2.2.2 Energy in View of National Economy

The energy consumption of Czechoslovakia is 93.13 million tons (in coal equivalent), and solid fuels such as bituminous coal and brown coal account for 62% of the energy consumption. The per capita energy consumption is more than those in western advanced countries (see Fig. 2.2-1), and it is more than twice as much as those in USA and European countries in GNP unit requirement (see Fig. 2.2-2). One of the reasons for such high energy consumption is the adverse climatic conditions, and another reason is the energy-consuming industrial structure with the energy utilization efficiency which is not more than one-third (see Fig. 2.2-3) due to obsolete technologies and inadequate application of market principles to pricing.

2.2.3 Long-term Outlook

(1) Outline

The Czech and Slovak Federal Republic government published the "Scenarios of CSFR's Energy Economics till the Year 2005" in 1991.

In the publication, the federal government estimated energy supplies and demands of the country for two scenarios of 1) Low Growth Scenario and 2) High Growth Scenario according to economic growth rates from 1990 to 2000. The Low Growth Scenario assumes an annual growth rate of -0.8% (which assumes that the largest drop in GNP is -11.2% in 1991 and that the GNP would recover in 1996). The High Growth Scenario, on the other hand, assumes an annual growth rate of 1.8% (which assumes that the largest drop in GNP is -9.8% in 1991 and that the GNP would recover in 1993)(see Table 2.2-3 and Figs. 2.2-4 and 2.2-5).

(2) Demand

The High Growth Scenario assumes that the GNP would increase from 1993 by the effects of large-scale economic reforms due especially to improvements in efficient energy consumption structure, in addition to the effects of large-scale privatization of enterprises, and the mean annual energy consumption and electric power consumption for years 1990 to 2000 would decrease by 2.8% and 1.8%, respectively as seen in Table 2.2-4 and Fig. 2.2-6.

The scenario also estimates that the energy consumption in GNP unit requirement would decrease by 23.4% during the same period due to improvement in energy utilization efficiency.

The Low Growth Scenario, on the other hand, assumes that the recovery of GNP would be from 1997 on the premises that the economy of the country might be severely deteriorated due to adverse internal and external factors and the improvement in energy efficiency might also be slow. The mean annual energy consumption and electric power consumption for years 1990 to 2000 in this scenario decrease by as much as 4.9% and 3.9%, respectively. In addition, the energy consumption in GNP unit requirement would decrease by 7.5%, which is not much improvement in energy consumption.

In either scenario, the reduction in electric power consumption is as small as 1.8 to 3.9%, and it tends to increase from 1993 (see Tables 2.2-4 and 2.2-5 and Figs. 2.2-6 and 2.2-7).

(3) Supply

As for the supply of energy, either scenario places the greatest emphasis on solving environmental problems, and efforts to be made include the following:

1) To shift the energy sources from low quality brown coal to natural gas and electric power

2) Improvement of energy producing and consuming technologies

3) Diversification of energy import

4) Reduction of energy demands by such means as promotion of energy saving

5) Integration of the energy system of Czechoslovakia with the European system

The scenarios are emphasizing to reduce the dependence on brown and bituminous coals, which is now over 90%, to less than 50%, and shift the power source to electricity.

The Low Growth Scenario envisions development of 1000 MW of new electric power by year 2005 through the operation of new nuclear power plants (Temerin Nos. 1 and 2 and Mohobicze), closing of old brown coal fired power plants and installation of DeSOx equipment to coal fired power plants. The High Growth Scenario envisions import of electricity in addition to development of 2000 MW of new electric power.

(4) Problems in Scenarios

It is judged that the keys to the balance of energy supply and demand are improvement of energy efficiency and shifting to electricity. It is essential to promote energy saving, but it is difficult, in the current state of affairs, to provide incentives for energy saving because tariff systems based on market principles, which would promote energy saving, are yet to be formed.

For the improvement of energy producing and consuming technologies, it is also thought to be necessary to provide economic motivation in the process of moving to market economy in the future.

It is thought to be appropriate, from the viewpoints of diversification of energy sources and effects to environment, to reduce the high dependency of energy supply on coal, but the diversification can only be made by import without domestic natural gas or petroleum resource. Such import of fuels used to come mostly from the former Soviet Union, but the scenarios envision to diversify to Middle East, North Sea and other supply sources. Such diversification, however, is not without problems such as funding for payment, end of the peak in development of North Sea oil field and construction of new pipelines.

As for shifting of energy to electricity, the safety of old VVER type nuclear power plants and installation of DeSOx equipment to existing coal fired power plants are getting to be urgent problems. In addition, not to mention the problem of funding, there are other problems such as providing incentives, e.g., tax exemption on installation of environmental equipment such as De-SOx installations, and proper inclusion of costs in utility charges.

As discussed above, there are many problems to be solved in ensuring supply of energies envisioned in the scenarios.

Table 2.2-1 The Supply and Demand of Primary Energy

(Unit: 1,000 ton coal equivalent)

	Production					Import	Differential
	Coal	Liquid Fuel	Gas	Electricity	Total		
1980	64,431	137	722	1,141	66,432	44,242	619
1981	63,545	134	783	1,154	65,616	43,661	136
1982	64,176	134	776	1,179	66,265	41,764	146
1983	64,850	137	659	1,232	66,878	41,532	687
1984	65,017	135	820	1,291	67,262	42,624	480
1985	63,854	180	789	1,981	66,804	42,259	-385
1986	63,609	209	813	2,685	67,316	43,131	-185
1987	63,486	215	882	3,331	67,914	43,620	491
1988	62,301	209	1,013	3,401	66,924	43,292	1,075
1989	59,573	210	951	3,544	64,278	43,726	131
1990	54,822	180	792	3,531	59,325	41,053	0
	Consumption					Export	Not Distributed
	Coal	Liquid Fuel	Gas	Electricity	Total		
1980	63,513	20,134	10,157	1,367	95,170	8,479	6,406
1981	63,616	22,031	10,200	1,420	97,267	7,547	4,328
1982	64,319	19,244	9,776	1,401	94,740	7,884	5,260
1983	64,296	18,882	10,330	1,523	95,031	8,202	4,490
1984	64,491	19,388	11,558	1,627	97,065	6,873	5,469
1985	64,069	19,467	11,542	2,416	97,493	6,915	5,046
1986	63,955	18,079	12,885	2,864	97,783	7,421	5,428
1987	63,062	18,705	13,096	3,751	98,614	7,429	4,999
1988	61,926	17,375	13,255	3,776	96,332	7,848	4,961
1989	59,441	15,927	14,401	3,869	93,639	8,677	5,874
1990	54,938	12,139	16,632	3,936	87,645	5,911	6,823

Note: The Heat Rate; 7,000 kcal/kg is assumed.

Source: UN Energy Statistics Yearbook, 1982-1989

Table 2.2-2 The Production and Consumption of Coal and Lignite

(Unit: 1,000 ton)

		1970	1975	1980	1985	1986	1987	1988	1989	1990
Hard Coal	Production	28,194	28,394	28,307	26,223	25,658	25,720	25,478	25,053	22,770
	Import	4,497	5,183	5,057	4,630	4,792	4,192	4,698	4,503	4,000
	Export	2,973	3,669	3,669	2,620	2,444	1,961	1,947	2,219	2,000
	Consumption	29,840	29,593	29,589	28,309	27,495	28,182	27,669	27,144	24,770
Lignite	Production	81,298	86,272	94,890	100,387	100,771	100,352	97,999	92,318	85,521
	Export	45	0	78	-	-	-	-	-	-
	Import	1,094	1,664	2,143	2,797	2,794	2,259	1,948	2,275	2,000
	Consumption	80,128	84,722	92,203	98,252	99,385	96,465	94,583	90,064	83,521

Source: UN: Energy Statistics Yearbook

Table 2.2-3 Scenarios of Energy Policy

		Scenario	
		Low	High
Average GNP Growth between 1990 - 2000		▲0.8	1.8
Maximum GNP Drop	Year in	1991	1991
	Rate (%)	▲11.2	▲9.8
Year of Recovery of GNP		1996	1993
1990 - 2000 Average Annual Growth of Gross Industrial Production (%)		▲2.6	0.2

Source: Scenarios of CSFR's Energy Economics till the Year 2005

Table 2.2-4 Scenarios of Energy Demand

(Unit: %)

	1990 - 1995		1990 - 2000	
	Low Scenario	High Scenario	Low Scenario	High Scenario
Average Annual Growth of Energy Consumption	▲8.0	▲6.6	▲4.9	▲2.8
Average Annual Growth of Power Consumption	▲7.0	▲5.4	▲3.9	▲1.8
Unit Consumption of Energy	▲3.2	▲7.5	▲18.2	▲23.4
Unit Consumption of Power	0.6	▲1.9	▲9.7	▲14.9
Average Annual Growth of Unit Consumption of Power	0.1	▲0.3	▲1.0	▲1.6

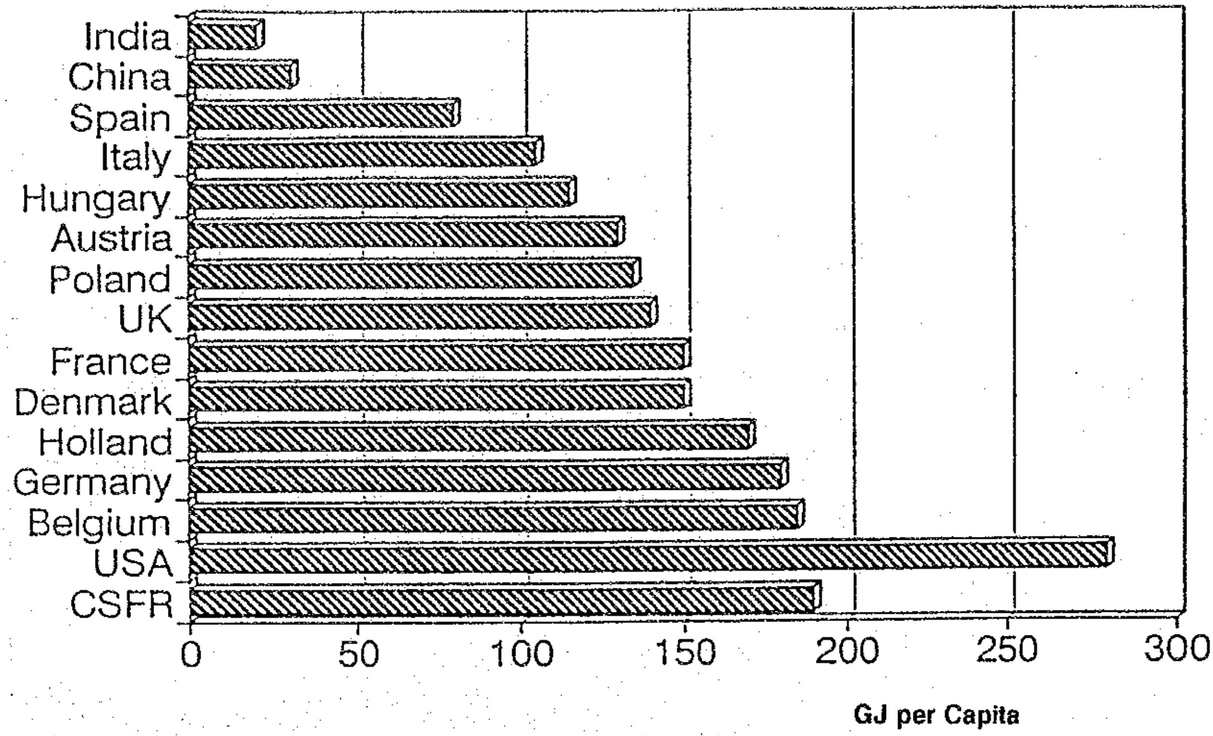
Source: Scenarios of CSFR's Energy Economics till the Year 2005

Table 2.2-5 Scenarios of Primary Energy Demand (Average Annual Growth between 1990 - 2000)

(Unit: %)

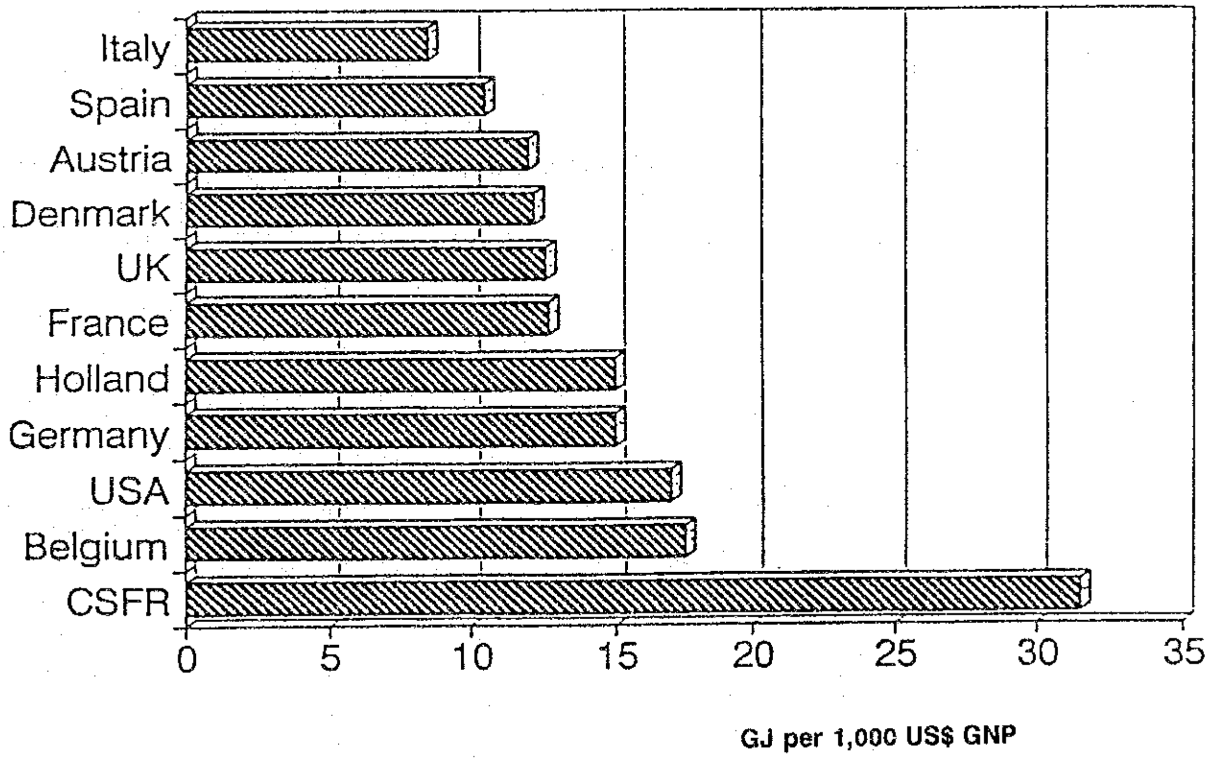
	Scenario	
	Low	High
Coal and Lignite	▲5.5	▲5.1
Liquid Fuel	▲8.1	▲6.9
Gas	▲4.3	▲1.4
Heat	▲4.8	▲2.1
Power	▲3.9	▲1.8
Total	▲4.9	▲2.8

