NOx)



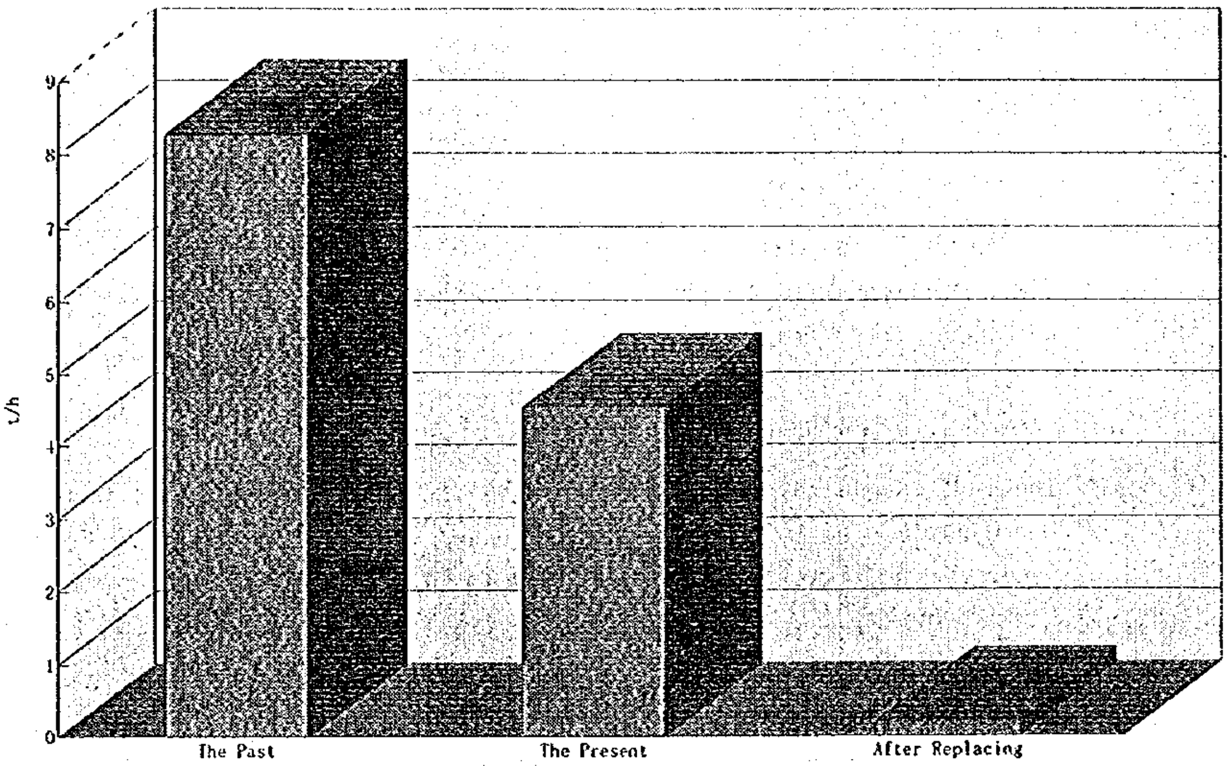
Unit : $\mu g/m^3$

Figure 9-3-1-11 Annual Mean Concentration(CASE－III, Dust)



	The Past	The Present	After Replacing
Operating Condition	No.1~4 unit No.5~6 unit Dryer	No.1~4 unit Dryer	No.R1~R2 unit
Total SOx Amount of Discharge	About 54.4t/h	About 32.5t/h	About 5.3t/h
Reduction Ratio	Base	About 40 %	About 90 %
	About 167 %	Base	About 84 %

Table9-3-1-7 Total SOx Amount of Discharge and Reduction Ratio at Maritsa East No.1



	The Past	The Present	After Replacing
Operating Condition	No.1~4 unit No.5~6 unit Dryer	No.1~4 unit Dryer	No.R1~R2 unit
Total Dust Amount of Discharge	About 8.28t/h	About 4.54t/h	About 0.20t/h
Reduction Ratio	Base	About 45 %	About 98 %
	About 182 %	Base	About 96 %

Table9-3-1-8 Total Dust Amount of Discharge and Reduction Ratio at Maritsa East No.1

9.3.2 Noise

(1) Prediction and Evaluation of Noise

(a) Sound Source Power Level

The sound source power level of the machinery which will be newly built upon reconstruction are shown in Table 9-3-2-1. The machinery installed indoors is included in the building sound sources.

(b) Prediction and Evaluation of Noise

The result of the forecast noise level at the site boundary based on the above data (a) is as shown in Table 9-3-2-2 and contour maps based on replaced equipment are shown in Figure 9-3-2-1a,b. These show a slightly increase from the current levels.

As there is not the noise standard at the site boundary in Bulgaria, evaluation is done by comparing forecast noise levels at the site boundary with the highest admissible noise levels in industrial district - 70 dB(A) in the daytime, 60 dB(A) at night (Hygienic Norms No. 0-64) - as reference.

Though two forecast noise levels in Table 9-3-2-2 (boundary No.2,3 at night) are over the reference admissible one in addition to current excess boundary points (boundary No.16 in the daytime, boundary No. 13,16,17,18 at night), it is judged that noise levels at residential areas are lower than those of reference admissible owing to reduction effect of distance. It is not considered a problematic level.

(2) Recommendation

In the regulations on the noise in Bulgaria, more importance is attached to the noise from the viewpoint of the work environment rather than the noise at the site boundary. However, when the life of the power plant is taken into consideration, it is expected that the noise regulation is strengthened during the period of the plant's life. It will result in a larger amount of expenses and harder works if prevention measures are taken after the actual troubles have occurred.

Therefore, it is desirable to install those machinery which may become the generating source of indoor noise, adopt low-noise machinery for those installed outdoors, and take a countermeasures such as building shield walls and installing mufflers when necessary.

Table 9-3-2-1 Sound Power Level List

No	Facility	Time	SPL (dBA)	No	Facility	Time	SPL (dBA)
1	A Backet Wheel Reclaimer	day-time	89	29	LJT-1 (LBC-2→3)	day-time	70
2	B Backet Wheel Reclaimer	day-time	89	30	LJT-2 (LBC-3→4)	day-time	70
3	B Tripper	day-time	85	31	LJT-3 (LBC-5→6)	all day	70
4	B Portal Reclaimer	all day	95	32	Vacuum Fan	all day	102
5	BC-1A Conveyer	day-time	78	33	Filter Separator	all day	95
6	BC-1B Conveyer	day-time	78	34	Air-Intake Valve	all day	80
7	BC-2 Conveyer	day-time	80	35	Vacuum Transfer Tube	all day	96
8	BC-3 Conveyer	day-time	80	36	No.1 Ash Transfer Fan	all day	103
9	BC-5 Conveyer	day-time	80	37	No.1 Ash Transfer Tube	all day	75
10	BC-6C Conveyer	day-time	80	38	Ventilator for Silo	all day	85
11	BC-7B Conveyer	all day	75	39	No.2 Ash Transfer Fan	day-time	103
12	BC-8B Conveyer	all day	77	40	No.2 Ash Transfer Tube	day-time	75
13	BC-9B Conveyer	all day	77	41	Boiler House (upper)	all day	58
14	BC-1A Conveyer Drive	day-time	90	42	Boiler House (middle)	all day	60
15	BC-1B Conveyer Drive	day-time	90	43	Boiler House (lower)	all day	59
16	BC-7B Conveyer Drive	all day	92	44	Boiler Conbeyer House	all day	67
17	BC-2 Sampler House	day-time	70	45	Boiler House (roof)	all day	57
18	JT-1 (BC-3→5)	day-time	70	46	ESP	all day	67
19	JT-4 (BC-5→6C)	day-time	70	47	IDF	all day	80
20	Screen Crusher House	all day	80	48	Flue Gas Duct	all day	70
21	BC-9B Sampler House	all day	80	49	Turbine House (upper)	all day	58
22	Tripper	day-time	85	50	Turbine House (middle)	all day	60
23	Portal Reclaimer	all day	94	51	Turbine House (lower)	all day	55
24	LBC-2 Conveyer	day-time	70	52	Turbine House (roof)	all day	53
25	LBC-3 Conveyer	day-time	70	53	Main Trans	all day	70
26	LBC-4 Conveyer	day-time	70	54	House Trans	all day	70
27	LBC-5A Conveyer	all day	69	55	Starting Trans	day-time	70
28	LBC-6A Conveyer	all day	69	56	Waste water pump group	all day	75

Table 9-3-2-2 Noise Forecast at Boundary

dB(A)

No.	Daytime	Night	No.	Daytime	Night
(1)	56.9	56.7	(14)	57.0	60.0
(2)	61.3	61.2	(15)	61.0	58.6
(3)	65.4	65.3	(16)	71.0	68.1
(4)	58.7	56.2	(17)	61.0	64.7
(5)	54.6	52.3	(18)	60.0	61.4
(6)	50.8	46.2	(19)	57.6	60.0
(7)	51.4	56.2	(20)	56.8	58.9
(8)	59.7	56.2	(21)	53.1	55.6
(9)	59.3	54.5	(22)	53.8	54.9
(10)	63.2	55.6	(23)	51.8	51.6
(11)	60.6	56.4	(24)	49.5	45.4
(12)	56.5	56.6	(25)	49.0	46.4
(13)	59.3	61.5	(26)	50.4	46.1

Notes: 1) Measured date: Daytime 1995.6.28 15:00, Night 1995.6.29 21:00
2) During taking night data at (7) - (23), there was influence of traffic.

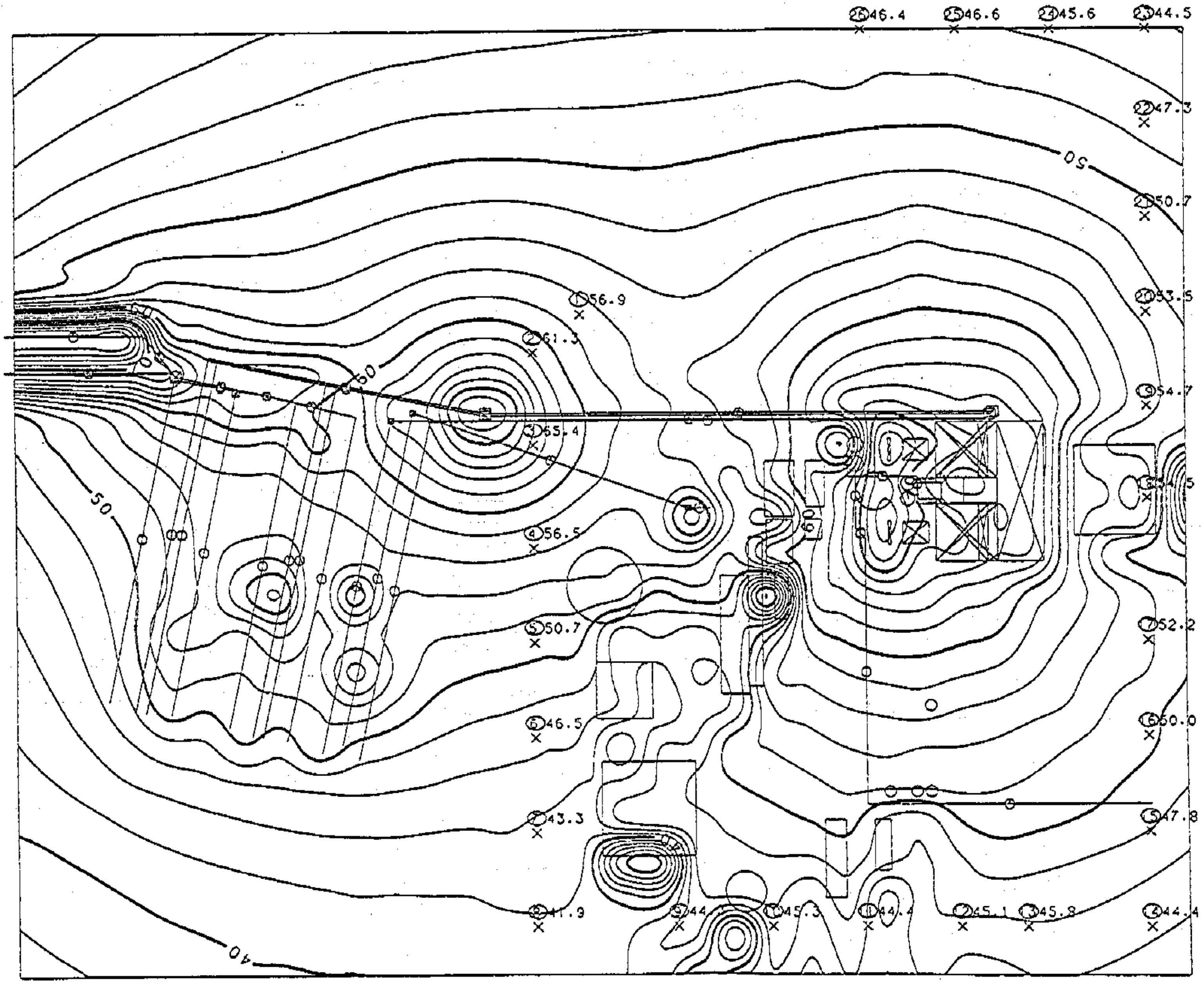


Figure 9-3-2-1a Contour Map based on replaced equipment (Daytime)

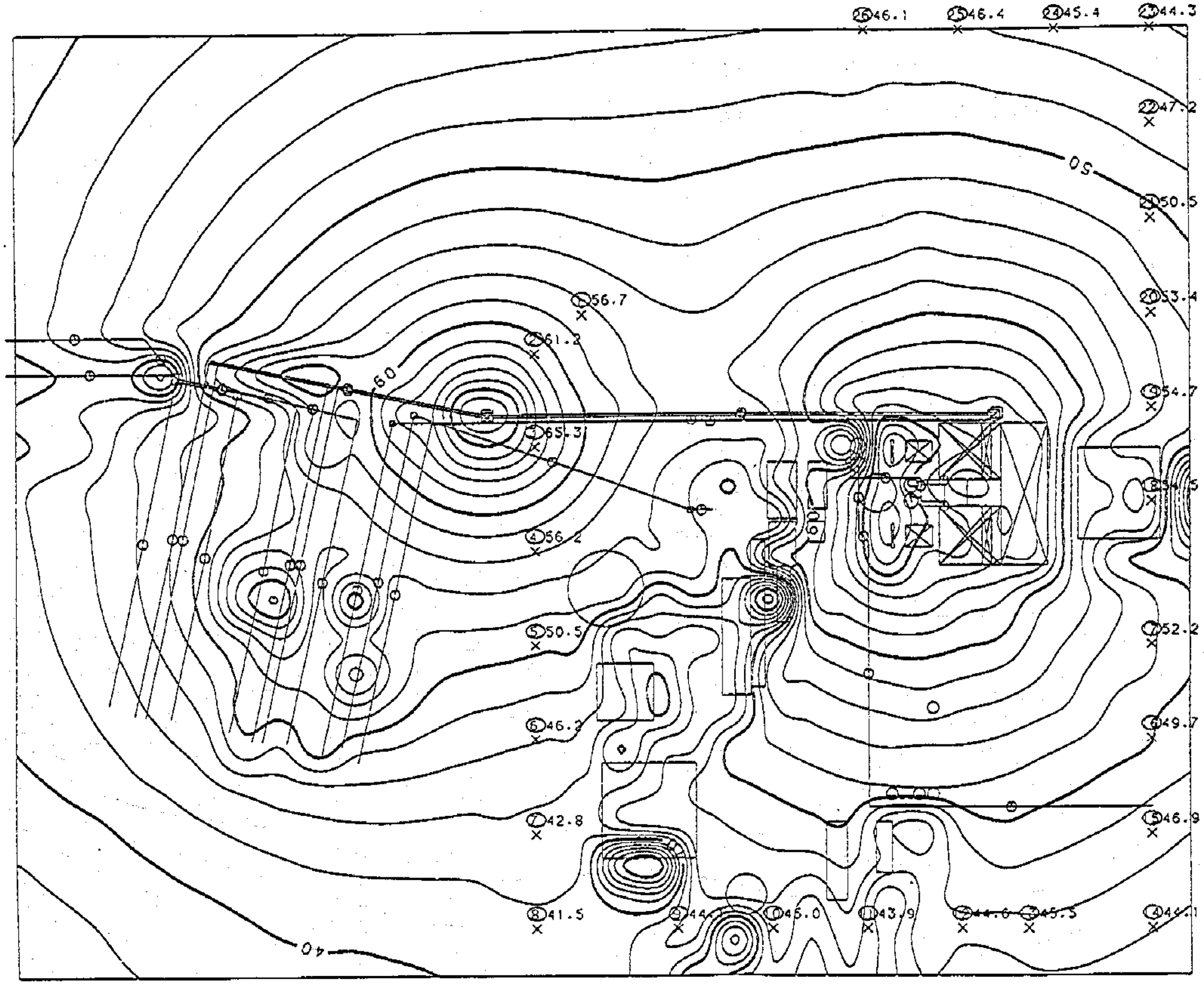


Figure 9-3-2-1b Contour Map based on replaced equipment (Night)

9.4 Study of the Lake Water Temperature

Rozovkladenetz lake is located near the Maritsa East No.1 Thermal Power Plant. As it supplies the water for the power generation and receives the dischargewater from the power plant, its water temperature is expected to rise. Therefore, the study of lake water temperature was carried out. Consequently, the applicability of the Rozovkladenetz lake water as a condenser cooling water source has been evaluated based on the results of actually measuring the lake water temperature, and executing the diffusion analysis of warm waste water and so forth. At the same time, the impact of warm waste water upon the aqueous environment has also been assessed.

