JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

No. 46

THE SECRETARY OF ENERGY(S.E.)
THE REPUBULICA ARGENTINA

STUDY ON AIR POLLUTION CONTROL FOR THERMAL POWER PLANTS IN THE REPUBLICA ARGENTINA

(SUMMARY)

SEPTEMBER 1994

UNICO INTERNATIONAL CORPORATION
SANYO TECHNO MARINE, INC.

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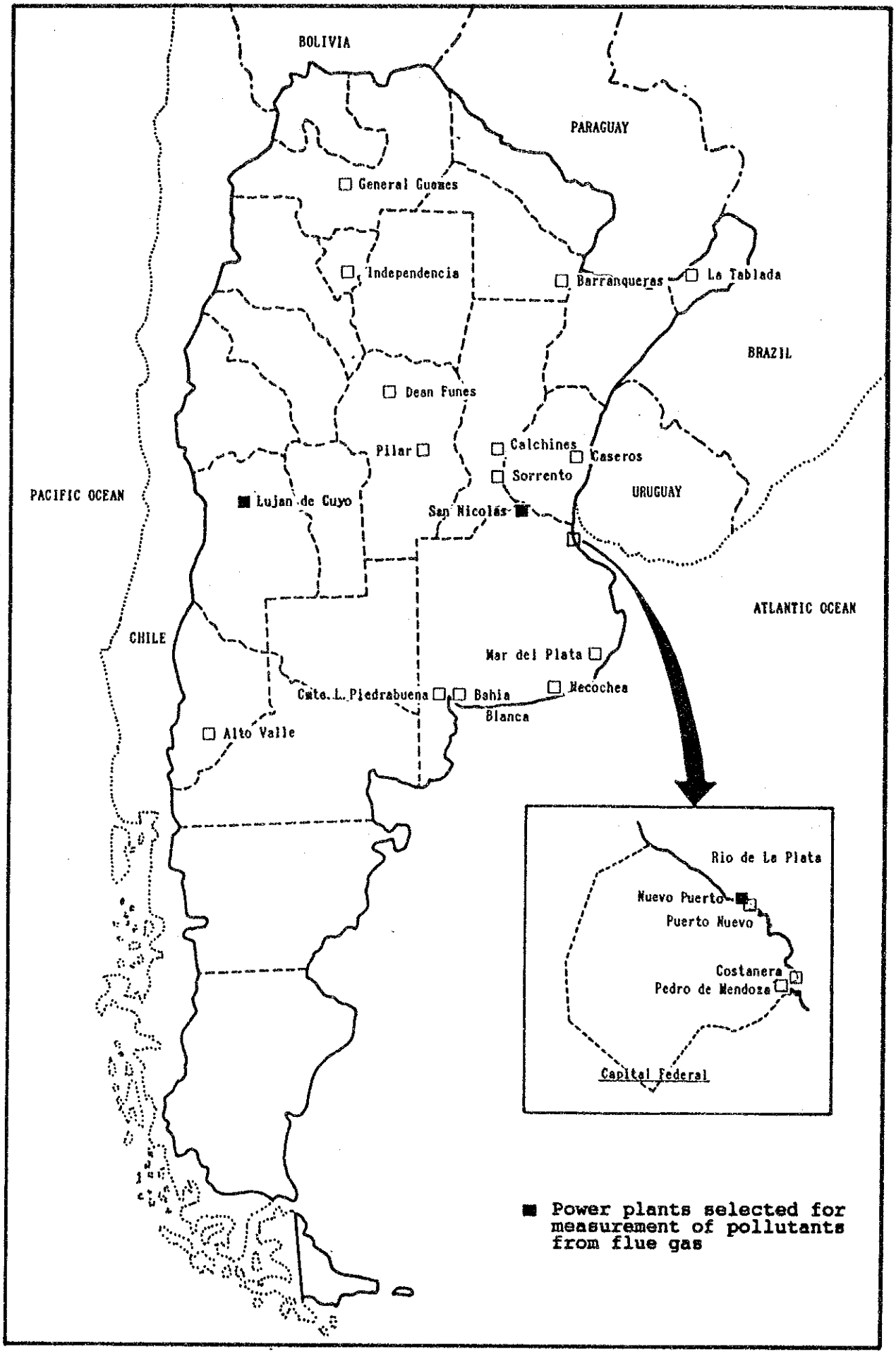

Map of Thermal Power Plant Locations in the Republic of Argentina
(Steam Turbine Generator)

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1 Outline of the Study

1.1 Background of the Study

Between 1970 and the mid 1980's the Argentine Republic suffered destructive inflation and mounting external debt resulting from political instability and failure of economic policies leading to prolonged stagnation of the economy. The current administration, however, has vigorously promoted economic reforms including privatization of national enterprises, introduction of a floating exchange rate system and freeze of excessive liquidities.
As a result, the inflation has been overcome as indicated by 1.8 percent per month decrease in whole sale prices and a mere 0.5 percent per month rise in consumer prices in 1992.

The overall economy as well has steadily grown as demonstrated by recent GDP growth rates: about 8.5 percent both in 1991 and 1992 and 9 percent in 1993.

In addition to the above, the privatization program has continued to be implemented actively since 1992 facilitating expanded investment, improved efficiency leading to economic growth and healthier national budget.

In the meanwhile, the electricity generating capacity of Argentina totals 16,235 MW while demand amounts to 39,130 GWH, 50.8 percent of which is being met by thermal power stations operating at a 36.5 percent utilization ratio. Although the major fuel used by thermal power stations is natural gas, fuel oil and coal are also used in winter when natural gas supply is short of increased demand.

The privatization program of the electricity sector initiated in 1992 was almost completed, enabling power companies to pursue active effort, for increased profitability by renovating their generating facilities. At the same time, the government is attempting to streamline its regulatory supervisory functions matching post-privatization circumstances.

Under such circumstances, the Secretary of Energy (hireinafter referred to as "SE") of the Ministry of Economics representing the Government in the field of the power sector has been formulating environmental protection policies including their detailed operational plans and are ready to implement them in accordance with the contract between the government and power companies at the time of privatization.

In view of such evolutions, the SE of the Argentine Republic requested the Japanese government to provide managerial and technical cooperation relating to environmental pollutants discharged by thermal power stations. The two governments signed an agreement in November, 1992 followed by this study titled "The Study of Air Pollution Control for Thermal Power Plants in Argentine Republic" conducted by the mission sent in March 1993 by the Japanese government acting through the Japan International Cooperation Agency (JICA).

1.2 Objectives of the Study

The study aims to review a governmental policy on air pollution control measures in the Republic of Argentina, to survey its present status, to contribute a technology transfer concerning the quantitative investigation and measurement procedure for the environmental pollutants emitted from flue gas sources in thermal power stations under privatization, to make a recomendation on future administrative role to be execute by SE forth issues, and to propose to SE a measure for the environmental pollution control in accordance with the policy of SE through the investigation of present condition and medium - and long term analysis of an impact of pollutants by the thermal power sector to the whole country.

1.3 Contents of the Study

(1) Review of existing policy and present situation of air pollution control

1) Review of macro-economic condition and economic development policy
2) Review of national policy and present situation of the energy sector
3) Collection and review of existing data concerning air pollution
4) Review of policy and regulations of air pollution control
5) Review of future plan of air pollution control

(2) Investigation of present status of the thermal power plants on air pollution

1) Review of outline of each plant (organization, management, finance, facilities, operation and maintenance, fuel, etc.)
2) Analysis of emission of pollutants from each plant
3) Selection of model plants for measuring the emission gas
4) Measurement of emission gas at each selected model plant
5) Estimation of environmental impact by pollutants from each model plant
6) Evaluation of measured emission gas data and existing power plants from the viewpoint of air pollution control

(3) Study on air pollution control plan on thermal power plants

1) Study on air pollution control strategy
2) Study on measures for air pollution control from the technical and economic viewpoints

(4) Formulation of inspecting and monitoring systems for emission of pollutants from thermal power plants

1) Planning of inspecting system for emission of pollutants from thermal power plants
2) Planning of monitoring system for emission of pollutants from thermal power plants

3) Cost estimated
4) Scheduling

(5) Economic evaluation

1) Analysis of cost effectiveness
2) Analysis of impact to national economics
3) Evaluation of socioeconomic effects

(6) Seminar

A seminar regarding the Study as well as environmental protection in case of Japan will be held in pursuit of technology transfer to Argentine counterpart personnel during the Study conducted in Argentina.

2 Present Status of Economy and Industry in Argentine

2.1 Present Status of Macro Economy

2.1.1 Country Profile

The foundation of the country is laid in 1816 when the independence from the rule of Spanish Emperor was realized. Since that time the development of the country continued consistently with the help of rich, agricultual productivity of the country.

In particular, during the time of 1910's the Argentina developed her agriculture as one of the largest suppliers of agricultural product to the international market, and the status of the country was established as one of the richest countries in the world.

People: It is generally considered that Argentina is the most europeanized country in the South America and the life style of majority of people in the country is very similar to that of Europe. The majority of population at present is the descendants of Spanish and Italian. In addition, substantial number of people are descendants of France, Poland, Russia and Germany. The population was 32,610,000 persons in 1991.

Society: It is well-known that the medical care and the sanitary conditions in the country are quite excellent, which have been maintained by the high living standard of the nation, and therefore there are very little epidemics in the country.

Religion: The majority of the inhabitants is Catholic and the Catholic is accepted as the national religion, however, the freedom in religion is assured by the constitution.

Education:

The level of education in Argentina is also very high. Primary education is compulsory and free for all children from six to fourteen years of age. There are many

universities such as Buenos Aires, Cordoba, La Plata, Santa Fe, Tucuman and Cuyo where the students from other Latin American countries are studing.
It is also well-known that the illiteracy in the country is the lowest in the South America.

Culture: Argentina's cultural life has always had a European orientation. The basic heritage of spanish culture has been maintained in the every field of cultural activities.
In addition, strong influence of France to art and culture of Argentina are observed in similar way of other Latin American countries.
In Buenos Aires, there are more than 60 art galleries, museums, theaters and concert halls. The other large cities also have many such facilities.

Transportation:
Argentina has the most developed railway system in Latin America with 40,000km of railroad line, and the well prepared high way connects the most of major cities in the country.
The navigation and air line system well cover the major parts of the country.

2.1.2 Present Macro Economy of Argentine

(1) Present Condition of Macro Economy

Foreword

The recent development of economy of Argentine indicates clearly the success of economic policy of the present government headed by the President Menem.

The following records of GDP growth, Gross Fixed Investment and annual variation of consumers price disclosed in 1993 by the report of "Ministerio de Economia y Obras y Servicios Publicos" shows the remarkable improvement from the past.

GROWTH RATE OF GROSS FIXED INVESTMENT

Year	%	Year	%
1980	5.0	1987	14.8
1981	-16.3	1988	-2.0
1982	-16.4	1989	-24.4
1983	-0.7	1990	-9.9
1984	-3.4	1991	25.1
1985	-17.8	1992	30.9
1986	15.2		

GDP GROWTH RATE AT CONSTANT PRICES

Year	%	Year	%
1980	1.5	1987	2.6
1981	-5.7	1988	-1.9
1982	-3.1	1989	-6.2
1983	3.7	1990	0.1
1984	1.8	1991	8.9
1985	-6.6	1992	8.7
1986	7.3		

ANNUAL VARIATION IN CONSUMER PRICES

Unit:Annual percentage
Period:1975-1990

Period	General Level Consumer Prices
1975	335.0
1976	347.5
1977	160.4
1978	169.8
1979	139.7
1980	87.6
1981	131.3
1982	209.7
1983	433.7
1984	688.0
1985	385.4
1986	81.9
1987	174.8
1988	387.7
1989	4923.6
1990	1343.9
1991	70.3(Dec)
1992	17.5
1993	6.5(expected)

2.2 Governmental Policy on Air Pollution Preventive Measure

2.2.1 Standard to Control the Air Pollution

In 1973, the government of Argentine enacted the regulations (Derecto) 4858/73 "Preservacion del Medio Ambiente" to keep the proper level for whole general environments in Argentina. And for the atmospheric environment, the standard for maintenance of atmospheric environment has been determined in the same 1973, by the law (Ley) 20284/73 "Preservacion de los Recursos de Aire".

(1) Country's law for maintenance of atmospheric environment (Ley 20284/73)
This law determined the following items:
- The power company shall report the all generating sources having a possibility of air pollution.
- For the country, provinces, and Bs As city (Buenos Aires city), the supervision authority shall be given in each jurisdiction area.
- When the discharge from the contamination source spreads over the complex jurisdiction areas, the committee among the jurisdiction areas shall perform the control and operation.

In addition, the law determined the regulations related to the concentration of contaminants and air pollution levels, together with determining the discharged or exhaust approved limits to the contaminants discharged or exhausted from the vaious fixed generating sources and moving generating sources to the regions, to oblige the publication.

In particular, for the concentration of contaminants, the law determined four levels of "Normal, Watch, Alert, Danger", also determined the penalty regulations together with giving an authority related to restrictions and inhibitions of operations and activities in the contaminated areas, as required.

Regulations related to the concentration by each concentration level are shown in Table 2-2-1.

The section in charge of control for current atmospheric environment as a whole in Argentine government is determined as Governmental Board of Health by the law (Ley 20284/73). This corresponds to the current Natural Resources Life Environment Ministry (Secretaria de Recursos Naturales y Ambiente Humano).

Table 2-2-1 AIR POLLUTION CONTROL STANDARDS IN ARGENTINE

Concentration level / Items	Normal		Watch		Alert		Danger	
	Concent-ration	(Hour)	Concent-ration	(Hour)	Concent-ration	(Hour)	Concent-ration	(Hour)
CO	10 50	8 1	15 100	8 1	30 120	8 1	50 150	8 1
NO_x	0.45	1	0.6 0.15	1 24	1.2 0.3	1 24	0.4	24
SO_x	0.03 70*	Monthly average	1 0.3	1 8	5	1	10	1
O_3 and general oxidant	0.10	1	0.15	1	0.25	1	0.40	1
Suspended matter	150*	Monthly average	Not applied		Not applied		Not applied	
Settled dust	1.0**	30 days	Not applied		Not applied		Not applied	

Note: The unit of concentration is ppm, however, the mark * shows $\mu g/m^3$, and the mark ** shows mg/m^3

CO : 10 mg/m^3 = 8 ppm
NO_x: 10 mg/m^3 = 5 ppm
SO_x: 10 mg/m^3 = 3.8 ppm

(2) Legal regulations in local governments

(a) Buenos Aires city

Bs As city determined the environmental contamination prevention rule "Ordenanza Municipal 39025/83" conforming to the governmental law (Ley 20284/73). For the air pollution level according to the air pollutants as shown in Table 2-2-2, regulation values are determined respectively for short-term (CAPC) and long term (CAPL). In these values, the regulation value for lead whose regulation is not determined by the government.

The section in charge of control for current atmospheric environment in Bs As city is "Environmental Sanitation Department in General Environmental Policy

Control Division" (Direccion General de Politica y Control Ambiental Direccion de Higiene Ambiental).

Table 2-2-2 AIR POLLUTION CONTROL STANDARDS OF BS AS CITY

Items \ Concentration level	Standard	
	Short-term	Long-term
CO	15 mg/m^3	3 mg/m^3
NO_x	0.4 mg/m^3	0.1 mg/m^3
SO_x	0.5 mg/m^3	0.07 mg/m^3
O_3 and general oxidant	0.1 mg/m^3	0.03 mg/m^3
Suspended matter	0.500 mg/m^3	0.150 mg/m^3
Settled dust	1.0 mg/m^2	30 days
Lead	0.01 mg/m^3	0.001 mg/m^3

CO : 10 mg/m^3 = 8 ppm
NO_x: 10 mg/m^3 = 5 ppm
SO_x: 10 mg/m^3 = 3.8 ppm

(b) Mendoza province

Mendoza province determined the atmospheric environmental pollution prevention law "Ley 5100/86" conforming to the governmental law (Ley 20284/73) in the same way as Bs As city.
For the air pollution level due to the air pollutants, as shown in Table 2-2-3, the regulation values are determined by hourly quantity and concentration. In these values, the regulation values for lead and hydrocarbon whose regulation values are not determined by the government are added.
The section in charge of current atmospheric environment in Mendoza province is "Environmental Control Division / Urban Planning / Housing Ministry (Ministerio de Medio Ambiente Urbanismo y Vivienda Direccion de Control Ambiental)".