Source: Scenarios of CSFR's Energy Economics till the Year 2005



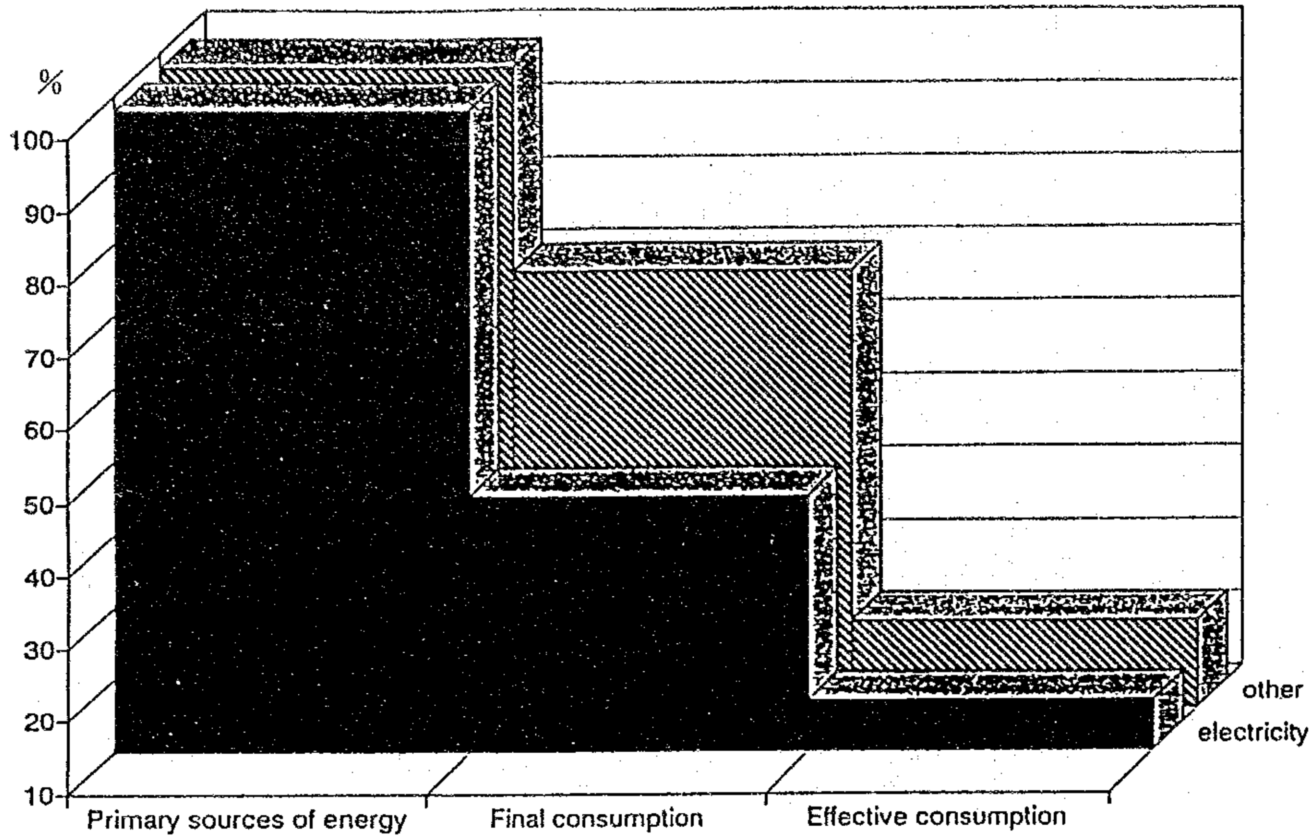
(Source) National Report (March 1992)

Fig. 2.2-1 CONSUMPTION OF PRIMARY ENERGY SOURCES PER CAPITA (1985)



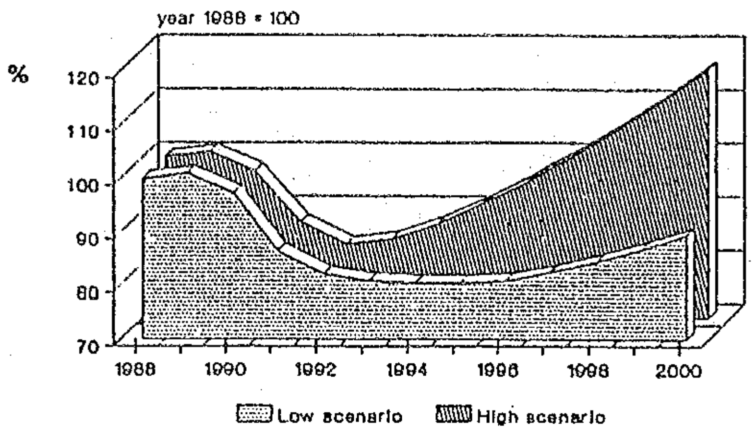
(Source) National Report (March 1992)

Fig. 2-2-2 CONSUMPTION OF PRIMARY SOURCES OF ENERGY



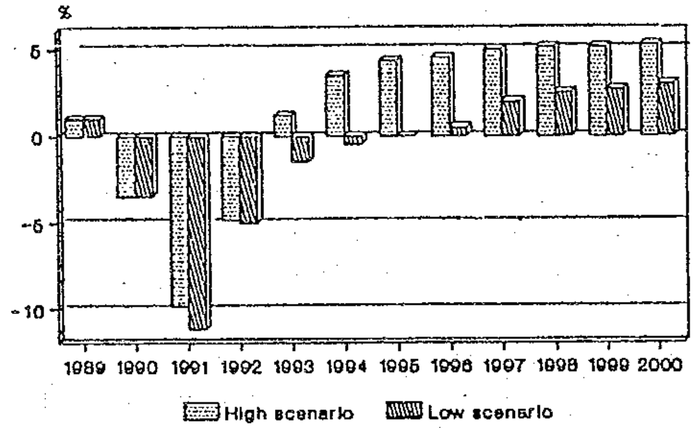
(Source) National Report (March 1992)

Fig. 2.2-3 ENERGY USE EFFICIENCY IN CSFR



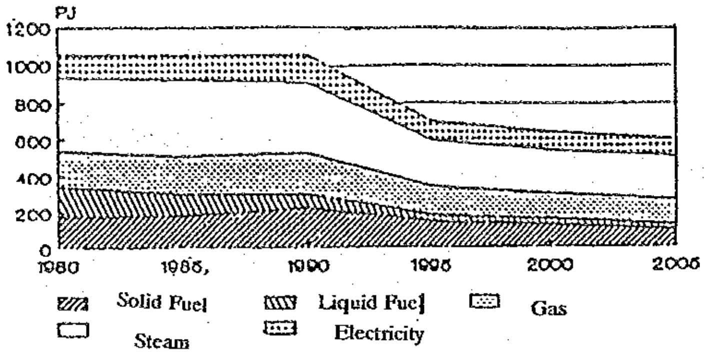
(Source) Scenarios of CSFR's Energy Economics till the Year 2005

Fig. 2.2-4 THE SCENARIOS OF GNP



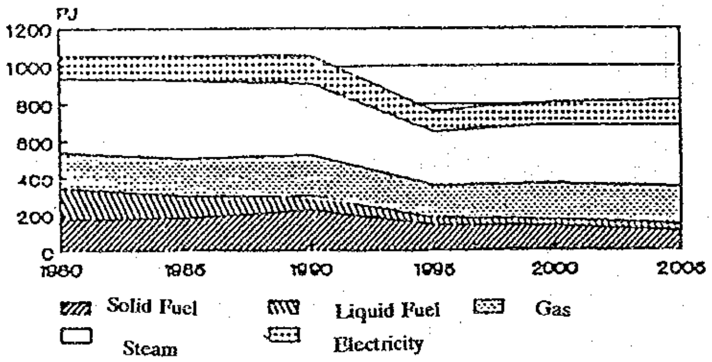
(Source) Scenarios of CSFR's Energy Economics till the Year 2005

Fig. 2.2-5 THE SCENARIOS OF GNP (ANNUAL CHARGE)



(Source) Scenarios of CSFR's Energy Economics till the Year 2005

Fig. 2.2-6 THE SCENARIO OF PRIMARY ENERGY (LOW SCENARIO)



(Source) Scenarios of CSFR's Energy Economics till the Year 2005

Fig. 2.2-7 THE SCENARIO OF PRIMARY ENERGY (HIGH SCENARIO)

2.3 Environmental Problems

The progress of environmental pollution associated with industrial development is getting to be a serious social problem. The problem is appearing in many fields such as the air, water quality and soil, but the problem of air pollution, which mostly comes from the use of brown coal, is most serious. A huge quantity of low quality brown coal is used for power generation and domestic heating, and it is making the problem of air pollution more serious.

The total emission of sulfur oxides (SOx) in Czechoslovakia is 2.56 million tons per year (which is about 2.5 times as much as that in Japan), and it is 22.4 t/year per 1 km^2 of the land, which is the second highest in the world only after former East Germany. The emission of nitrogen oxides (NOx) is as much as 1.1 million tons per year.

The environmental damage is serious especially in regions of borders of Czechoslovakia, Poland and former East Germany, the area which is now called the "Black Triangle," and coniferous forests in northern Bohemia have been severely damaged. According to the survey on damages by acid rain conducted by the United Nations European Economic Committee (UNECE) in 1988, the rate of damage of forests in Czechoslovakia is as much as 71%, and not only the effects on forestry but also on human health are apprehended.

The SOx emission in the Czech republic is 1.88 million tons per year, which is about 70% of the SOx emission of 2.56 million tons per year in Czechoslovakia. The emission is severe especially in northern Bohemia and Prague, where it is over 100 t/year-km2 (25 and 11 t/year-km2 on average in the Czech and Slovak republics, respectively).

The environmental protection movement is also strong in the country, and more than 100 groups including authorized groups of "Brontosaurus" and "Czech and Slovak Unions of Nature Protectors" which are active since "old" days are operating in the country.

Czechoslovakia ratified the Helsinki Protocol in 1985, and the country is obliged to reduce the level of SOx emission to about 70% of the 1980 level by 1993 and freeze the level of NOx emission to the current level by 2000. The country, in addition, is recommended to improve the air pollution by neighboring countries.

With such background, a new environmental protection act was enacted in October, defining limits of emissions for each source of emissions.

2.4 Current Status of Electric Utility Industry

2.4.1 Electric Power System

Policies on overall energy are currently determined by the Federal Ministry of Economy (FME), but specific policies are being executed by the Ministry of Economy of each republic.

Under the supervision of such administrative agencies, the electric utility industry in Czechoslovakia is operated by national enterprises for respective sectors of power generation, transmission and distribution. Two national enterprises of Ceske Energeticke Zavody (CEZ) and Slovenske Energeticke Podniky (SEP) are in charge of power generation. There are eleven distribution enterprises nationwide (8 in Czech and 3 in Slovakia). As for power transmission, the Ceskoslovensky Statni Energeticky Dispecinik (CSED) is operating the transmission systems for CEZ and SEP. CSED is authorized by the agreement between CEZ and SEP. CEZ and SEP are responsible to the administration of each republic (i.e., Ministry of Economy of each republic).

The CEZ changed to public limited company in May of 1992.

In association with the change, heat supplying, environmental measurement and some other businesses were transferred from CEZ and undertaken by separate companies. (see Fig. 2.4.-1).

The 30% of all shares of CEZ is going to be sold to the public by the coupon system. (70% are going to be held by the republic.)

2.4.2 Power Demand and Supply Balance

(1) Electric Power Demand

The electric power consumption in the Czech republic was steadily increasing up to 1989 as shown in Table 2.4-1, but it decreased in 1991 to 42.9 TWh or by 2.8 TWh from 1990 (decrease of about 6%) due to decrease in large-scale consumption reflecting the slump in general industrial production, notwithstanding the increase in civic and small-scale consumption, . No data was obtained for the Slovak republic, but it is estimated from the economic state of the republic that the decrease in electric power consumption in the republic is much more than that in the Czech republic.

The future increase in electric power demand in the Czech republic seems to depend much on the success of the undergoing economic reforms in consideration of the large ratio of larger industrial demands in the republic (see Table 2.4-1).

(2) Electric Power Supply

The electric power generated in 1991 in the CSFR was 83.3 TWh, and 51.6 TWh (62%) of the amount was generated by the CEZ. As for power sources, coal and brown coal account for 75%, nuclear power 23%, and hydraulic 2%. It should be noted that the electric power generation is decreasing since 1989 reflecting the economic slump of the republic (see Fig. 2.4-2).

Power transmission systems of the country are connected with those of former COMECON countries and Austria, and electric power is imported from and exported to such countries. The import of the Czech republic is always exceeding the export since 1980, and the import in 1991 was 1,900 GWh in contrast to the export which was 1,259 GWh. The largest exporter to the republic is the former Soviet Union and the largest importer from the republic is Italy (see Table 2.4-2).

For the whole country, the import and export are 3.1 and 1.3 TWh, respectively, showing that electric power dependence on import is high in the Slovak republic. Czechoslovakia is planning to connect its transmission systems with those of the UCPTE. The electric power balance between demand and supply is as shown in Table 2.4-3.

2.4.3 Price of Electric Power

The price of electric power (for final users) has been determined by the Federal Ministry of Finance taking political considerations into account. The income of the CEZ or SEP has been coming from the difference between the final user price and the charges to be paid to the distribution enterprises.

The electric price was not immune to the economic changes associated with the transfer to market economy since 1990, and the price has been raised by 70% for domestic use (October 1991) and 175% for industrial use (December 1990 and April 1991) during the last 2 years. The average wholesale price of electricity of CEZ in 1991 was 0.975 kcs/KWh (¥4.42/KWh). The average retail ones of CR were 1,310 kcs/KWh (¥5.94/KWh) for industrial use and 0.483 kcs/KWh (¥2.19/KWh) for domestic use.

Exchange rates used in this calculation were 1US$=¥135.27, 1US$=29.82 KCS, based on the average of 1991.

As for the price of electricity supplied to distribution companies by CEZ or SEP and that supplied to final users by distribution companies, it can be possible to determine either price by summing up the costs. It seems that cost calculations are being made well for accounting, but the prices are not reflecting the costs as a total pricing system of electricity because the final user prices are determined from political considerations.

The Czech Ministry of Economy is now studying for a new pricing system including the possibility of instituting a price regulatory organ, and the ministry intends to establish a new pricing system like those of Europe and USA (a rate base system which sums up costs) within this year.

For the time being, however, it is planned to raise the price of electricity for domestic use by 40% in January 1993 to correct the current distortion in prices (where electricity for domestic use is cheaper than that for industrial use).

2.4.4 Power Facilities

(1) Generating Facilities

The total output of generating facilities in the country is 21.5 GW as of 1990. The total output is 18.8 GW, however, when private generation for industrial use is excluded.

Coal and brown coal fired power plants, among others, are 15.0 GW, which accounts for about 70% of the all facilities. The history of total generating capability is as shown in Table 2.4-4. The history of fuel consumption, etc. is shown in Table 2.4-5.