9.4.1 Measurement of Lake Water Temperature

(1) Measurment Period

Summer : 27 Jul., 1995 ~ 29 Jul., 1995
Winter : 5 Dec., 1995

(2) Measurement Points

Nine Points (Refer to Figure 9-4-1-1)

(3) Measurement Profile

The measurement profile at Rozovkladenetz lake is shown in Figure 9-4-1-2. The maximum depth is about 7 m.

(4) Measurement Result

(a) Summer (See Table 9-4-1-1)

The water temperature is within a range from 21.7 ~ 32.0 ℃. Among the interlayer water temperatures, the water temperature in the surface layer is observed higher than that in other layers. The water temperature at the condenser cooling water discharge outlet also was higher than at other measurement points.

(b) Winter (See Table 9-4-1-2)

In winter, the water temperature is within a range from 8.2℃ to 15.8℃ and distributed roughly equally between the respective water layers. The temperature is observed higher at the condenser cooling water discharge outlet than that at the other measurement points.

According to the results of investigations, the water temperature tends to be higher at the condenser cooling water discharge outlet than other points as mentioned above. However, the distribution range of warm waste water is limited to the water area adjacent to the discharge outlet. Therefore, the Rozovkladenetz lake is evaluated to satisfy the requirements of a condenser cooling water source for cooling the existing power plant equipment.

The subsequent extent of the impact of this replacement project will be predicted throughanalysis of warm waste diffusion and so forth.

9.4.2 Prediction of Warm Water Distribution

The simulation and analyses of waste water diffusion have been carried out to predict the range of mixing and diffusion of warm waste water from the equipment under this replacement project.

(1) Simulated Condition

(a) Flow amount of discharged water

20.7 m^3/s

(b) Discharged water velocity

2.02 m^3/s

(c) Rising temperature

7°C

(d) Water temperature and Ambient temperature

	Water temperature	Ambient temperature
CASE - I (Summer)	23°C	26°C
CASE - I Winter)	0°C	5°C

(2) Calculation results

According to the results of caluculation presented in Figure9-4-1-2,3.there has been observed to be no impact of warm waste water upon the cooling water intake.

9.4.3 Estimating the Range of Warm Waste Water

The lake area to be required in case condenser cooling water under this reconstruction project is to be cooled only around the lake surface has been estimated based on the respective method presented in Table 9-4-1-3. According to the results of calculation, the lake area estimated to be required based on either of the respective methods is smaller than the Rozovkladenetz lake area. Since the calculated area is the effective area, therefore, it cannot necessarily be said that there is a sufficient allowance in the caluculated lake area.

9.4.4 Assessment

The Rozovkladenetz Lake is an artificial lake built to acquire condenser cooling water for Maritsa East No.1 Power Plant. To study whether this lake has been functioning satisfactorily or not as a cooling water supply source, warm waste diffusion analysis and so forth have been carried out. As a result, there is concluded to be no problem regarding the function of the lake.

At the existing discharge outlet, a stone embankment has been provided presumably in anticipation of the increase in the amount of evaporation due to rise of water temperature and attaining uniform diffusion of warm waste water throughout the lake. Since the extend of the effect of this embankment has been unknown, such an effect is disregareded in this study. However, this embankment is considered to act further favorably.

Therefore, According to the results of study adopted the existing data, the implementation of this reconstruction project is evaluated to cause no lake water temperature rise. However, it is recommended to execute the following items;

- Since the precipitation is small around the proposed project site, the amount of lake water lost by evaporation should be made up with water from the rivers adjacent thereto.

- The discharge channel branched from the main discharge channel for fish culturing should not be used for discharging warm waste water in order to secure a sufficent separation between both of the discharge channels (Fish culturing should be carried out on the main discharge channel side.)

- The basic data (surface area of lake, bathymetric, meteorological data etc) should be reconfirm.

Where further extension project is to be planned after implementation of this reconstruction project, it will be necessary to carry out detailed studies regarding the cooling capacity of the lake after executing particularly accurate meteorological observation. In this case, it is recommended to install cooling towers as far as practicable, as seen in the case of the Maritsa East Nos.2 and 3.

Although a certain extent of impact of warm waste water upon the surrounding environment is predicted, the range of such an impact is limited to the area around the discharge outlet. Rather, fish raising has already been practiced by making effective use of warm waste water.

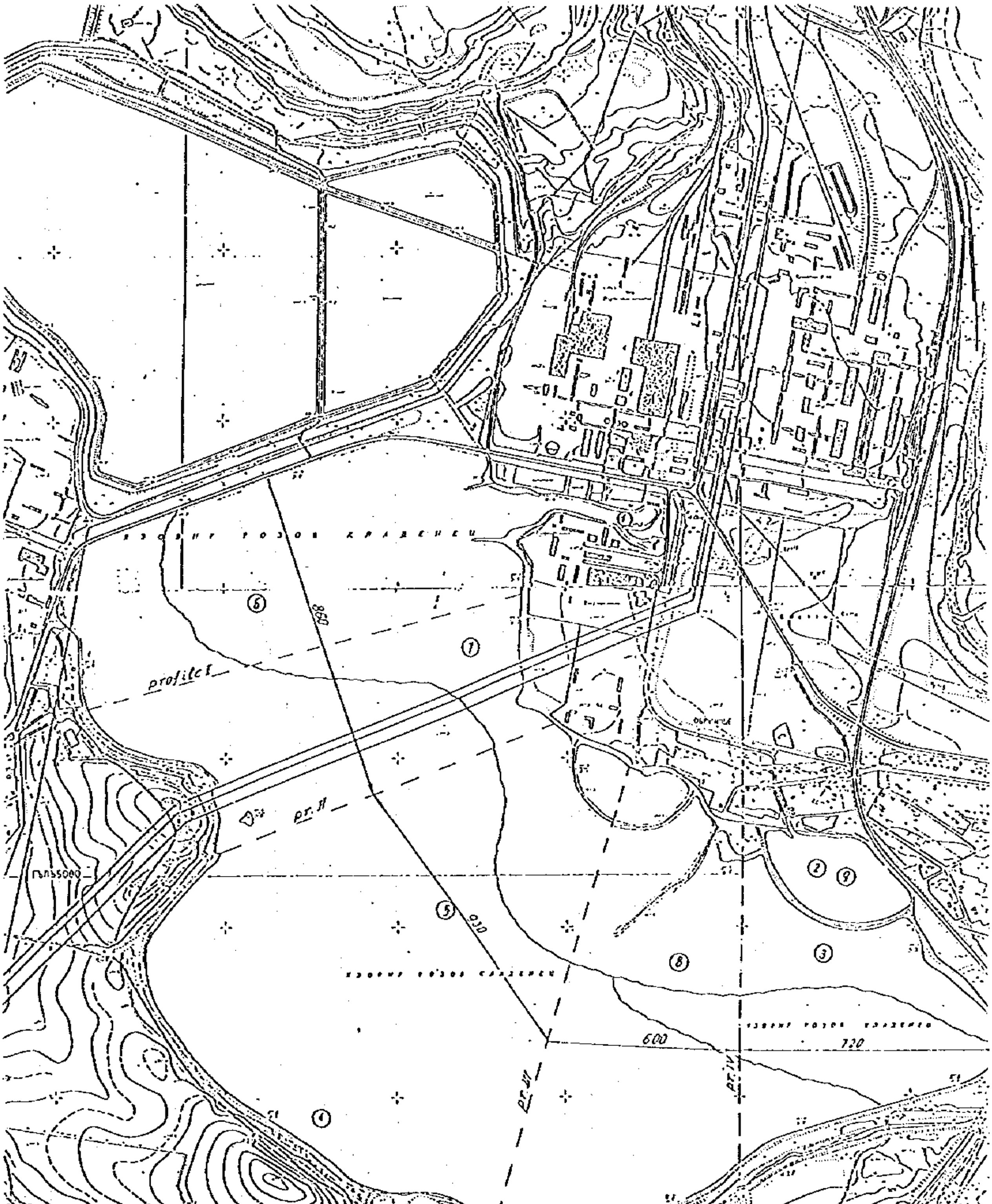


Figure9-4-1-1 Location Map of Lake Water Temperature Mesurement Points

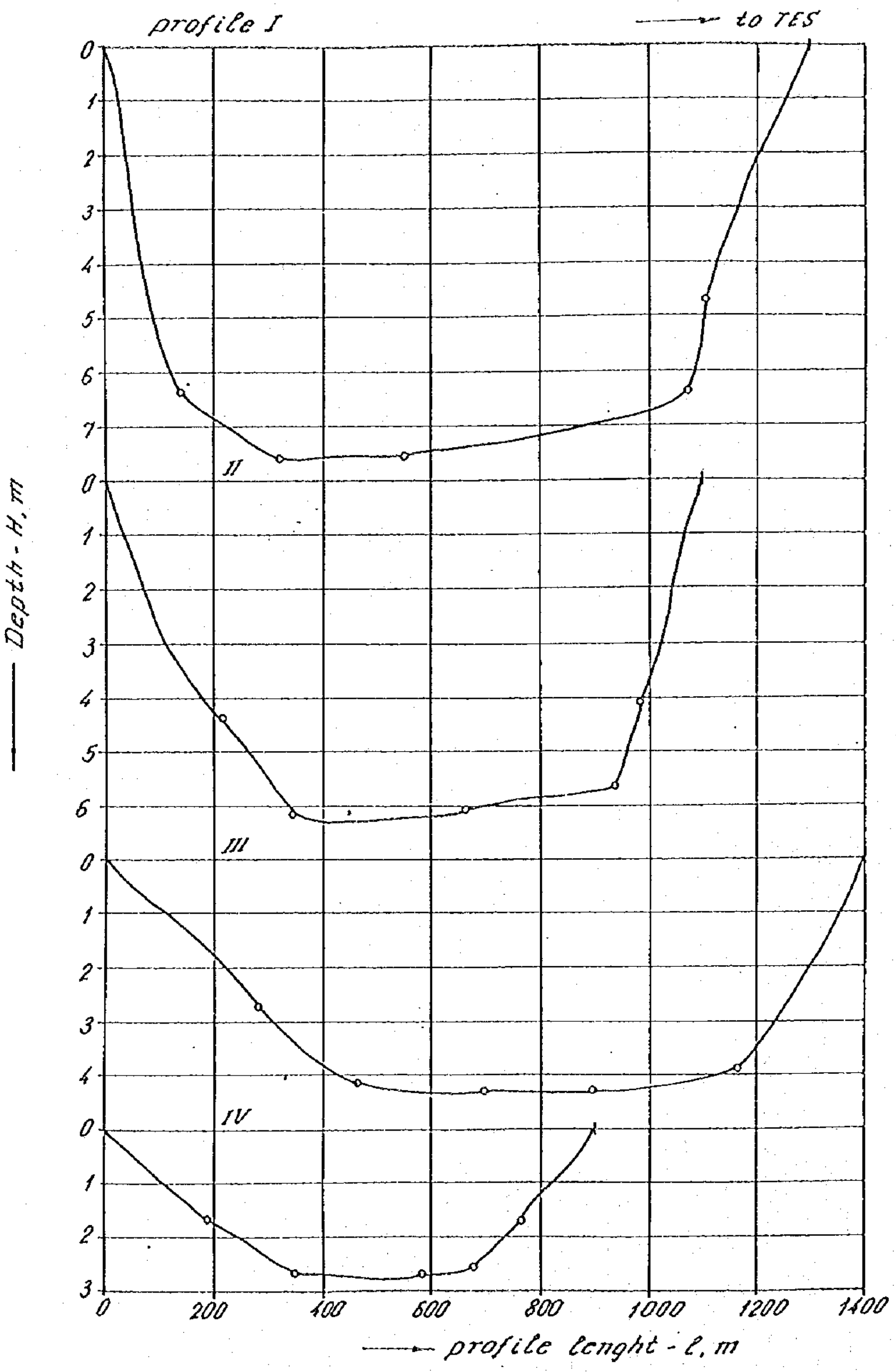


Figure9-4-1-2 Mesuremnt Profile at Rozovkladenetz Lake

Table 9-4-1-1 Measurement Result of Lake Water Temperature at Rozovkładenetz Lake

No.	Sampling Point		Temperature °C	Date of Measurement	Note
1	2		3	4	5
1.	Depth	0.1 m	31.1	27.07.95	Sunny
		1 m	26.4		15-18^{30} h
		2 m	25.9		
		3 m	25.8		
		4 m	25.6		
		5 m	25.5		
		6 m	22.8		
		7 m	22.4		
		7.5 m	21.7		
2.	Depth	0.1 m	32.0	29.07.95	Cloudy
		1 m	31.8		18-21 h
		2 m	31.7		
		2.3 m	31.7		
3.	Depth	0.1 m	30.0	29.07.95	Cloudy
		1 m	29.2		18-21 h
		2 m	27.3		
		2.5 m	27.1		
4.	Depth	0.1 m	28.7	29.07.95	Cloudy
		1 m	28.0		18-21 h
		2 m	27.2		
		3 m	26.8		
		4 m	26.0		
		5 m	25.6		
		5.3 m	25.4		

5.	Depth	0.1 m 1 m 2 m 3 m 4 m 5 m 5.7 m	29.3 28.8 26.8 26.3 25.4 24.7 24.0	29.07.95	Cloudy 18-21 h
6.	Depth	0.1 m 1 m 2 m 3 m 4 m 5 m 6 m 7 m 7.5 m	31.1 26.4 25.9 25.8 25.6 25.5 22.8 22.4 21.7	27.07.95	Sunny 15-18^{30} h
7.	Depth	0.1 m 1 m 2 m 3 m 4 m 5 m 6 m 7 m	31.1 28.5 26.7 26.3 25.7 25.5 24.4 23.6	27.07.95	Sunny 15-18^{30} h
8.	Depth	0.1 m 1 m 2 m 2.2 m	29.3 28.1 27.0 26.8	29.07.95	Cloudy 18-21 h
9.	Depth	0.1 m 1 m 2 m 3 m 3.7 m	32.5 32.2 32.2 32.2 32.1	29.07.95	Cloudy 18-21 h