Table 2-2-3 AIR POLLUTION CONTROL STANDARDS IN MENDOZA PROVINCE

Concentration level / Items	Watch			
	Concentration $\mu g/m^3$	Hours	Concentration ppm	Hours
CO	10 * 40 *	8 hours 1 hour	9 36	8 hours 1 hour
NO_x	100 200	1 year 24 hours	0.05 0.10	1 year 24 hours
SO_x	80 260	8 hours 1 hour	0.03 0.1	8 hours 1 hour
O_3 and general oxidant	125	1 hour	0.06	1 hour
Suspended matter	100 260	30 days 24 hours		
Settled dust	1000 $\mu g/m^2$	30 days		
Lead	10	30 days		
Hydrocarbon (Except for CH_4)	0.19	3 hours		
Hydrocarbon (Total H/C)	160	3 hours		

Note: The mark * shows mg/m^3

CO : 10 mg/m^3 = 8 ppm

NO_x: 10 mg/m^3 = 5 ppm

SO_x: 10 mg/m^3 = 3.8 ppm

2.3 Present Status of Electricity Sector

2.3.1 Outline of Power Facilities

(1) Power system

In Argentine, large capacity hydraulic power plants are located in the northern and western area, nuclear power plants are located in the central area, and large capacity thermal power plants surround the metropolitan area.
These main power generation are connected to on the Ultra-High-Voltage transmission line of 500 kV. They are also connected to the national power supply network with the voltage levels of 330 kV, 220 kV and 132 kV.
The power systems of Argentine are also connected to those of surrounding countries, namely, the Oriental Republic of Uruguay, the Republic of Paraguay and the Republic of Bolivia.
The main power systems in Argentine are shown in the Figure 2-3-1.

(2) Past and current condition of power generation plant

The power generation system in Argentine consists of the hydraulic power generation, thermal power generation (Steam turbine, gas turbine, internal combustion engine) and the nuclear power generation, and trend of plant composition from 1980 to 1993 is shown in Table 2-3-1 and Figure 2-3-2. The power generation capacity increases to approx. 1.61 times in these 13 years, which means the average increasing rate of approx. 4% per year. In particular, the hydraulic power generation plant (approx. 1.9 times) and the nuclear power generation plant (approx. 2.8 times) have shown the great increasing rate, however, for the time, the main part of power source is the thermal power generation plant, so that the thermal power generation occupies the majority, 50.8% in total power generation facilities.

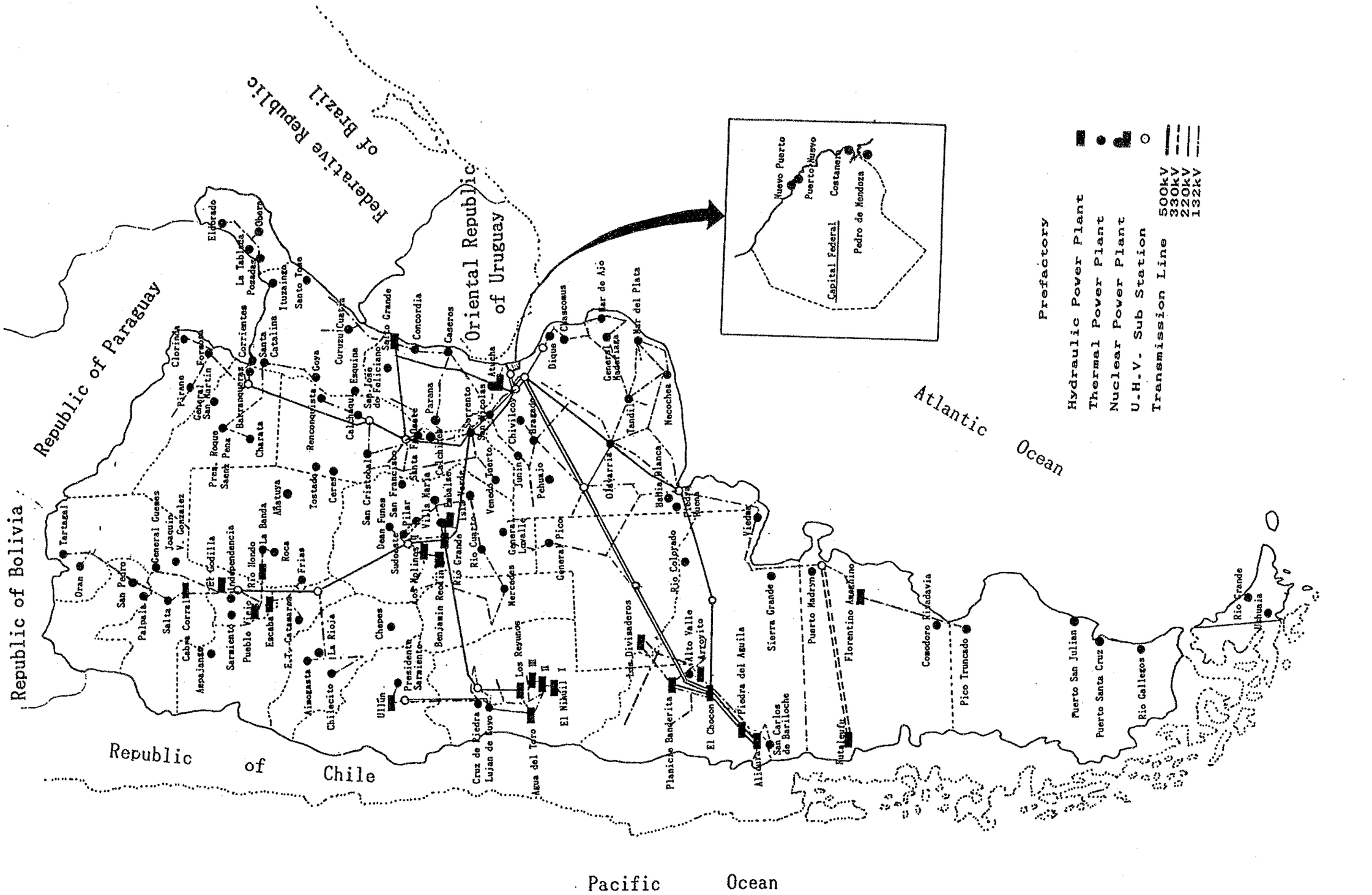


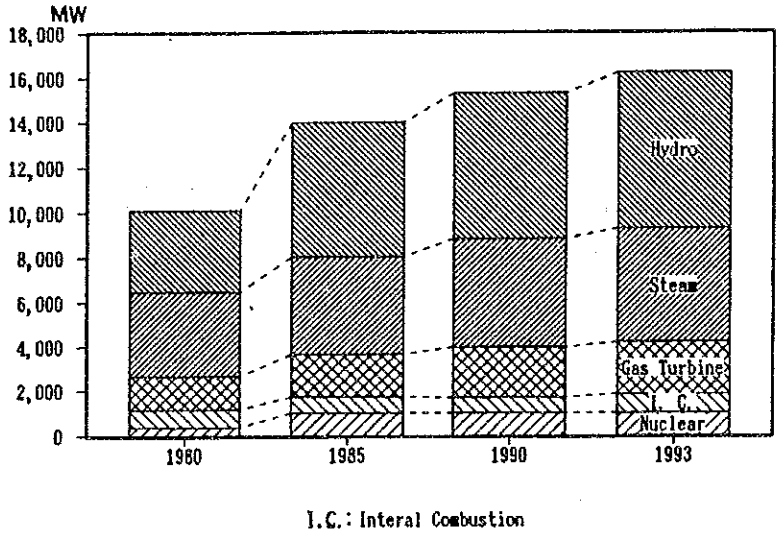
Figure 2-3-1 ELECTRIC POWER SYSTEM IN ARGENTINE

Table 2-3-1 CONFIGURATION AND CAPACITY OF POWER GENERATION PLANTS

(Unit: MW)

Items / Year	Hydraulic power generation	Thermal power generation				Nuclear power generation	Total
		Steam	Gus turbine	Internal combustion power	Total of thermal power generation		
1980	3,601	3,818	1,514	783	6,115	370	10,086
1985	5,967	4,387	1,897	725	7,009	1,020	13,996
1990	6,477	4,874	2,234	683	7,791	1,020	15,288
1993	6,970	5,070	2,355	* 820	8,245	1,020	16,235

Note: * include the combined cycle power plant (160MW)



I.C.: Interal Combustion

Figure 2-3-2 CONFIGURATION AND CAPACITY OF POWER GENERATION PLANTS

2.3.2 Summary of the Condition of Thermal Power Plant in Argentine

(1) Current condition of thermal power plant

The thermal power plants in Argentina consist of the steam, gas turbine combined cycle, and internal combustion power, and the total capacity of power plants at the end of 1993 has reached 8,245 MW.

The outline of main thermal power plants is shown in Table 2-3-2, and for the number of power plants and the number of units, the steam power plants were 21 places (67 units), the gas turbine power plants were 56 places (127 units) the combined cycle power plants 2 places (4 units), and the internal combustion power plants of more than 5 MW were 43 places (252 units).

The maximum unit capacity of thermal power plant is 350 MW of either of No. 6 unit in Costanera power plant, the steam power generator, and No. 5 unit of San Nicolas power plant.

Table 2-3-2 SUMMARY OF MAIN THERMAL POWER PLANT(1) [1992]

(End of March 1993)

Province	Power Plant	Rated Output (kW)	Unit Number	Fuel	Type
Capital Federal	Costanera	1,260,000	7	FG	STEAM
	Nuevo Puerto	420,000	3	FG	STEAM
	Pedro de Mendoza	33,000	3	F	STEAM
	Puerto Nuevo	589,000	3	FG	STEAM
	Pedro de Mendoza	50,000	3	G.GO	T. GAS
Gran Buenos Aires	Dique	152,000	8	D.G.GO	T. GAS
	Dock Sud	211,000	8	D.G	T. GAS
Buenos Aires	Bahia Blanca	50,000	2	F	STEAM
	Mar del Plata	90,000	3	F.G.	STEAM
	Necochea	206,000	4	F.G.	STEAM
	San Nicolas	670,000	5	F.G.C.	STEAM
	Piedra Buena	620,000	2	F.G.	STEAM
	Chivilcoy	19,370	5		DIESEL
	General Madariaga	5,599	4		DIESEL
	Pehuajo	6,026	4		DIESEL
	Tandil	9,452	8		DIESEL
	Bahia Blanca	32,000	2	G.GO	T. GAS
	Bragado	12,000	1	—	T. GAS
	Chascomus	3,400	1	GO	T. GAS
	Junin	16,000	1	GO	T. GAS
	Mar de Ajo	32,000	2	GO	T. GAS
	Mar del Plata	58,882	3	G.GO	T. GAS
	Olavarria	16,000	1	G.GO	T. GAS
	Pehuajo	12,000	1	GO	T. GAS
Catamarca	Ampajango	5,084	7		DEISEL
	E.T. Catamarca	18,000	1	G	T. GAS
Cordoba	Dean Funes	33,000	1	F.G.	STEAM
	Pilar	216,000	4	F.G.	STEAM
	Isia Verde	9,345	3		DEISEL
	Dean Funes	34,000	2	D.G.	T. GAS
	General Lavalle	46,000	2	D.G.	T. GAS
	Rio Cuarto	34,000	2	D.G.	T. GAS
	San Francisco	40,000	2	D	T. GAS
	Sudoeste	140,000	4	D.G.	T. GAS
	Villa Maria	51,000	3	D.G.	T. GAS
Corrientes	Esquina	5,936	8		DIESEL
	Goya	9,586	8		DIESEL
	Ituzaingo	8,268	8		DIESEL
	Santo Tome	7,450	5		DIESEL
	Corrientes	16,000	1	GO	T. GAS
	Curuzu Cuatia	2,750	1	—	T. GAS
	Goya	17,300	1	GO	T. GAS
	Ituzaingo	2,750	1	—	T. GAS
	Santa Catalina	78,200	4	GO	T. GAS
	Santo Tome	2,750	1	GO	T. GAS
Chaco	Barranqueras	45,000	4	F	STEAM
	Charata	5,592	6		DIESEL
	General San Martin	7,296	6		DIESEL
	Pres. Roque Saenz Peña	8,169	3		DIESEL
	Barranqueras	76,300	5	GO	T. GAS
	Pcia. Roque Saenz Peña	17,000	1	—	T. GAS

※ Under 5,000kW DIESEL Type are excluded

Table 2-3-2 SUMMARY OF MAIN THERMAL POWER PLANT(2) [1992]

(End of March 1993)

Province	Power Plant	Rated Output (kW)	Unit Number	Fuel	Type
Chubut	Comodoro Rivadavia	9,000	3		DIESEL
	Comodoro Rivadavia	131,760	6	G	T. GAS
	Puerto Madryn	45,600	2	G	T. GAS
Entre Rios	Caseros	22,400	4	F	STEAM
	Concordia	6,360	2		DIESEL
	San Jose de Feliciano	5,584	8		DIESEL
	Parana	15,400	1	GO	T. GAS
Formosa	Clorinda	8,190	9		DIESEL
	Formosa	16,000	5		DIESEL
	Pirane	7,785	8		DIESEL
	Clorinda	7,400	2	D	T. GAS
	Formosa	16,000	1	D	T. GAS
Jujuy	Palpala	35,600	2	D.G	T. GAS
	San Pedro	31,700	2	G	T. GAS
La Pampa	General Pico	17,000	1	—	T. GAS
La Rioja	Aimogasta	5,936	6		DIESEL
	Chepes	5,736	5		DIESEL
	Chilecito	13,680	7		DIESEL
	La Rioja	9,610	5		DIESEL
	La Rioja	32,000	2	G	T. GAS
Mendoza	Lujan de Cuyo	245,000	3	F.G.	STEAM
	Lujan de Cuyo (1)	31,700	1	—	STEAM
	Cruz de Piedra	36,640	2	G.GO	T. GAS
	Lujan de Cuyo (1)	108,060	4	G.GO	T. GAS
Misiones	La Tablada (2)	22,400	1	—	STEAM
	Eldorado	8,513	7		DIESEL
	Posadas	11,176	4		DIESEL
	La Tablada (2)	87,790	4	D	T. GAS
	Obera	35,200	2	D	T. GAS
Neuquén	Alto Valle	30,000	2	F.G	STEAM
	Alto Valle	67,500	3	G	T. GAS
Rio Negro	San Carlos de Bariloche	7,668	4		DIESEL
	Viedma	11,600	7		DIESEL
	Rio Colorado	7,450	2	GO	T. GAS
	San Carlos de Bariloche	10,928	4	G	T. GAS
	Sierra Grande	36,000	2	G	T. GAS
Salta	General Guemes	245,000	3	G	STEAM
	Joaguin V. Gonzalez	5,735	5		DIESEL
	Oran	9,894	6		DIESEL
	Joaquin V. Gonzalez	2,750	1	GO	T. GAS
	Oran	4,700	1	—	T. GAS
	Salta	10,500	1	—	T. GAS
	Tartagal	17,500	3	G	T. GAS
San Juan	Presidente Sarmiento	31,500	3	G	T. GAS
San Luis	Mercedes	7,780	5		DIESEL
Santa Cruz	Puerto San Julian	5,656	7		DIESEL
	Puerto Santa Cruz	5,640	4		DIESEL
	Rio Gallegos I	6,726	5		DIESEL
	Rio Gallegos II	12,800	4		DIESEL
	Pico Truncado I	43,600	4	G	T. GAS
	Pico Truncado II	21,000	2	G	T. GAS

※ Under 5,000kW DIESEL Type are excluded

Table 2-3-2 SUMMARY OF MAIN THERMAL POWER PLANT(3) [1992]

(End of March 1993)

Province	Power Plant	Rated Output (kW)	Unit Number	Fuel	
Santa Fe	Calchines	40,000	3	F.G	STEAM
	Sorrento	226,000	3	F.G	STEAM
	Calchaqui	5,248	4		DIESEL
	Ceres	5,866	8		DIESEL
	Reconquista	21,140	7		DIESEL
	San Cristobal	6,605	8		DIESEL
	Tostado	5,104	8		DIESEL
	Venado Tuerto	16,976	9		DIESEL
	Renconquista	4,700	1	D	T. GAS
	Santa Fe Oeste	39,000	2	GO	T. GAS
Santiago del Estero	Añatuya	5,372	7		DIESEL
	Roca	9,600	5		DIESEL
	Frias	32,000	2	G	T. GAS
	La Banda	16,000	1	G	T. GAS
Tierra del Fuego	Ushuaia	7,400	5		DIESEL
	Rio Grande	34,000	2	G	T. GAS
	Ushuaia	5,000	2	G	T. GAS
Tucuman	Independencia	80,000	5	G	STEAM
	Independencia	30,100	2	G	T. GAS
	Sarmiento	25,150	2	G.GO	T. GAS
TOTAL		7,756,913	451		

※ Under 5,000kW DIESEL Type are excluded

2.3.3 Medium and Long Term Supply policy of Electricity

(1) The ongoing construction of power plants are listed by Table 2-3-3, which envision start-ups by 1997 of 3608 MW consisting of 1709 MW hydro-power plants, 1154 MW thermal power (gas turbine) plants and 745 MW nuclear power plants.