The power generating facilities of CEZ, as of 1991, are shown in Table 2.4-6. The total output of the facilities is 12,391 MW, of which 75% is generated using coal or brown coal. As for nuclear facilities, four Soviet-made VVER type nuclear power units are existing in Dukovany. As for thermal power units, the largest unit in single capacity is the 500 MW Part III of Melnik Power Station. Other units are mainly of 200 and 110 MW classes. As for hydraulic power generation, the Dalesice pumped storage power station is equipped with four 112.5-MW generators. Other hydraulic power stations are small having generators of up to 91 MW.

Most thermal power units, 95.2% of all, are using coal or brown coal as their fuel. At CEZ, especially, all thermal power units excepting the bituminous coal fired 165-MW Porici No. 2 are using brown coal as their fuel, and they are mostly concentrated in northern Bohemia and suburbs of Prague, the region being called Black Triangle where the air pollution is serious.

(2) Transmission and Substation Facilities

The Czechoslovak Power Dispatching Center is carrying out system operations of federal level, that is, operation of 400-kV and 200-kV power transmission system. Three regional dispatching stations of Czech (Bohemia), Moravia and Slovakia are operating systems of below 200 kV under the Czechoslovak Power Dispatching Center.

The overall distance of power transmission lines of CEZ is 4,187 km, and those of power transmission lines of 400 and 200 kV among others are 2,504 and 1,552 km, respectively.

2.4.5 Electric Power Development Plan

As for electric power development plans in Czechoslovakia, specific plans are being studied by each republic based on the "Scenarios of CSFR's Energy Economics till the Year 2005". In the Czech republic, two scenarios (High and Low Scenarios) till the year 2005 shown in Fig. 2.4-3 have been prepared based on the strategies.

In either scenario, no specific large-scale power development is planned for the time being excepting the Temerin Nuclear Power Station where No. 1 and 2 units (1,014 MW each in equipment capacity) are planned to start operation in May 1994 and November 1995, respectively.

The reason for no planned large-scale power development is reflecting the perspectives that the power demand will decrease for the time being due to the slump in industrial production (the recovery to the current level of demands is expected to occur in 1995 by the High Scenario and in 1999 by the Low Scenario) and that the increase in power demands will be moderate thereafter by the effects of energy saving in industrial sectors.

It is planned to shut down old brown coal fired power plants when the nuclear power plants start to operate. Three old brown coal fired units amounting to total equipment capacity of 323 MW were already closed in 1991, and nine similar units amounting to 983 MW are planned to be shut down by 1996.

Although no data have been obtained, it is estimated that power development plans of the Slovak republic are also similar to those of the Czech republic. According to the power supply plan for 1995 compiled by FME, it is estimated that the dependence on coal and brown coal will decrease from 64% of 1989 to 47% (see Table 2.4-7).

In addition to such plans, the CEZ plans to make coal fired power plants amounting to 7,700 MW "clean" by such means as installation of DeSOx systems by October 1996 with the understanding that they are a major source of air polluting causes in Czechoslovakia. The cost for "cleaning" is estimated to be 2.3 billion dollars in total, and the problem of how to fund such plans is an urgent subject to be solved.

2.4.6 Environmental Measures in Electric Power Sector

It is getting necessary for the electric power sector to take environmental measures including those against air pollution caused by coal and brown coal fired power plants, and it is essential to take such measures urgently.

The New Clean Air Act enacted in October 1991 is the only regulations for enforcing prevention of air pollution on emission sources such as thermal power plants. The law obliges the owner of power units to stop their operations if measures for meeting the regulatory limits shown in Table 2.4-12 are not taken by October 1996.

Technical measures under consideration at the electric power sector for reducing SOx emissions are as follows:

(1) Introduction of flue gas desulfurization technology
(2) Introduction of combustion (FBC) technology

2.4.7 Status of Accounts at CEZ

(1) Outline

Accounting data of SEP were not obtained. The total assets of CEZ in 1991 were 104,714 million kčs (¥475.4 billion), and the total capital including the ordinary profit of that fiscal year and the debt were 89,796 million kčs (¥407.7 billion) and 12,431 million kčs (¥56.4 billion), respectively (see Table 2.4-8).

The accounting of CEZ is being made as a fully independent system, that is, expenditures are covered by wholesale charges of electricity and heat received from distribution companies and the profit is retained.

Under the current wholesale pricing system, the wholesale prices are determined by negotiation with distribution companies based on the final user prices which are determined through political considerations, and the system is much different from the cost-base pricing system. In addition, there are many special items in the accounting items. Arthur-Andersen, a consulting company of UK is currently studying for the change of the accounting and pricing systems to Euro-American type systems, and the systems will be revised within this year at the earliest.

The revenue for 1991 was 55,745.99 million kčs (¥253.1 billion) where major incomes were 47,330.58 million kčs (¥214.9 billion) for the sale of electricity and 6,680.47 million kčs (¥30.3 billion) for the sale of heat. The borrowed capital, both long and short term, are being borrowed from the National Bank. The average interest of the long-term capital is 15 to 17%, the average one of short-term capital is 13%. The term of long-term borrowed capital is 8 years and the short-term one is 1 to 2 years.

Expenditures, on the other hand, were 32,353.14 million kčs (¥146.9 billion) resulting a profit of 23,392.85 million kčs (¥105.7 biilion), and the profit after tax was 10,476.32 million kčs (¥47.6 billion) (see Tables 2.4-9 and 2.4-10). The profit-to-sales ratio was as high as 42%, but it is estimated that the large profit ratio comes from price rises which were made for raising money for environmental measures such as installation of desulfurizers to be made.

The CEZ needs to make investment amounting to 129 billion kčs, by 1996, in such projects as environmental measures (60 billion kčs) and construction of Temerin power plants (30 billion kčs), and the CEZ plans to finance 70 billion kčs of the total amount by themselves. Although no information is available on the new pricing system under study, it is judged that some other means such as tax exemption and introduction of foreign capital may have to be considered for execution of such project if a cost-based pricing system similar to those in USA and Europe is employed.

(2) On the Revenue from Power Charges

The unit price of electric power (per MWh) is obtained by dividing the revenue on the sale of electricity by the total supplied electric power:47,330,578,000 kčs ÷ 51,622,681 MWh = 916.9 kčs/MWh (or ¥4.16/KWh)

(3) On the Cost of Power Production

Cost items of the account statement are outlined below because the cost of power production and that of heat production are not handled separately in the balance sheet of the CEZ.

1) Fuel Cost

The account control on fuel cost in Czechoslovakia is made based on the heating value, which is different from that in Japan. According to the CEZ, the ratio of fuel cost in total cost has risen to 48.3% from 41.5% in 1990 due to the rise in the coal price notwithstanding the fuel consumption which decreased. The change in the coal price is shown in Fig. 2.4-4. As for the fuel cost in the future, it is estimated that the fuel cost will rise further because of the liberalization of price which is expected.

2) Repair Cost and Other Related Costs

According to the CEZ, the repair cost and other costs associated with repairs rose to 4,498 million kčs in 1991 because of steep rise in prices of equipment and materials.

About half of the repair and related costs was expended relating to scheduled inspections.

3) Labor Cost

The total number of employees at CEZ in 1991 is 31,112. When the total labor cost is divided by the number of employees, the labor cost per employee is obtained as follows:

4,044,984,000 kčs ÷ 31,112 employees = 130,013 kčs/employee.

4) Depreciation

The standard methods of depreciation are defined by ordinances of the Federal Ministry of Finance. The scrap value is zero, and the rate of depreciation is defined for each equipment. The depreciation standards are summarized in Table 2.4-11.

Table 2.4-1 Development of Electric Power Consumption in the CR

(Unit: TWh)

	1975	1980	1985	1989	1990	1991
Population	4.6	6.2	8.0	9.2	9.6	9.7
Small-scale Consumption	4.6	4.5	5.5	6.1	6.0	6.4
Large-scale Consumption	21.4	25.3	28.0	30.5	30.1	26.8
Total	30.6	36.0	41.4	45.8	45.7	42.9

Source: CEZ Annual Report 1991

Table 2.4-2 The Export and Import of Electric Power by CEZ (1991)

(Unit: GWh)

	Import	Export
Former USSR	922	53
Austria (SWAP)	167	116
Switzerland	105	247
Italy	-	638
Others	706	205
Total	1,900	1,259

Source: CEZ VY ROCNI ZPRAVA

Table 2.4-3 The Electric Power Balance (1991)

(Unit: TWh)

	CR	CSFR
Generation		
Coal Fired St.	38.6	47.0
Nuclear St.	12.1	23.8
Hydroelectric St.	0.9	3.1
Others	-	9.5
Total	51.6	83.4
Purchase from Factory Power St.	0.6	-
Import	1.9	3.1
Resources Total	54.1	86.5
Export	1.2	1.3
Sales SEP	3.2	-
Sales Distribution Enterprises	44.1	-
Own Consumption	3.6	5.7
Transmission Loss	1.0	5.6

Source: CEZ Annual Report 1991

Table 2.4-4 Installed Capacity in CSFR

(Unit: GW)

	Coal Fired St.	Nuclear St.	Hydroelectric St.	Total
1980	10.3	0.6	2.1	13.0
1981	13.4	0.9	2.6	16.9
1982	14.4	0.9	2.8	18.1
1983	14.6	0.9	2.8	18.3
1984	14.7	1.1	2.8	18.6
1985	11.3	2.6	2.8	16.7
1986	11.1	2.9	2.8	16.8
1987	10.8	3.2	2.9	16.9
1988	10.8	3.2	2.9	16.9
1989	11.3	3.2	2.9	17.4
1990	15.0	3.5	3.0	21.5

Source: CEZ Annual Report, etc.

Table 2.4-5 The Fuel Consumption for Electric Power Station

Fuel Type	1980		1985		1986		1987		1988		1980	
	Heat (10^{12}J)	Ratio (%)	Heat (10^{12}J)	Ratio (%)	Heat (10^{12}J)	Ratio (%)	Heat (10^{12}J)	Ratio (%)	Heat (10^{12}J)	Ratio (%)	Heat (10^{12}J)	Ratio (%)
Black Coal	-	18.9	115,040	16.6	100,719	14.9	99,471	15.8	98,554	15.6	106,023	16.7
Lignite	-	71.1	542,398	78.3	538,077	79.7	499,424	79.2	505,024	80.1	498,985	78.5
Crude Oil	-	5.8	19,129	2.8	14,639	2.2	15,037	2.4	12,953	2.1	11,813	1.9
Natural Gas	-	)	7,474	1.1	13,013	1.9	7,966	1.2	5,366	0.8	7,046	1.1
Producing Gas	-	) 4.2	2,588	0.4	3,162	0.5	2,971	0.5	3,301	0.5	5,374	0.8
Gas Cokery	-	)	4,483	0.6	3,741	0.6	4,172	0.7	4,252	0.7	4,177	0.6
Others	-	-	1,404	0.2	1,440	0.2	1,475	0.2	1,376	0.2	2,453	0.4
Total	-	100.0	692,516	100.0	674,791	100.0	630,516	100.0	630,826	100.0	635,871	100.0

Source: UN: Annual Bulletin of Electric Energy Statistics for Europe, etc.

Table 2.4-6 Available Power of CEZ (1991)

(Unit: MW)

	Available Power
Coal-fired Power Plant	9,362
Nuclear Power Plant	1,760
Hydroelectric Power Plant	1,205
Others	64
Total	12,391

Source: CEZ Annual Report 1991

Table 2.4-7 The Electric Power Supply Plan of CSFR

(Unit: TWh)

	1989	1990	1995
Coal-fired Power Plant	60.6	58.1	39.2
Hydroelectric Power Plant	4.1	3.9	6.0
Nuclear Power Plant	24.6	24.6	34.7
Import	5.5	6.7	3.9
Total	94.8	93.3	83.8

Source: Presentation Data

Table 2.4-8 Economic Balance Sheet in 1991

1. Assets

(Unit: 10^6 kčs)

	Items	Amount of Money
	Investment Goods at Purchase Price	89,698
	Depreciation of Investment Goods	▲45,990
	Depreciated Value of Investment Goods	43,708
	Investments and Instalments	25,439
(1)	Total Investment Assets	69,147
	Cash	1,581
	Fuel Inventory	4,141
	Other Inventory	1,769
	Accounts Receivable	4,320
	Other Return Assets	22
(2)	Total Return Assets	11,833
(3)	Taxes and Dues	23,734
	Total Assets ((1) + (2) + (3))	104,714

2. Liabilities

(Unit: 10^6kčs)

	Items	Amount of Money
	Basic Capital	58,467
	Reserve Funds	5,339
	Utility Funds	74
	Reserves and Other Time Margin	2,182
	Subsidies and Other Income	35
	Accumulated Retained Earnings from Last and Current Year	306
	Distributed Profit	23,393
(4)	Equity - Overall	89,796
	Existing Credits - Investment	10,497
	Existing Credits - Operational	1,934
(5)	Long-Term Borrowed Capital; Total	12,431
	Investment and Non-investment Supplier's Instalment	245
	Other Short-term Commitments	2,242
(6)	Short-term Borrowed Capital; Total	2,487
	Total Liabilities ((4) + (5) + (6))	104,717

Source: CEZ Annual Report

Table 2.4-9 Economic Performance of CEZ in 1991

(Unit: 10^3 kčs)

	Items	Amount of Money
Revenue	Income from Electricity Sales	47,330,578
	Income from Heat Sales	6,680,474
	Other Income	1,674,760
	Income Total	55,685,812
	Income incl. Special Income	55,745,993
Cost	Material Consumption	2,067,075
	Fuel Consumption	15,642,315
	Maintenance and Repair	2,071,943
	Write-Off of Basic Means	1,710,593
	Wages	4,044,984
	Interests	389,577
	Other Financial Costs	1,642,977
	Other Costs	4,783,677
	Total Costs	32,353,141
Profit		23,392,852

Source: CEZ Annual Report

Table 2.4-10 The Profit of CEZ in 1991

(Unit: 10^3 kčs)

Items	Amount of Money
Profit	23,392,852
Tax	12,916,526
Profit Deducting Tax	10,476,326

Source: CEZ Annual Report

Table 2.4-11 The Standard of Depreciation

	Depreciation Rate	Depreciation Year
Building	2%	50 years (30 years)*
Turbine	5%	20 years (15 years)
Machines	5 ~ 6%	17 ~ 20 years (15 years)
De-Sox Installations	8%	12.5 years (7 years)

Note: The standard of DeSOx Installations is not regulated.
The statement above is about the standard of chemical plant.

*: Japanese case

Source: ODPISOVANI ZAKLANICH PROSTREDKU (1991.5)

Table 2.4-12 Emission Standards in Czechoslovakia

Emission Standard				
Kind of Fuel	Emission Limits (mg/m^3N)	Installed Capacity (Thermal Output - MWt)		
		5 - 50	50 - 300	> 300
Solid (Coal)	SO_2	2,500	1,700*	500*
	ηDeSOx(%)		(70)	(85)
	NOx (as NO_2)	650	650	650
	Solid (Dust)	150	100	100
Liquied (Oil)	SO_2	1,700	1,700	500
	NOx (as NO_2)	450	450	450
	Solid (Dust)	100	50	50
Gas	SO_2	35	35	35
	NOx (as NO_2)	200	200	200
	Solid (Dust)	10	10	10
Remarks		• The value with *mark is the upper limit of SO_2 emission by regulation without DeSOx installation. If it is not possible to meet this regulation, the regulation of efficiency of over the value shown in brackets is applied. • Figure of concentration described here is all as of dry base and 6% O_2 equivalent. • Plant operation without DeSOx system, caused by FGD failure is allowed as long as 360 hours per year and 96 hours per once in maximum. • This standards are applied to all Emission Sources from October 1996.		