Table 9-4-1-2 Measurement Result of Lake Water Temperature at Rozovkladenetz Lake

No.	Sampling Point		Temperature °C	Date of Measurement	Note
1	2		3	4	5
1.	Depth	0.1 m	9.3	05.12.95	Cloudy
		1 m	9.2		13-18 h
		2 m	9.0		Tair=2.6℃
		3 m	9.0		
		4 m	9.0		5 boilers
		5 m	9.1		and
		6 m	9.2		4 turbines
		6.5 m	9.2		work
2.	Depth	0.1 m	15.8	05.12.95	Cloudy
		1 m	15.5		18-21 h
		1.5 m	15.4		
3.	Depth	0.1 m	15.3	05.12.95	Cloudy
		1 m	9.8		18-21 h
		1.5 m	8.4		
4.	Depth	0.1 m	9.6	05.12.95	Cloudy
		1 m	9.0		18-21 h
		2 m	8.9		
		3 m	8.5		
		4 m	8.2		
		4.5 m	8.2		

5.	Depth	0.1 m	9.5	05.12.95	Cloudy 18-21 h
		1 m	9.0		
		2 m	8.9		
		3 m	8.5		
		4 m	8.2		
		4.5 m	8.2		
6.	Depth	0.1 m	9.9	05.12.95	Sunny 15-18^{30} h
		1 m	10.4		
		2 m	10.5		
		3 m	10.5		
		4 m	10.5		
		5 m	10.4		
		6 m	9.9		
		6.5 m	9.8		
7.	Depth	0.1 m	10.3	05.12.95	Sunny 15-18^{30} h
		1 m	9.3		
		2 m	9.0		
		3 m	8.9		
		4 m	9.1		
		5 m	9.2		
		6 m	9.2		
8.	Depth	0.1 m	14.9	05.12.95	Cloudy 18-21 h
		1 m	8.5		
		1.3 m	8.3		
9.	Depth	0.1 m	16.0	05.12.95	Cloudy 18-21 h
		1 m	15.8		
		2 m	15.6		
		2.8 m	15.6		

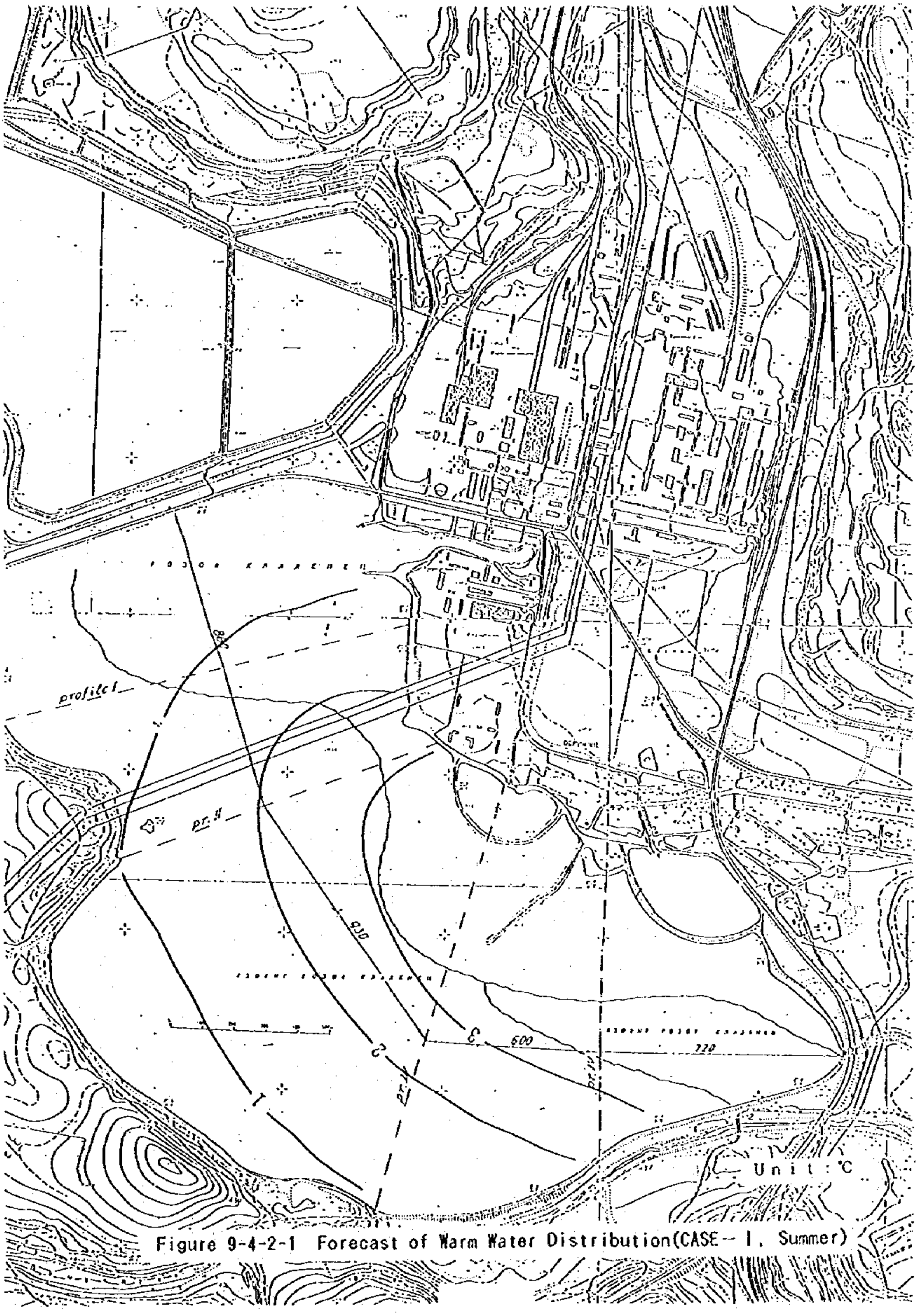


Figure 9-4-2-1 Forecast of Warm Water Distribution(CASE－Ⅰ, Summer)

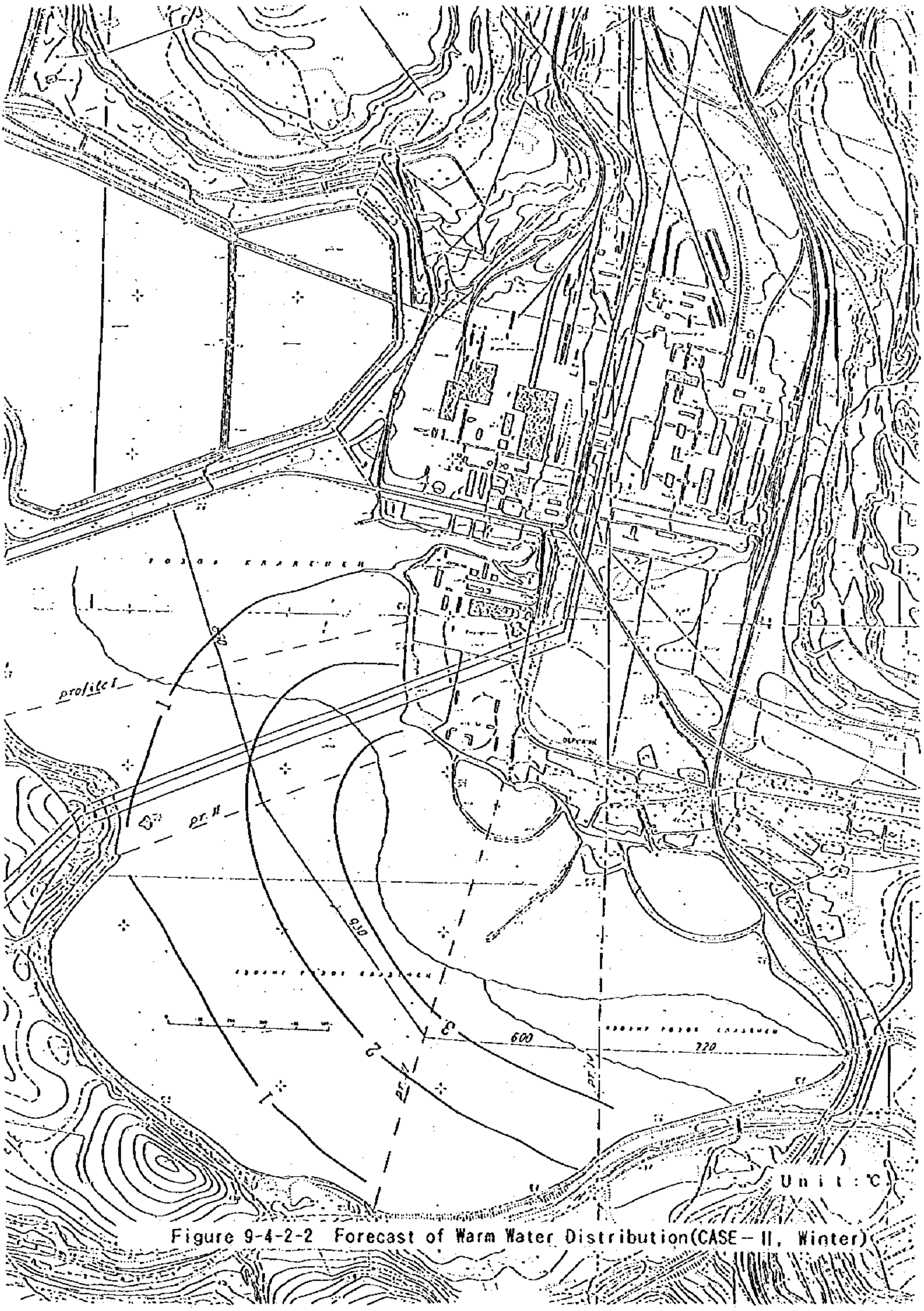


Figure 9-4-2-2 Forecast of Warm Water Distribution(CASE-II, Winter)

Table 9-4-1-3 Mthods of Estimating The Range of Warm Waste Water

Method	Description	Results
1. Metod based on actual measurement valuses,etc (The Japan Society of Civil Engineers)	· Values estimated based on the results of predicting the distribution of warm waste water diffusion, and those estimated based on the results of prediction from experiment of numerical values. · Estimation based on the discharge rate of 20m³/sec. · Estimation based on the intake and discharge water temperature difference of 7℃.	Warm waste water diffusion : 130ha (<360ha) Equivalent radius : 0.91km (<1km) ※The surface area of the Rozovkladenetz= 360ha The distance between intake and discharge channels = 1km
2. Metod based on empirical formula (Formula of Nitta)	· The range of impact is estimated by replacing the difference of warm waste water density with a water temperature difference according to an empirical formula induced based on the results of study regarding the diffusion of fresh water.	216ha (<360ha) ※Flow amount of discharged water= 20.7m³/s
3. Method based on energy balance (Electricity Authority of The United Kingdom)	· The range of impact is estimated of exhaust heat from a power plant per unit time is equal to the value obtained by integrating the amount of heat lost per unit area with respect to an overall water temperature rise area.	290ha (<360ha) ※Flow amount of discharged water= 20.7m³/s
4. Method based on evaporation heat (Thermal and Nuclear Power Engineering Society)	· The range of impact is estimated on the assumption that warm waste water is cooled by the evaporation heat based on the amount of water evaporated from the surface of a pond.	At wind blowing / At no wind Summer 21ha 49ha Winter 132ha 309ha Yealy mean 35ha 83ha (<360ha) ※Flow amount of discharged water= 20.7m³/s
5. Method based on heat exchange between the water surface and atmosphere (Power Plant Sytem Design)	· The diffusion range is predicted based on heat exchange between the water surface and atmosphere. · The caluculation conditions are assumed to be the same as those mentioned above. Amount of daily solar radiation (cal/cm² · day) Summer 552 Winter 126 Yeary mean 339	At wind blowing / At no wind Summer 21ha 49ha Winter 132ha 309ha Yealy mean 35ha 83ha (<360ha) ※Flow amount of discharged water= 20.7m³/s

Conditions for method 4:

	Ambient Temperature (℃)	Humidity (%)	Water Temperature (℃)	Wind Velocity (m/s)
Summer	23	65	26	2.5
Winter	0	83	5	3.5
Yeary mean	12	73	18	2.5

9.5 Environmental Preservation Plan

9.5.1 Basic Items of Requirements

To prevent or mitigate the environmental impact resulting from implementation of this project, countermeasures should be taken to preserve the environment.

9.5.2 Countermeasures for Preventing Air Pollution

The basic concept of the countermeasures for preventing air pollution caused by flue gas discharged from thermal power plant is to reduce the amount of emissions by taking various countermeasures ; reduction of the amount of sulfur oxides by desulfurizing characteristic in a circulating type fluidized bet combustion boiler, nitrogen oxides by low temperature the combustion in the same boiler, dust by adoption of electrostatic precipitator and other means.

9.5.3 Countermeasures for Prevention of Water Pollution

To reduce the amount of the water pollution load to lakes and rivers as much as practicable, countermeasures should be taken as appropriate to treat general waste water from power plant.

9.5.4 Noise Preventive Countermeasures

Although the regulations pertaining to the noise control standards in Bulgaria have not been clarified, a priority is given for reducing the noise level in the working environment of workers rather than the noise level at the border of power plant. When the service life of power plant is taken into account, however, the noise control regulation is predicted to be strengthened certainly during the service life, where any noise preventive countermeasure is to be taken after occurrence of trouble, the modification cost and work for noise reduction will become extraordinarily extensive.

Therefore, appropriate noise preventive countermeasures should preferably be taken by indoor installation of equipment causing noise, adoption of low noise type for equipment installed outdoors, and installation of noise insulation wall and silencer as required.

9.5.5 Countermeasures for Prevention of Vibration

To reduce the vibration level at the border of the power plant according to the relevant environmental standards, any equipment constituting a vibration source should be separated sufficiently from the border of the site, and sufficiently firm foundation be adopted for any such equipment. In addition, other appropriate vibration preventive countermeasures should be take as required.

9.5.6 Countermeasures for Preventing Settlement of Ground

Any ground water should not be pumped up to prevent differential settlement of ground.

9.5.7 Countermeasures for Preventing Offensive Odor

Any such chemical as causing offensive order should not be used.

9.5.8 Countermeasures for Warm Water Discharge

Rising temperature, which is the water temperature difference between intake water and discharge water,will be of 7 ℃ less. The countermeasures pertaining to intake and discharge of cooling water have been considered to minimize its impact upon aquatic life in lake water area.

9.5.9 Countermeasures for Disposal of Industrial Wastes (Coal ash)

Any coal ash and other industrial wastes should be disposed of by land reclamation at the existing coal disposal yard or other specified ash disposal site. Moreover, the portion of the fully reclaimed yard should be covered with soil to prevent dispersion of coal ash.

9.5.10 Countermeasures to be Taken during the Reconstruction Work

During the reconstruction work, sufficient countermeasures should be taken to prevent air and water pollution in the surrounding area. In addition, noise and vibration preventive countermeasures should be taken as required to reduce the noise and vibration levels by using sound insulation cover, selection of appropriate low noise or low vibration equipment and so forth.

9.5.11 Others

(1) For preservation of the historical remains existing within the compound of the power plant, appropriate countermeasures should be taken under instructions of the relevant authority. In addition, equipment arrangement and reconstruction work should be carried out so carefully as to eliminate any adverse effect upon the historical remains.

(2) To ensure harmony with the surrounding environment, planting should be carried out within the compound of the power plant.

9.6 Environmental Monitoring Plan

9.6.1 Basic Environment Monitoring Plan

To reinforce the monitoring system for preservation of environment, installation of monitoring equipment has been promoted in Bulgaria.

In consideration of such situations, an appropriate environment monitoring plan will be formulated regarding air pollution, water pollution and so forth.