Table 2-3-3 POWER DEVELOPMENT SITES UNDER CONSTRUCTION

Power Plant	Type	Output(MW)	Operation
Piedra del Aquila	Hydro	700	1993 1)
		350	7/1994
		350	12/1994
Filo Morado	Gasturbine	45	1993 1)
Aqua del Cajon	Gasturbine	90	12/1993
		144	9/1994
Loma de la Lata	Gasturbine	125	5/1994
		125	6/1994
		125	7/1994
Casa de Piedra	Hydro	30	6/1994
		30	9/1994
Tucuman 2)	Gasturbine	500	1996
Pichi Picun Leufu	Hydro	83	1/1997
		83	4/1997
		83	7/1997
Atucha II	Nuclear	745	1997
Yacyreta 3)	Hydro	155	9/1994
		155	11/1994
		155	1/1997
		155	4/1997
		155	6/1997
		155	9/1997
		155	11/1997
		155	1/1997
		155	4/1997
		155	6/1997
		155	8/1997
		155	11/1997
		155	1/1997
		155	4/1997
		155	6/1997
		155	8/1997
		155	11/1997
		155	1/1997
		155	3/1997
		155	6/1997

1) Under operation
2) The plan has be licensed in 1992 but not be constructed.
3) Operation with reduced level reservoir to 1998.

In addition, the Yacyreta Hydro-power Station, whose construction plan was approved by SE, plans to develop 3100 MW (155 MW x 20 units) by July, 1998 as Table 2-3-3 shows.

Furthermore, the power development plans in their pre-construction procedural stages include 3 thermal power plants (gas turbine) totaling 1100 MW as Table 2-3-4 lists, and are expected to start operating in the later 1990's

Table 2-3-4 POWER DEVELOPMENT SITES UNDER PREPARATION FOR CONSTRUCTION

Power Company	Type	Output (MW)	Construction Point
Termo Rio. S.A.	Gasturbine	450	Comahue
Sideco S.A.	Gasturbine	160	El Bracho(NOA)

Consequently, generetors expected to start operating by 2000 will total 7,818 MW, consisting of 2,264 MW thermal plants, 4,809 MW hydro-power plants and 745 MW nuclear plants, on the other hand, electricity requirements in 2000 are predected to reach 77,973 MW at a 95% confidence interval, consisting of 25,274 thermal, 40,939 MW hydro and 11,760 MW nuclear power.

The capacity of electric power generators is expected to reach 24,053 MW, 1.5 times as large as 1993, on the basis of existing facilities and on-going projects.

Table 2-3-5 GENERATING CAPACITY IN 2000

Description / Type	Installed Capacity (MW)			Output (GWh)	Annual Abaila-bility Factor (%)
	1993	2000	Total		
Thermal	8,245	2,264	10,509	25,274	27.5
Hydro	6,970	4,809	11,779	40,939	39.7
Nuclear	1,020	745	1,765	11,760	76.1
Total	16,235	7,818	24,053	77,973	Ref:37.0

Incidentally, of the total electricity of 40,939 GWh to be generated by hydro-power plants in 2000, the Yacyreta Station is projected to account for about 50%.

(2) Supply policy until 2010

As Table 2-3-6 demonstrates, the incremental power generation between 2000 and 2010 is planned to reach 20,765 GWh meeting demand at a 95% confidence level, all of which is planned to be met by thermal power generation.

Table 2-3-6 INCREASE OF PRODUCTION OVER 2000
- Inteval of Confidence at 95% -

Description / Type	Forecast in 2000 (GWh)	Forecast in 2010 (GWh)	Increase (GWh)
Thermal	25,274	46,039	20,765
Hydro	40,939	40,939	0
Nuclear	11,760	11,760	0

Accordingly, thermal power plants to be needed to start operating after 2000 will be either gas turbine plants or combined cycle plants, whose fuel and operating costs are the lowest, under such circumstance, new thermal power plant totaling 3,200 MW at 75% utilization ratio as an example need to be completed by 2010, although the capacity requirements differ depending on what utilization ratio is applied, the standard elements of these estimated facilities are listed by Table 2-3-7.

Table 2-3-7 DETAILS OF FASCILITIES FOR DEVELOPMENT

Description	Unit	Combined Cycle Unit	Gasturbine Unit
Capacity	MW	300	100～150
Heat Rate	kcal/kWh	2,200	2,700
Annual Abailability Factor	%	75	75
Fuei Type	—	Natural Gas	Natural Gas
Unit Price of Construction	$/kW	700	400

These expanded thermal power plants meeting future demand will be installed in the Comahue and NOA regions as Figure 2-3-3 shows, of which 70% is planned to be located in Comahue and 30% in NOA.
These ratios meet both with reserves and production capacity of natural gas and forecasted electricity demand of these regions, Incidentelly, Comahue's demand includes that in the Bs As and Gran Bs As regions, while NOA's demand includes Centro's and Cuyo's.

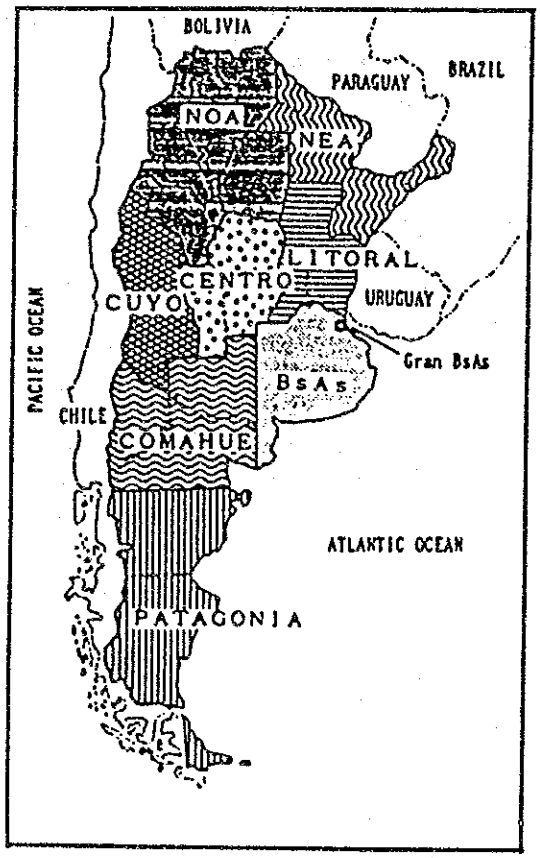


Figure 2-3-3 DIVITED AREA BY ENERGY

3 Current Conditions of Air Pollution by Thermal Power Plants

3.1 Governmental Policy Related to Air Pollution Preventive Measures of Thermal Power Stations

3.1.1 Laws and Regulations Related to Atmospheric Environmental Protection

For atmospheric environmental protection on whole country of Argentina, as mentioned in item 2.5.1, the atmospheric environmental standards have been determined in 1973 by the law (Ley) 20284/73 "Preservacion de los Recursos de Aire", and the power sectors arrange the enforcement regulations (Resoluciones) in turn conforming to the standard.
As a part of these regulations, for the thermal power stations, "Resolución SE N° 718/87" has been enacted.

(1) Enactment of environmental control manual on thermal power plant

For the environmental protection on thermal power plant of conventional type, the enforcement regulation Resolución S.E.E. 149/90 "Manual de Gestion Ambiental de Centrales Termicas Convencionales" has been enforced in 1990.
The content of this enforcement regulation is to define the concrete measures required to maintain the atmospheric environments of power plant at satisfactory level by considering the factors influence the air, water, soil, and other environments at each step from the design to the operation for construction of the steam turbine thermal power plant of conventional type under the control of central government.

(2) Revision of environmental protection manual (Resolución SE N° 154/93)

The privatization of power sector is advanced, and most of the thermal power plant which were under the control of cen tral government are already privatized and the privatization of the transmission companies and distribution companies followed.

Therefore, SE revised a part of enforcement regulation 149/90 shown above (1), and enacted the enforcement regulation 154/93 in 1993.
Namely, the conventional enforcement regulations were applied for the thermal power plant before privatization, however, in future, the enforcement regulations will be developed so as to be applied for all enterprises and organs holding the power plant under the control of central government, and during the operation or will start the operation, together with abolition of provisions which determined the targets of environmental protection to the air, water, soil, and other environmental factors to show the concrete targets and countermeasures newly.

(a) Enactment of emission standards

The emission standards for SO_2 and the dust included in the flue gas exhausted from stacks of thermal power plant are shown in Table 3-1-1.

Table 3-1-1 EMISSION STANDARDS RELATED TO FLUE GAS

Items \ Fuels	Fuel oil	Natural gas	Coal
SO_2 (mg/Nm^3)	≤ 1,700	-	≤ 1,700
Dust (mg/Nm^3)	≤ 140	≤ 6	≤ 120

(b) Measuring items and frequency of flue gas

The measuring items and frequency of flue gas exhausted from stacks for steam turbine generators and gas turbine generators are shown in Table 3-1-2

Table 3-1-2 MEASURING ITEMS AND FREQUENCY OF FLUE GAS

Types / Items	Steam turbine generators		Gas turbine generator
	Less than 50 MW	More than 50 MW	
SO_2	Once/month	Continuously 1)	Once/month
NOx	Once/month	Continuously 1)	Once/month
Dust	Once/month	Periodically 2)	Once/month

Notes: 1) The continuous measurement shall be performed using the continuous automatic measuring instrument with recorder.
2) The intermittent measurement shall be performed using the intermittent automatic measuring instrument.

(c) Countermeasures for NO_x

When a plant (unit) is installed newly, for the boiler of steam turbine generater whose output is more than 50 MW, a low NO_x burner shall be installed.

(d) Observation of regulations

When enterprises or organs having the responsibility of design, construction, and operation of thermal power plant did not observe the regulations above, the jurisdictional organ shall give the warning. Even when the term determined by the jurisdictional organ has passes, if this regulation is not observed, the jurisdictional organ can instruct the stop of the work or the operation of the corresponding generator until the causes are dissolved.

(e) Air pollution preventive measures for power plant except for the power plant under the control of central government

For the thermal power plant which are possessed by the provinces, cooperative societies, and other organizations (City management, etc.) except for the plant under the control of central government, the regula-

tions of S.E.E. 149/90 or 154/93 are applied, if they are inter-connected. And all basic policies to reduce the influence to the atmospheric environments due to the flue gas from the thermal power plant are in the same conditions regardless of owners. From this recognition, the future policies of regulations in each organ who controls the province managed thermal power stations or other thermal power stations are in the same direction as the policies for power companies under the control of central government.

Therefore, for power stations except for the plant under the control of central government, the future policies for regulations are advanced in the direction to apply correspondingly the serial targets and countermeasures such as emission standards or flue gas measurement, etc. shown in the enforcement regulation 154/93.

(3) Laws and regulations concerned

For the atmospheric environmental protection of thermal power plant, laws and regulations concerned are shown below;

1) Law (Ley) 24065/92 and governmental ordinance (Decreto) 634/91
These law and ordinance determine the partial charge of role accompanied by reorganization of power plant.

2) Law (Ley) 21608/77 "Promocion Industrial"
For the project to be constructed newly, when receiving the government encouragement plan, this law obliges to perform environmental impact predicting assessment.

3) Law (Ley) 24051/91 and governmental ordinance (Decrete) 831/93 "De Residuos Peligrosos"
These law and ordinance determine the standard for emission of contaminants generated from the industrial projects to the air.

3.1.2 Management Organs for Atmospheric Environmental Protection of Thermal Power Plant

(1) Management and supervision organs

As an organ to control the operation in each section from the power generation to the consumption of power sections properly, the Electrical Power Administrative Management System (Ente Nacional Regulador de la Electricidad, ENRE) was established conforming to the law (Ley) 24065/92.
The basic enterprise that ENRE performs is the supervision for execution sections of public services, which includes, effective supply, transmission, and distribution of power, in the jurisdiction area conforming to the governmental ordinance (Decreto) 1398/92.
In the supervision functions, the responsibility of setting up required regulations and standards related to the general safety and environmental protection is included, when each facility of power generation, transmission, transformation, and distribution is constructed or operated.

(2) Role of ENRE related to air pollution protection

ENRE is obliged to control the execution of various measures required for atmospheric environmental protection of thermal power plant determined by the enforcement regulation (Resolucion SE N° 154/93 including annexture regarding the air pollution control for privatization) and ENRE instructs the periodic presentation of measured data from power plant to control the flue gas data obtained in each power plants together with control the achievement condition of emission standards.
Also, ENRE may perform the cross check to the flue gas measurement of power plant.
In addition, ENRE performs examination of environment assessment report submitted by the power plants (Evaluacion de Impacto Ambiental) whose presentation is obliged by SE when each power plants is privatized.
ENRE is also in the situation to advice the power plant for selection of measuring methods and measuring instruments

suited to each power plants for the flue gas measuring performed by each power plants.

3.1.3 Execution System of Investigation Related to Air Pollution Prevention

In order to establish the system to perform the investigation of environmental problems related to power supply, SE concluded the technical cooperative agreement with the Argentine Atomic Energy Commission (Comision Nacional de Energia Atomica CNEA) in 1992.

(1) Contents of the technical cooperative agreement

The purpose of the technical cooperative agreement concluded between SE and CNEA is common creation and execution of the plan related to the investigation of the following environmental problems.

- The investigation related to drain or flue gas generated from the power generating facilities.
- Evaluation of environmental condition in the surounding area of power plants
- Deployment of talents related to the operation of measuring instruments for environmental monitoring and the data analysis.

(2) Relevance between SE and ENRE

As mentioned above, SE has the obligation for the enactment of environmental law and standards related to the power sector, and management of observation for these law and standards shall be performed by ENRE.
Therefore, according to the technical cooperative agreement between SE and CNEA, the inspection of environmental measurement for which ENRE is responsible can be performed smoothly by incorporating the inspection work into the investigation system of environmental problem by CNEA who has the personnel, system, and experience related to the whole environmental problems, such as, drain or flue gas, etc.

(3) Role of CNEA

CNEA performs through the Department of the New Sources and Rational use of Energy, the work entrusted by the coordinative committee (Comite Coordinador) organized between CNEA and SE directly or through a third party, and performs management of the work shown in (1) above simultaneously.
CNEA also performs the measurement, for which ENRE judges necessary, to manage the observation condition in power companies, for the "emission standards related to solid wastes, flue gas, and drain generated from thermal power plant" set by SE.

3.2 Measurement of Pollutants from Flue Gas and in the Ambient Air in the Selected Model Plants

3.2.1 Outline of the Measurement of Pollutants from Flue Gas and in the Ambient Air

(1) Objective of Measurement

In order to develop a monitoring system for flue gas emission of power plants, it is very important to establish a standard procedure of measurement and analysis of pollutants in flue gas of the stack and in the area around the target emission source together with set-up of institutional measures by the Government.

Therefore, it was agreed by the both Government through several discussions that actual measurement of pollutants from selected model plants and in the ambient air around the area of these shall be conducted by the Study Team in cooperation with CNEA, counterpart organization of the Government of Argentina, and that technology transfer on overall technology of monitoring of pollutant emission from flue gas shall be carried out from the Team to CNEA.

In addition to the above, through the actual measurement, it is clear that investigation of the present state of pollutants emission from the thermal power plants shall be carried out to understand a contribution of pollutant emission from the thermal power sector to the air pollution level of the country.

(2) Plan and Procedure of Measurement

1) Targeted Model Plants

The following three thermal power plants have been selected as candidates for a model plant based on the first field Survey conducted from 6 to 30 of March, 1993.

(a) Nuevo Puerto Power Plant (Number 5 Unit for Turbine, 13 Unit for Boiler)

Nuevo Puerto Plant is located in the Federal Capital, that is one of the biggest cities in the world and its capacity is relatively large, and also, Nuevo Puerto is one of the biggest thermal power plants in view of their capacities, therefore, it is considered that its impact of emission from these shall be investigated as a typical model in the BSAS which is in an urban type air pollution.

(b) Lujan de Cuyo Power Plant (Number 12 Unit)

Lujan de Cuyo plant is deemed as one of the typical small and medium scale power plant in Argentina and its location characteristics of the area where various kind of manufacturing industries are located are also very interesting and its impact and influences to the area should be studied.

(c) San Nicolas Power Plant (Number 5 boiler, Turbine 5 Unit)

San Nicolas Plant is the only one coal-fuel power plant in Argentina, the use of coal can not be ignored at this moment, in view of the necessity of diversification of energy sources, and it is agreed that SO_2 impact test shall be conducted in this plant in consideration of the topographical characteristics of the land around the plant and non-existence of emission sources of SO_2 excluding ACEROS PARANA steel plant.

2) Pollutants to be Measured for Flue Gas and in Ambient Air

(a) Pollutants in Emission from Flue Gas

Important pollutants from flue gas emission are sulfuric dioxide (hereinafter referred to as SOx excluding in the analytical definition in this report, because this

SO_2 is converted to SO_3 in the process of oxidation in the air), Nitrogen Monoxide (hereinafter referred to as NOx as same in case of SOx) and Dust.

Therefore, it was determined that these three pollutants including oxygeon as an important parameter for operational control of combustion of boiler shall be measured and analyzed in the measurement of flue gas for the model plants.