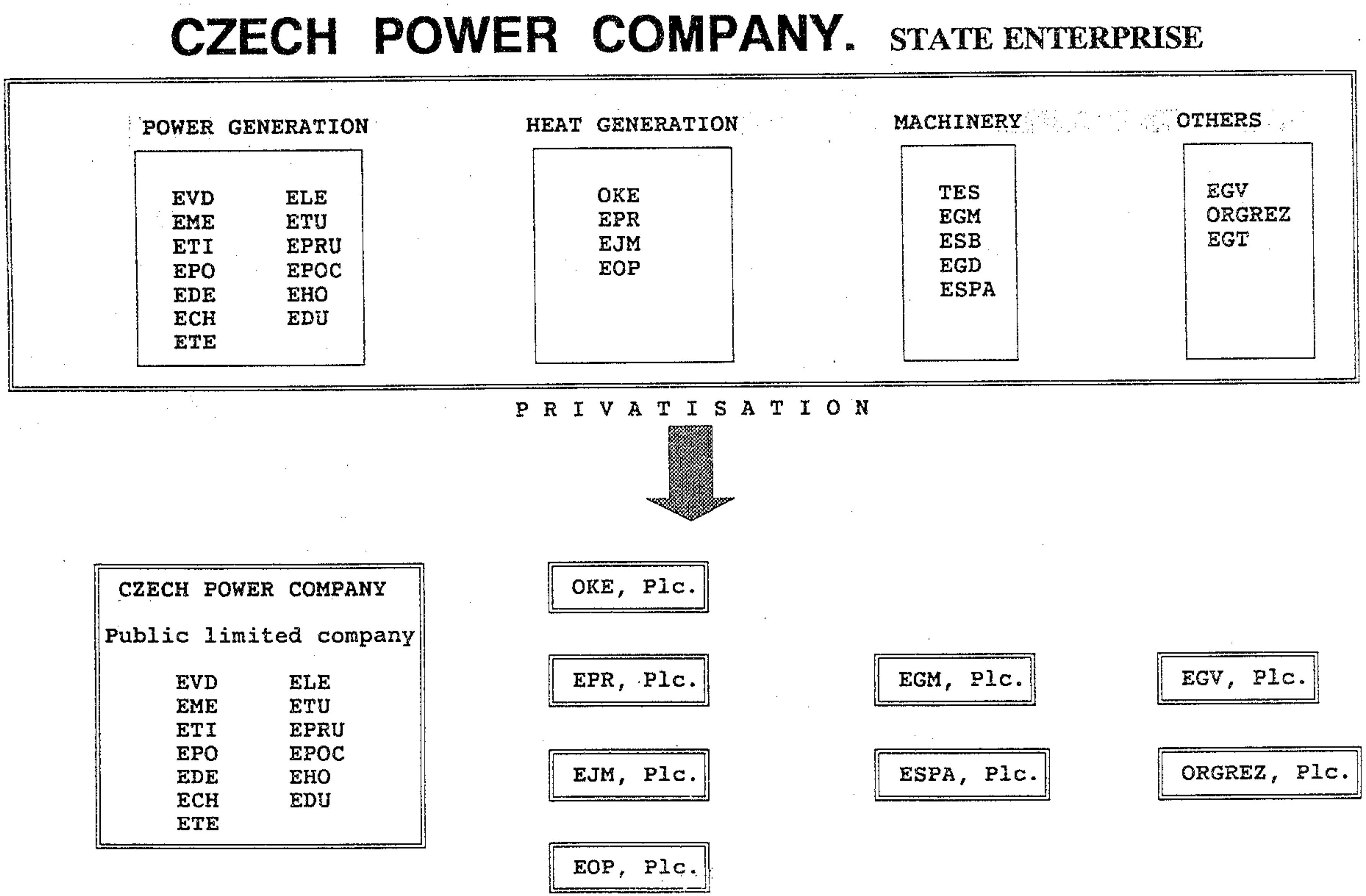


Fig. 2.4-1 The Privatization of CEZ

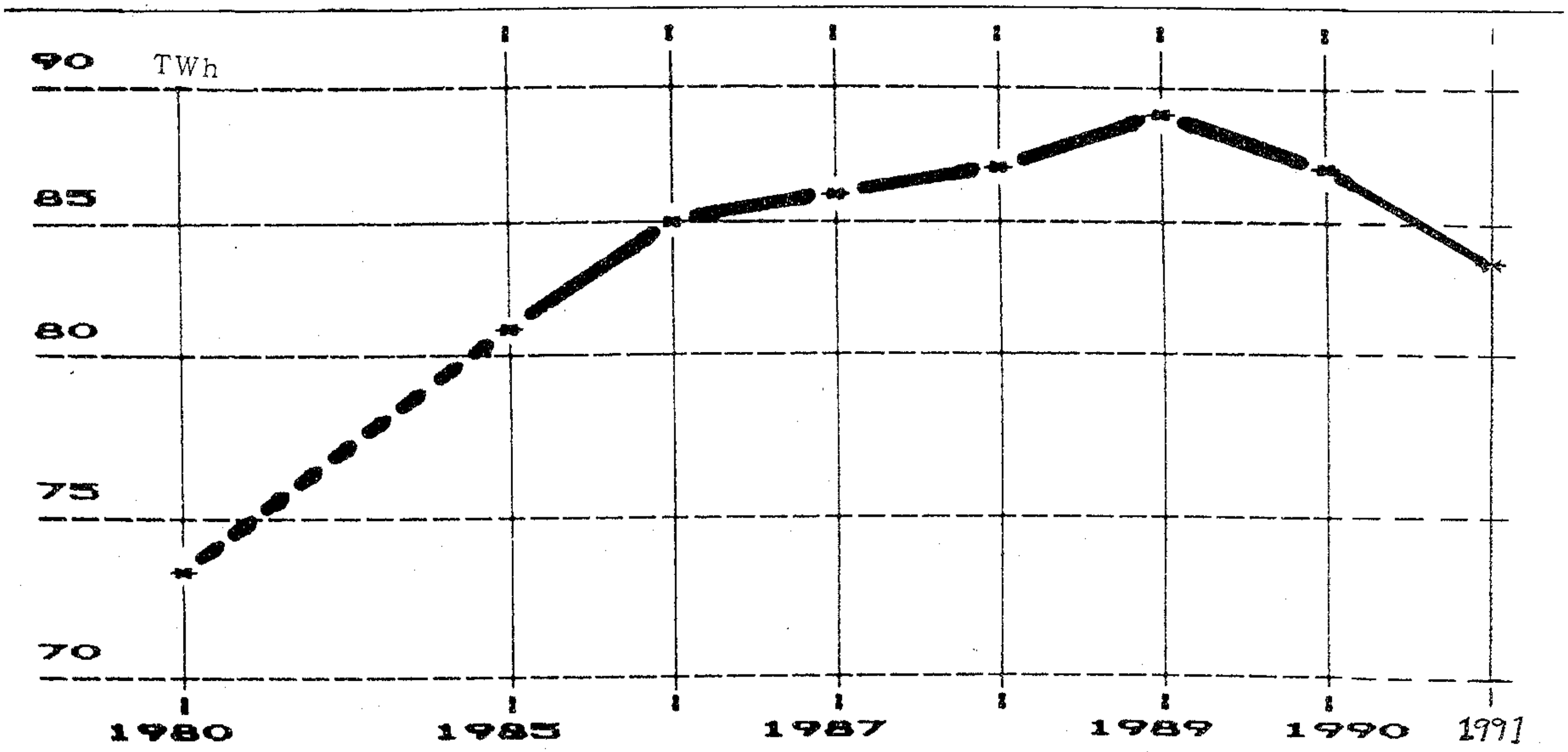


Fig. 2.4-2 The Supply of Electricity in CSFR

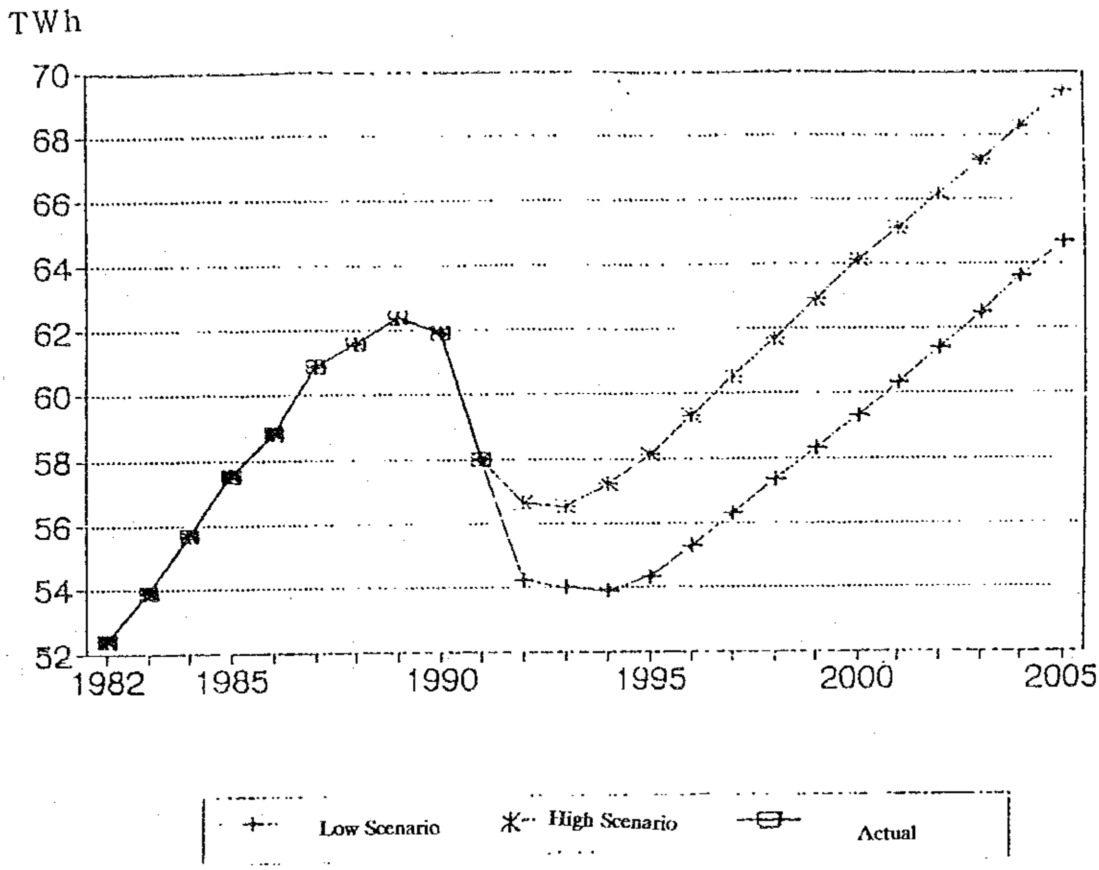


Fig. 2.4-3 The Demand of Electricity in CR

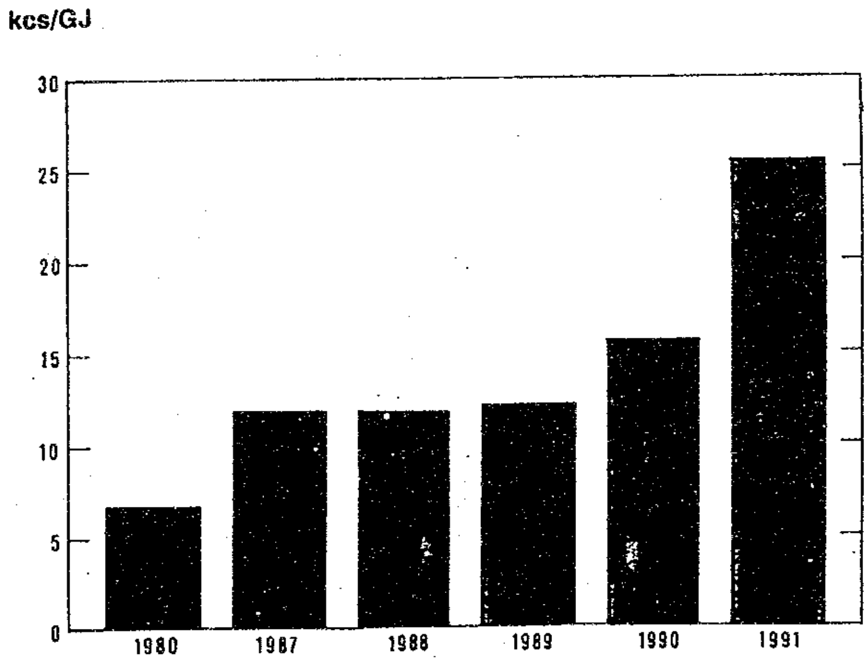


Fig. 2.4-4 THE COST OF FUEL

2.5 General Description of the Melnik Power Station

2.5.1 Outline

The Melnik Power Station, which is located on the left bank of the Labe (Elbe) River at 35 km north of Prague, is a brown coal fired power station having the output capacity of 1,270 MW.

The construction of the Melnik Power Station began in 1957 and the first unit started its operation in September 1960. The Melnik Power Station is a group of power plants consisting the Part I (55 MW x 6 units), Part II (110 MW x 4 units) and Part III (500 MW x 1 unit) plants and 11 units in total.

The Part III plant, consisting of a unit which is the newest in the country, started operation in November 1981. The single unit capacity is the largest in the country.

Configuration, output, the date of start of operation of units of each plant are shown in Table 2.5-1.

The total generation capacity of 1,270 MW of the Melnik Power Station is about 6% of the total generating capacity of 21,500 MW of the country (about 8.5% of the total generating capacity of 14,900 MW of the Czech republic). The Melnik Power Station is the third largest power station in the country, and an important supplier to the capital of Prague.

The Part II plant is planned to supply heat to the capital of Prague. Remodeling of turbine generators and installation of heat supply systems will be completed by the end of 1996 for Nos. 7 and 8 units and by the end of 1998 for Nos. 9 and 10 units, and the plant will become a complex having an electric power output of 280 MW and a heat output of 600 MWt.

Facilities of the Part II and Part III plants, which are under study this time, are outlined in Table 2.5-2.

2.5.2 Organization

The Melnik Power Station has total personnel of about 1,630. The organization and human allocation are shown in Tables 2.5-3 and 2.5-4.

2.5.3 Operation

The generated electricity and facility availability factors since 1988 are shown in Table 2.5-5.

2.5.4 Status of Accounting

(1) Assets

The balance sheet of the Melnik Power Station (as of December 31, 1991) is shown in Table 2.5-6. The construction cost for Melnik Part III (started operation in November 1981) is 3,279.6 million kčs. (No data was obtained for Melnik Part II.)