9.6.2 Smoke and Dust

On the basis of a basic policy for smoke and dust emission monitoring, the concentrations of SOx, NOx dust and CO should be measured periodically after installing measurement seats in the boiler flue (Refer to Figure 9-6-1).

In the future, it is desirable to perform regular monitoring in the central control room by installing continuous measuring instruments, and constantly monitor the flue gas conditions at the chimney outlet by installing industrial TV sets at the same time.

9.6.3 General Waste Water

As a means of monitoring the quality of general waste water causing water pollution, pH value and turbidity should be measured periodically to check the water quality at the outlet of waste water treatment equipment to be installed in the power plant. In the future, it is desirable to continuously measure the quality of waste water by using automatic measuring instruments.

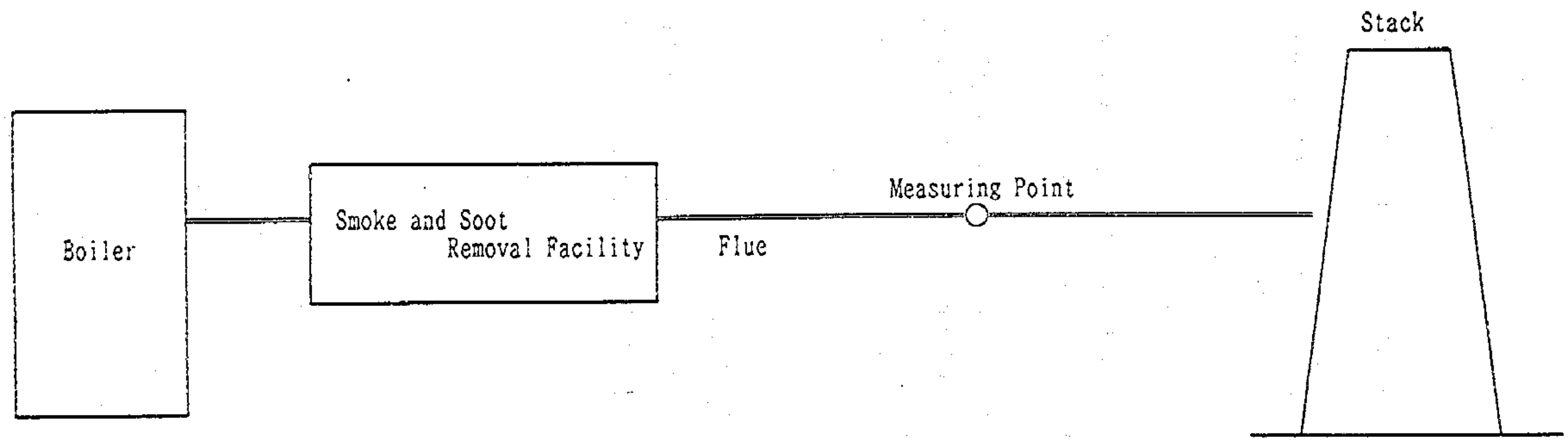


Figure 9-6-1 SOx, NOx, Dust and CO Monitoring System

9.7 Overall Evaluation

The Maritsa East No. 1 Thermal Power Plant Reconstruction Project is intended to bear a part of the burdens of future electric power supply in Bulgaria and make effective utilization of lignite, only a domestic energy source available in the country.

The reconstruction project should be implemented to ensure thorough preservation of the natural and social environment in the surrounding area.
In other words, the amount of smoke and dust emitted from the power plant should be reduced to a minimum possible extent by installing the flue gas desulfurization equipment, electrostatic precipitators and other equipment. To prevent water pollution caused by discharge of waste water, moreover, general waste water should be treated appropriately by adopting waste water treatment and other equipment. The countermeasures for reducing the noise and vibration levels from any equipment constituting such noise and vibration sources should be taken by indoor installation of equipment, adoption of low noise equipment, adoption of firm equipment foundations and so forth.

In addition to the above, such miscellaneous countermeasures as described herein should be taken. Thereby, it is considered possible to reduce the impact of the Maritsa East No. 1 Thermal Power Plant Reconstruction Project upon the surrounding environment.

After completion of the reconstruction project, the total amount of dust and sulfur oxide emissions will be reduced to much smaller than the present levels. In parallel with promotion of home electrification and regional heat supply, it is predicted possible to reduce environmental pollution resulting from burning of coal (Briquette) used as a domestic heat source.

Therefore, this reconstruction project is concluded to contribute highly significantly for improving the environmental quality in the surrounding area.

CHAPTER 10. ECONOMIC EVALUATION AND FINANCIAL EVALUATION

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CHAPTER 10 ECONOMIC EVALUATION AND FINANCIAL EVALUATION

10.1 Economic Evaluation

10.1.1 Methodology

(1) Basic approach

The economic evaluation of the project is made on the bases of indexes such as (1) net present value, (2) benefit/cost ratio and (3) economic internal rate of return (EIRR) of the project. These indexes are derived from the economic benefit and economic cost of the project. These indexes themselves are determined using so-called "Discounted Cash Flow."

When the market prices of the goods and services are determined directly and totally based on their actual economic values, such market prices can directly be applied to the calculations of the costs and benefits for the purpose of the economic evaluation of the project. However, in most instances, the market prices deviate from their actual economic values due to the effect of imperfect market mechanism.

The estimations of cost and benefit are primarily designed to serve the purpose of the optimum allocation of the limited resources. Thus, in order to attain this purpose, the given market prices of goods and services should be converted to their actual costs and benefits which reflect their actual economic values. For this reason, the World Bank and other international financing organizations estimate the project prices and market prices on the bases of international market prices.

On the other hand, economic evaluation for a development project is carried out measuring " its socio-economic impact on the country" by comparing two cases; the project is developed and the project is not developed. As a rule, development project may result in waking an alternative project not realized due to consumption of limited economic resources for this awarded project. Therefore, a selected project gives an impact on the country not only in producing its product but also in consuming limited resources.

In this regard, an alternative equipment approach is applied to this project. If a project is incorporated in a long term electric power development policy to satisfy future power demand (i.e., if the project is not to be implemented, another means of supply is to be substituted for it), an alternative equipment approach will be employed to measure and evaluate economic costs of the proposed project and the alternative project.

(2) Method of economic evaluation

In general, the method of economic evaluation adopted by the international financing organizations including the World Bank consists of the following phases:

Phase-1: Excluding the (items transferred to) domestic income

Phase-2: Converting a market price into a calculated price by the category such as foreign trade goods, Non-foreign trade goods, skilled labor and skilled labor

Phase-3: Determining an economic internal rate of return based on calculated price, and comparing it with an opportunity cost of the capital in the country concerned

Phase-4: Making socio-economic evaluation of the project, taking into account the national saving and distribution of income, based on the above result

The economic evaluation of the present project is made by the processes including phase 4. (See Fig. 10-1-1-1)

In general, when the calculation of the benefit is possible, the economic evaluation of a electric power development project is made primarily by measuring for comparison the benefit and cost attributed to this project itself, based on the Long-Range Marginal Cost (LRMC) method or the tariff system.

The cost-benefit is calculated for comparison as follows :

a) Cost

All the costs accruing during the term of the project should be added except the following transfer items.

- Taxes and Public Rates

  The expenditures falling under this category will not reduce the resources available for the development of national economy at all. Since the economic calculation of the project aims at optimum allocation of the economic resources, the expenditure such as tax payment, which is a transfer of the economic resources and not the expense for consumption, should be excluded from the calculation of the cost.

1) Interest

The economic benefit can be considered to be an opportunity cost of the invested capital. The opportunity cost of the capital is a result of economic calculation and this cost itself includes the interest on the borrowing. Thus, the interest paid or payable should be excluded from the calculation in order to prevent the duplication of the calculation.

2) Depreciation cost

In the economic calculation, the costs are calculated on accrual basis. The depreciation cost accrues from the equipment investment and will not be calculated during the term of construction work but after the completion of the construction work in terms of accounting. Furthermore, the depreciation cost is calculated as the cost not requiring the expenditure of the fund.

Moreover, the capital cost is included in the category of the cost, and so reckoning the depreciation cost will result in duplicate entry of the cost. For this reason, the depreciation cost should be excluded.

3) Repayment of borrowing

Borrowing, like a tax, is a transfer cost and not a consumption cost, and so the borrowing should be excluded from the calculation.

b) Benefit

The cost of an alternative power plant is regarded as a benefit of the proposed project. For instance, executing a proposed project will give an impact on national economy by consuming the resources which would be consumed for the alternative project, accordingly the cost or resources which would be consumed for the alternative project can be considered to be a benefit of the proposed project.

In calculating the cost-benefit as described above, the following concepts of (c) present value and (d) economic costs should be taken into account. Figure 10-1-1-1 shows the calculation flowchart for this cost-benefit.

c) Present value

In making economic calculations, all the costs-benefits are estimated only at their present values. Therefore, they must be converted into present values using a discount rate.

d) Economic cost (Shadow price)

In general, project cost is estimated based on the actual or current price prevailing in the market of a country (market price). Market prices are usually distorted and to exclude this distortion, the market price is converted into a shadow price. The shadow price system is applied to all the costs of the project.

Costs of the project are divided into two categories: tradable goods and non tradable goods. As for tradable goods, importable goods are taken at their CIF price, and exportable goods are taken at their FOB price. Non tradable goods are taken at opportunity cost which is equivalent to the international market price.

In order to simplify the process, the standard conversion factor (SCF), determined from the total value of major exports (FOB) and imports (CIF), is used as a general indicator to avoid distorting domestic prices and to convert these prices of non-tradable goods into international market prices.

In making these economic evaluations, the most recent economic data are well used to calculate a standard conversion factor (SCF) and to convert the prices of non-tradable goods into international market prices. The SCF is obtained by the following calculation formula:

$$SCF = \frac{CIF + FOB}{CIF + TAX(import) + FOB - Tax(export) + Subsidies}$$

As shown above, economic evaluations are made by the following indexes after having converted the cost-benefit into shadow prices :
The details are as follows.

e) Economic evaluation

- Net Present Value (Benefit-Cost)

$$\sum \frac{Bn}{(1+i)^n} - \sum \frac{Cn}{(1+i)^n} = \text{Net present value}$$

where,
B: benefit, C: cost, i = Opportunity cost of capital, n = period (years)

[Note] A higher present value indicates better conditions of a project.

- Ratio of benefit to cost (benefit/cost)

$$\frac{\sum \frac{Bn}{(1+i)^n}}{\sum \frac{Cn}{(1+i)^n}} = Cost/Benefit\ Ratio$$

(Remarks)
The bigger the Cost/Benefit Ratio is, the better the Project is.

- Economic Internal Rate of Return (EIRR)

$$\sum \frac{Bn}{(1+i)^n} = \sum \frac{Cn}{(1+i)^n}$$

i : Internal Rate of Return is the rate which offers that the accumulated Present Value benefit and accumulated cost are the same.

(Remarks)
i) If EIRR is higher than opportunity cost; the better the Project is.
ii) If FIRR is higher than interest rate, the better the Project is. (FIRR is described in the next chapter 10.2 in detail.)

(3) Selection of alternative power plant

The recent energy development plan of Bulgaria is considered to stress priority on the following points:

a) A high priority is given to the measures for saving the consumption of energy for both the industrial and civil uses under the current pressing condition of supply-demand of electric power.

b) Extension of service lives of existing and currently operating cogeneration plants of heat supply and corresponding improvement of measures for the conservation of environment.

c) Construction of new lignite-fired thermal power plants with environmental facilities by increasing the output of the lignite as domestically available energy resource or extension of the service lives of existing ones measures in view of national security with respect to the stable supply of energy and national defense.

d) Necessity of constructing coal-fired thermal power plants to introduce and operate imported coal thermal power plants or combined cycle gas turbine power plants to a certain extent in parallel with the construction of lignite-fired thermal power plants using the domestically available lignite, as part of the country's electric power development plan.

e) Considering the feasibility of constructing other atomic power plants for stable supply of electric power in the future, though it should be preceded by the repairing and restoration of existing Kozloduy nuclear power plant.

As the power supply for the base load, this project is proposed to construct alternative coal-fired thermal power plants which can offer equivalent services in view of these economic evaluations.

After consultations with NEK, it is decided from the viewpoint of economic evaluations of the Maritsa East R1 and R2 units that imported coal-fired thermal power plants will be constructed as alternative project to them.

10.1.2 Economic Cost of Project

The economic cost of the proposed project can be obtained by applying the conversion factor given above on the basis of the financial cost obtained in "Chapter 8.2, Construction Cost", excluding the interest which may be yielded during the construction works.

On the basis of the "Chapter 5, Optimum Development Plan", this project is designed to supply electricity for power plant and centralized regional heating. The heat are supplied only in winter, so that their cost is included in the power plant cost and not itemized in this project.

According to the construction schedule, there are 6 months time lag between R1 and R2 unit. However, in economic calculation, it is assumed that R1 and R2 units are to be commercial operation from January 2002.

(1) Investment cost

In the economic cost required for the construction works are included the direct construction cost, physical contingency, and engineering cost without taking into account possible inflations during the construction works.

In general, the economic cost due to the expropriation of a land used as the power plant site is compensated by the product given at the sacrifice of such a land. In the present project, this product can be considered to be very small in comparison with the total economic cost of the construction works, judging from the use of the planned replacement land. Therefore, it is not included in the investment cost.

The foreign currency portion in the construction cost of the present project is given in CIF price. In calculating the domestic currency portion, it is usual to take into account controls on raw material prices, governmental subsidies or regulations. This rule is also applied to Bulgaria to calculate the economic cost of the domestic currency portion after consulting with NEK. As a result, standard conversion factor (SCF) of 0.97 was determined.

Tables 10-1-2-1 and 10-1-2-2 give the market and economic costs incurred by the present project.

(2) Operation and maintenance cost (O&M Cost)

The O&M cost is obtained by multiplying the economic cost of the construction works by a certain maintenance cost rate (4%).

(3) Fuel cost

The lignite coal used as the fuel for the present project is procured from the north lot of Troyanovo coal mine in Maritsa East Complex.

The fuel cost is calculated by multiplying the lignite-coal price (on the basis of coal price at 6.0 US$/ton as in January, 1996) by the annual consumption of coal.

This method is used to calculate the initial investment cost as the cost flow to estimate the project from economical point of view and the total economic cost incurred throughout its whole life of the project.

10.1.3 Parameters and Economic Cost of Alternative Thermal Power Plant

As mentioned before, an imported coal fired thermal power plant was assumed as the alternative facility with which the economic benefit of this project is calculated.

The economic cost of the alternative thermal power plant is regarded as one of the benefits to be offered by the present project and is compared with the economic cost of the project.

The alternative thermal power plant as the basis of the economic evaluation is supposed to be constructed at the location inland from Black Sea and nearest to the Maritsa East project site.

The basis conditions and factors adopted to economically estimate this thermal power plant are given in Tables 10-1-3-3 and 10-1-3-4. Table 10-1-3-4 also gives the conditions applied to calculate the economic cost for the Maritsa East No.1 Power Plant project.

(1) Initial investment cost for the alternative thermal power plant

The economic cost for the alternative thermal power plant is divided into foreign currency and domestic currency portions. The latter portion is calculated using the standard conversion factor. Tables 10-1-3-1 and 10-1-3-2 give the initial investment of the project and the total cost throughout its whole life in relation with its market and economic costs.

(2) Operation and maintenance cost (O&M Cost)

The O&M cost is calculated by multiplying the total economic cost of the project by a factor of 4%.

(3) Fuel cost

The imported fuel coal is supposed to be procured from international market at its most economic price on the following conditions:

Fuel cost was calculated by multiplying annual energy consumption by the cost of imported coal and cost of heavy oil (Coal: 60.00US$/ton).

In this method, the initial investment of the project and the total economic cost throughout the whole life of the project is calculated as the benefit flow to evaluate the alternative thermal power plant.