(b) Pollutants in the Ambient Air

In general, air contaminants to be measured for the ambient air are primary air pollutants composed of fine particles less than 100 micro mm, sulfur compound (SOx), oxides of nitrogen (NOx), carbon monoxide, halogen compounds, organic compounds, and radioactive compounds and secondary air pollutants consists of ozone, formaldehyde, peroy acetyl nitrate, photochemical smog and acid mist etc.

However, any other pollutants except SOx, NOx, and dust were deleted to our measurement because these are not included in our target stationary sources, boiler and/or secondary air pollutants to be generated together with other stationary or mobile sources.

Therefore, measurement of these pollutants (SOx, NOx, and Suspended particulate matter, SPM) was planned with the major aim contributing to technology transfer from the Study Team to CNEA.

In addition to the above, impact test of SOx emission from a thermal power plant was planned to evaluate how much impact of stack emission was observed in the surrounding area of the plant.

Regarding the site, San Nicolas plant was recommended as a model plant for this test because topographical condition is desirable in view of its flatness of land

and there are few other stationary sources except ACEROS PARANA Steel plant against the recognition of existence of many complicated condition for other sites of Nuevo Puerto and Lujan de Cuyo Plant and only SOx measurement shall be conducted among the target pollutants to eliminate any other measurement which may disturb to exact evaluation of the impact of emission source.

3) Outline of Analytical method and Analyzers utilized in the measurement

During the site survey conducted in July and November in 1992 and the first survey by this Study Team, it was found that there are few instrument analyzers popularily used in Argentina and also there are few institutional organizations and/or private research institutes which are conducting actively a measurement of pollutants in ambient air and also from emission sources.

However, it was observed in several thermal power plants which are actively going to introduce the instrument to monitor the emission of flue gas in accordance with the agreement with SE concerning on a privatization of the power plant.

Therefore, in principle, analytical methods and analyzers to be utilized in this measurement are determined in accordance with following criteria:

(a) EPA and/or WHO popularly used in the USA and European countries including some Latin American countries shall be adapted if there are no obstacles in the procurement of the instruments and/or small supporting equipment or chemical reagents.

(b) Chemical analysis methods shall be a major method because they are very important for the Government of Argentina to promote and establish a further institutional set-up of own measurement procedures.

(c) Instrument analyzers shall be arranged and prepared in consideration of the time when fuel oil for boiler are converted to natural gas due to characteristics of the present system in the power plants.

(d) Portable instrument analyzers are principally selected in consideration of easy transportation and inspection promotion by the CNEA staff and also, some portable analyzer being introduced to some thermal power plants are provided in view of necessities of internal checking of measured value of pollutants by the power plants and consultation of difficulties on the analyzer.

(e) It was decided by the Japanese Government that analyzer to be needed for a further promotion of measurement of pollutants from flue gas and in the ambient air shall be provided to the Government of Argentina if these analyzers will be technically transferred to the counterpart during the measurement period and being effectively used in the counterpart for NOx, SOx, and SPM monitor.

Major analytical methods and analyzers used in this measurement are shown in Table 3-2-1.

Table 3-2-1 OUTLINE OF ANALYTICAL METHODS AND ANALYZERS UTILIZED IN THE STUDY

Analysis method	: Analyzer	: Remarks
1. Measurement of Flue Gas		
1)Electro-chemical	Portable Analyzer MSI-2000	SOx,NOx,O_2,CO
2)Infrared Absorption	Auto-mated Conti-nuous analyzer IRA-107	SOx

3)Chemiluminescence	Auto-mated Continuous Analyzer NOA-7000	NOx, O_2
4)Zinc-NEDA	Chemical Analysis	NOx
5)Precipitation Titration	Chemical Analysis	SOx
6)Direct Weight Measurement	Dust Sampler	Dust, Sampling of NOx, SOx
7)Light Scattering	Portable Dust Monitor	Dust
8)Chemical Absorption	Orsat Apparatus	O_2, CO, CO_2
2. Measurement of Ambient Air		
1)Saltzman	Chemical Analysis Absorption: Air Sampler and Impinger set S601, 8003-2	NOx
2)Pararosaniline	Chemical Analysis Absorption: Air Sampler and Impinger set S-601, 8003-2	SOx
3)Direct Weight Measurement	High Volume Air Sampler HVC-1000N	SPM
4)Beta-Ray Absorption	Auto-mated Continuous Monitor BAM-102S	SPM
5)Chemiluminescence	Auto-mated Continuous Monitor APNA-350E	NOx
6)Ultraviolet Absorption	Auto-mated Continuous Monitor APSA-350E	SOx
7)Beta-Ray Absorption	Auto-mated Continuous Monitor APDA-350E	SPM

3. Supporting Equipment

1)Wind Speed Meter	Propeller type	Wind direction and speed
2)Electric Balance	3100gr x 10mg	for chemical analysis
3)Personal Computer	486, IBM Compatible	for data analysis and simulation
4)Chemical Reagent	Zinc-NEDA, Precipitation Titration, Saltzman, Pararosaniline	
5)Glass Ware	Same as above	
6)Incubator		for cooling and storage of sample
7)Transportation Vehicle	Renault	for circular measurement services to the plants

(3) Overall Schedule of Measurement

Measurement was conducted for eight weeks at three model plants. The overall schedule is shown in Figure 3-2-1.

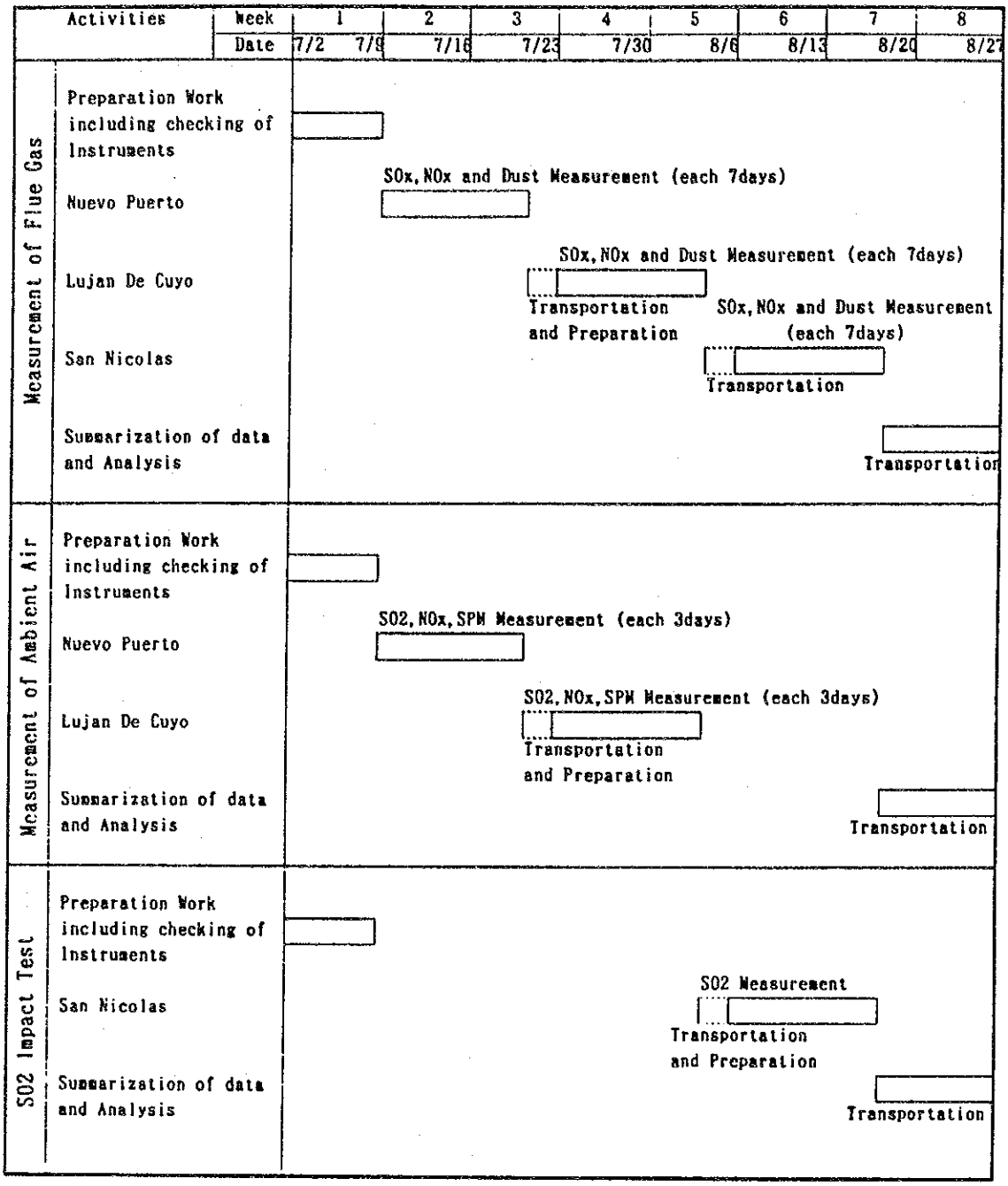


Figure 3-2-1 MASTER SCHEDULE FOR MEASUREMENT OF FLUE GAS AND AMBIENT AIR IN THE TARGETED MODEL THERMAL GENERATION PLANTS

3.3 Evaluation of Impact of Pollutants Emitted from Thermal Power Plants

3.3.1 Evaluation through Simulation Model

(1) Input data

Table 3-3-1 shows input data for the 3 candidates.

(2) Output data

Table 3-3-2 shows output data for the 3 candidates.

Table 3-3-1 PARAMETERS FOR CALCULATION OF SHORT TERM DISPERSION MODEL

Item \ Power Plant	(Unit)	Nuevo Puerto	Lujan de Cuyo	San Nicolas
Boiler No.		13	12	5
Power Generation	(MW)	110	60	350
Ranges in East-West [X]	(m)	50,000	35,000	40,000
Ranges in North-South [Y]	(m)	50,000	35,000	40,000
Stack Height [HO]	(m)	47	50	120
Stack Diameter [D]	(m)	3	4.1	8.1
Amount of Flue Gas (Wet)	(Nm3/h)	468,000	271,000	1,410,000
Flue Gas Temperature	(℃)	136	116	134
Amount of Pollutants (SO2)	(Nm3/h)	94	72	630
Wind Direction	(°)	NE (45)	SW (225)	E (90)
Wind Speed	(m/s)	3.9	1.7	3.2
Potential Temperature Gradient	(℃/m)	0.0033		
Plume Rise Formula		CONCAWE		
Dispersion Formula		Pasquill-Gifford		
Atmospheric Stability		D (Neutral)		
Mean Diffusion Time	(min)	60		
Effective Stack Height	(m)	182.6	225.7	390.8
Smoke Rising Height	(m)	135.6	175.7	270.8
C max:Maximum Ground Concentration	(ppm)	0.006259	0.006527	0.007345
Distance from source to C max point	(m)	7,998.2	11,061.4	26,962.7

Table 3-3-2 OUTPUT DATA FOR THE 3 CANDIDATES

Place	Concentration of Superposition (ppm)	Location (m) X: East-West	Y: North-South
Nuevo Puerto P.P	—	45,000	5,000
Boca	0.000E+00	48,530	13,530
CNEA-Tandar	0.000E+00	28,660	4,250
Moron	1.733E-05	25,000	15,000
Luian de Cuyo P.P	—	5,000	30,000
CNEA-Cuyo	5.011E-03	16,650	17,140
Munici. LH	1.141E-05	16,050	7,090
Parque SM	4.048E-06	12,630	12,310
Polideportivo	1.299E-04	20,970	21,160
Escuela No.1-237	0.000E+00	12,430	32,110
San Nicolas P.P	—	38,000	20,000
Club Somisa	0.000E+00	38,560	20,200
Aero Club	0.000E+00	36,350	23,580
Club CyP	0.000E+00	37,640	25,420
Camping LyF	0.000E+00	34,070	23,210
Escuela No.35	0.000E+00	33,270	19,760
Munici. SN	0.000E+00	34,260	17,920

※ Location [X=0, Y=0] Corresponds to NW Corner

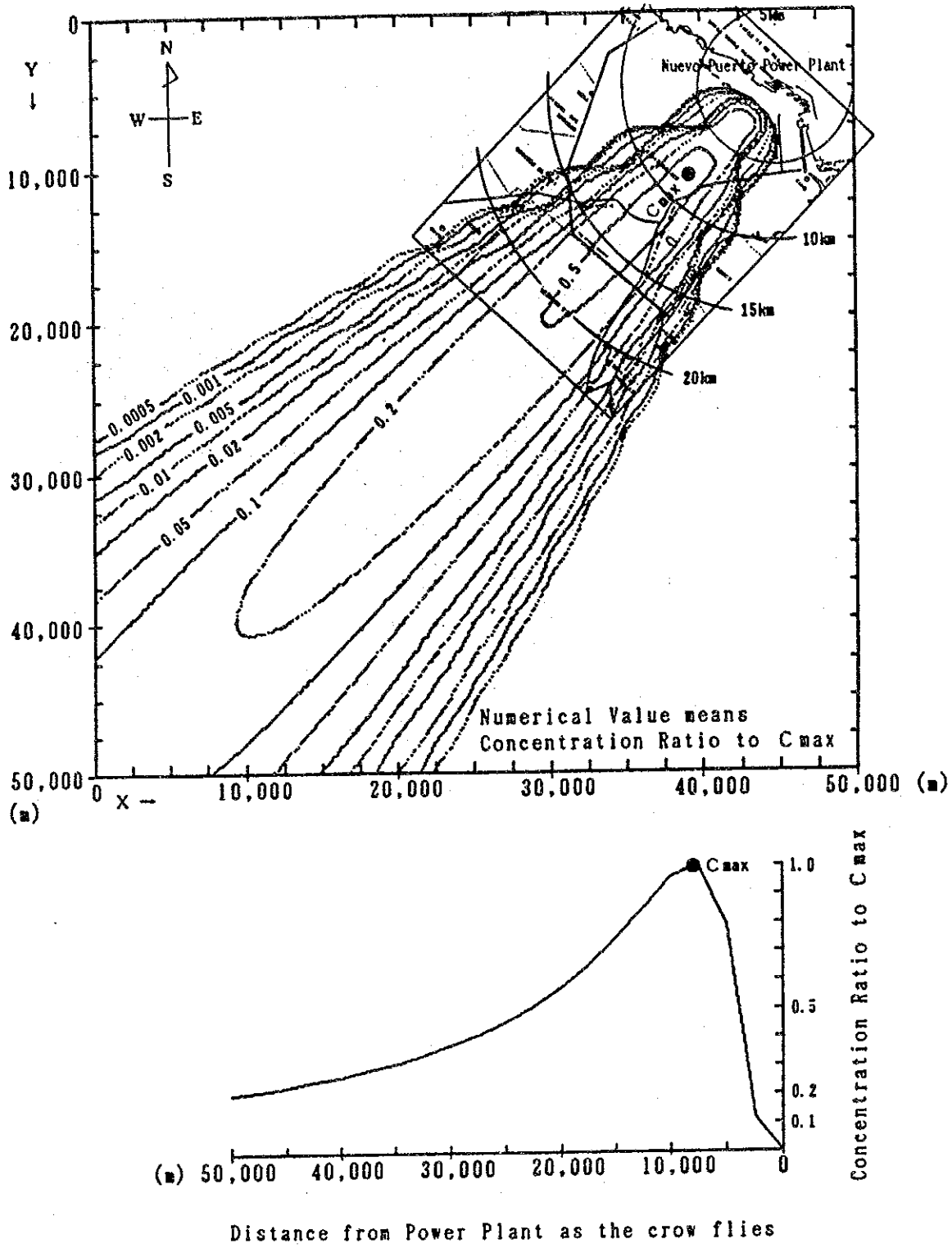


Figure 3-3-1 NUEVO PUERTO POWER PLANT AREA [BUENOS AIRES]