(2) Power Production Cost

1) General

The power production cost at the Melnik Power Station in 1991 was 477.39 kčs/MWh at Part II and 435.59 kčs/MWh at Part III (see Tables 2.5-7 and 2.5-8). The power production cost corresponds to 47 to 52% of the unit power price of CEZ of 916.9 kčs estimated in 2.4.7 (2). When compared with that in 1990, the power production cost rose by about 32% at Part II, excluding Part III where large scale repairs were carried out at a scheduled inspection. It is judged that such rise in production cost came from rises in cost of materials such as the fuel.

It is judged, in comparison with other coal fired power plants, that the production costs at the Part II and Part III plants are low (see Table 2.5-9).

2) Constituents of the Power Production Cost

a. Fuel cost

The unit cost of heating value of coal in 1991 is obtained by dividing the fuel cost, which occupies the greater part of the power production cost, by the total heating value, and it is 26 kčs/GJ for each plant. The heating value per weight is 2,600 kcal/kg (10,920 kJ/kg), which is very low.

The total tonnage of coal used in 1991 is calculated as 2.19 million tons for Part II and 2.40 million tons for Part III.

The unit price of coal used in 1991 is calculated based on the data above as 278.5 kčs/t (¥1,264/t).

b. Labor cost

The allocation of personnel in the Power Station is described earlier, and the labor cost in 1991 is described below.

According the information which we got, the total labor cost is 101,948,000 kčs, and the annual labor cost per employee is 62,506 kčs (about ¥280,000).

When seen by sectors, chief operators of the operation sector get the highest salary of 86,640 kčs (about ¥390,000) a year at Part II and 98,400 kčs (about ¥450,000) a year at Part III. The salary for workers working in shifts is 58,128 kčs (about ¥260,000).

It is estimated that the escalation rate of labor cost in 1991 is about 30 to 40%.

c. Depreciation

The standards of depreciation were described earlier. The mean rate of depreciation at the Melnik Power Station is 4.4%.

d. Repair cost

Repairs are made according to schedule and operation.

The repair cost in 1991 was 154,121,000 kčs (about ¥700 million) at Part II and 93,970,000 kčs (about ¥400 million) at Part III, corresponding to 1,600,000 and 860,000 yen per MW, respectively.

In Japan, the repair cost is about 3% of the construction cost, although it depends on how old the facility is. The repair cost in Japan therefore is 4.5 billion yen for a plant costing 150 billion yen for construction (i.e., for a plant of 600 MW in equipment capacity, although it depends on the location), and it corresponds to 7.5 million yen per MW. The burden for repairs at the Melnik Power Station appears to be large in consideration of the difference in labor cost and material prices. The large burden seems to come from insufficient equipment renewal due to money shortage and low availability, although it may come also from the level of deterioration of facilities.

Table 2.5-1 The Structure of Melnik Power Station

Part	Unit Number	Output	Stack	Start of Construction	Date of Commissioning
I	1	55 MW	120 m high × 1	1957	Sep. 30, 1960
	2	55 MW			
	3	55 MW			
	4	55 MW	120 m high × 1		∫
	5	55 MW			
	6	55 MW			Sep. 27, 1961
II	7	110 MW	200 m high × 1	1967	Dec. 30, 1970
	8	110 MW			May 20, 1971
	9	110 MW			Sep. 28, 1971
	10	110 MW			Nov. 27, 1971
III	11	500 MW	270 m high × 1	1976	Nov. 5, 1981

Table 2.5-2 Outline of Melnik Part II and III

Items	Outline of Facilities	
	Part II	Part III
1. Major Equipment	Units Nos. 7 - 10	Unit No. 11
(1) Unit Output	110 MW	500 MW
(2) Boiler		
Type	Drum type, natural circulation type	Drum type, forced circulation type
Maximum Evaporation	350 T/H	1,670 T/H
Firing System	Pulverized coal-firing	Pulverized coal-firing
Fuel	Lignite	Lignite
Mill Type	Fan Type	Fan Type
(3) Turbine		
Type	Tandem reheat, condensers, 3-casing type	Tandem reheat, condensers, 3-casing type
Speed	3,000 rpm	3,000 rpm
Main Steam Pressure	129 kg/cm^2g	165 kg/cm^2g
Main Steam Temperature	540°C	540°C
Reheat Steam Temperature	540°C	540°C
(4) Environmental Facility	Electrostatic Precipitator (180 ~ 200°C)	Electrostatic Precipitator (160 ~ 180°C)
(5) Stack	1 stack for No. 7 - No. 10 Units 200 m Height	1 stack 270 m Height
2. Condenser Cooling Water	Taken from Labe River	Taken from the condenser outlet of Part II's cooling water.
3. Coal Yard	Outdoor storage system, 3 piles used by all Units, transported to coal yard by rail.	
4. Ash Disposal Site	Ash slurry transported by pipeline to a site about 1.5 km to the south-west of the plant.	

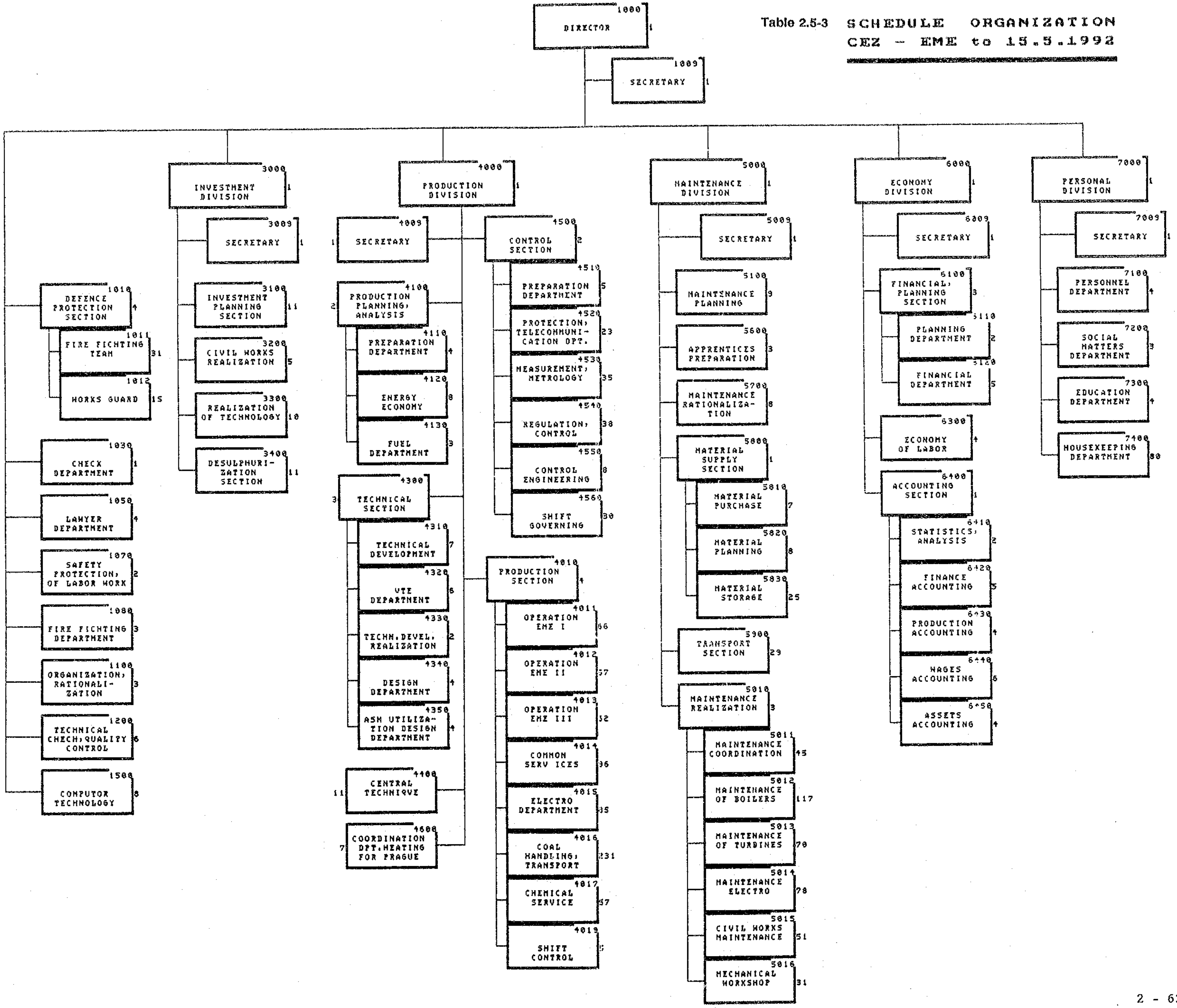


Table 2.5-3 SCHEDULE ORGANIZATION CEZ - EME to 15.5.1992

Table 2.5-4 Personnels of Melnik Power Station

Division	Description of Division	Personnels
Office Division	Fire Fighting Team, Works Guard, etc.	77
Investment Division	Desulphurization Section, Realization of Technology, etc.	39
Production Division	Fuel Department, Control Section, Production Section, etc.	897
Maintenance Division	Maintenance Planning, Maintenance Rationalization, Transport Section, etc.	487
Economy Division	Financial Planning Section, Economy of Labour, etc.	38
Personal Division	Personnel Department, Social Matters Dept., etc.	93
Total		1,631

Table 2.5-5 Energy Generation and Capacity Factor of Melnik Power Station

	Part I		Part II		Part III	
	Energy Generation (MWh)	Capacity Factor (%)	Energy Generation (MWh)	Capacity Factor (%)	Energy Generation (MWh)	Capacity Factor (%)
1988	1,565	54.1	1,882	48.8	2,264	51.7
1989	1,514	52.4	1,563	40.6	2,007	45.8
1990	1,434	49.6	2,076	53.9	349	8.0
1991	995	34.4	2,207	57.3	2,446	55.9

Table 2.5-6 Balance of Assets and Debits of Melnik Power Station (December 31, 1991)

1. Assets

(Unit: 10^6 kčs)

	Items	Amount of Money
	Foundation Means	5,363.1
	Depreciation	▲3,351.0
	Depreciated Value	2,012.1
	Investments	68.3
(1)	Total Investment Assets	2,080.4
	Cash	18.4
	Accepted Part Payments	76.5
	Outstanding Debts	167.4
	Reserves	334.4
	Others	28.2
(2)	Total Return Assets	624.9
	Total Assets ((1) + (2))	2,705.3

2. Liabilities

(Unit: 10^6 kčs)

	Items	Amount of Money
	Basic Property and Time Differenciation	2,531.0
	Fonds	1.1
	Undistributed Last Year	16.6
	Current Year Profit	47.6
(3)	Total	2,596.3
	Investment Debits Sphere	5.0
	Bank Credits	41.0
(4)	Long-Term Borrowed Capital; Total	46.0
	Constant Debits	38.7
	Other Sources	24.3
(5)	Short-Term Borrowed Capital; Total	63.0
	Total Liabilities ((3) + (4) + (6))	2,705.3

Table 2.5-7 Calculation Sheet of Melnik Part II

	Items		1989	1990	1991
	1. Power Production	(MWh)	1,563,100	2,076,470	2,207,540
	2. Internal Energy Consumption	(MWh)	137,997	175,382	182,975
	3. Supply of Energy	(MWh)	1,425,103	1,901,088	2,024,565
	4. Energy Consumption of Fuel	(GJ)	17,327,916	22,789,652	23,956,497
Cost	5. Energetic Fuel	(10^3kčs)	271,431	401,959	608,072
	6. Material	(10^3kčs)	2,158	1,783	11,298
	7. Wages	(10^3kčs)	10,862	10,663	14,080
	8. Water	(10^3kčs)	55,871	72,811	77,686
	9. Repairs and Maintenance	(10^3kčs)	140,812	115,371	154,121
	10. Depreciation	(10^3kčs)	56,709	52,768	67,859
	11. Other Expenses	(10^3kčs)	8,844	9,661	13,849
	12. Overhead Expenses	(10^3kčs)	10,718	20,631	19,540
	Total		557,405	685,647	966,505
Unit Proper Expenses (kčs/MWh)			391.13	360.66	477.39

Table 2.5-8 Calculation Sheet of Melnik Part III

	Items		1989	1990	1991
	1. Power Production	(MWh)	2,007,260	348,900	2,446,602
	2. Internal Energy Consumption	(MWh)	108,442	17,791	126,953
	3. Supply of Energy	(MWh)	1,898,818	331,109	2,319,649
	4. Energy Consumption of Fuel	(GJ)	21,903,457	3,793,256	26,217,554
Cost	5. Energetic Fuel	(10^3kčs)	342,682	67,248	670,373
	6. Material	(10^3kčs)	2,184	2,795	6,176
	7. Wages	(10^3kčs)	11,415	10,314	14,711
	8. Water	(10^3kčs)	4,115	785	13,143
	9. Repairs and Maintenance	(10^3kčs)	36,211	187,596	93,970
	10. Depreciation	(10^3kčs)	132,863	128,343	154,423
	11. Other Expenses	(10^3kčs)	11,834	11,410	17,568
	12. Overhead Expenses	(10^3kčs)	24,673	33,955	40,049
	Total		565,976	442,446	1,010,413
Unit Proper Expenses (kčs/MWh)			298.07	1,336.25	435.59

Table 2.5-9 The Electricity Production Cost of CEZ Major Coal Power Plants in 1991

	Capacity (MW)	Electricity Production Cost (kčs/MWh)
Melnik Part I	330	535.22
Melnik Part II	440	477.39
Melnik Part III	500	435.59
Hodonin St.	210	605.05
Porici St.	165	592.82
Opatovice St.	330	475.10
Chvaletice St.	800	467.54
Detmarovice St.	800	614.32
Tusimice Part I	660	391.06
Tusimice Part II	800	404.64

Chapter 3. Descriptions of FGD Project Site

CHAPTER 3 Description of FDG Project Site

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Chapter 3 Description of FGD Project Site

3.1 Location

The Melnik Power Station is located at latitude 50°20'N and longitude 14°28'E about 35 km north of Prague, Czechoslovakia. The Labe River, which is the major source of cooling water for the Power Station, is an international river which meet with the Vlatava River near the town of Melnik and flows into the North Sea via Germany. The Melnik Power Station is located on the left bank of the Labe River about 9 km downstream of the point of meeting.

3.2 Access

The town of Melnik is about 40 km from Prague on Motorway No. 8 and then Highway No. 9. The Melnik Power Station is about 10 km from the town crossing the Labe River. Railway tracks are getting in the Melnik Power Station for transportation of coal and construction materials, etc. The railway will be effective also for carrying materials for construction and installation of the flue gas desulfurization project.

3.3 Climate

3.3.1 Outline

The weather in Czechoslovakia is just about middle between the oceanic climate of Europe on the west and the continental climate on the east. In comparison with the climate in Western Europe at similar latitude, it is hotter in summer and colder in winter in Czechoslovakia. The weather data attached hereto are those observed at Tisice, about 17 km southeast of the Melnik Power Station.

3.3.2 Temperature

The average, maximum and minimum daily temperatures averaged for each month are shown in Fig. 3.3-1 and Tables 3.3-1. According to the figure and tables, it is the coldest in January in a year with a average temperature of -1.3°C and average minimum temperature of -4.5°C. The temperature is the highest in July with a mean temperature of 19.0°C and average maximum temperature of 24.9°C. The annual average temperature is approximately 9.2°C.