10.1.4 Economic Evaluation

On the basis of the flows of the benefits and costs calculated on the above-mentioned suppositions, the surplus of benefit (B - C), benefit/cost ratio (B/C) and equivalent discount rate (so called economic internal rate of return : EIRR) of the present project are calculated as given in Tables 10-1-4-1 and 10-1-4-2.

(1) Net present value and benefit/cost ratio

As indicated by the deux indexes of net present value (benefit - cost) and benefit/cost ratio (B/C), the construction, maintenance costs and fuel cost of the present project prove to be economically more advantageous than the alternative project.

(2) Economic internal rate of return

As shown by Table 10-1-4-2, the discount rate (namely, EIRR) is set to be 25.3% when the present value of the investment to the present project throughout its whole life becomes equal to that of the alternative thermal power plant in the first year of the project. This rate exceeds evidently the opportunity cost of capital set to 10%.

As described in Item (1) and (2), this project proves to be more advantageous than the alternative imported coal thermal power plant from economical point of view and can be said to be feasible enough judging from all index.

10.1.5 Sensitivity Analysis

The sensitivity of the proposed project is analyzed under the following conditions:

Case 1	Increase by 20% in construction cost
Case 2	Discount rate changed to 8%, 12%
Case 3	Increase by 5% in fuel cost

As a result, the EIRR, B-C and B/C resulting from these flows are shown in Table 10-1-5 and indicate the advantageous merits inherent in the present project.

10.2 Financial Evaluation

10.2.1 Methodology

In making the financial evaluation of the proposed project, a cash flow at market prices was developed for all costs of the project; direct construction cost, maintenance cost and fuel cost of the project.

This cash flow of these costs was compared with the cash flow of the benefit calculated based on the estimate of revenue deriving from the sales of electricity and heat for district heating, generated from this project, and then financial internal rate of return (FIRR) was calculated by the discount cash flow method (DCF method).

The discount rate was determined to be 10% through discussion with NEK. Table 10-2-2-1 shows basic conditions used for financial evaluation of this project.

10.2.2 Financial Cost of Project

Total amount of initial investment of this project was obtained on the bases described in " Chapter 8.2 Construction Cost". The operation and maintenance cost was determined to be 4% of construction cost.

From the above, total financial cost of initial investment and all life of project which is a cost flow for making financial evaluation of the project, was calculated. Table 10-2-2-1 shows the calculated costs.

10.2.3 Financial Revenue of the Project

The financial revenue of the project derives from the sales of electricity and heat for district heating. This revenue was calculated based on electricity tariff (4.5 cent/kWh) to be applied in 2001 to major cities and industrial areas such as Sofia and Ruse, which are considered to be MW class electricity consumption area located in the neighborhood of the project site. Likewise, the revenue of heat for district heating was calculated based on heat tariff ($31.4/Gcal) to be applied to residences and factories in Maritsa East in 2001. Throughout the life of the project, (a) the average of annual generation of electric power is considered to be electric power which can be sold to consumers and (b) the amount of heat supplied for district heating was considered to be the amount of heat which can be sold. Table 10-2-3-1 shows the annual financial revenue calculated based on the above mentioned tariff.

10.2.4 Financial Evaluation

Table 10-2-4-1 shows the result of the financial evaluation. As shown in this table, the financial internal rate of return (FIRR) was calculated to be 8.8 %.

This FIRR is higher than the interest rate of 8% in terms of borrowing foreign currency. On the other hand, this rate is lower than the average interest rate of 10% in terms of borrowing foreign currency for both foreign and local portion from international financial organization (this interest can be considered to be opportunity cost of the capital). Thus, it is concluded that NEK should examine average unit electricity tariff so that the project can be more attractive under the same discount rate. NEK should also examine the condition of borrowing from international financial organization for decreasing necessary amount of fund.

10.3 Repayment Schedule of Borrowing

10.3.1 Basic Consideration and Condition

In general, construction of a power plant requires a huge amount of initial investment during the term of construction work. Furthermore, the return from that investment starts only after the construction work is completed. The period required for the recovery of the investment is much longer than those required for the investments in the manufacturing facilities of durable goods. Thus, it is natural for the investor to seek the borrowings available at lowest possible interest rate, with longest possible period of deferment of repayment and longest possible repayment term.

In Bulgaria, the interest rate itself reflects inflation and the domestic central base interest rate is extremely high. Thus, as a result of discussion with NEK about borrowing condition of the project, the conditions of other projects are taken into account and a repayment schedule was created on the premise that all necessary funds including foreign and domestic moneys were procured from international financial organizations.

Interest rate: Interest rate of international funds is 8% for foreign money and 10% for domestic money. In any cases, no commitment charge is included.

Repayment condition: Repayment during the term of construction work for the project is to be deferred.
The sum of the principal and interest is to be paid by equal installment in 20 years for foreign fund and 15 years for domestic fund.

10.3.2 Necessary Amount of Fund

The proposed project is scheduled to be incorporated into the existing electric power supply network in 2001. The amount of necessary fund including fund borrowed from international financial organization was estimated based on the prices as of January 1996.

At this time, inflation during the term of construction was not taken into account.

A rise of current inflation in Bulgaria is abnormally high and this brings to 32.9% for 1995. Estimating changes of exchange rate to dollar and other currencies, of Bulgarian currency, future prices were set on dollar basis for both foreign funds and domestic funds and a prospect of fund repayment flow was established.

Table 10-3-2-1 shows the schedule of borrowing and schedule of repayment.

10.3.3 Revenue and Cost

The revenue was calculated based on electricity tariff and heat tariff and the amount of electricity and heat which can be sold, obtained from estimation of its demand. The expenditure includes depreciation cost, fuel cost and operation/maintenance cost. Then, the balance of income and expenditure was considered.

(1) Revenue by sale

The investment is recovered by revenue derived from (1) sale of electricity and (2) sale of heat for district heating, which is supplied to Maritsa East area in winter.

Because it is difficult to estimate average electricity tariff and heat tariff for district heating in 2001, the electricity tariff to be applied to ordinary regions of Bulgaria, based on an estimation of the demand in this country is utilized.

The electricity tariff and heat tariff in 2001 was determined to be 4.5 cent/kWh and $31.4/Gcal respectively as a result of discussion with NEK.

(2) Sales cost

The sales cost comprises operation/maintenance fuel cost and depreciation cost of the project. The annual O/M cost was estimated to be 4% of the construction cost.

Straight-line method was employed assuming that residual value was zero and the durable service life left was estimated to be 30 years.

10.3.4 Repayment Schedule of Borrowing

The source of fund to be appropriated for repayment of borrowing is supposed to be derived from the operating income [Sales of electricity and heat for district heating - Operation/Maintenance cost - (depreciation cost + interest paid)]. (Besides, the cash reserved by depreciation cost should be taken into account too.)

Tables 10-3-4-1 and 10-3-4-2 show cash flow statement and statement of profit and loss based on fund procurement, repayment condition and sales income/expenditure balance. As shown in Table 10-3-4-2, the investment cost will be recovered in the sixth year from the beginning of the operation. After that, income will exceed the investment cost, thereby producing profit.

10.4 Calculation Under the New Electric Tariff System

10.4.1 Present Situations of Electric Tariff and Their System

(1) Electric tariff

In Bulgaria there are two electric tariff systems, the systems to cover electricity for industrial use and the system to cover electricity for private use. Conventionally, electric tariff (end-user prices) and local heating tariff are approved by the government via Energy Committee.
Table 10-4-1-1 shows the current level of electric tariff.

Under the influence of domestic inflation and exchange rates resulting from the shift to the market economy which started in 1989, during the two years of 1994 and 1995 electric tariff was raised by 30% to 50% for home use, and 30% to 40% for industrial use.

Therefore, in November, 1994 the government decided to review the system intended to have the progress of inflation and the increase in costs reflected in the electric tariff as much as possible. Taking into account the variation in exchange rates, the progress of inflation, and changes in national incomes as the factors subject to adjustment, the cause of the repeated raise in electric tariff has been investigated.

In 1995 the average electric tariff per consumer type was 3.01 cent/kWh (approx. ¥3/kWh) for industrial use and 2.33 cent/kWh (approx. ¥2.3/kWh) for private use.

End-user prices are established and controlled through accumulation of the costs of individual power plants belonging to each local branch (Maritsa East No. 1 Power Plant Branch, etc.).
However, since governmental subsidies are granted in various phases of establishing end-user prices so that the burdens on enterprisers and consumers may be eased, the electric tariff system as a whole is not considered as being based on the market price which reflects the costs involved (See Table 10-4-1-2).

In the current tariff system of the country, the tariffs to the end users are determined with political consideration and there is a big departure from the cost-based tariff systems.
The No.1 Maritsa East Power Plant is subjected to the cost control systems applicable to the regional branch of the company. The actual cost is reported to each regional office every 3 months, which are used as the basic data for the Government review of the electricity tariff.
The total revenue in 1994 was 543,946,000 Lev (¥1,006 million) and the total cost of 1,081,849,000 Lev (¥2,001 million) was accrued, meaning that the region is not in a position to recover the cost.

The largest point of issue in the attempt of revising the current tariff system for 1994 onward is lack of a mechanism to collect long-term investment. From a static point of view there is no structure of well-balanced revenue and expenditure. In order to make a large-scale investment with a long-term capital to be loaned, a stable income base of a proper tariff system is needed. Therefore, an institutional problem at present is how to continuously reflect in the future electric tariff the capital expenses (interest and depreciation expenses) required for the intended proper investment.

We have not obtained the information regarding the new tariff systems which is said to be under review. If, for instance, the cost based pricing of each plant is adopted as is a standard for the Euro-American countries, special measures will have to be considered such as tax exemption for installation of environmental protection equipment or encouragement of foreign investment.

(2) Power generation costs

In NEK's statement of profit and loss, power generation costs and heat supply costs are not separately indicated.

For the details of cost items, refer to Table 10-4-1-2.

(a) Fuel costs

According to NEK, because of a sharp rise in coal prices the ratio of fuel costs to the total costs was raised by approx. 90% compared with that of 1992 although the amount of fuel consumption was slightly increased.

In view of the price liberalization expected to take place in the future, fuel costs may further rise.

(b) Repair and related costs

According to NEK, the costs of repairs both ordered to outside workshops and conducted within the organization were increased compared with those of 1992 owing to the rise in the prices of various machinery and materials. Although this is partly attributable to its decrepit equipment, this may have something to do with its insufficient capital to be invested in the renewal of the equipment as well as with the coefficient of utilization still being small.
Since regular inspections largely depend on the orders placed on outside workshops and, consequently, the expenses involved may be comparatively high.

(c) Personnel expenses

The manpower allocation at the No.1 Maritsa East Power Plant is shown in the chapter 2.1.2. The manpower related cost based on the price level in the year 2001 is estimated as follows.

Although the manpower plans for the R5 and R6 projects of the No.1 Maritsa East Power Plant is yet to be determined, NEK assumes 100 people including those for operations and maintenance of the existing No.5 and No.6 plants. By having more sophisticated replacing thermal plants, we believe that the manpower cost can be squeezed.

(d) Depreciation costs

The standards for depreciation are legally provided by the Ministry of Finance of the republic. Residual value is specified as zero, and depreciation ratios are separately specified for individual units and equipment.

Table 10-4-1-3 shows the outline of these standards.

As referred to in the previous chapter, in order to collect capital expenses for proper investment in the future, it would be necessary to consider a tariff system with depreciation costs reflected in tariff costs.

10.4.2 Consideration on the New Electric Tariff System and Its Effect

(1) Evaluation technique

This project is roughly divided into two parts, i.e. a) thermal power plant using lignite coal in accordance with the reconstruction plan and b) steam supply for heating. Profits will be obtainable in case electric tariff is established so that sales of electricity and steam for heating may cover the costs of investment, maintenance, and operation.

Based on the financial evaluation of chapter 10.2 and assuming the year 2001 standard electricity sales price for the cash balance calculation, a new tariff system will be reviewed as follows.
The electric tariff salable in the future will be the unit price sufficient to avoid a deficit in the net income, not the price with which to discuss the essence of the salable electric tariff. Accordingly, we have analyzed the cash flow in view of the financial evaluation and the profitability of the project. The basic assumptions used are two different unit prices which are

calculated from the current tariff as extended to the 5 years from 1996 through 2001 by two annual increasing rate of 5% and 11% respectively.

The tariffs for the years beyond year 2001 are assumed as follows. The same capital financing conditions as in the chapter 10.3.4 debts repayment schedule are used.

Case 1: Annual Rate 5% : Unit price for 2001 - 3.8 cent/kWh
Case 2: Annual Rate 11%: Unit price for 2001 - 5.0 cent/kWh

(2) The result of review

The cash flow analysis for each case of assumptions is demonstrated below.

1) In case the unit sale price is 3.8 cent/kWh:

The total annual amount of cash balance would mark a deficit for the period of 18 years but would turn out a surplus afterwards. In the final year of repayment to the financial institution the total surplus would be US$35,208,000.

2) In case the unit sale price is 5.0 cent/kWh:

The cash balance for a single fiscal year would mark a deficit up to the 2nd year from the beginning but would turn out a surplus the next year onward.

In the case of electricity sales price of 3.8 cents/kWh, it is not advisable to balance the revenue and the cost and to repay the debt with the standard tariffs of electricity and steam fixed at the 2001 level without any change in future. This recommendation is based on the financial evaluation and the cash flow statement as well as the assumptions of 20- year repayment of foreign currency debts with 8.0% annual interest rate, and 15-year repayment of local currency debts carrying 10 % interest.

Thus, with the same financing conditions as above, the 5.0 cents /kWh case appears to be the most feasible level. Also, more favorable terms of borrowing must be negotiated with the international financial institutions in order to reduce the overall cost of procurement funds required.

10.5 Socio-Economic Influence

10.5.1 Outline

So far any certain method has not been established to evaluate socio-economic influence on macro basis by introduction of environmental equipment. It shall be pursued in the future.

Therefore, this chapter described some estimations made so far after it stated history of introduction of environmental technology in Japan and then estimated socio-economic influence by reconstruction of Maritsa East first thermal power plant in Bulgaria.

We have learned from our experience that there are the following possibilities for benefits and losses generated from introduction of environmental equipment.

(Benefits)

- Reduction of disease of the people
- Improvement of living, social and natural environment
- Economic growth and expansion of employment by investment for environmental equipment
- Decrease of the sum paid for the indemnity for healthy damage

(Losses)

- Rise of consumer price by addition of environmental cost and decrease of purchasing ability of the people

10.5.2 History of Introduction of Environmental Equipment in Japan

Since Japan promoted economic recovery and expansion of the production after World War II, GNP recovered in 1955 (10 years after 1945) to the same as the highest level before World War II. Average annual increase of GNP recorded 8.8% in the latter half of 1950's, 9.3% in the former half of 1960's and 12.4% in the latter half of 1960's. Economic growth had been triggered by export of industrial products and investment for production equipment. Since heavy chemical industry in which more environmental pollutant was discharged per unit production, environmental condition was getting worse in this period. However the portion of the investment for environmental protection in total capital investment of private sector was still low; around 3% in 1965.

Although some environmental laws were enacted after the latter half of 1950's, governmental position for environmental protection was still unclear at that period as seen in the example that such clause as "the harmony between environmental protection and sound economic growth" was stipulated in the laws. No governmental authorities existed for integrate administration in the field of environmental protection.

Environmental pollution expanded in around 1970 all over the country, and it became the most serious social problem. A total of 14 new environmental laws were enacted and the clause of "to protect the environment in harmony with economic growth" was deleted from Environmental Organic Law. The Environmental Agency was established for the integration of the environmental administration in 1971. Since that period the movement for environmental protection promoted rapidly. In electric sector, its regulation system was arranged neatly. As a result, introduction of discharge substance suppression technology was accelerated, so that currently, flue gas desulfurizers have been introduced for mainly coal thermal power and high sulfuric heavy oil thermal power plants.