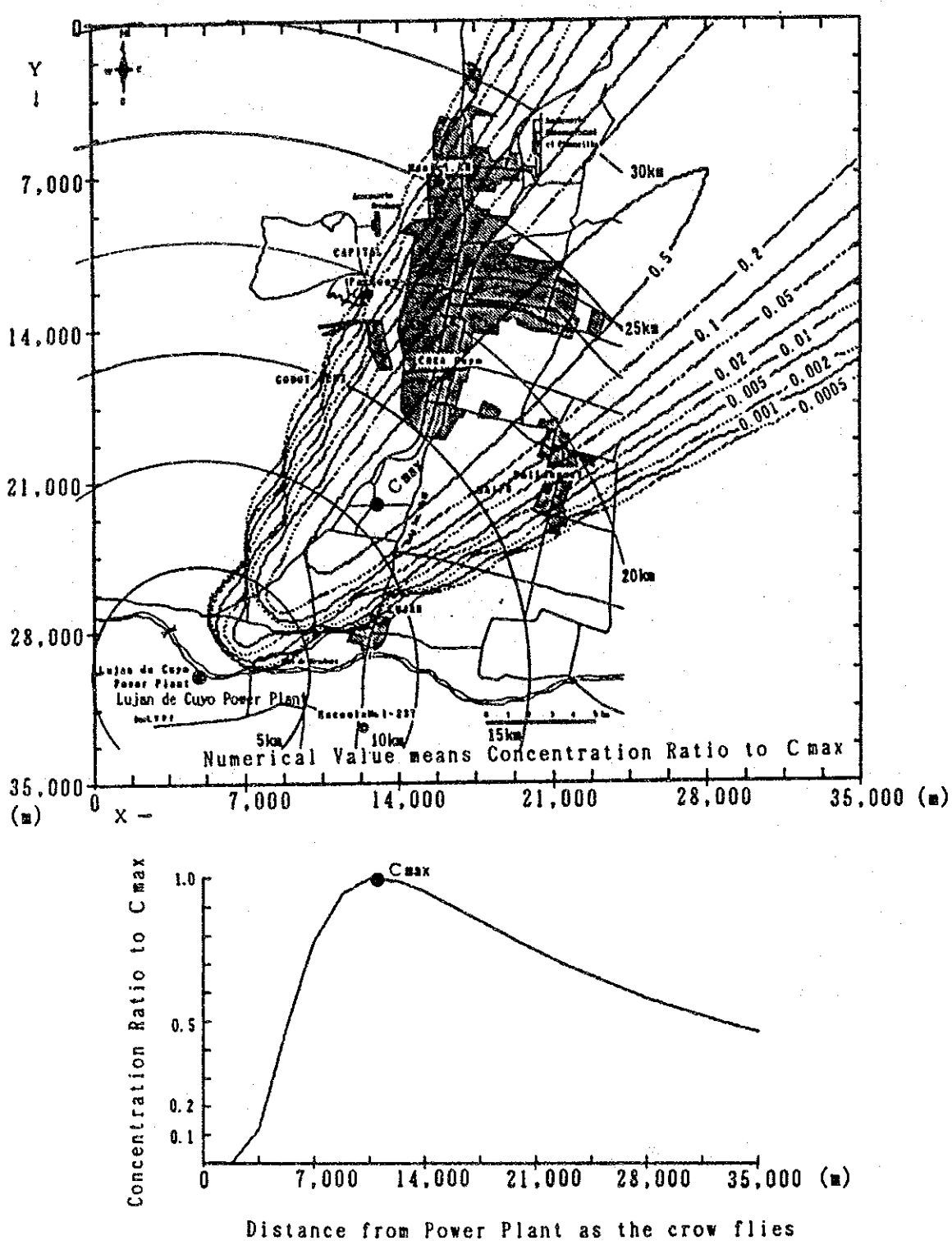


Figure 3-3-2 LUJAN DE CUYO POWER PLANT AREA [MENDOZA]

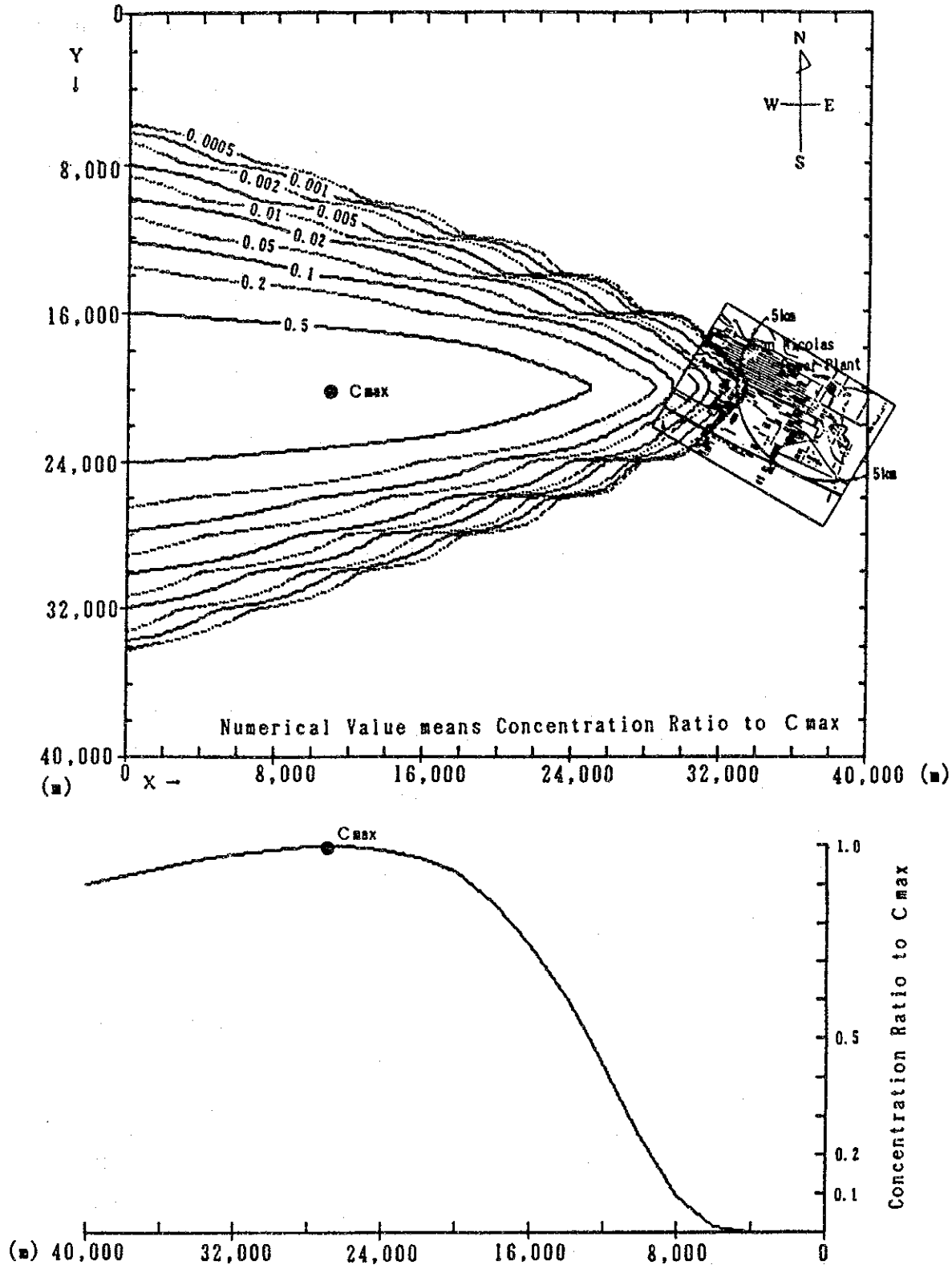


Figure 3-3-3 SAN NICOLAS POWER PLANT AREA [SAN NICOLAS]

3.3.2 Overall Assessment of Emission from Thermal Power Plants

(1) Estimated Amount of Pollutants from majour subsector

Estimation of Total Environmental Pollutants in Argentine Republic

	SOx	NOx	Dust
Electricity	38079	71693	
Steel Plants	11564	8157	88062
Petrochemicals	3728	1176	
Cement		84950	17900
Paper and Pulp	13843	5736	4037
Automobile		107994	
Total	67214	279706	109999

	Environment Index	NOx	SOx
Gross GDP (million US$)	93260		
Gross Population (mill.)	32.61		
GDP per Cap (US$/head)	2860		
Primary Energy consumption (thousand toe)	34196		
Primary Energy consumption per head (kg-oe/head)	1049		
Energy Consumption per GDP (toe/GDP)	367		
Emission (Ton/yr)		279706	67214
Emission per head (kg/head)		8.6	2.1
Emission per GDP (g/US$)		3	0.72
NOx cal (1000 Ton/yr)1/,2/	302		342
Emission per head (kg/head)	9		10
Emission per GDP (g/US$)	3		4

(2) Relationship between Population, GDP and Consumption of Primary Energy

Table 3-3-3 shows world's energy consumption per capita annual average growth rate of the year. The 1987 per capita energy consumption of the world was 1680 kg-oe,and those in Asia, Africa, Middle East and Latin America were lower than this figure. As for regional records, developing countries consumed 636 kg-oe, the planning economy countries 1646 kg-oe, and to OECD countries 5060 kg-oe per capita in 1987.

Figure 3-3-4 shows GDP per capita and energy consumption per capita of the major regions, demonstrating GDP and energy consumption per capita are positively correlated.
Figure 3-3-5 shows GDP per capita of energy consumption per GDP dollar of the world, demonstrating GDP per capita and energy consumption per GDP dollar are negatively correlated perhaps partly due to energy conservation efforts made since the second oil crisis.
As Table 3-3-3 shows, Argentina belongs to the world average group in terms of energy consumption per capita and matches the Middle East group in terms of energy consumption per GDP dollar, possibly due to underestimated GDP or energy conservation pursued more effectively than is thought.

(3) Relation between GDP and SOx Emission

Figure 3-3-6 shows the relationship between GDP and SOx emission. The SOx emission per capita of Argentina is 2.1kg (Japan 6.7, USA 83.2, Canada 144.7, Germany 15.7) and the SOx emission per GDP dollar is 0.72g (Japan 0.5, USA 4.6, Canada 8.5, Germany 1.5), which are rather low.

Table 3-3-3 POPULATION, ENERGY CONSUMPTION OF OECD COUNTRIES

Country	Population (1000)	Area (1000 km2)	Consumption of Energy (MTOE/MTEP)	GDP (billion of US$) 1989	Electricity Garanted (TWh)	Consumption of Energy by GDP (TOE/1000 $US)	SOx (1000tons)	NOx (1000tons)	Energy (kg-oe/ Capita)	GDP/人	Energy (toe/ MilUS$)	SOx (g-SOx/ US$)	NOx (g-NOx/ US$)	SOx (kg/ Capita)	NOx (kg/ Capita)
Canada	26.248	9.976.1	164.06	449.2	499.4	0.46	3.800	1.959	6.250.4	17.114	365	8.5	4.4	144.77	74.63
USA	248.777	9.372.6	1.392.71	4.547.0	2.954.1	0.38	20.700	19.800	5.598.2	18.277	306	4.6	4.4	83.21	79.59
Japan	123.116	377.8	288.51	1.714.2	791.2	0.21	835	1.176	2.343.4	13.923	168	0.5	0.7	6.78	9.55
Australia	16.807	7.686.9	57.47	213.1	147.1	0.30			3.419.4	12.676	270	0	0	0	0
N.Zealand	3.343	268.7	9.23	33.8	28.7	0.24			2.761.0	10.114	273	0	0	0	0
Austria	7.624	83.9	20.27	90.5	49.3	0.26	121	213	2.658.7	11.868	224	1.3	2.4	15.87	27.94
Belgium	9.938	30.5	33.80	119.7	66.8	0.34	414	297	3.401.1	12.043	282	3.5	2.5	41.66	29.89
Denmark	5.132	43.1	13.42	66.3	22.8	0.27	242	249	2.615.0	12.927	202	3.6	3.8	47.16	48.52
Finland	4.964	338.0	22.69	66.1	53.7	0.40	302	276	4.570.9	13.306	344	4.6	4.2	60.84	55.6
France	56.160	549.0	142.60	725.2	403.0	0.24	1.223	1.656	2.539.2	12.912	197	1.7	2.3	21.78	29.49
Germany	78.665	356.9	190.88	822.9	438.4	0.28	1.237	2.859	2.426.5	10.461	232	1.5	3.5	15.72	36.34
Greece	10.033	132.0	14.83	64.5	34.2	0.21			1.478.1	6.430	230	0	0	0	0
Iceland	253	103.0	1.08	3.6	4.5	0.29			4.268.8	14.111	303	0	0	0	0
Ireland	3.515	70.3	7.44	28.0	13.5	0.30	174	115	2.116.6	7.963	266	6.2	4.1	49.5	32.72
Italy	57.525	301.2	118.15	708.5	207.3	0.18	2.006	1.705	2.053.9	12.317	167	2.8	2.4	34.87	29.64
Luxembourg	378	2.6	3.24	5.7	0.6	0.79	12	22	8.571.4	15.185	564	2.1	3.8	31.75	58.2
Netherlands	14.849	40.8	50.95	180.3	73.1	0.33	259	585	3.431.2	12.144	283	1.4	3.2	17.44	39.4
Norway	4.227	324.2	17.88	61.6	116.7	0.34	67	225	4.230.0	14.561	290	1.1	3.7	15.85	53.23
Portugal	10.337	92.4	12.17	63.9	25.7	0.17	205	122	1.177.3	6.180	191	3.2	1.9	19.83	11.8
Spain	38.888	504.8	58.75	355.6	145.6	0.18	-	826	1.510.7	9.144	165	0	2.3	0	21.24
Sweden	8.493	450.0	33.18	116.7	143.7	0.36	213	396	3.906.7	13.742	284	1.8	3.4	25.08	46.63
Switzerland	6.723	41.3	19.73	105.4	53.8	0.20	74	194	2.934.7	15.680	187	0.7	1.8	11.01	28.86
Turkey	55.255	780.6	39.11	219.3	52.0	0.19	25	2.642	707.8	3.969	178	0.1	12	0.45	47.81
UK	57.236	244.8	147.95	727.2	310.7	0.24	3.813	480	2.584.9	12.705	203	5.2	0.7	66.62	8.39
Yugoslavia	23.800	255.8	25.04	0.0	86.3		1.600	21.700	1.052.1	0	ERR	ERR	ERR	67.23	911.76
N. America	275.025	19.348.8	1.556.77	4.996.0	3.453.6	0.39	24.200	12.600	5.660.5	18.166	312	4.8	2.5	87.99	45.81
Australia	20.150	7.955.5	66.71	246.8	175.9	0.29	-	10.900	3.310.7	12.250	270	0	44.2	0	540.94
OECD	430.195	4.489.3	948.12	4.530.8	2.215.7	0.25	-	36.200	2.203.9	10.532	209	0	8	0	84.15
EEC	342.656	2.368.4	794.19	3.866.9	1.741.8	0.24	-		2.317.7	11.285	205	0	0	0	0
OECD	848.486	32.171.4	2.860.11	11.488.0	6.636.3	0.30			3.370.8	13.539	249	0	0	0	0
World	5.292.200	133.824.7	5.566.40		11.403.3									0	0