3.3.3 Relative Humidity

The humidity tends to be high in winter and low in summer during a year. The monthly average of relative humidity is the lowest at 67.7% in April and highest at 84.5% in December.

Monthly average humidities are shown in Fig. 3.3-2 and Table 3.3-1.

3.3.4 Rainfall

The annual rainfall is 527.3 mm. It rains in summer much and the rainfall of 281.9 mm, or about 53% of annual rainfall, is occurring during the four months of May to August. Monthly rainfall are shown in Fig. 3.3-3 and Table 3.3-1.

3.3.5 Wind

Wind directions are mostly NW, W and SW throughout the year. The annual average of calmness is 37.9%.

The frequency distributions of wind direction and speed in each month are shown in Fig. 3.3-4 and Table 3.3-2.

3.4 Topography

The topography around the Melnik Power Station is showing a gentle slope from a small hill (about 260 m in elevation) on the southwest of the Power Station, where the ash disposal area is located, toward the Labe River, and the elevation at the Power Station is 160 m.

The 100-year probability flood water level of the Labe River at the Power Station is 158.4 m in elevation and the flood flow is 4,300 m3/s.

Fields on the mild slope around the Power Station are being used to raise wheat, barley for beer, sugar beet, etc.

The place for installation of the FGD for Part II, under study, is planned to be the area between the stack and the railway track for receiving coal, and the place is currently occupied by a train defreezing plant and a steel warehouse.

For Part III, it is planned to install the FGD at an empty space, on the northeast of the power plant, between Part III boiler house and the light-weight block factory where light-weight blocks are being made utilizing the coal ash from the power plant. There are some buildings in the empty space, but they will soon be moved or demolished by CEZ.Fig. 3.4-1 shows a map around the Power Station and Fig. 3.4-2 shows a general plan of the Power Station.

3.5 Geology

As for the geology around the Melnik Power Station, the land surface is covered with sediments of the Labe River. About 2 m of soil at the top is loess, and layers of sand with gravel are existing down to 11 m deep (EL. 149 m) from the ground level. Arenaceous marl and muddy limestone are existing below EL. 149 m.

The mean underground water level is EL. 154.5 m.The bearing capacity of the ground is on the order of 3.5 kg/cm2 at sand and gravel layers, and existing heavy weight structures of the Power Station such as powerhouses and stacks are built on spread foundation.

A typical soil profile at the Power Station is shown in Fig. 3.4-3.

Table 3.3-1 MONTHLY METEOROLOGICAL DATA AT TISICE

YEAR:1981～1990

	UNIT	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVERAGE
MONTHTHLY AVERAGE	℃	-1.3	-0.3	4.8	9.1	14.8	17.0	19.0	18.4	14.4	9.8	3.7	1.1	9.2
MONTHTHLY MAXIMUM AVERAGE	℃	1.7	3.5	9.3	14.7	20.4	22.4	24.9	24.6	19.9	14.6	6.8	3.7	13.9
MONTHTHLY MINIMUM AVERAGE	℃	-4.5	-3.9	0.5	3.5	8.5	11.1	12.7	12.5	9.3	5.3	0.8	-1.5	4.5
MONTHTHLY AVERAGE HUMIDITY	%	81.8	79.1	73.8	67.7	68.6	71.5	70.9	75.0	79.9	80.1	83.6	84.5	76.4
														ANNUAL
MONTHTHLY AVERAGE RAINFALL	mm	26.7	24.2	27.6	33.6	58.2	58.7	87.2	77.8	38.3	30.5	33.8	30.7	527.3

Table 3.3-2 MONTHLY WIND SPEED & DIRECTION (1/2)

(1986～1990)

MONTH: JANUARY

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	1.1	0.9	3.9	1.3	1.1	1.7	1.7	5.2		
0.1--3.9	1.1	1.3	10.1	2.4	2.8	4.5	4.5	8.0		
0.1--5.9	1.1	1.5	11.8	3.7	3.9	8.0	8.8	9.2		
0.1--MAX	1.3	1.5	13.5	4.3	6.0	9.7	13.1	10.1		
TOTAL	1.3	1.5	13.5	4.3	6.0	9.7	13.1	10.1	40.4	100.0

MONTH: FEBRUARY

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	3.3	1.4	4.3	2.1	0.9	2.1	2.8	5.2		
0.1--3.9	3.5	2.4	9.2	3.8	2.4	4.7	6.6	6.4		
0.1--5.9	3.8	2.4	10.9	5.2	3.3	8.3	8.7	7.8		
0.1--MAX	3.8	2.4	15.6	5.7	4.5	12.5	15.4	9.0		
TOTAL	3.8	2.4	15.6	5.7	4.5	12.5	15.4	9.0	31.2	100.0

MONTH: MARCH

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.6	1.7	3.2	1.3	0.9	1.7	2.4	4.5		
0.1--3.9	1.3	3.7	7.3	1.9	2.6	4.1	7.1	6.0		
0.1--5.9	1.9	4.5	12.0	3.2	4.5	9.0	10.8	7.5		
0.1--MAX	2.4	4.7	13.3	3.9	4.7	14.4	17.8	10.3		
TOTAL	2.4	4.7	13.3	3.9	4.7	14.4	17.8	10.3	28.4	100.0

MONTH: APRIL

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	1.6	1.1	2.0	0.7	0.9	1.3	2.0	3.8		
0.1--3.9	4.4	5.1	7.3	2.2	2.7	4.2	6.0	8.0		
0.1--5.9	6.9	7.3	10.9	4.2	3.3	6.7	9.3	9.6		
0.1--MAX	8.0	8.0	12.4	4.9	3.8	9.6	13.1	12.2		
TOTAL	8.0	8.0	12.4	4.9	3.8	9.6	13.1	12.2	28.0	100.0

MONTH: MAY

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOYAL
0.1--1.9	1.1	2.6	3.0	1.3	0.2	1.5	2.4	3.4		
0.1--3.9	1.9	5.2	8.0	3.0	1.7	4.5	4.7	9.5		
0.1--5.9	2.2	7.3	11.8	4.9	2.2	6.0	7.3	12.9		
0.1--MAX	2.8	7.5	13.1	5.4	2.6	7.5	9.5	16.1		
TOTAL	2.8	7.5	13.1	5.4	2.6	7.5	9.5	16.1	35.5	100.0

MONTH: JUNE

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.9	0.7	3.1	2.0	0.4	2.0	4.2	4.2		
0.1--3.9	2.4	3.1	5.3	3.6	0.9	5.6	7.6	9.8		
0.1--5.9	3.6	4.7	6.2	4.9	1.3	9.8	12.2	12.2		
0.1--MAX	5.3	4.9	6.9	5.1	1.3	12.7	14.0	13.6		
TOTAL	5.3	4.9	6.9	5.1	1.3	12.7	14.0	13.6	36.2	100.0

Table 3.3-2 MONTHLY WIND SPEED & DIRECTION (2/2)
(1986～1990)

MONTH: JULY

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.9	1.3	2.4	2.4	1.9	1.7	3.7	3.9		
0.1--3.9	2.4	2.6	4.1	3.9	2.8	8.4	8.8	7.3		
0.1--5.9	2.6	3.2	4.3	5.6	3.2	11.6	12.5	10.8		
0.1--MAX	2.8	3.4	4.5	6.0	3.2	15.1	13.8	12.7		
TOTAL	2.8	3.4	4.5	6.0	3.2	15.1	13.8	12.7	38.5	100.0

MONTH: AUGUST

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.6	1.9	3.0	1.3	0.9	1.9	2.8	2.8		
0.1--3.9	2.2	3.2	5.2	3.9	1.5	3.2	5.6	7.3		
0.1--5.9	3.2	3.9	5.4	5.4	1.9	6.7	7.7	10.8		
0.1--MAX	3.2	3.9	6.2	6.0	2.2	9.0	10.8	13.5		
TOTAL	3.2	3.9	6.2	6.0	2.2	9.0	10.8	13.5	45.2	100.0

MONTH: SEPTEMBER

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.4	0.9	2.9	1.8	0.0	0.9	1.3	2.4		
0.1--3.9	2.0	1.3	4.7	2.9	1.8	8.0	4.9	6.0		
0.1--5.9	2.4	1.6	7.1	3.3	2.2	12.4	9.8	8.7		
0.1--MAX	2.7	1.6	7.1	3.3	2.7	16.7	13.1	10.0		
TOTAL	2.7	1.6	7.1	3.3	2.7	16.7	13.1	10.0	42.9	100.0

MONTH: OCTOBER

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.2	0.4	1.7	1.7	0.4	0.2	1.5	1.1		
0.1--3.9	1.3	2.8	9.5	5.6	0.9	2.8	3.9	3.0		
0.1--5.9	2.2	3.9	12.7	8.0	1.1	6.9	7.1	3.4		
0.1--MAX	2.2	3.9	15.1	9.5	1.3	9.0	8.2	4.5		
TOTAL	2.2	3.9	15.1	9.5	1.3	9.0	8.2	4.5	46.5	100.0

MONTH: NOVEMBER

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.0	0.7	2.0	2.9	0.9	1.8	0.4	1.6		
0.1--3.9	0.4	2.7	6.9	4.4	2.0	5.3	5.3	3.1		
0.1--5.9	1.3	3.6	9.1	5.1	2.4	11.1	10.4	5.1		
0.1--MAX	2.0	3.8	9.1	5.1	2.4	14.0	14.4	6.4		
TOTAL	2.0	3.8	9.1	5.1	2.4	14.0	14.4	6.4	42.7	100.0

MONTH: DECEMBER

UNIT:%

SPEED	N	NE	E	SE	S	SW	W	NW	CALM	TOTAL
0.1--1.9	0.0	0.6	1.1	2.2	1.1	2.6	1.3	1.7		
0.1--3.9	0.6	1.3	5.6	4.3	2.8	4.3	5.4	5.6		
0.1--5.9	1.7	1.5	8.4	4.7	3.7	10.1	12.0	7.1		
0.1--MAX	2.4	1.5	8.8	4.7	3.7	14.6	18.5	8.2		
TOTAL	2.4	1.5	8.8	4.7	3.7	14.6	18.5	8.2	37.6	100.0