10.5.3 Examples of Estimate for Socio-Economic Influence by Introduction of Environmental Countermeasure

Although no concrete method for macro economical estimation on socio-economic influence by execution of environmental countermeasures has not been established yet as described in 10.5.1, some examples have been conducted. Thus, this section will describe two of them.

(1) Comparison between the sum of damages from environmental pollution and the cost incurred from countermeasure for environmental protection

In a paper presented at the 1982 Tokyo conference of the Club of Rome, Professor Yoichi Kaya of the University of Tokyo offered a comparison between the amount of anti-pollution funds spent in one year to deal with sulfur oxides at their sources, such as plants, and the amount of damage estimated to result from pollution where there was a total lack of pollution countermeasures. This comparison was based on notably bold assumptions. As indicated by the tentatively calculated costs shown in Table 10-5-3-1, the total damage arising from the absence of anti-pollution measures (about \6 trillion, or $45 billion, annually in 1976 prices) far exceeded the estimated actual costs of anti-pollution measures (about \480 billion, or $3.7 billion, at 1976 prices).

(2) Tentative statistics relating to the economic impact of anti-pollution investments

The impact on the economy of anti-pollution investments must be considered in terms of two major factors: namely, (1) the impact on prices, brought about by increased costs related to investments; and (2) the impact on income, induced by the increased demand for the anti-pollution products and services.

The first factor, the impact on prices, would vary according to the supply-demand relationship of the specific products. Nonetheless, cost increases due to investments in pollution control will have an effect on the prices of the particular products concerned. This, in turn, will affect the prices of the products consumed by the industries that manufacture goods using the particular products or parts in question as raw materials. This, furthermore, will affect the prices of the end consumer goods. When these prices rise, the demand for the various consumer goods will decline according to their price elasticities (rates of changes in demand according to price changes). This will result in a decrease in investment in plant and equipment in each industry, which in turn will lower its supply capacity.

The second factor, the significant impact on income will be that anti-pollution investments will become part of the cost of the industries making the investments, and at the same time will increase the demand for the products and services of the industries that receive the investments. Furthermore, the increased demand in the anti-pollution industries will expand the demand for materials and parts needed in investments relating to those industries, and will constitute a factor promoting investments in related industries and their capacity for supply.

As we have seen above, the effect of the first factor is to reduce the real GNP (i.e. price effect) and the second factor is to expand the real GNP (i.e. income effect).

The *Environment White Book* published in 1977 by Japanese Government focuses on these two effects and offers tentative statistics relating to the macroeconomics impact produced by the environmental measures taken during the decade between 1965 and 1975.

According to this document, the total private-sector investment in anti-pollution measures during this period was $40 billion (about ¥5.3 trillion at 1970 prices). The following estimates for some economic indices were shown as the effect of the investment for the environmental equipment compared with the case where such investment had not been carried out.

10.5.4 Estimation of Socio-Economic Influence in Bulgaria

On the background of the above stated analysis, macro economic influences induced by introduction of environmental protection equipment for the reconstruction plant in coal thermal power plants in Bulgaria, are considered, regarding (1) changes of people's consciousness, (2) harm on people's health and other social cost, (3) impact on national economy, and (4) influence on surrounding countries by suppression of pollution diffusion, as follows.

(1) Review of electricity tariff system

Although cost relating to investment must be recovered by electricity tariff, the ratio occupied by electricity tariff is not so large. If appropriate cost recovery system is adopted, an effect of tariff reduction with a passage of time can be expected. Currently, Bulgaria is reviewing its electricity tariff system so as to include its money exchange rate to US dollar, inflational rate, and changes of fuel price in international market into its power generation cost.

Thus, it is possible to include environmental equipment cost in this review process accurately.

(2) Economic diffused influence and expansion of employment capacity can be expected due to increase of investment.

Although procurement of as many material as possible in the country is intended in achievement plan of this project as well, quite large economic diffusion effect and expansion of employment force such as expansion of GNP can be expected by domestic private and public organizations' achieving this production and distribution plan.

(3) Economic diffusion effect to export can also be expected.

From the viewpoints of technological standard of Bulgaria, it will not take so long time to absorb production and operation technologies of flue gas desulfurizer. Because Bulgaria applied for participation in EU in 1995, it is expected that installation and spreading of flue gas desulfurizers for new coal thermal power development and in existing power plant will be still greatly demanded. Thus, it is possible to position export of flue gas desulfurizers to other countries as a prominent goal for industrial growth, by making the best use of advantage of relative production cost of environmental protection equipment in the domestic country.

Table 10-1-2-1 Initial Investment Cost of ME-1 Replacing Thermal Power Plant (Market Price Basis)

(Unit: 10^3 US$)

Year		1	2	3	4	Total
Civil/Erection Island	FC	18,600	13,000	15,500	14,900	62,000
	LC	24,700	17,300	20,500	19,700	82,200
Boiler Island	FC	0	76,800	96,100	19,200	192,100
	LC	0	13,600	17,000	3,300	33,900
Turbine Island	FC	0	36,000	45,100	9,000	90,100
	LC	0	6,400	7,900	1,600	15,900
Coal/Limestone Handling Island	FC	0	18,900	41,700	15,100	75,700
	LC	0	3,300	7,400	2,700	13,400
General Expenses	FC	2,000	6,000	6,000	23,000	37,000
	LC	0	0	0	3,000	3,000
Total	FC	20,600	150,700	204,400	81,200	456,900
	LC	24,700	40,600	52,800	30,300	148,400
Total (FC + LC)		**45,300**	**191,300**	**257,200**	**111,500**	**605,300**

(Note) 1. Interest on borrowing accrued during the term of construction work is not included in the above amounts.

2. General expenses include the indirect cost of contingency and engineering fee.

Table 10-1-2-2 Initial Investment Cost of ME-1 Replacing Thermal Power Plant (Economic Price Basis)

(Unit: 10^3 US$)

Year		1	2	3	4	Total
Civil/Erection Island	FC	18,600	13,000	15,500	14,900	62,000
	LC	23,959	16,781	19,885	19,109	79,734
Boiler Island	FC	0	76,800	96,100	19,200	192,100
	LC	0	13,192	16,490	3,201	32,883
Turbine Island	FC	0	36,000	45,100	9,000	90,100
	LC	0	6,208	7,663	1,552	15,423
Coal/Limestone Handling Island	FC	0	18,900	41,700	15,100	75,700
	LC	0	3,201	7,178	2,619	12,998
General Expenses	FC	2,000	6,000	6,000	23,000	37,000
	LC	0	0	0	2,910	2,910
Total	FC	20,600	150,700	204,400	81,200	456,900
	LC	23,959	39,382	51,216	29,391	143,948
Total (FC + LC)		44,559	190,082	255,616	110,591	600,848

(Note) 1. Interest on borrowing accrued during the term of construction work is not included in the above amounts.

2. General expenses include the indirect cost of contingency and engineering fee.

Table 10-1-3-1 Initial Investment Cost of Alternative Thermal Power Plant (Market Price Basis)

(Unit: 10^3 US$)

Year		1	2	3	4	Total
Civil/Erection Island	FC	16,800	11,800	14,000	13,500	56,100
	LC	22,300	15,600	18,600	17,900	74,400
Boiler Island	FC	0	59,100	73,900	14,800	147,800
	LC	0	10,500	13,000	2,600	26,100
Turbine Island	FC	0	30,000	37,600	7,500	75,100
	LC	0	12,900	16,100	3,200	32,200
Coal/Limestone Handling Island	FC	0	13,700	30,100	10,900	54,700
	LC	0	5,800	12,900	4,700	23,400
General Expenses	FC	2,000	6,000	6,000	23,000	37,000
	LC	0	0	0	3,000	3,000
Total	FC	18,800	120,600	161,600	69,700	370,700
	LC	22,300	44,800	60,600	31,400	159,100
Total (FC + LC)		**41,100**	**165,400**	**222,200**	**101,100**	**529,800**

(Note) 1. Interest on borrowing accrued during the term of construction work is not included in the above amounts.

2. General expenses include the indirect cost of contingency and engineering fee.

Table 10-1-3-2 Initial Investment Cost of Alternative Thermal Power Plant (Economic Price Basis)

(Unit: 10^3 US$)

Year		1	2	3	4	Total
Civil/Erection Island	FC	16,800	11,800	14,000	13,500	56,100
	LC	21,631	15,132	18,042	17,363	72,168
Boiler Island	FC	0	59,100	73,900	14,800	147,800
	LC	0	10,185	12,610	2,522	25,317
Turbine Island	FC	0	30,000	37,600	7,500	75,100
	LC	0	12,513	15,617	3,104	31,234
Coal/Limestone Handling Island	FC	0	13,700	30,100	10,900	54,700
	LC	0	5,626	12,513	4,559	22,698
General Expenses	FC	2,000	6,000	6,000	23,000	37,000
	LC	0	0	0	2,910	2,910
Total	FC	18,800	120,600	161,600	69,700	370,700
	LC	21,631	43,456	58,782	30,458	154,327
Total (FC + LC)		40,431	164,056	220,382	100,158	525,027

(Note) 1. Interest on borrowing accrued during the term of construction work is not included in the above amounts.

2. General expenses include the indirect cost of contingency and engineering fee.

Table 10-1-3-3 Basic Condition for Economic Evaluation

1. The 1 US$ = 67Lv is the exchange rate of average 1995, which is adopted in the economic and financial evaluation to convert into the unit price.

2. Basic price point for evaluation is assumed to be the prices as of January, 1996.

3. Other Parameter and Data

Item	Assumed Data and Conditions
1) Method of Analysis	Alternative Plant Approach (Imported coal-fired plant)
2) Study Period	30 year plus construction period
3) Discount Rate	10%
4) Opportunity Cost of Capital	10%
5) Selection of Benefit	Cost of Imported coal-fired TPP
6) Standard Conversion Factor (SCF)	0.97

Table 10-1-3-4 Basic Factors for Economic Evaluation

Item		Maritsa East No.1 Replacing Plant	Alternative Plant
1.	Capacity	230 MW x 2 Units	230 MW x 2 Units
	Heat supply	25 Gcal/H	25 Gcal/H
2.	Site	Maritsa East-1 site	Maritsa East 1 site
3.	Annual Utilization	70 %	70 %
4.	Plant efficiency	28.5 %	38.3 %
	Boiler	68.3 %	93.8 %
	Turbine	45.0 %	45.0 %
	In-house ratio	7.0 %	9.0 %
	Plant loss	0.3 %	0.3 %
5.	Annual production (GWh)	2,821	2,821
6.	Net annual production [at sending end] (GWh)	2,623	2,567
7.	Fuel calorific value [LHV]	1,686 kcal/kg 7,058 kJ/kg	5,898 kcal/kg 24,689 kJ/kg
8.	Fuel consumption (t/year)	$5,052 \times 10^3$	994×10^3
9.	Fuel cost (unit cost)		
	- Economic cost	6.6 $/T	60.0 $/T
	- Financial cost	6.0 $/T	60.0 $/T
10.	Annual O'M cost (US$/year)	$22,030 \times 10^3$	$18,960 \times 10^3$
11.	Plant life	30 years	30 years

Table 10-1-4-1 Net Present Values and Benefit-Cost Ratio

(Unit: 10^3 US$)

	ME-1 Thermal Power Plant		Alternative Thermal		Difference		
	Total Cost	Present Value (C)	Total Cost	Present Value (B)	Total	(B-C)	(B/C)
	2,183,334	804,823	2,896,367	915,270	713,034	110,447	1.14

Table 10-1-4-2 Economic Evaluation of ME-1 Thermal Power Plant

(1,000 US $)

No.		YEAR	Maritsa East No.1 Replacing PROJECT: Construct. Cost	Maritsa East No.1 Replacing PROJECT: O & M Cost	Maritsa East No.1 Replacing PROJECT: Fuel	Maritsa East No.1 Replacing PROJECT: (C) TOTAL COST	Alternative Thermal Power PROJECT (Imported Coal-fired) IMPORTED TPP: Constr. Cost	Alternative Thermal Power PROJECT (Imported Coal-fired) IMPORTED TPP: O & M Cost	Alternative Thermal Power PROJECT (Imported Coal-fired) IMPORTED TPP: Fuel Cost	(B) TOTAL COST	(B) - (C)
1		1998	44,559			44,559	40,431			40,431	-4,128
2		1999	190,082			190,082	164,056			164,056	-26,026
3		2000	255,616			255,616	220,382			220,382	-35,234
4		2001	110,591			110,591	100,158			100,158	-10,433
5	1	2002		22,438	30,312	52,750		19,405	59,640	79,045	26,295
6	2	2003		22,438	30,312	52,750		19,405	59,640	79,045	26,295
7	3	2004		22,438	30,312	52,750		19,405	59,640	79,045	26,295
8	4	2005		22,438	30,312	52,750		19,405	59,640	79,045	26,295
9	5	2006		22,438	30,312	52,750		19,405	59,640	79,045	26,295
10	6	2007		22,438	30,312	52,750		19,405	59,640	79,045	26,295
11	7	2008		22,438	30,312	52,750		19,405	59,640	79,045	26,295
12	8	2009		22,438	30,312	52,750		19,405	59,640	79,045	26,295
13	9	2010		22,438	30,312	52,750		19,405	59,640	79,045	26,295
14	10	2011		22,438	30,312	52,750		19,405	59,640	79,045	26,295
15	11	2012		22,438	30,312	52,750		19,405	59,640	79,045	26,295
16	12	2013		22,438	30,312	52,750		19,405	59,640	79,045	26,295
17	13	2014		22,438	30,312	52,750		19,405	59,640	79,045	26,295
18	14	2015		22,438	30,312	52,750		19,405	59,640	79,045	26,295
19	15	2016		22,438	30,312	52,750		19,405	59,640	79,045	26,295
20	16	2017		22,438	30,312	52,750		19,405	59,640	79,045	26,295
21	17	2018		22,438	30,312	52,750		19,405	59,640	79,045	26,295
22	18	2019		22,438	30,312	52,750		19,405	59,640	79,045	26,295
23	19	2020		22,438	30,312	52,750		19,405	59,640	79,045	26,295
24	20	2021		22,438	30,312	52,750		19,405	59,640	79,045	26,295
25	21	2022		22,438	30,312	52,750		19,405	59,640	79,045	26,295
26	22	2023		22,438	30,312	52,750		19,405	59,640	79,045	26,295
27	23	2024		22,438	30,312	52,750		19,405	59,640	79,045	26,295
28	24	2025		22,438	30,312	52,750		19,405	59,640	79,045	26,295
29	25	2026		22,438	30,312	52,750		19,405	59,640	79,045	26,295
30	26	2027		22,438	30,312	52,750		19,405	59,640	79,045	26,295
31	27	2028		22,438	30,312	52,750		19,405	59,640	79,045	26,295
32	28	2029		22,438	30,312	52,750		19,405	59,640	79,045	26,295
33	29	2030		22,438	30,312	52,750		19,405	59,640	79,045	26,295
34	30	2031		22,438	30,312	52,750		19,405	59,640	79,045	26,295
TOTAL			600,848	673,126	909,360	2,183,334	525,027	582,140	1,789,200	2,896,367	713,034
Present Value I = 10%						804,823				915,270	110,447
										N.P.V.	110,447
										E.I.R.R.	25.3%
										B / C	1.14

Table 10-1-5-1 Sensitivity Analysis

		B-C (10^3 US$)	B/C	EIRR (%)
Case - 1	Construction cost (20% up)	17,411	1.02	11.2
Case - 2	Discount rate (8%)	142,607	1.15	22.6
	Discount rate (12%)	78,468	1.11	25.3
Case - 3	Fuel cost (5% up)	100,867	1.12	24.2

Table 10-2-1-1 Basic Conditions for Financial Evaluation

Item	Assumed Data and Conditions
1) Revenue for Financial Evaluation	4.5 cent/kWh (Electricity) 31.4 US$/Gcal (Heat) These are estimated average tariff as of 2001 for NEK
2) Study Period	30 years plus construction period
3) Method of Repayment	Principal & Interest in equal installment
5) Escalation	Not considered
6) Depreciation	Straight line method/zero residual value