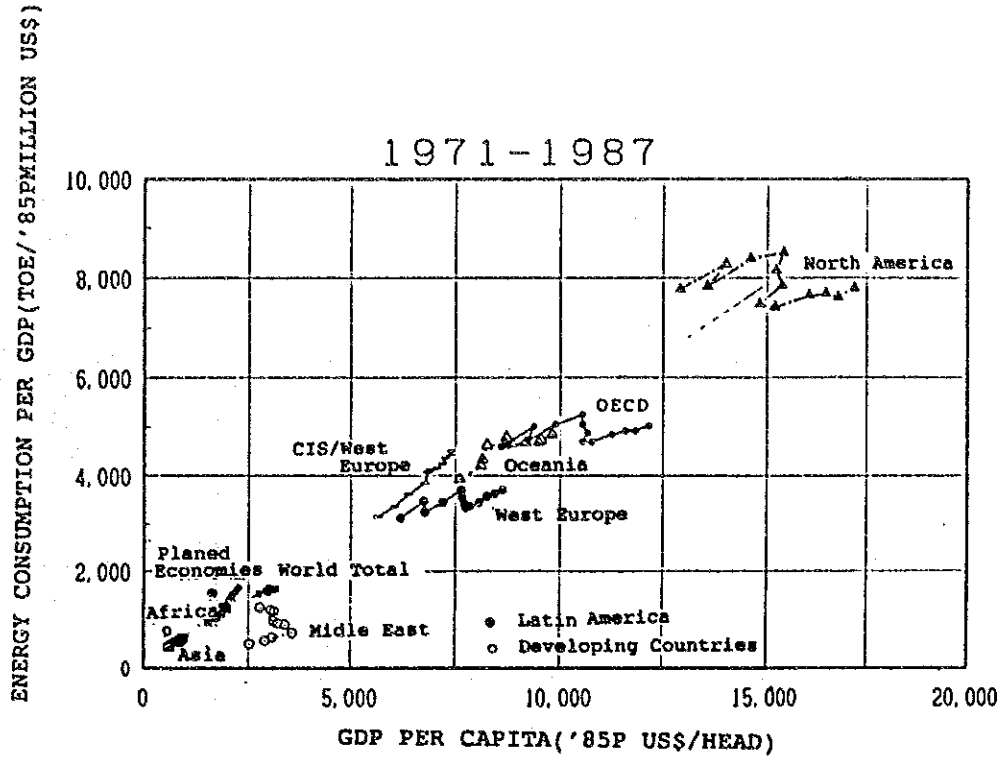


Figure 3-3-4 RELATIONSHIP BETWEEN GDP PER CAPITA AND ENERGY CONSUMPTION FOR REGION OF THE WORLD

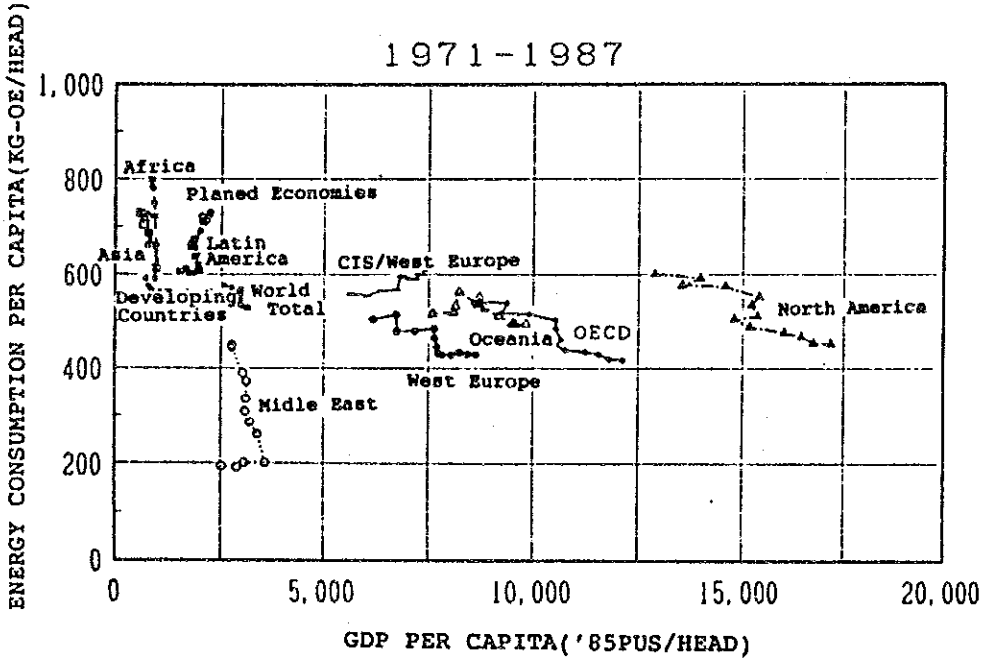


Figure 3-3-5 RELATIONSHIP BETWEEN GDP PER CAPITA AND ENERGY CONSUMPTION PER GDP

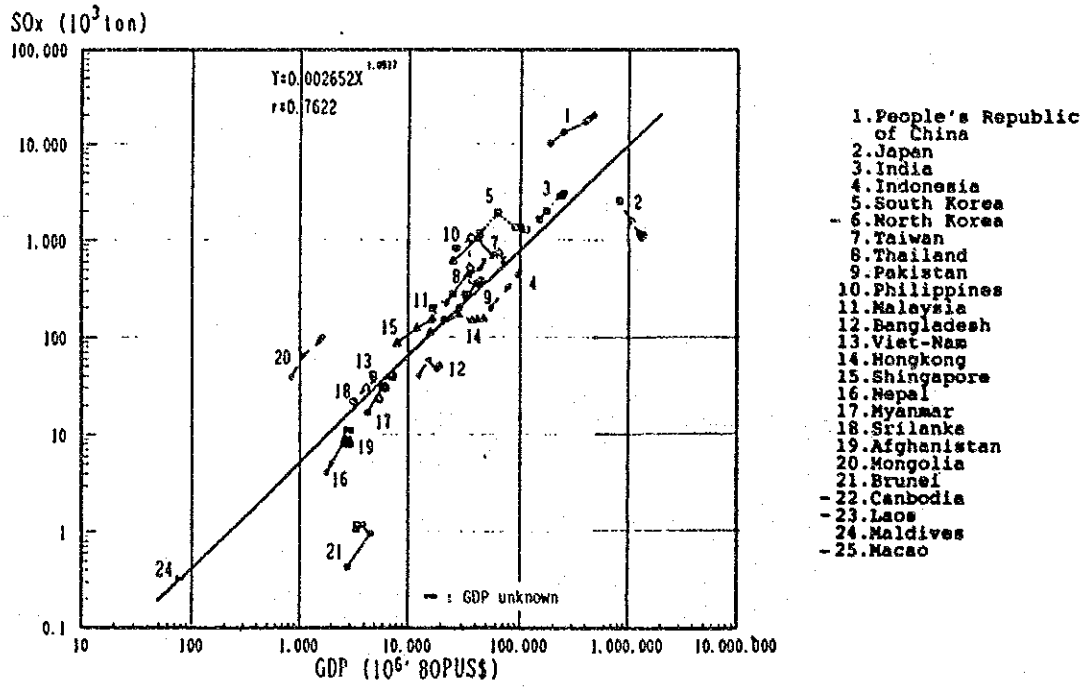


Figure 3-3-6 RELATIONSHIP BETWEEN GDP AND SOx EMISSION

4 Air Pollution Control Measure for Thermal Power plant

4.1 Scheme of Master Plan Related to Air Pollution Control

As the air pollution preventive mesures for thermal power plants in Argentine, various subjects that need consideration of related parties are suggested as shown below as a typical plan.

These subjects are classified into two; the subjects to be examined by administrative organs and the subjects to be examined by power companies. Since nationwide air pollution preventive plans and countermeasures including sectors other than power sectors in Argentina will be implemented gradually in future, it is necessary to have adequate coordination between these plans and countermeasures and the general plan of power sectors. Therefore, it is necessary to select these subjects conforming to the progress of current air pollution preventive measures.

4.2 Role of Administrative Organs to Control Air Pollution

The role for which the administration should play is shown in Figure 4-2-1 by setting a target to grasp the emission conditions of air pollution materials caused by the thermal power plants, together with schedule a long plan related to the air pollution control finally while estimating the future trend, and to scheme the maintenance of atmospheric environment in the surrounding of thermal power plants.

4.3 Role of Power Companies Related to Control Air Pollution

To maintain the atmospheric environment of adjecent area according to the nature of air pollution materials emitted from the possessed thermal power plants, the private sector thermal power companies shall observe the various restrictions imposed from the administration, also shall perform the high quality operation, maintenance, and control of facilities. It is also necessary to scheme the sufficient coordination with the local governments concerned and the adjecent power companies under the leading of administration.

These actions are useful for improvement of efficiency of thermal power plants and for protection of accidents before hand, consequently the power companies will receive the great merits. Figure 4-3-1 shows the roles that the power companies should play to control air pollution.

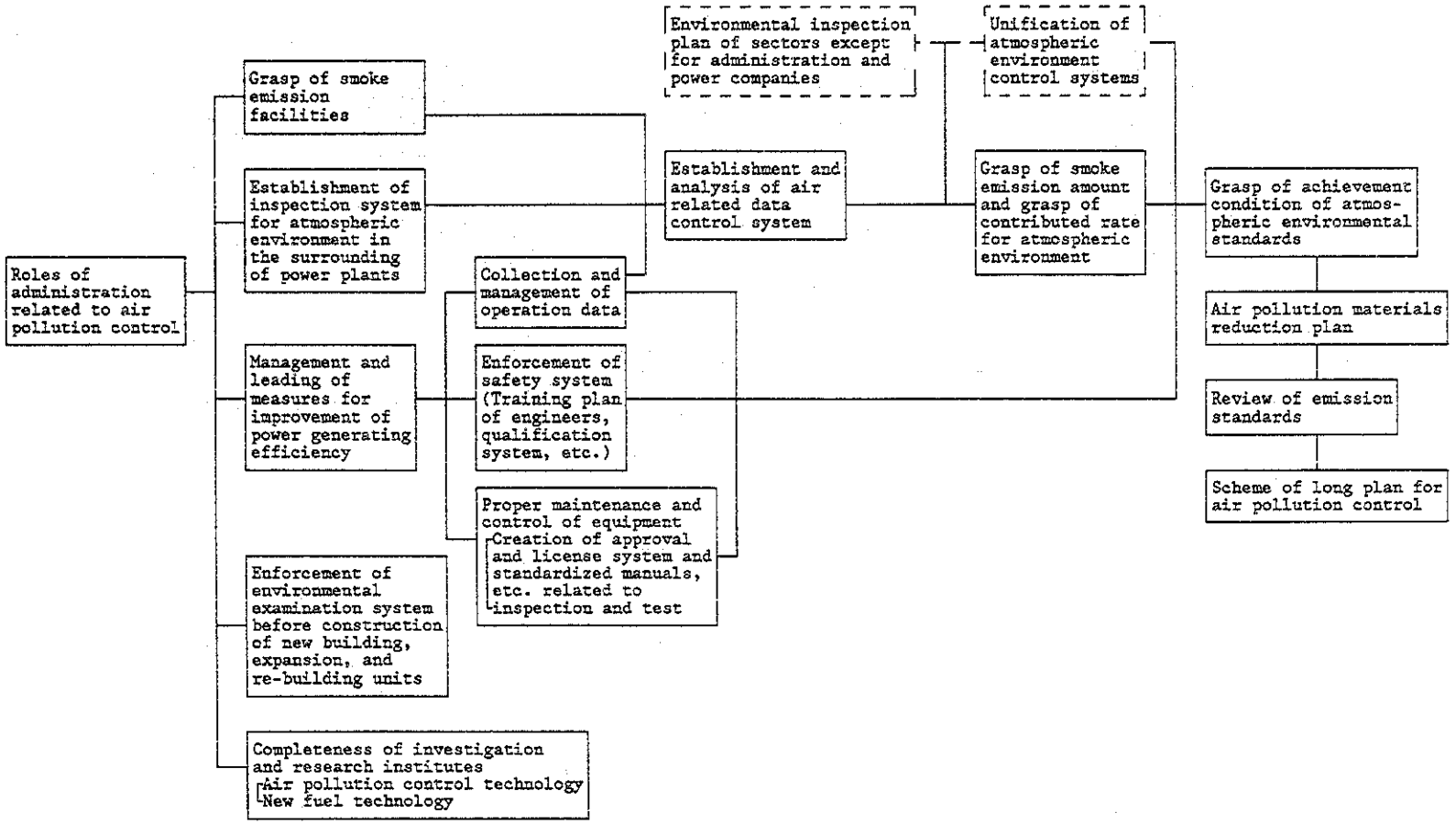


Figure 4-2-1 ROLES OF ADMINISTRATION TO CONTROL AIR POLLUTION

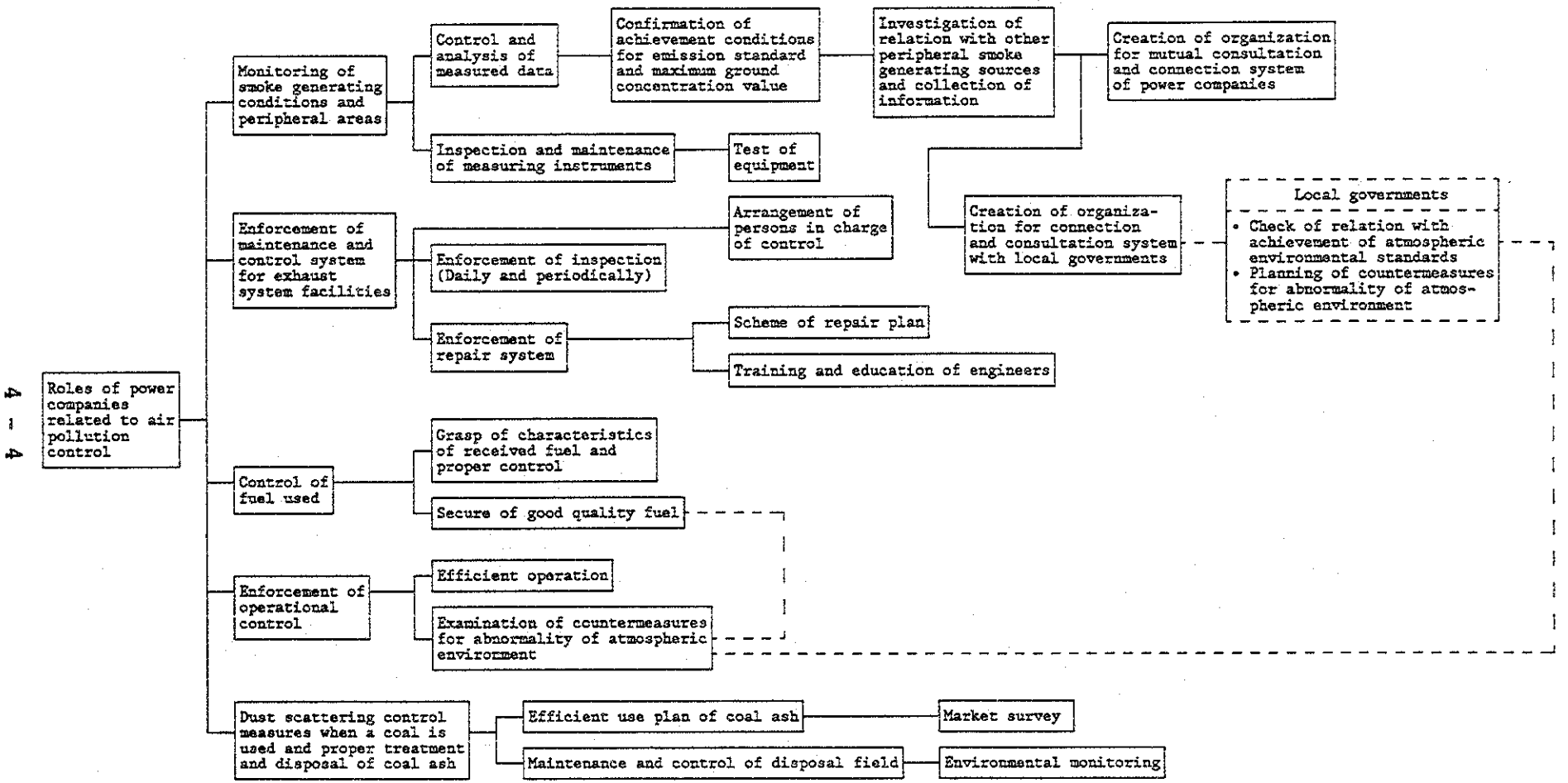


Figure 4-3-1 ROLES OF POWER COMPANIES TO CONTROL AIR POLLUTION

4.4 Necessities of Improvement of Combustion Technology for Reduction of Pollutant Emission from Flue Gas

Most of thermal power plants in Argentina use natural gas as the fuel for 9 months of each year, and fuel oil for the remaining 3 months. Natural gas is essentially clean energy and exhaust gas after combustion contains few pollutants, excepting NOx, and SOx and dust are not likely to exceed emission standards. Thus, only NOx reduction measures are needed for the 9-month period during which natural gas is burned. On the other hand, the 3-month oil-burning period requires measures to reduce NOx, SOx, and sometimes dust in flue gas.

Clearly, it is uneconomical to install flue gas treatment facilities which are used for only 3 months, thus a true solution should be related to national energy policy. Accordingly, the planning of the measure for reduction of emission of pollutants from the flue gas in the thermal power plant, are concerned to the national level policy and countermeasures like (a) An expansion of natural gas distribution network to release the supply control of natural gas to the thermal power plant in winter season, (b) National price policy for fuel and (c) National development plan of electrical power in consideration with the aboves, it may be said that these issues shall be beyond our scope of the study.

As the matter is out of scope of the present study, this section discusses improvement requirements to comply with the existing emission standards when existing thermal power plants continue to use natural gas for 9 months and fuel oil for remaining 3 months.

(1) SOx reduction measures

As for SO_2 reduction measures during the 3-month period, the SO_2 emission standard is 1,700mg/Nm^3, which is equivalent to flue gas produced by burning fuel oil with sulfur content of 1.1% or coal with the 0.7% sulfur content. Thus, to comply with existing emission standards, it is obviously economical to use fuel oil or coal of the above quality, rather than to

install new SOx reduction facilities.

(2) Dust control measures

The existing dust emission standard in the case of oil burning is 140mg/Nm^3, which is equivalent to flue gas produced by burning fuel oil with the 0.94% sulfur content. According to EPA, the dust produced by burning of fuel oil increases in proportion to the content of sulfur contained in the fuel. Again, it is economical to use fuel oil which sulfur content is below the above level, rather than to install a new electrostatic precipitator (EP).

Using fuel oil of the 0.9% sulfur content will reduce dust concentration in flue gas to around 140mg/Nm^3 and SO_2 concentration to 1,500mg/Nm^3, which are within present emission standards.

In the case of coal firing, dust concentration at the boiler outlet reaches 10,000 ~ 30,000mg/Nm^3, which is reduced to 200 - 600mg/Nm^3 or less in flue gas after going through the EP.

(3) NOx reduction measures

At present, Argentina has no NOx emission standards for thermal power plants. Nevertheless, there is public recognition that NOx is a major factor in producing oxidants and serves as a detrimental pollutant to cause environmental pollution, particularly in urban areas. Thus, controlling NOx production to a minimum level contributes to environmental preservation and fuel saving, and the following improvements are recommended.