YEAR 1981~1990

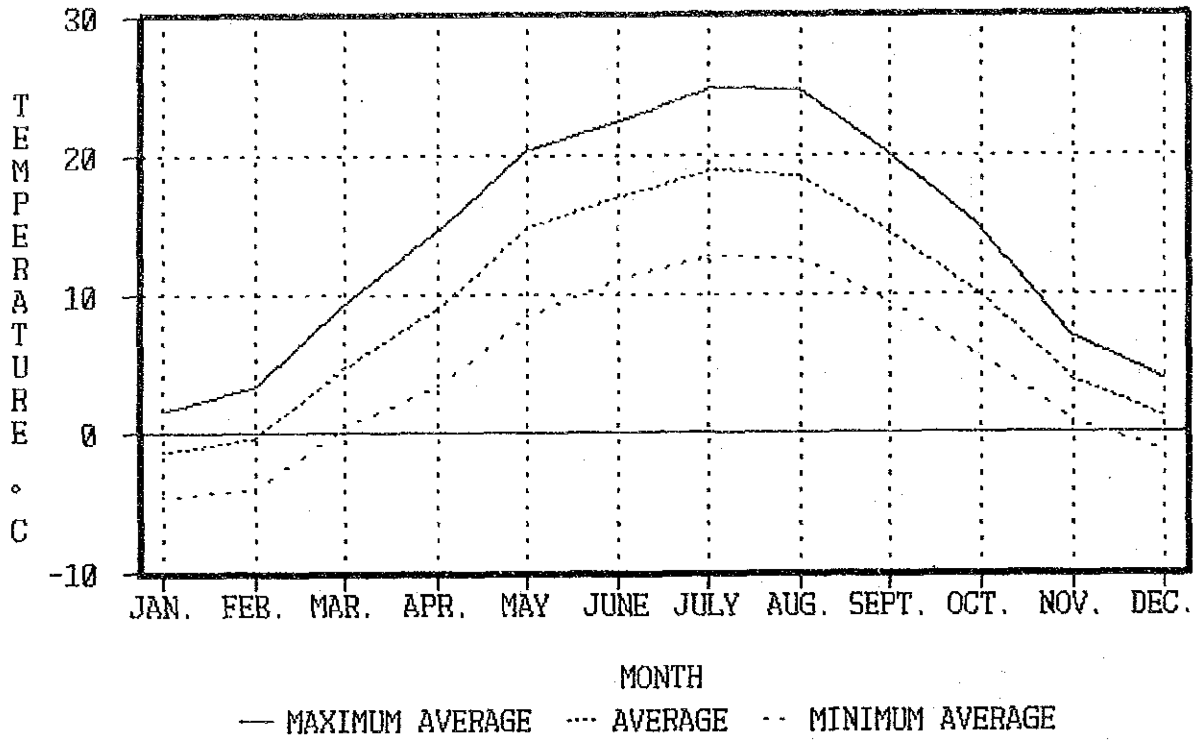


Fig. 3.3-1 MONTHLY AVERAGE TEMPERATURE AT TISICE

YEAR 1981~1990

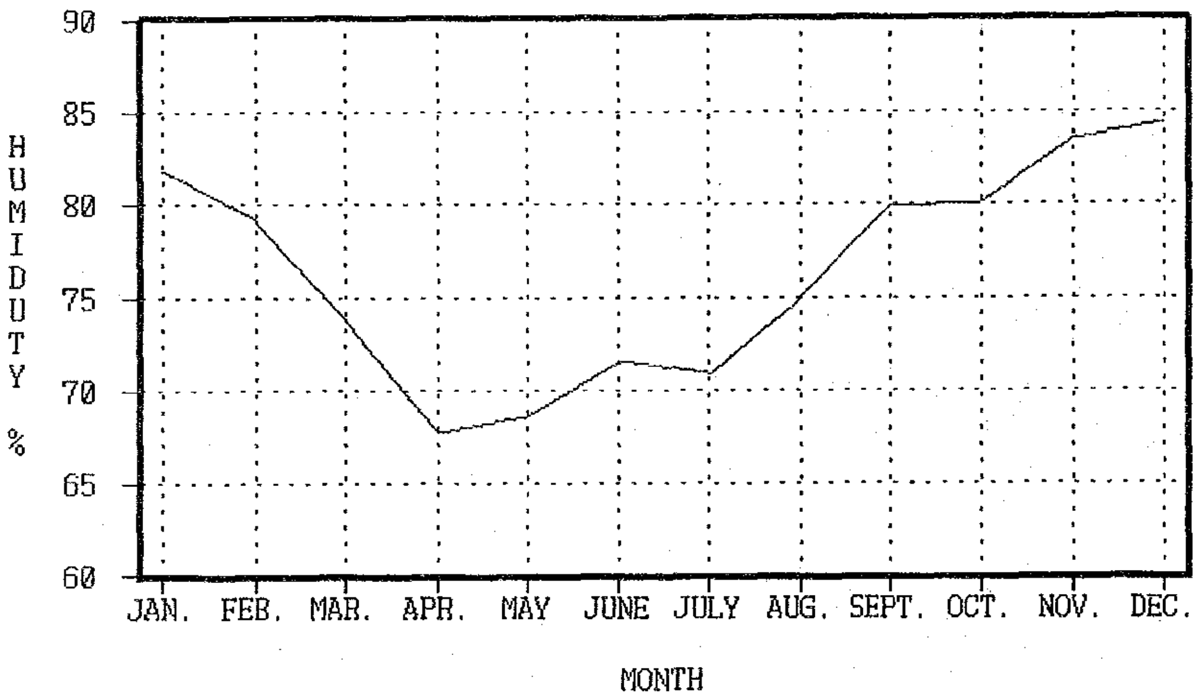


Fig. 3.3-2 MONTHLY AVERAGE HUMIDITY AT TISICE

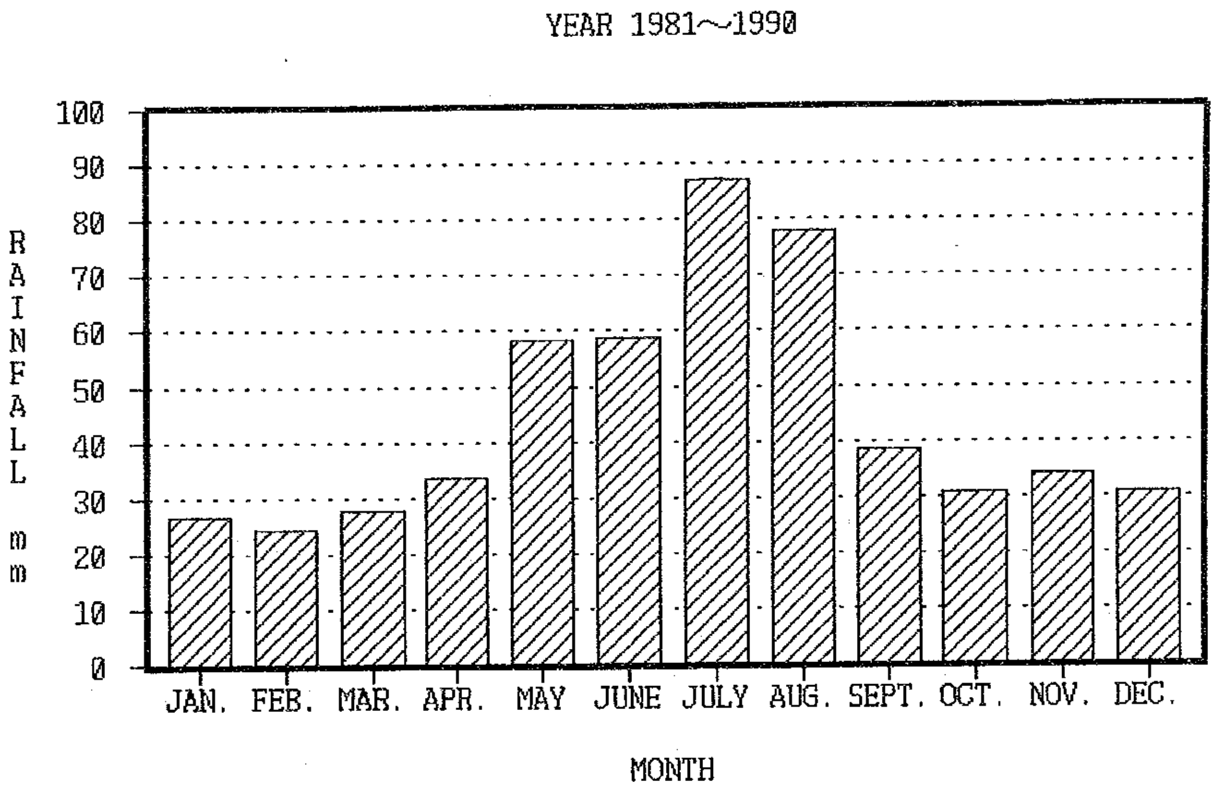


Fig. 3.3-3 MONTHLY RAINFALL AT TISICE

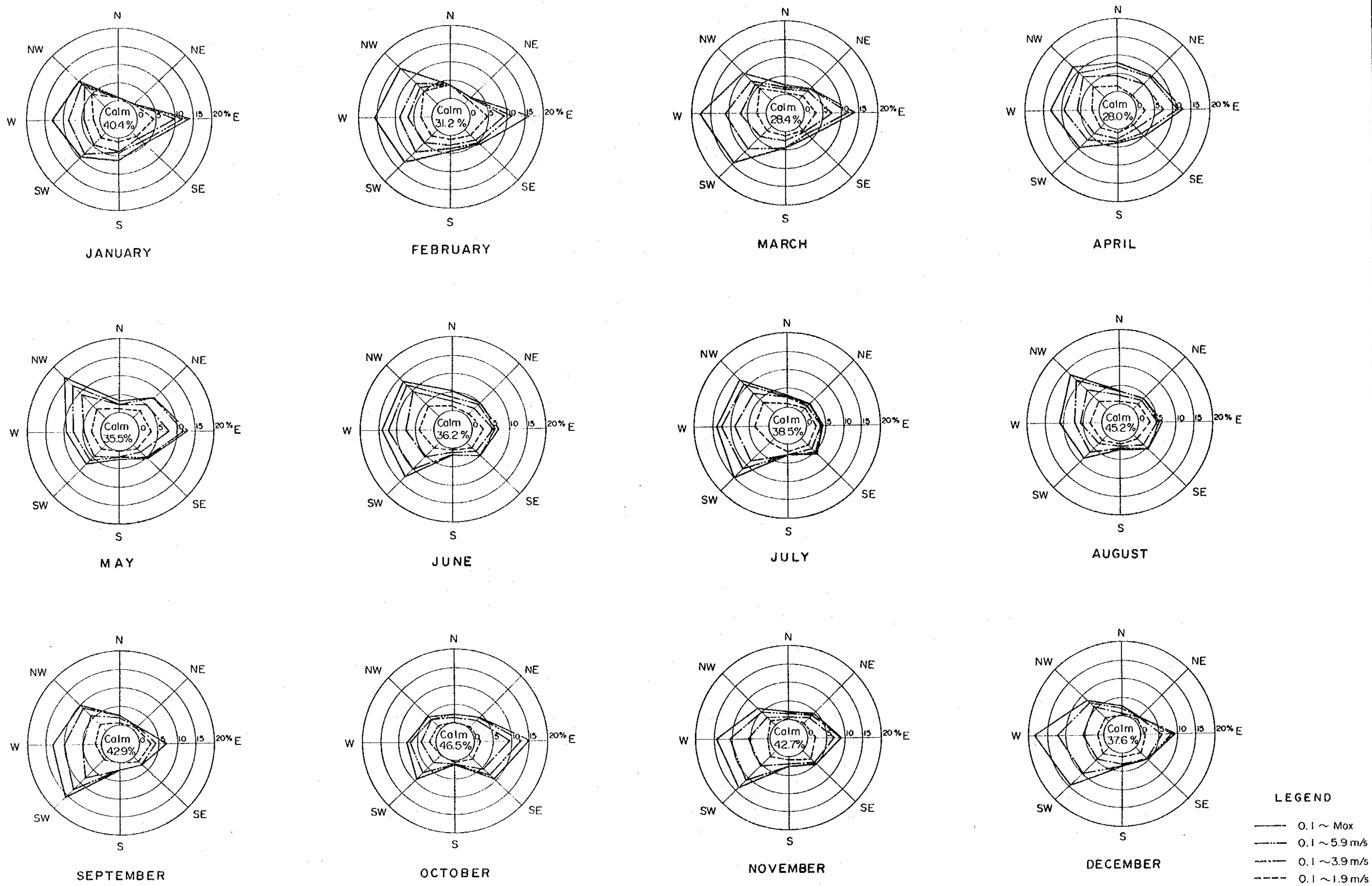
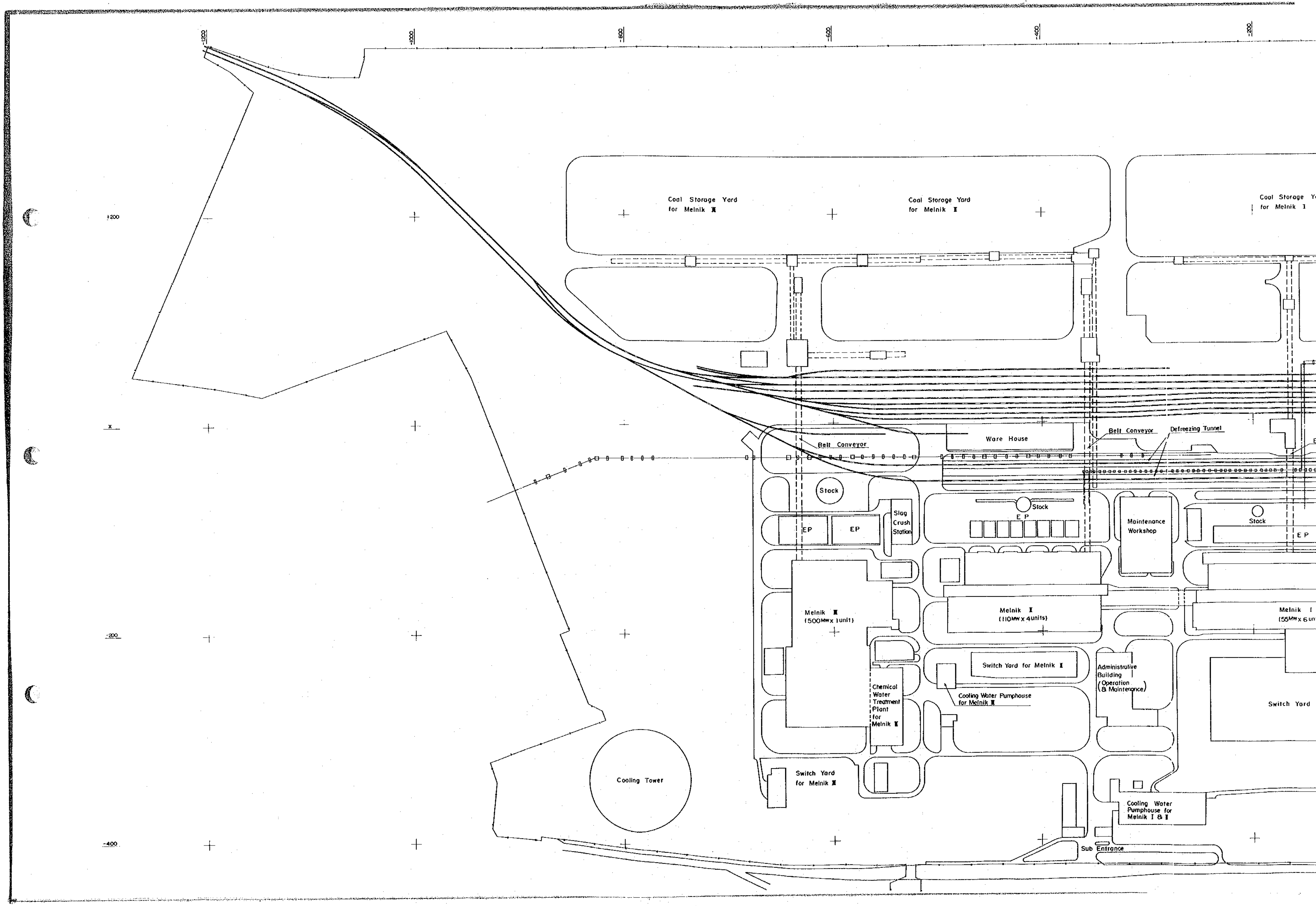


Fig. 3.3-4
MONTHLY WIND ROSE AT TĪSICE
(YEAR : 1986 ~ 1990)

Fig. 3.4-1
MELNIK POWER STATION
LOCATION MAP



-1200
-1000
-800
-600
-400
-200
+200
x
-200
-400
Coal Storage Yard for Melnik Ⅲ
Coal Storage Yard for Melnik Ⅱ
Coal Storage Y for Melnik Ⅰ
Belt Conveyor
Ware House
Belt Conveyor
Defreezing Tunnel
Stock
Stock
Stock
EP
EP
EP
EP
Slag Crush Station
Maintenance Workshop
Melnik Ⅲ (500MW x 1unit)
Melnik Ⅱ (110MW x 4units)
Melnik Ⅰ (55MW x 6 un
Switch Yard for Melnik Ⅱ
Cooling Water Pumphouse for Melnik Ⅲ
Chemical Water Treatment Plant for Melnik Ⅲ
Administrative Building (Operation & Maintenance)
Switch Yard
Cooling Tower
Switch Yard for Melnik Ⅲ
Cooling Water Pumphouse for Melnik Ⅰ & Ⅱ
Sub Entrance