Table 10-2-3-1 Revenue from Sales of Electricity and Heat

	Electricity	Heat
Annual net energy	2,624 GWh/year	100,000 Gcal/year
Electricity price (cent / kWh)	4.5	-
Annual electricity revenue (10^3US$)	118,059	-
Heat price (US$ / Gcal)	-	31.4
Annual heat revenue (10^3US$)	-	3,140

(1) Basic assumption for Salable Annual Electricity and Heat Supply

1) Electricity

R_1 unit: [230MW x 12 months]

230MW x 24 h x 365 day x 0.7 x (1 - 0.07)

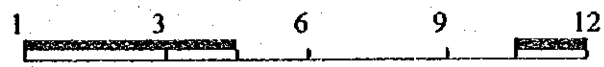
R_2 unit: [230MW x 6 months; 200MW x 6 months (During Heat Supply)

230MW x 24 h x (365 day/2) x 0.7 x (1 - 0.07)

200MW x 24 h x (365 day/2) x 0.7 x (1 - 0.07)

2) Heat

a) The period of supply: 6 (months)



b) Average annual operating period: 4,000 (hours)

c) Total supply heat: 100,000 (Gcal/year)

Table 10-2-4-1 FINANCIAL EVALUATION OF ME-1 Thermal Power Plant

(Unit : 1,000 US $)

No.		YEAR	Marista East No.1 PROJECT				(B) REVENUE		(B) - (C)
			Construct. Cost	O & M Cost	FUEL	(C) TOTAL COST	POWER SALES	HEAT SALES	
1		1998	45,300			45,300			-45,300
2		1999	191,300			191,300			-191,300
3		2000	257,200			257,200			-257,200
4		2001	111,500			111,500			-111,500
5	1	2002		22,612	30,312	52,924	114,198	3,135	64,409
6	2	2003		22,612	30,312	52,924	114,198	3,135	64,409
7	3	2004		22,612	30,312	52,924	114,198	3,135	64,409
8	4	2005		22,612	30,312	52,924	114,198	3,135	64,409
9	5	2006		22,612	30,312	52,924	114,198	3,135	64,409
10	6	2007		22,612	30,312	52,924	114,198	3,135	64,409
11	7	2008		22,612	30,312	52,924	114,198	3,135	64,409
12	8	2009		22,612	30,312	52,924	114,198	3,135	64,409
13	9	2010		22,612	30,312	52,924	114,198	3,135	64,409
14	10	2011		22,612	30,312	52,924	114,198	3,135	64,409
15	11	2012		22,612	30,312	52,924	114,198	3,135	64,409
16	12	2013		22,612	30,312	52,924	114,198	3,135	64,409
17	13	2014		22,612	30,312	52,924	114,198	3,135	64,409
18	14	2015		22,612	30,312	52,924	114,198	3,135	64,409
19	15	2016		22,612	30,312	52,924	114,198	3,135	64,409
20	16	2017		22,612	30,312	52,924	114,198	3,135	64,409
21	17	2018		22,612	30,312	52,924	114,198	3,135	64,409
22	18	2019		22,612	30,312	52,924	114,198	3,135	64,409
23	19	2020		22,612	30,312	52,924	114,198	3,135	64,409
24	20	2021		22,612	30,312	52,924	114,198	3,135	64,409
25	21	2022		22,612	30,312	52,924	114,198	3,135	64,409
26	22	2023		22,612	30,312	52,924	114,198	3,135	64,409
27	23	2024		22,612	30,312	52,924	114,198	3,135	64,409
28	24	2025		22,612	30,312	52,924	114,198	3,135	64,409
29	25	2026		22,612	30,312	52,924	114,198	3,135	64,409
30	26	2027		22,612	30,312	52,924	114,198	3,135	64,409
31	27	2028		22,612	30,312	52,924	114,198	3,135	64,409
32	28	2029		22,612	30,312	52,924	114,198	3,135	64,409
33	29	2030		22,612	30,312	52,924	114,198	3,135	64,409
34	30	2031		22,612	30,312	52,924	114,198	3,135	64,409
TOTAL			605,300	678,360	909,360	2,193,020	3,425,933	94,050	1,326,963

Base case: 4.5 cent/kWh F.I.R.R. 8.8%

Table 10-3-2-1 Fund Requirement and Repayment

(Unit : 1,000 US $)

No.		FUND REQUIREMENT			REPAYMENT SCHEDULE							
					FOREIGN FOR FOREIGN CONSTRUCTION				FOREIGN FOR LOCAL			
		Foreign	Local	Total	Interest	Principal	Total	Balance	Interest	Principal	Total	Balance
					( )				(0)			
	1	20,600	24,700	45,300	(824)				(1,235)			
	2	150,700	40,600	191,300	(7,676)				(4,500)			
	3	204,400	52,800	257,200	(21,880)				(9,170)			
	4	81,200	30,300	111,500	(33,304)			522,752	(13,325)			178,990
1	5				41,820	11,423	53,243	511,329	17,899	5,633	23,532	173,357
2	6				40,906	12,337	53,243	498,992	17,336	6,197	23,532	167,160
3	7				39,919	13,324	53,243	485,667	16,716	6,817	23,532	160,343
4	8				38,853	14,390	53,243	471,277	16,034	7,498	23,532	152,845
5	9				37,702	15,541	53,243	455,736	15,284	8,248	23,532	144,597
6	10				36,459	16,785	53,243	438,952	14,460	9,073	23,532	135,524
7	11				35,116	18,127	53,243	420,824	13,552	9,980	23,532	125,544
8	12				33,666	19,578	53,243	401,247	12,554	10,978	23,532	114,566
9	13				32,100	21,144	53,243	380,103	11,457	12,076	23,532	102,490
10	14				30,408	22,835	53,243	357,268	10,249	13,283	23,532	89,207
11	15				28,581	24,662	53,243	332,606	8,921	14,612	23,532	74,595
12	16				26,608	26,635	53,243	305,971	7,459	16,073	23,532	58,522
13	17				24,478	28,766	53,243	277,205	5,852	17,680	23,532	40,842
14	18				22,176	31,067	53,243	246,138	4,084	19,448	23,532	21,393
15	19				19,691	33,552	53,243	212,586	2,139	21,393	23,532	0
16	20				17,007	36,237	53,243	176,349				
17	21				14,108	39,136	53,243	137,214				
18	22				10,977	42,266	53,243	94,947				
19	23				7,596	45,648	53,243	49,299				
20	24				3,944	49,299	53,243	0				
Total		456,900	148,400	605,300	542,117	522,752	1,064,869		173,997	178,990	352,987	

Note: Figures in parentheses are I.D.C.
Funds to be required do not include the amount of interest

Remarks: Repayment condition

Foreign currency : 8.00% (20 Year)
Local currency : 10.00% (15 Year)
Grace Period : 4 years (construction period including preparation)

Table 10-3-4-1 Profit and Loss Statement

(Unit : 1,000 US $)

No.	Operating Revenue (A)	Operating Expenses O & M	Operating Expenses Depreci-ation	Total (B)	Operating Income (C)=A-B	Financial Expenses* F.C.	Financial Expenses* L.C.	Total* (D)	Net Income (E)=C-D
1						(0)	(0)	(0)	
2						(824)	(1,235)	(2,059)	
3						(7,676)	(4,500)	(12,176)	
4						(21,880)	(9,170)	(31,050)	
5						(33,304)	(13,325)	(46,629)	
6	117,338	22,612	16,921	39,533	77,805	41,820	17,899	59,719	18,086
7	117,338	22,612	16,921	39,533	77,805	40,906	17,336	58,242	19,563
8	117,338	22,612	16,921	39,533	77,805	39,919	16,716	56,635	21,170
9	117,338	22,612	16,921	39,533	77,805	38,853	16,034	54,888	22,917
10	117,338	22,612	16,921	39,533	77,805	37,702	15,284	52,987	24,818
11	117,338	22,612	16,921	39,533	77,805	36,459	14,460	50,919	26,887
12	117,338	22,612	16,921	39,533	77,805	35,116	13,552	48,669	29,137
13	117,338	22,612	16,921	39,533	77,805	33,666	12,554	46,220	31,585
14	117,338	22,612	16,921	39,533	77,805	32,100	11,457	43,556	34,249
15	117,338	22,612	16,921	39,533	77,805	30,408	10,249	40,657	37,148
16	117,338	22,612	16,921	39,533	77,805	28,581	8,921	37,502	40,303
17	117,338	22,612	16,921	39,533	77,805	26,608	7,459	34,068	43,737
18	117,338	22,612	16,921	39,533	77,805	24,478	5,852	30,330	47,475
19	117,338	22,612	16,921	39,533	77,805	22,176	4,084	26,261	51,545
20	117,338	22,612	16,921	39,533	77,805	19,691	2,139	21,830	55,975
21	117,338	22,612	16,921	39,533	77,805	17,007	0	17,007	60,798
22	117,338	22,612	16,921	39,533	77,805	14,108	0	14,108	63,697
23	117,338	22,612	16,921	39,533	77,805	10,977	0	10,977	66,828
24	117,338	22,612	16,921	39,533	77,805	7,596	0	7,596	70,209
25	117,338	22,612	16,921	39,533	77,805	3,944	0	3,944	73,861
Total	2,346,755	452,240	338,413	790,653	1,556,102	542,117	173,997	716,114	839,988

*Note: Figures in parentheses are I.D.C.

Remarks: Operating revenue :

Electricity :	2,537.73 GWh /Year x	0.045	US$/kWh=	114,198 Thousand US$/year
Heat :	100,000 Gcal /Year x	31.40	US$/Gcal=	3,140.0 Thousand US$/year
				117,338 Thousand US$/year

Table 10-3-4-2 Cash Flow Sheet

(Unit : 1000 US $)

No.	CASH INFLOW				CASH OUTFLOW						BALANCE	
	Fund Requirement	Net Income	Depreciation	Total (A)	Construction Cost	Principal Repayment F.C.	Principal Repayment L.C.	Principal Repayment Subtotal	I.D.C.	Total (B)	Yearly (A)-(B)	Accummulation
	0	0	0	0	0	0	0	0	0	0	0	0
1	45,300	0	0	45,300	45,300	0	0	0	2,059	47,359	-2,059	-2,059
2	191,300	0	0	191,300	191,300	0	0	0	12,176	203,476	-12,176	-14,235
3	257,200	0	0	257,200	257,200	0	0	0	31,050	288,250	-31,050	-45,285
4	111,500	0	0	111,500	111,500	0	0	0	46,629	158,129	-46,629	-91,914
5	0	18,086	16,921	35,007	0	11,423	5,633	17,057	0	17,057	17,950	-73,964
6	0	19,563	16,921	36,484	0	12,337	6,197	18,534	0	18,534	17,950	-56,014
7	0	21,170	16,921	38,090	0	13,324	6,817	20,141	0	20,141	17,950	-38,065
8	0	22,917	16,921	39,838	0	14,390	7,498	21,888	0	21,888	17,950	-20,115
9	0	24,818	16,921	41,739	0	15,541	8,248	23,789	0	23,789	17,950	-2,165
10	0	26,887	16,921	43,807	0	16,785	9,073	25,857	0	25,857	17,950	15,785
11	0	29,137	16,921	46,057	0	18,127	9,980	28,107	0	28,107	17,950	33,735
12	0	31,585	16,921	48,505	0	19,578	10,978	30,556	0	30,556	17,950	51,685
13	0	34,249	16,921	51,169	0	21,144	12,076	33,220	0	33,220	17,950	69,634
14	0	37,148	16,921	54,069	0	22,835	13,283	36,119	0	36,119	17,950	87,584
15	0	40,303	16,921	57,224	0	24,662	14,612	39,274	0	39,274	17,950	105,534
16	0	43,737	16,921	60,658	0	26,635	16,073	42,708	0	42,708	17,950	123,484
17	0	47,475	16,921	64,396	0	28,766	17,680	46,446	0	46,446	17,950	141,434
18	0	51,545	16,921	68,465	0	31,067	19,448	50,515	0	50,515	17,950	159,384
19	0	55,975	16,921	72,895	0	33,552	21,393	54,946	0	54,946	17,950	177,333
20	0	60,798	16,921	77,719	0	36,237	0	36,237	0	36,237	41,482	218,816
21	0	63,697	16,921	80,618	0	39,136	0	39,136	0	39,136	41,482	260,298
22	0	66,828	16,921	83,749	0	42,266	0	42,266	0	42,266	41,482	301,780
23	0	70,209	16,921	87,130	0	45,648	0	45,648	0	45,648	41,482	343,263
24	0	73,861	16,921	90,782	0	49,299	0	49,299	0	49,299	41,482	384,745
Total	605,300	839,988	338,413	1,783,701	605,300	522,752	178,990	701,742	91,914	1,398,956	384,745	

Table 10-4-1-1 Trend of Electricity and Heat Price

Year (Month)		Electricity (Lv/kWh)			Heating (Lv/GCal)	
		Households		Industry		
		Day time	Night time		Households	Buildings
February	1991	0.167	0.088	0.314	50	202
June	1991	0.284	0.150	0.534	85	343
April	1992	0.383	0.202	0.721	115	463
December	1992	0.440	0.233	0.793	149	509
May	1993	0.660	0.350	0.837	238	610
April	1994	0.850	0.450	1.138	450	705
March	1995	1.250	0.660	1.461	810	n.a.
September	1995	1.560	0.830	2.016	810	n.a.

Source: NEK

Table 10-4-1-2 Breakdown of Generating Cost Expenditures of ME-1

[Electric Power]

(Unit: 10^3Lv)

	Items		1992	1993	1994
	1. Power Production	(10^3Wh)	1,103,096	1,117,711	979,873
	2. Internal Energy Consumption	(10^3Wh)	240,906	238,165	199,040
	3. Supply of Electricity	(10^3Wh)	862,190	879,546	780,833
	4. Heat for Sale	(GCal)	1,558,904	1,555,046	1,102,194
Revenue	5. Revenue of Electricity Sales		155,908	96,430	543,946
Cost	6. Fuel for Power Generation		596,975	667,077	653,834
	7. Energy		980	2,550	2,564
	8. Overhauls		90,627	119,528	137,788
	9. Materials and Contractor Services		36,405	71,721	80,362
	10. Insurance		NEK + 999	NEK + 84	NEK + 128
	11. Depreciation		NEK	NEK	NEK
	12. Salaries		54,850	83,871	120,682
	13. Social ' employee benefits, unemployment fundds		25,913	43,859	65,931
	14. Financial Costs		17,281	271	461
	15. Special Costs		9,475	6,972	20,099
	16. TOTAL COSTS		833,505	995,933	1,081,849
	17. Net Electricity Generation, Min. kWh		862.190	879.546	780.833
	18. Heat for Sale - thousands of Gcal		1,558.904	1,555.046	1,102.194
	19. Costs per 1 kWh, Levs/kWh		0.57	0.67	0.85
	20. Costs per 1 Gcal, Levs/Gcal		216	256	376

Source: NEK

Table 10-4-1-3 Standard of Depreciation

	Depreciation Rate	Depreciation Year*
Building	4%	years (30 years) 25
Turbine	20%	years (15 years) 5
Machines	20%	years (15 years) 3
De-Sox Installation	- %	years (7 years)

Note : The standard of DeSOx Installations is the case of ME-2.
The standard above is about the case of coal thermal power plant.