NOx produced from combustion of a fuel in a boiler are mostly nitrogen monoxide (NO) and nitrogen dioxide (NO_2), and generally, NO accounts for around 95% of NOx. NOx produced from combustion are divided into thermal NOx which is produced when nitrogen molecules in the air mixed with the fuel reacts with oxygen under high temperature, and fuel

NOx which is produced when nitrogen compounds contained in the fuel are oxidized during combustion. Although varying with the type and method of combustion, thermal NOx accounts for 100% of all NOx produced from combustion of gas, 30% - 40% in the case of fuel oil or crude oil, and 10% - 20% in the case of coal. Thermal NOx can be reduced by lowering combustion temperature and oxygen concentration, and reducing the period of combustion gas staying in the high temperature range.

In particular, NOx can be reduced by 10% to 30% by reducing O_2 in the combustion gas by half (2% to 3%). This can be accomplished by reducing excess air for combustion. Careful control is required to prevent incomplete combustion accompanied by soot due to insufficient air supply. Table 4-4-1 shows reduction of NOx production through low excess air combustion.

In developing countries, O_2 in combustion gas is not measured and highly excess air is used to avoid incomplete combustion. As a result, NOx production amounts to [2] in Table 4-4-1. By controlling excess air to the minimum required level on the basis of accurate measurement of O_2 in the combustion gas, NOx can be reduced by 20% - 30%, with saving in fuel consumption by 5% - 10%.

Table 4-4-1 REDUCTION OF NOx BY LOW EXCESS AIR COMBUSTION

(Unit: NOx ppm)

Fuel		Coal	Fuel Oil	Gas
N(%)		0.7-3	0.1-0.5	0
O2 Equivalent (%)		6	4	5
[1]	Standard Combustion	550-800	400-500	300-400
[2]	Air Excess Combustion	600-900	500-600	350-450
[3]	Low Oxygen Combustion	450-650	300-400	200-300

Note : NOx 1ppm is equivalent to $2mg/m^3$

Reduction of excess air also leads to the reduction of SO_3. SO_3 adversely affects the environment and corrodes equipment after a combustion furnace or boiler, such as air heaters and EPs. Since SO_3 cannot be fully removed through the wet type flue gas desulfurization process, control of excess air is considered as an important means to reduce it.

As mentioned above, NOx can be reduced by 10% to 30% by controlling excess air during combustion to cut residual O_2 in combustion gas by half (to 2% - 3%), with 5% to 10% saving in fuel. This method requires, however, careful combustion control to prevent incomplete combustion due to the shortage of air, accompanied by soots, from occurring. Assuming that each power plant is equipped with an automated combustion control device, it can be used for low excess air combustion of the boiler. In addition to immediate effects of NOx reduction and fuel saving, the low excess air operation forms a basis of future NOx reduction measures and serves as an opportunity for plant workers to raise their awareness and learn necessary techniques. It should be noted, however, that the low excess air operation will increase dust concentration, which should be controlled below the respective emission standard.

NOx concentration at present is estimated at 600 - 900mg/Nm^3 for gas combustion, 800 - 1,200mg/Nm^3 for fuel oil combustion, and 1,100 - 1,800mg/Nm^3 for coal combustion. Through the low excess air combustion, these figures can be reduced to 400 - 600mg/Nm^3, 600 - 800mg/Nm^3, and 900 - 1,300mg/Nm^3, respectively.

(4) Summary

The above improvement proposals are summarized as follows:

1) Use of low-sulfur fuel
   To use fuel oil with sulfur content of 0.9% or less, or coal with the 0.7% or less sulfur content.

2) Low excess air operation

The major effect of the improvement measure is fuel saving due to low excess air combustion, which may compensate to a certain degree for a higher fuel cost of a low sulfur fuel. At the same time, introduction of the new operation will help raise awareness of plant workers and learn techniques related to energy conservation.

Also, NOx reduction will lead to the reduction of environmental impacts.

5 Proposal of Flue Gas Monitoring System

5.1 Basic Design of Flue Gas Monitoring System

Thermal power stations in Argentina are now legally bound to regularly measure and report SOx, NOx and dust. Although, by using the results, SE has a good grasp at all times through ENRE of environmental pollutants discharged from thermal power stations, the team has studied set-up of regional monitoring stations as one of the survey proposals which is to monitor environmental pollutants from thermal power stations.

The set-up of the regional monitoring stations, naturally, is not to be carried out by SE alone, but through the joint efforts of the Ministry of Environment of Argentina. Ministry of Economics and Foreign Trade, as well as State governments and city governments. It is, therefore, very significant for SE to proceed with its implementation as a pioneering demonstration plant as SE administers organizations discharging high level environmental pollutants.

While it is advisable to set up regional monitoring stations in 13 regions of SE's administrative district, three sites will be chosen as a first step. In other words, a central monitoring station will be put in place and regional monitoring stations will be established initially in three regions.

(1) Components of project

The project is made up of the following elements:

(a) Regional monitoring stations (three sites)

The purpose of these stations is to monitor soot in the regions concerned. This part of the project consists of the following facilities for close technical cooperation with thermal power stations in the region

as well as measurement of atmospheric concentration of pollutants and collection of meteorological data.

- building of measuring stations
- Service facilities
- Plumbing for gas
- Instruments for meteorological observation
- Tools for chemical analyses
- Various monitoring gauges
- Processing equipment for data observed and measured
- Mobile observation vehicles

(b) Central monitoring station

The central monitoring station has two functions; namely, technical supports intended to reduce environmental pollutants from thermal power stations and monitoring of pollutants discharged from all the thermal power stations in Argentina. It is equipped with the following:

- Buildings as a measuring station and room for its staff
- Instruments for soot monitoring and atmospheric pollutants observation
- Instruments for meteorological observation
- Processing equipment for data observed and measured and desk publishing apparatus
- Library
- Printing equipment
- Major research and development equipment

(c) Personnel development plan

For the purpose of reducing environmental pollutants from thermal power stations and improving measurement techniques in line with SE's plan, overseas and domestic training will be conducted for staff of SE and thermal power stations and technical cooperation with overseas organizations will be considered.

(2) Contents of project

(a) Establishing organization for project implementation

For the above activities to be implemented, the current SE's activities need to be re-constructed both organizationally and technically. The central monitos supervised by SE need to monitor environmental pollution in regions caused by local thermal power stations in collaboration with state and municipal authorities. Shown in Figure 5-1-1 are its systematic cooperative relationships among the project implementation bodies.

(b) Locations of regional monitoring stations

Eventually, in accordance with SE's administrative districts and meteorological segments, some six sites are considered to be appropriate at an intermediate grouping level, but in phase 1 three sites are suggested.

(c) Activities of central monitoring station

a) Public roles for improving an environmental regulation system and techniques

- Observation of environmental pollutant discharge from thermal power stations and study of its contributing rates
- Accumulation of technologies regarding measurement methods of soot and atmospheric pollutant concentration
- Review and re-arrangement of environment regulations
- Provision of environmental assessment, especially, a diffusion calculation system
- Promotion of bilateral and multilateral cooperation in R&D

b) Assistance to individual power stations

- Cruising measurement service for power stations
- Technical diagnostic service for power stations
- Assistance regarding analysis instruments and supply of back-up equipments and spare parts
- Training of technical personnel at thermal power stations

c) Activities of regional monitoring stations

- Continuous measurement of atmospheric pollutants in the regions
- Observation of meteorological data
- Cruising measurement service in the regions
- Monitoring of soot and warning in case of emergency
- Construction of cooperative system with State governments involved
- Training of State government personnel
- Assessment of environmental impact of thermal power stations in the region

(3) Equipment plan

Shown in Table 5-1-1 is an outline of equipment needed for implementation of the above plan, in Figure 5-1-2 the concept of the regional monitoring system, and in Figure 5-1-3, a map of their installations respectively.

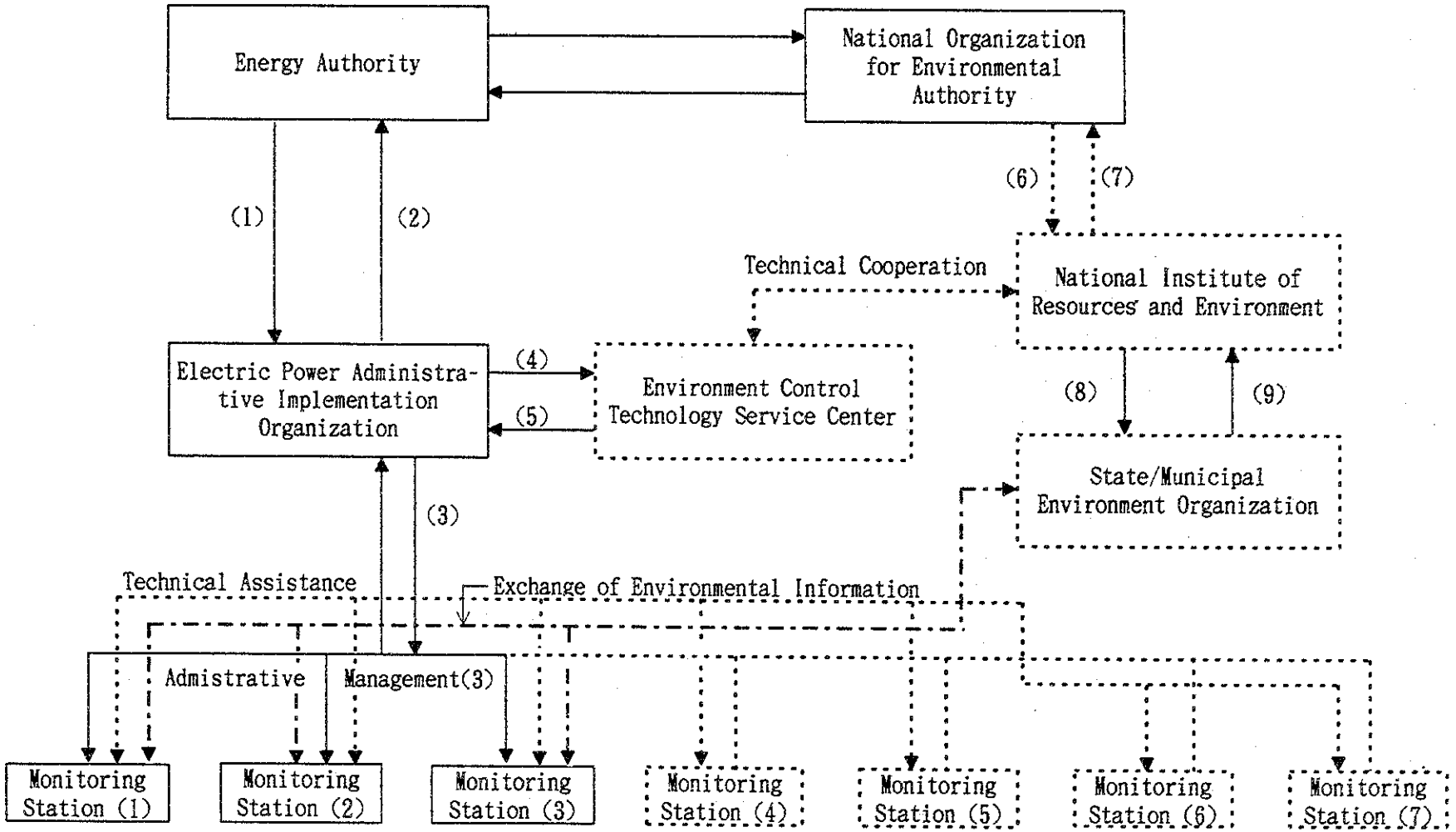


Figure 5-1-1 ESTABLISHMENT OF MONITORING STATION FOR THERMAL POWER PLANTS IN ARGENTINE REPUBLIC (PROPOSAL)

Table 5-1-1 REQUIRED ANALYSERS INSTRUMENTS AND EQUIPMENT

CODE No.	Item (Equipment Name)	Note
1	Ambient CO Monitor	Range : 0～10/20/50/100 ppm
2	Ambient SO2 Monitor	Range : 0～0.1/0.2/0.5/1.0 ppm
3	Ambient NOx Monitor	Range : 0～0.1/0.2/0.5/1.0 ppm
4	Ambient O3 Monitor	Range : 0～0.1/0.2/0.5/1.0 ppm
5	Ambient HC (Hydrocarbons) Monitor	Range : 0～5/10/20/50 ppmC
6	Ambient SPM Monitor	Range : 0～0.25/0.5/1/5 mg/cm3
7	Meteorological Observation Instrument	Wind Vane & Anemometer, Thermometer, Hygrometer, Pyrheliometer, Net Exchange Radiometer
8	System Rack for Monitor	
9	Ambient HF (Hydrogen Fluoride) Monitor	
10	High Volume Air Sampler	
11	Low Volume Air Sampler	
12	Stand Sampler	
13	Automatic Water Still	
14	Electric Drying Oven	
15	Electric Balance	200g/0.1mg, 3,200g/10mg, 430g/1mg
16	Spectro Photometer	
17	Chemical Analysis Glass Ware	
18	Personal Computer (486PC)	Desktop Computer, Laptop computer, Lazer Type Printer
19	Multi Pen Recorder	
20	Atomospheric Sampling Pipeline	
21	Span Gas Cylinder Set	
22	Standard Gas Generation Apparatus	