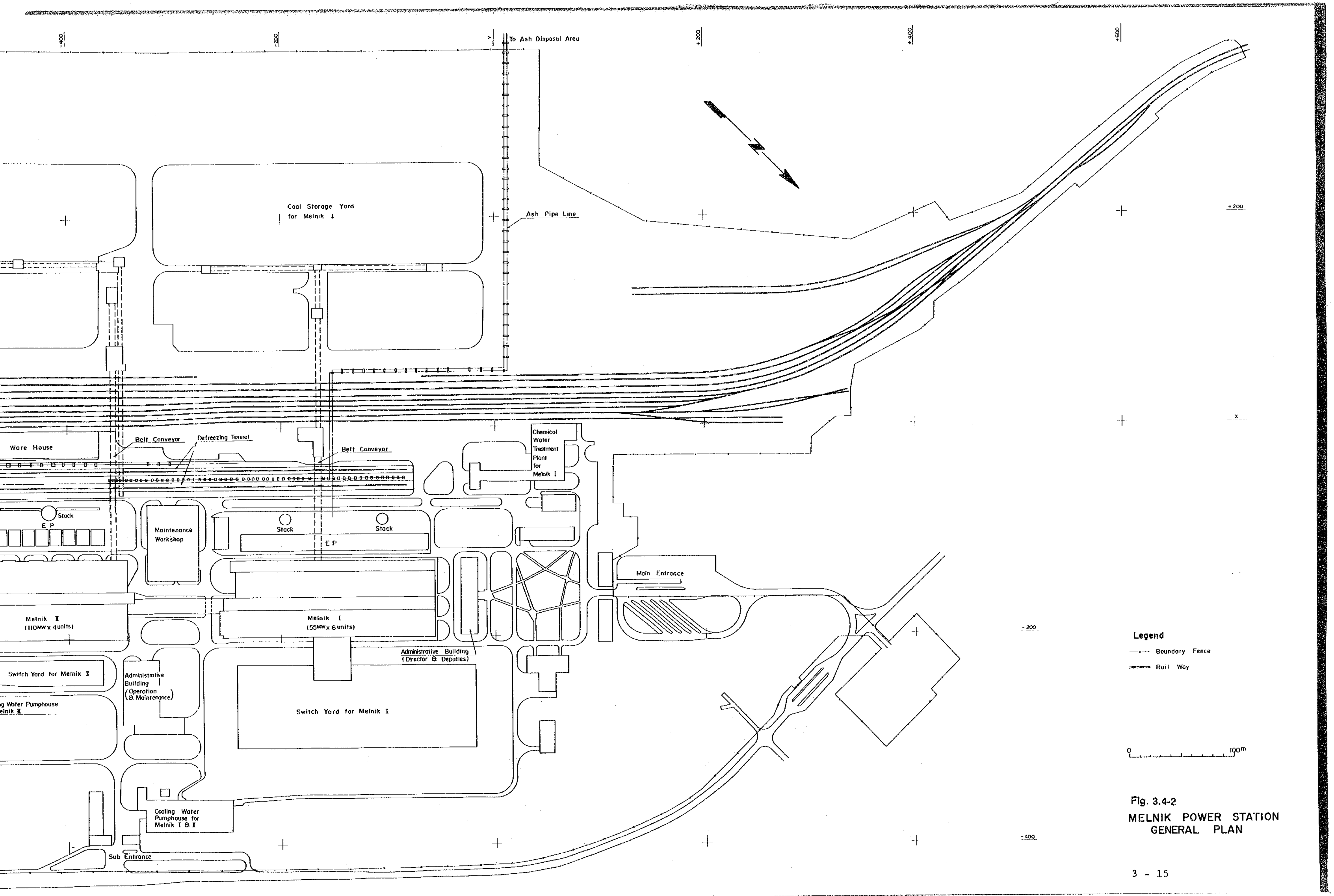


Fig. 3.4-2
MELNIK POWER STATION
GENERAL PLAN

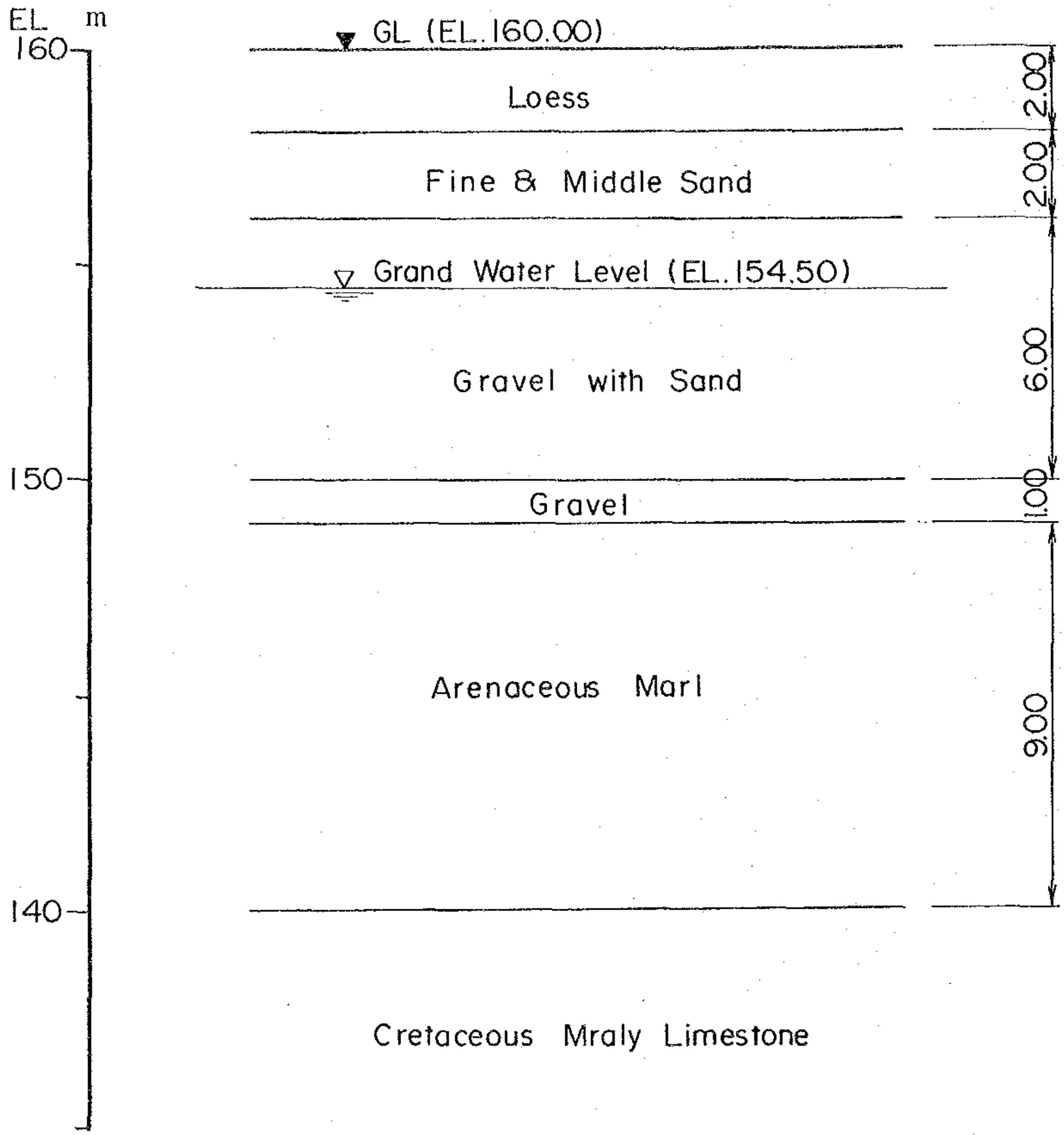


Fig. 3.4-3 SOIL PROFILE

Chapter 4 Selection of the Optimum DeSOx System

CHAPTER 4 SELECTION OF THE OPTIMUM DeSOx SYSTEM

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Chapter 4 Selection of Optimum DeSOx System

4.1 Emission Standards Applied to the Melnik Power Station

In Czechoslovakia, environmental standards (shown in Table 4.1-1) and emission standards (shown in Table 2.4-12) were enacted in October 1991. As for the emission standards, the regulatory limits depend on the fuel used and the scale of thermal output. Such emission standards will be enforced from October 1996, and emission sources are obliged to shut down if they do not meet applicable emission standards. Emission standards are applied to each emission source (i.e., each boiler), and emission standards to be applied to Part II and Part III of the Melnik Power Station are as follows:

- Part II of Melnik power station

  Single unit capacity: 110 MWe
  Thermal output of boiler = 255 MWt - 260 MWt
  (calculated from performance during 1990-1991)

The thermal output of this level falls in the category of <50 MWt - 300 MWt>, and thus the upper limit of SO_2 emission by regulation is 1,700 mg/m^3N or less without DeSOx installation. It is not possible to meet this regulation, and thus the regulation of "Installation of FGD with efficiency of over 70%" is applied.

- Part III of Melnik power station

  Unit capacity: 500 MWe
  Thermal output of boiler = 1,150 - 1,200 MWt
  (calculated from performance during 1990-1991)

Thus, Part III falls in the category of <300 MWt and greater> and the upper limit of SO_2 emission by regulation is 500 mg/m^3N or less without DeSOx installation. It is not possible to meet this regulation, and the regulation of "Installation of FGD with efficiency of over 85%" is applied to Part III.

Such applicable regulations are summarized in Table 4.1-2. It is envisioned that such an emission limit does not change and remain to be effective for about 10 years once it is applied to an emission source.

Optimum Flue Gas Desulphurisation (FGD) systems for the Melnik Power Station are selected in this Report based on such emission standards. To reduce the SOx emission from respective units to below regulatory limits, it is necessary to select an optimum FGD method from many possibilities and study the capacity, deSOx efficiency and the number of required FGDs and combination of plants to which FGDs are installed.

Optimum DeSOx systems for Part II and Part III are selected by the following procedures:

(1) To single out possible DeSOx methods, and compare their general technologies

(2) To determine specifications necessary for designing FGDs for Part II and Part III

(3) To carry out case studies of the methods of (1) in consideration of the specifications determined in (2), and select an optimum DeSOx method for Part III through comprehensive technical and economic evaluations

(4) To study and evaluate "combination" of FGDs to be applied to Part II based on the specifications determined in (2)

(5) To carry out case studies on methods selected in (1) for the DeSOx method for Part III selected in (3) and the "optimum combination" for Part II examined in (4) through comprehensive technical and economic examination and evaluation, and select an optimum DeSOx method for Part II

(6) To determine, finally, an optimum FGD configuration for all Part II and Part III units based on above examination and evaluation

The flow of the procedures is shown in Fig. 4.1-1.

Table 4.1-1 Ambient Air Quality Standards in Czech and Slovak

Pollutant		24 Hrs. Value Kd $\mu g/m^3$	30 Min. Value Kmax $\mu g/m^3$	Recommended Value $\mu g/m^3$
Name	Symbol			
Ammonia	NH_3	200	200	
Arsenic/inorganic compounds AsH_3 excluded	As	3	-	
Phenol	C_6H_5OH	10	10	
Fluorine/inorganic compounds	F	5	20	K_r 1
Formaldehyde	HCHO	35	50	
Chlorine	Cl_2	30	100	
Strong Mineral Acids 1/	H^+	-	6	
Lead/excluding Tetraethyllead	Pb	0.7	-	
Sulphur Dioxide	SO_2	150	500	K_r 60
Carbon Monoxide	CO	1000	6000	K_8 3000
Nitrogen Dioxide	NO_2	100	100	
Airborne Dust Particles 2/		150	500	K_r 40
Carbon Disulphide	CS_2	10	30	
Hydrogen Sulphide	H_2S	8	8	

Legend: 1/ H_2SO_4, HCl, HNO_3

2/ does not contain biologically active toxins

K_r : Average Concentration during 1 year

K_8 : Average Concentration during 8 hours

Table 4.1-2 Emission Standard of the Melnik Power Station

	Enforced from October 1996	
	Part II	Part III
SO_2	Installation of FGD with efficiency of over 70% Because it is not possible to meet 1,700 mg/m^3N or less without FGD installation.	Installation of FGD with efficiency of over 85% Because it is not possible to meet 500 mg/m^3N or less without FGD installation.
NOx (as NO_2)	650 mg/m^3N or less	650 mg/m^3N or less
Dust	100 mg/m^3N or less	100 mg/m^3N or less

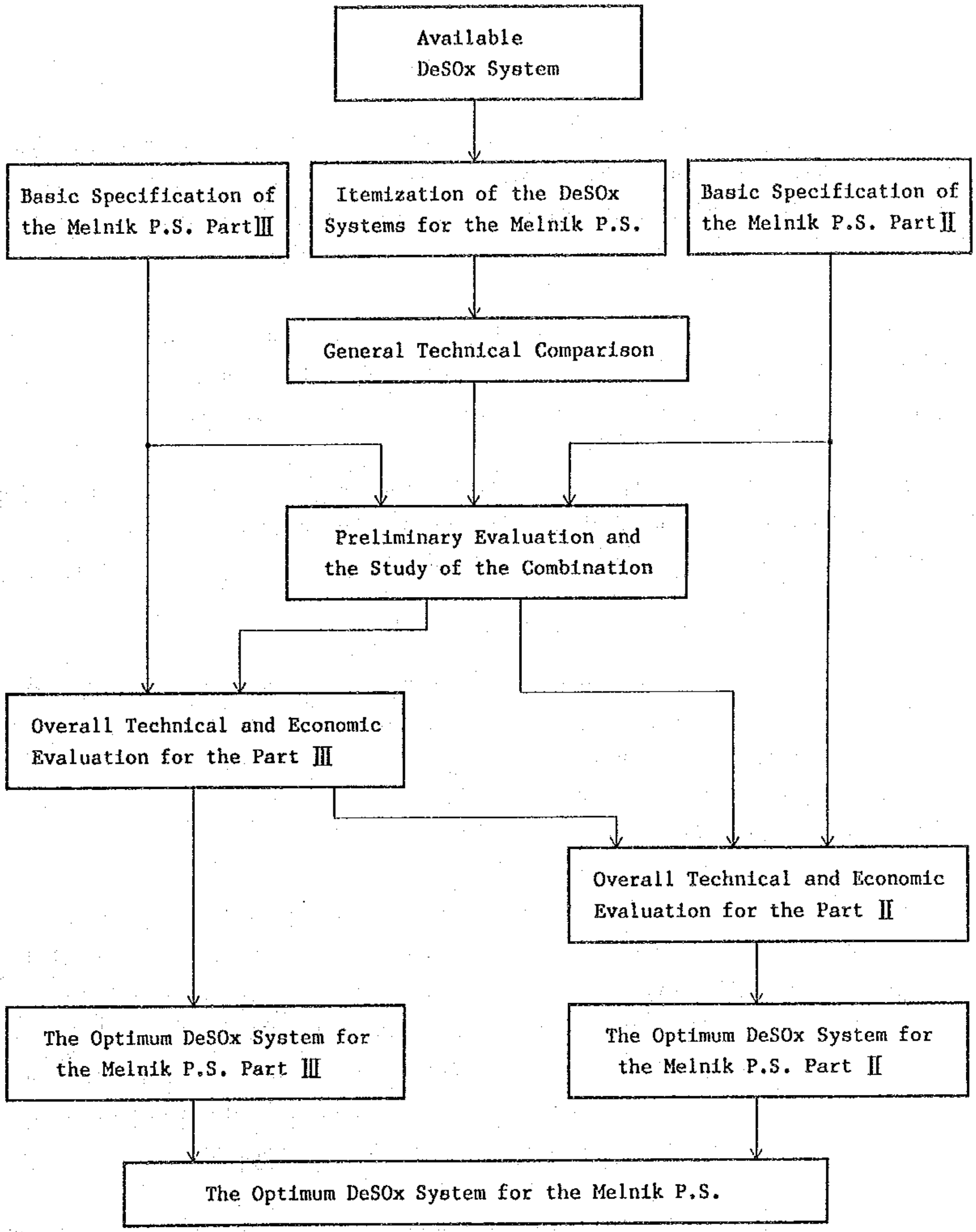

Fig.4.1-1 SELECTION FLOW OF THE OPTIMUM DeSOx SYSTEM

4.2 Selection and Technical Comparison of FGD Methods to be Evaluated

4.2.1 Selection of FGD Methods to be Evaluated

A large variety of FGD methods are being used, but many of them are similar in their principles. Such methods are categorized also in a variety of ways, but they are generally categorized into wet, semi-dry and dry methods depending on the use of water in their absorption process.

Judging from the current trends of FGD technologies in the world, the limestone method, where limestone slurry is used as the absorbent, is popular among the wet methods, and being employed at many utility plants.

The spray-dryer method is popular among the semi-dry methods. The spraydryer method corresponds to the semi-dry method. This method has not been employed in Japan at coal fired power plants although it has been employed at many plants in Europe and the USA.

Dry medthods include the activated coke method which uses activated coke as adsorbent and the electron beam method where ammonia is injected into flue gas and irradiated with electron beam. The activated coke method is in the stage where data are accumulated at utility plants and the electron beam method is in the stage of testing at demonstration plants.

From such wet, semi-dry and dry FGD methods, the seven methods shown in Fig. 4.2-1 were selected, based on their past performance at coal fired utility power plants, as methods which can be considered for the Melnik Power Station. The electron beam method described in the table, however, has not been at utility plants, but the method was included in the technical comparison just for reference because the method is attracting much attention worldwide and development activities are going with the pilot-scale plants.

These selected seven methods are outlined and their technologies are compared generally below. In Section 4.5, in addition, their technologies and economy are compared in considerations of conditions specific to the Melnik Power Station, and a method most appropriate for the Melnik Power Station is selected from the seven methods.