* : Figures indicated in ( ) is a Japanese case

Source : NEK

Table 10-4-2(1) Financial Evaluation of ME-1 Thermal Power Plant (Case 1)

(Unit : 1,000 US $)

No.		YEAR	Marista East No.1 PROJECT Construct. Cost	O & M Cost	FUEL	(C) TOTAL COST	(B) REVENUE POWER SALES	HEAT SALES	(B) - (C)
1		1998	45,300			45,300			-45,300
2		1999	191,300			191,300			-191,300
3		2000	257,200			257,200			-257,200
4		2001	111,500			111,500			-111,500
5	1	2002		22,612	30,312	52,924	96,434	3,135	46,645
6	2	2003		22,612	30,312	52,924	96,434	3,135	46,645
7	3	2004		22,612	30,312	52,924	96,434	3,135	46,645
8	4	2005		22,612	30,312	52,924	96,434	3,135	46,645
9	5	2006		22,612	30,312	52,924	96,434	3,135	46,645
10	6	2007		22,612	30,312	52,924	96,434	3,135	46,645
11	7	2008		22,612	30,312	52,924	96,434	3,135	46,645
12	8	2009		22,612	30,312	52,924	96,434	3,135	46,645
13	9	2010		22,612	30,312	52,924	96,434	3,135	46,645
14	10	2011		22,612	30,312	52,924	96,434	3,135	46,645
15	11	2012		22,612	30,312	52,924	96,434	3,135	46,645
16	12	2013		22,612	30,312	52,924	96,434	3,135	46,645
17	13	2014		22,612	30,312	52,924	96,434	3,135	46,645
18	14	2015		22,612	30,312	52,924	96,434	3,135	46,645
19	15	2016		22,612	30,312	52,924	96,434	3,135	46,645
20	16	2017		22,612	30,312	52,924	96,434	3,135	46,645
21	17	2018		22,612	30,312	52,924	96,434	3,135	46,645
22	18	2019		22,612	30,312	52,924	96,434	3,135	46,645
23	19	2020		22,612	30,312	52,924	96,434	3,135	46,645
24	20	2021		22,612	30,312	52,924	96,434	3,135	46,645
25	21	2022		22,612	30,312	52,924	96,434	3,135	46,645
26	22	2023		22,612	30,312	52,924	96,434	3,135	46,645
27	23	2024		22,612	30,312	52,924	96,434	3,135	46,645
28	24	2025		22,612	30,312	52,924	96,434	3,135	46,645
29	25	2026		22,612	30,312	52,924	96,434	3,135	46,645
30	26	2027		22,612	30,312	52,924	96,434	3,135	46,645
31	27	2028		22,612	30,312	52,924	96,434	3,135	46,645
32	28	2029		22,612	30,312	52,924	96,434	3,135	46,645
33	29	2030		22,612	30,312	52,924	96,434	3,135	46,645
34	30	2031		22,612	30,312	52,924	96,434	3,135	46,645
TOTAL			605,300	678,360	909,360	2,193,020	2,893,010	94,050	794,040

Case 1: 3.8 cent/kWh F.I.R.R. 5.9%

Table 10-4-2(2) Financial Analysis of ME-1 Thermal Power Plant (Case 1)

(Unit : 1000 US $)

No.	CASH INFLOW				CASH OUTFLOW						BALANCE	
	Fund Requirement	Net Income	Depreciation	Total (A)	Construction Cost	Principal Repayment F.C.	Principal Repayment L.C.	Principal Repayment Subtotal	I.D.C.	Total (B)	Yearly (A)-(B)	Accummulation
	0	0	0	0	0	0	0	0	0	0	0	0
1	45,300	0	0	45,300	45,300	0	0	0	2,059	47,359	-2,059	-2,059
2	191,300	0	0	191,300	191,300	0	0	0	12,176	203,476	-12,176	-14,235
3	257,200	0	0	257,200	257,200	0	0	0	31,050	288,250	-31,050	-45,285
4	111,500	0	0	111,500	111,500	0	0	0	46,629	158,129	-46,629	-91,914
5	0	322	16,921	17,243	0	11,423	5,633	17,057	0	17,057	186	-91,728
6	0	1,799	16,921	18,720	0	12,337	6,197	18,534	0	18,534	186	-91,543
7	0	3,406	16,921	20,326	0	13,324	6,817	20,141	0	20,141	186	-91,357
8	0	5,153	16,921	22,074	0	14,390	7,498	21,888	0	21,888	186	-91,171
9	0	7,054	16,921	23,975	0	15,541	8,248	23,789	0	23,789	186	-90,985
10	0	9,122	16,921	26,043	0	16,785	9,073	25,857	0	25,857	186	-90,800
11	0	11,372	16,921	28,293	0	18,127	9,980	28,107	0	28,107	186	-90,614
12	0	13,821	16,921	30,741	0	19,578	10,978	30,556	0	30,556	186	-90,428
13	0	16,485	16,921	33,405	0	21,144	12,076	33,220	0	33,220	186	-90,242
14	0	19,384	16,921	36,304	0	22,835	13,283	36,119	0	36,119	186	-90,057
15	0	22,539	16,921	39,460	0	24,662	14,612	39,274	0	39,274	186	-89,871
16	0	25,973	16,921	42,894	0	26,635	16,073	42,708	0	42,708	186	-89,685
17	0	29,711	16,921	46,632	0	28,766	17,680	46,446	0	46,446	186	-89,499
18	0	33,780	16,921	50,701	0	31,067	19,448	50,515	0	50,515	186	-89,314
19	0	38,211	16,921	55,131	0	33,552	21,393	54,946	0	54,946	186	-89,128
20	0	43,034	16,921	59,955	0	36,237	0	36,237	0	36,237	23,718	-65,410
21	0	45,933	16,921	62,854	0	39,136	0	39,136	0	39,136	23,718	-41,692
22	0	49,064	16,921	65,985	0	42,266	0	42,266	0	42,266	23,718	-17,973
23	0	52,445	16,921	69,366	0	45,648	0	45,648	0	45,648	23,718	5,745
24	0	56,097	16,921	73,018	0	49,299	0	49,299	0	49,299	23,718	29,463
Total	605,300	484,706	338,413	1,428,419	605,300	522,752	178,990	701,742	91,914	1,398,956	29,463	

Table 10-4-3(1) Financial Evaluation of ME-1 Thermal Power Plant (Case 2)

(Unit : 1,000 US $)

No.		YEAR	Marista East No.1 PROJECT Construct. Cost	O & M Cost	FUEL	(C) TOTAL COST	(B) REVENUE POWER SALES	HEAT SALES	(B) - (C)
1		1998	45,300			45,300			-45,300
2		1999	191,300			191,300			-191,300
3		2000	257,200			257,200			-257,200
4		2001	111,500			111,500			-111,500
5	1	2002		22,612	30,312	52,924	126,886	3,135	77,097
6	2	2003		22,612	30,312	52,924	126,886	3,135	77,097
7	3	2004		22,612	30,312	52,924	126,886	3,135	77,097
8	4	2005		22,612	30,312	52,924	126,886	3,135	77,097
9	5	2006		22,612	30,312	52,924	126,886	3,135	77,097
10	6	2007		22,612	30,312	52,924	126,886	3,135	77,097
11	7	2008		22,612	30,312	52,924	126,886	3,135	77,097
12	8	2009		22,612	30,312	52,924	126,886	3,135	77,097
13	9	2010		22,612	30,312	52,924	126,886	3,135	77,097
14	10	2011		22,612	30,312	52,924	126,886	3,135	77,097
15	11	2012		22,612	30,312	52,924	126,886	3,135	77,097
16	12	2013		22,612	30,312	52,924	126,886	3,135	77,097
17	13	2014		22,612	30,312	52,924	126,886	3,135	77,097
18	14	2015		22,612	30,312	52,924	126,886	3,135	77,097
19	15	2016		22,612	30,312	52,924	126,886	3,135	77,097
20	16	2017		22,612	30,312	52,924	126,886	3,135	77,097
21	17	2018		22,612	30,312	52,924	126,886	3,135	77,097
22	18	2019		22,612	30,312	52,924	126,886	3,135	77,097
23	19	2020		22,612	30,312	52,924	126,886	3,135	77,097
24	20	2021		22,612	30,312	52,924	126,886	3,135	77,097
25	21	2022		22,612	30,312	52,924	126,886	3,135	77,097
26	22	2023		22,612	30,312	52,924	126,886	3,135	77,097
27	23	2024		22,612	30,312	52,924	126,886	3,135	77,097
28	24	2025		22,612	30,312	52,924	126,886	3,135	77,097
29	25	2026		22,612	30,312	52,924	126,886	3,135	77,097
30	26	2027		22,612	30,312	52,924	126,886	3,135	77,097
31	27	2028		22,612	30,312	52,924	126,886	3,135	77,097
32	28	2029		22,612	30,312	52,924	126,886	3,135	77,097
33	29	2030		22,612	30,312	52,924	126,886	3,135	77,097
34	30	2031		22,612	30,312	52,924	126,886	3,135	77,097
TOTAL			605,300	678,360	909,360	2,193,020	3,806,592	94,050	1,707,622

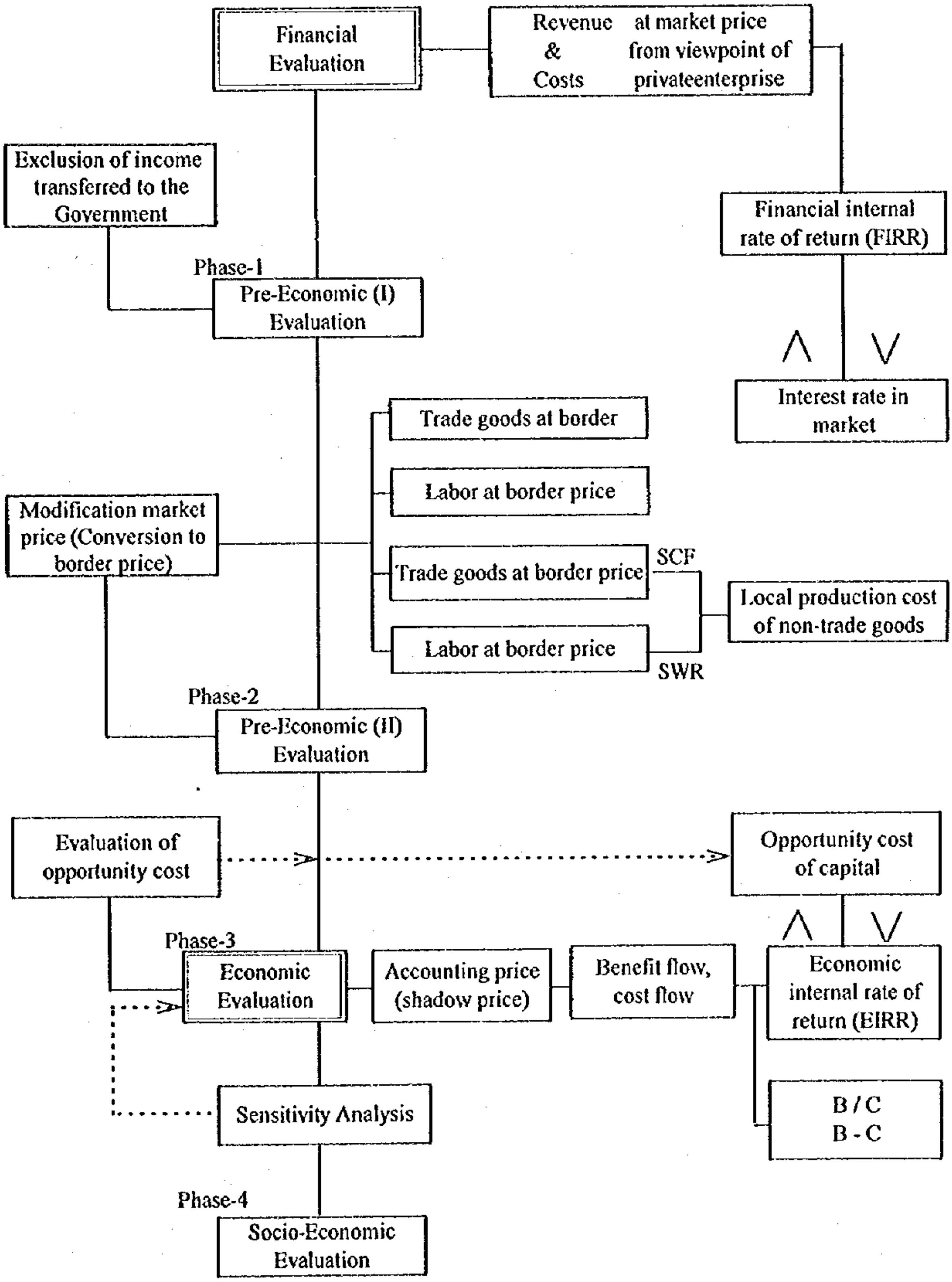
Case 2:	5.0 cent / kWh	F.I.R.R.	10.6%

Table 10-4-3(2) Financial Analysis of ME-1 Thermal Power Plant (Case 2)

(Unit : 1000 US$)

No.	CASH INFLOW				CASH OUTFLOW						BALANCE	
	Fund Requirement	Net Income	Depreciation	Total (A)	Construction Cost	Principal Repayment F.C.	Principal Repayment L.C.	Principal Repayment Subtotal	I.D.C.	Total (B)	Yearly (A)-(B)	Accummulation
	0	0	0	0	0	0	0	0	0	0	0	0
1	45,300	0	0	45,300	45,300	0	0	0	2,059	47,359	-2,059	-2,059
2	191,300	0	0	191,300	191,300	0	0	0	12,176	203,476	-12,176	-14,235
3	257,200	0	0	257,200	257,200	0	0	0	31,050	288,250	-31,050	-45,285
4	111,500	0	0	111,500	111,500	0	0	0	46,629	158,129	-46,629	-91,914
5	0	31,184	16,921	48,105	0	11,376	5,559	16,935	0	16,935	31,170	-60,744
6	0	32,650	16,921	49,571	0	12,286	6,115	18,401	0	18,401	31,170	-29,575
7	0	34,244	16,921	51,165	0	13,269	6,727	19,996	0	19,996	31,170	1,595
8	0	35,979	16,921	52,899	0	14,330	7,399	21,730	0	21,730	31,170	32,764
9	0	37,865	16,921	54,786	0	15,477	8,139	23,616	0	23,616	31,170	63,934
10	0	39,917	16,921	56,838	0	16,715	8,953	25,668	0	25,668	31,170	95,103
11	0	42,150	16,921	59,070	0	18,052	9,848	27,901	0	27,901	31,170	126,273
12	0	44,579	16,921	61,499	0	19,496	10,833	30,330	0	30,330	31,170	157,443
13	0	47,222	16,921	64,142	0	21,056	11,917	32,973	0	32,973	31,170	188,612
14	0	50,098	16,921	67,018	0	22,740	13,108	35,849	0	35,849	31,170	219,782
15	0	53,228	16,921	70,148	0	24,560	14,419	38,979	0	38,979	31,170	250,951
16	0	56,634	16,921	73,555	0	26,525	15,861	42,386	0	42,386	31,170	282,121
17	0	60,343	16,921	77,263	0	28,646	17,447	46,094	0	46,094	31,170	313,290
18	0	64,379	16,921	81,300	0	30,938	19,192	50,130	0	50,130	31,170	344,460
19	0	68,773	16,921	85,694	0	33,413	21,111	54,524	0	54,524	31,170	375,629
20	0	73,557	16,921	90,478	0	36,086	0	36,086	0	36,086	54,392	430,021
21	0	76,444	16,921	93,365	0	38,973	0	38,973	0	38,973	54,392	484,413
22	0	79,562	16,921	96,483	0	42,091	0	42,091	0	42,091	54,392	538,805
23	0	82,929	16,921	99,850	0	45,458	0	45,458	0	45,458	54,392	593,197
24	0	86,566	16,921	103,487	0	49,095	0	49,095	0	49,095	54,392	647,588
Total	605,300	1,098,303	338,413	2,042,016	605,300	520,584	176,630	697,214	91,914	1,394,428	647,588	

Figure 10-1-1-1 Flow Chart of Economic and Financial Evaluation



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