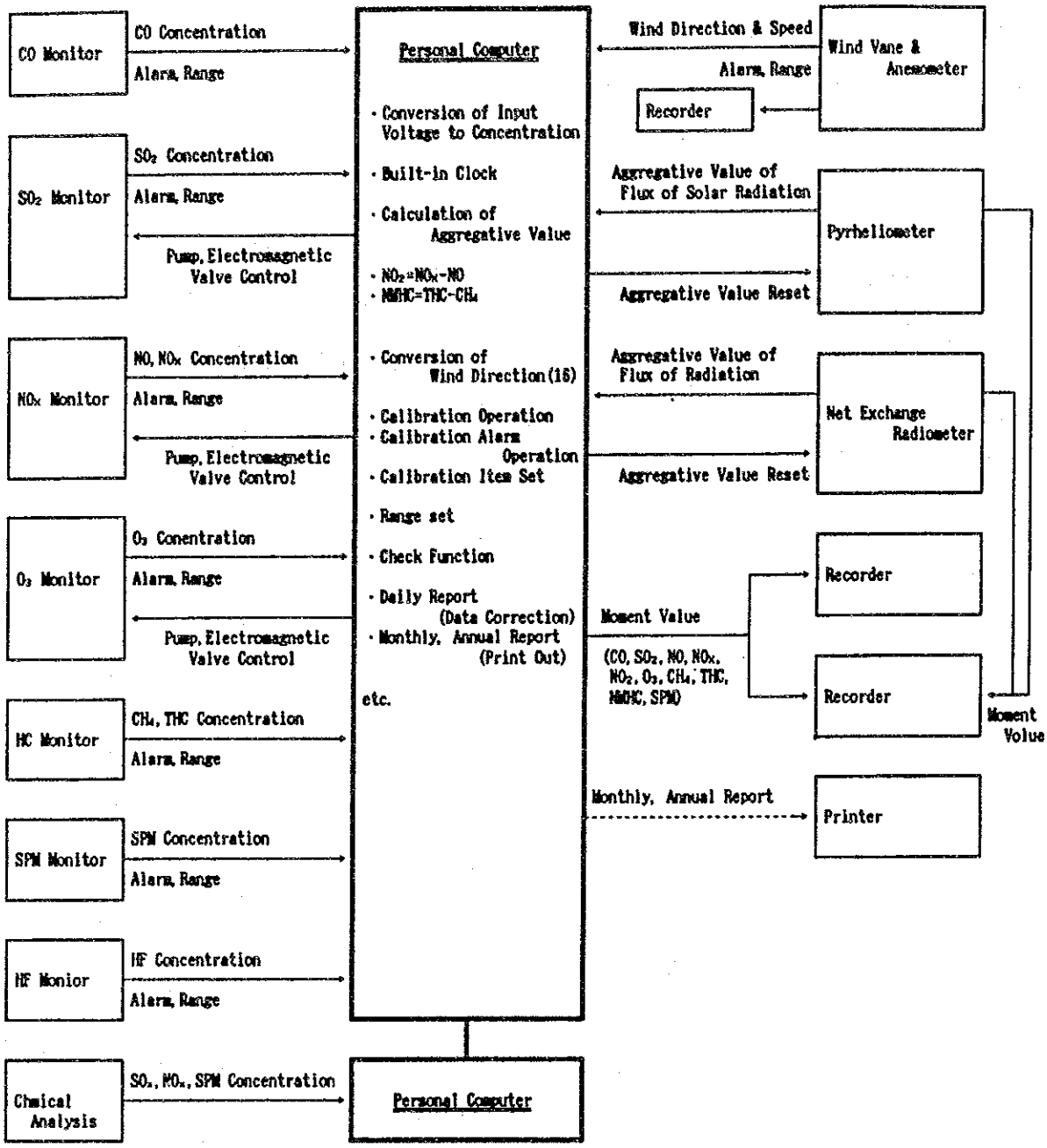


Figure 5-1-2 DIAGRAM FOR REGIONAL INSPECTION SYSTEM

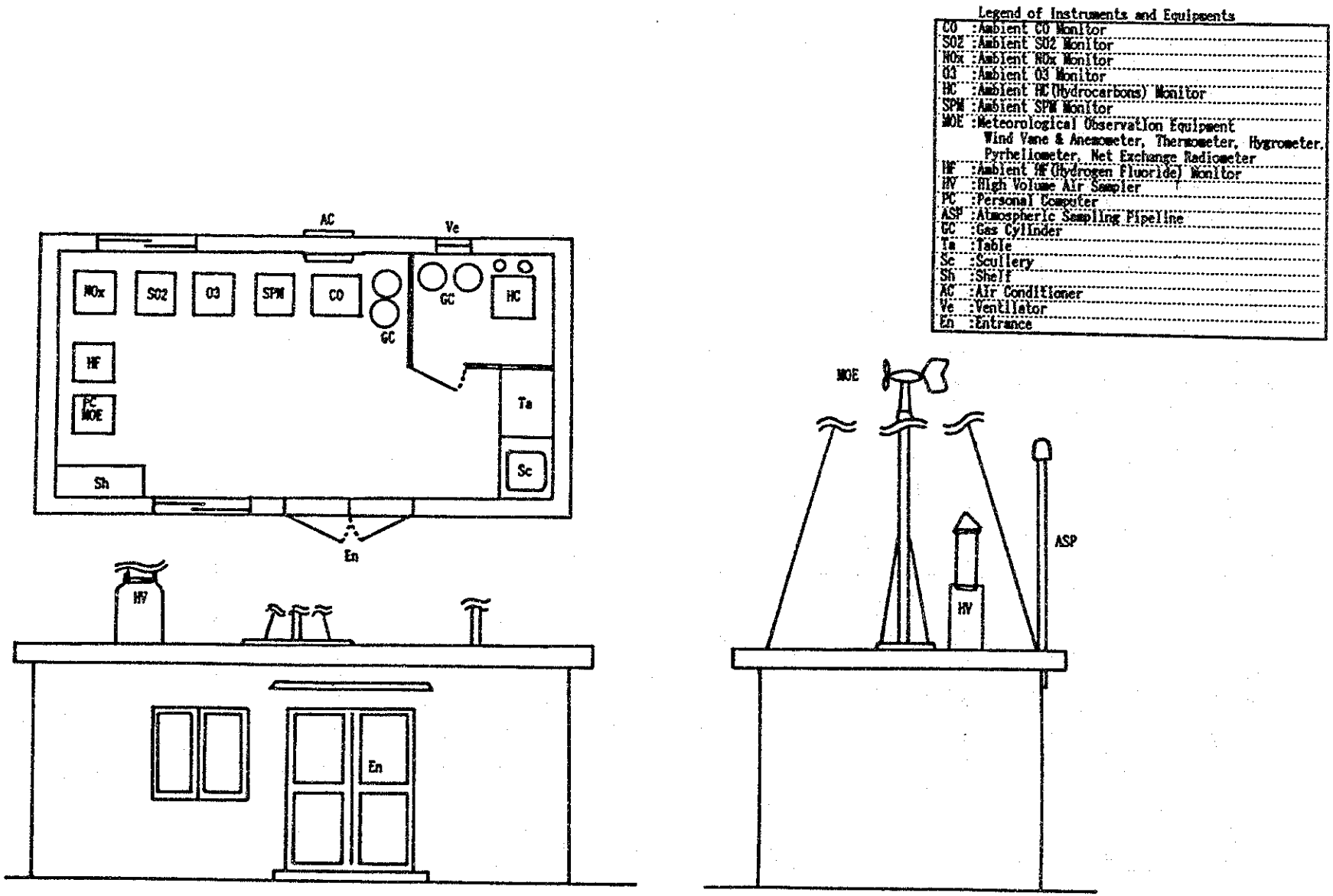


Figure 5-1-3 LAYOUT PLAN FOR INSPECTION STATION

5.2 Estimate of project cost

Given in Table 5-2-1 is the estimated project cost. The financial plan for this project appears feasible in the light of its general purpose, as the project may be able to obtain financing of multinational financial institutions like the World Band and Inter-American Development Bank or bilateral institutions like the Export-Import Bank of Japan. Overseas Economic Cooperation Fund of Japan, JICA, USAID and GTZ, as long as the project objectives and impelementating responsibilities are clearly defined.

Conversion or construction of buildings as monitoring stations incurring heat and light expenses and personnel should be paid by the Argentine government.

(1) Given in Table 5-2-2 is the number of staff necessary for implementation of this project. These people should be easily provided from among people currently employed by SE and its related organizations.

Table 5-2-1 SUMMARY OF PROJECT COST

(Unit: 1,000 US$)

Code No.	Item	Total
1	Base Cost	
1-1	Equipment Cost	
1-1-1	Anayzer	1,007
1-1-2	Inland Transportation	17
1-1-3	Installation	33
	Sub-Total	1,057
1-2	Civil Works	
1-2-1	Construction Work	100
	Sub-Total	100
1-3	Maintenance	132
1-4	Pre-Operational Costs	17
	Total of equipment component (per 1 station)	1,306
1-5	Staff Development	
1-5-1	Domestic Training	100
1-5-2	Overseas Training	450
1-5-3	Invitation of Foreign Exports	400
	Sub-Total	950
1-6	Consultant Services	
1-6-1	Design and Supervision of Civil Engineering Works	100
1-6-2	Oversea Engineering Service Consultant	500
	Sub-Total	600
1-7	Taxes and Duties	0
	Total	5,468

Total project cost for three stations

1) Station cost : 3 x 1,306	= US$3,918
2) Other cost (1-5 - 1-6)	= US$1,550
Total	US$5,468

Table 5-2-2 SCHEDULE FOR MAN-POWER ASSIGNMENT FOR THE PROJECT

	SMI	RIS			FGIC	Subtotal
		RIS1	RIS2	RIS3		
1. Project Director	2					2
2. Project Manager	2	1	1	1	1	6
3. Chemical Resarcher					1	1
4. Environmental Engineer		1	1	1	1	4
5. Chemical Analyst		1	1	1	1	4
6. Chemical Technician		1	1	1	1	4
7. Mechanical Engineer		1			1	2
8. Process Engineer		1			1	2
9. Instrumentation Technician		1			1	2
10. Project Engineer	1				1	2
11. Programmer	1	1	1	1	1	5
12. Officer	1	1			1	3
13. Clerk		1	1	1	1	4
TOTAL	7	10	6	6	12	41

Table 5-2-3 BREAK DOWN FOR ANALYSER

No.	Item	Quantity	Unit Price (US$)
1	Equipment Cost		
1-1	Ambient CO Monitor	1	25,600
1-2	Ambient SO2 Monitor	1	40,850
1-3	Ambient NOx Monitor	1	48,570
1-4	Ambient O3 Monitor	1	39,090
1-5	Ambient HC (Hydrocarbons) Monitor	1	39,020
1-6	Ambient SPM Monitor	1	37,450
1-7	Meteorological Observation Equipment	1	50,580
1-8	System Rack for Monitor	1	93,230
1-9	Telemeter		
1-10	Ambient HF (Hydrogen Fluoride) Monitor	1	323,800
1-11	High Volume Air Sampler	1	5,940
1-12	Low Volume Air Sampler	1	4,840
1-13	Stand Sampler	1	1,820
1-14	Automatic Water Still	1	11,650
1-15	Electric Drying Oven	1	2,620
1-16	Electric Balance (200g/0.1mg)	1	5,550
	Electric Balance (3,200g/10mg)	1	2,310
	Electric Balance (430g/1mg)	1	3,170
1-17	Spectro Photometer	1	6,000
1-18	Chemical Analysis Glass Ware	1	2,540
1-19	Personal Computer (486PC)	2	20,560
	Desktop Computer		
	Laptop Computer		
	Lazer Type Printer		
1-20	Multi Pen Recorder	2	25,640
2	Spare Parts & Consumables for 2 Years	1	28,120
3	Ocean Freight	1	11,900
4	Export Packing	1	8,090

6 Implementation Schedule for Flue Gas Monitoring System

As mentioned in Section 2 of Chapter 4, a few hundreds to a dozen hundreds of regional monitoring stations are needed when Argentina's vast land is considered, but SE's responsibility is monitoring pollutants from thermal power stations.

For that reason, six sites segmented by SE's administrative districts and meteorological groupings first should become a base on mid- to long-range terms. When the future plan and roles to be played by the State government have been clarified for other sectors in the country, efficient plans for monitoring stations should be established considering overall plans and pollutant levels of thermal power stations.

Under the circumstances, set-up of stations at three sites in view of SE's administrative districts and meteorological segments demanding eventual installation is defined as Phase 1, and set-up at the other three sites for SE's completion of the proposed initial planning as Phase 2. The four steps given below are desirable for implementation of the plan.

Step 1 : SE's mid- to long-range plan for electric power is to be used as a base and review is to be made of concrete implementation of environmental preservation policy from administrative and technical viewpoints.

Step 2 : Based on the above concept, basic plans for mid- to long-range monitoring should be laid out, and the plans should be presented to related organizations both in the country and overseas.

Step-3 : This is a step where, in line with progress made in Step 2, monitoring implementation plans are laid out and the plans is executed.

Step-4 : This is a step where the project is actually executed, for which SE's organization is streamlined, and plans for education and training are implemented.

The schedule prepared in line with the above concept is given in Figure 6-1.

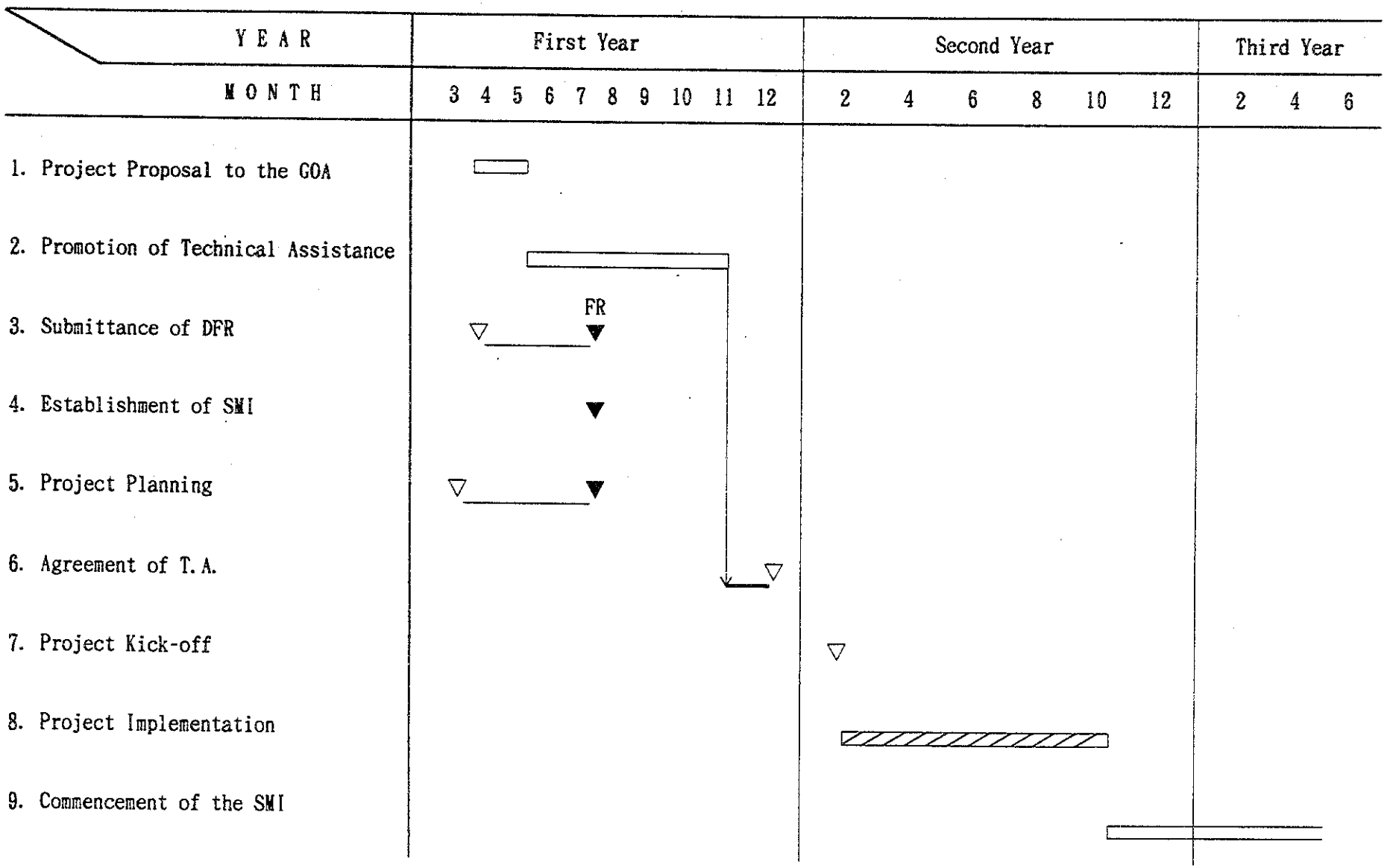


Figure 6-1 IMPLEMENTATION SCHEDULE FOR ESTABLISHMENT OF FLUE GAS MONITERING STATION

7 Conclusion and Recommendation

(1) Present Atmospheric Pollution

There is no serious air pollution problem in the country caused by the emission from the thermal power plant.

However, part of Buenos Aires suffer air pollution problem which mainly caused by emission from vehicles and minor contribution from industrial emission including from the thermal power plant, and part of Mendoza also suffer sometime deteriorated atmospheric condition particularly by particulate material which caused by several industrial facilities including thermal power plant.

These observation made by the JICA study team indicates that immediate introduction of costly pollution abatement facilities to the thermal power plant are not necessary.

It is strongly felt that the present actions taken by S.E. and E.N.R.E. in relation to the management of atmospheric environment need to be integrated with the activities of the other government agencies and state/municipal government to establish the national air pollution management systems.

The technology, which is proposed in this report and being developed by S.E. and its associated institution for inspection and monitoring the atmospheric environment, should be established immedeately and fully utilized by the other institutions in charge of atmospheric environment management.

(2) Establishing the system for the inspection and monitoring system

Although the present air pollution problem in the country is not serious, the present international concern on the global environment preservation together with the current regional and global movement to have common standard for environment preservation as the basis of free trade and common economic

community necessitate every country to establish national monitoring system to obtain reliable information on the present environmental conditions in the country, which is collected and assessed by the internationally acceptable methods.

It is recommended that the system proposed in this report for the undertaking by SE and being developed by S.E. for monitoring and inspection of the atmospheric management of the thermal power plant should be expanded to the national level through positive cooperation among other related government agencies.

(3) Future environment management for the thermal power plant

As the results of the fundamental restructuring of the economy and industries being proceeded in the country, the future development of energy sector including the electricity generation will be proceeded based on market economy mechanism.

According to the government economic development program "Growing Argentine 1993-1995", it is now clear that the economy of Argentine will continue rapid development up to next century.

This means the energy requirement including electricity supply will increase rapidly, and the requirement of energy and electricity will be almost doubled from present by AD 2010 as projected by the Ministry of Economy and SE.

Under such circumstance, the supply of clean energy such as hydroelectricity and natural gas might not be sufficient to meet such large additional demand.

This condition may results large scale use of high sulfur fuel oil and coal for requirement of industries and the thermal power plant.

If no adequate measures are taken to avoid the possible air

pollution by the emission from such fuel, there is high possibility of serious air pollution in the area, where heavy industries are locating, as it was experienced by industrialized countries during rapid expansion of manufacturing activities.

Since the future development of majority of manufacturing sector including energy sector are in the hand of private sector, maintaing the harmony between environment preservation and cost saving will be complicated.

It is recommended that well prepared guidance by the related authority should be provided in time for leading the activities of private enterprises to prevent environmental pollution without harming the positive development of the economy of the country, which will be supported by the private enterprises.

The guidance should be prepared based on long range energy supply demand master plan, national plan for siting industrial projects in the country and the national regulatory system to adjust the emission standards to be imposed to the emission sources in accordance with the systematic monitoring system.

(4) International Cooperation

It is understood that the Government of Argentine is positively participating international activities for global environment preservation program such as Montreal treaty. As the current open trade policy are adopted world wide, any country will have to maintain international standard for protection of global environment as a member of international society.

It is recommended that the technical cooperation between Argentine and Japan in relation to environment preservation shoul be considered positively to develop international cooperation to accelerate global environment preservation activities.

STUDY ON AIR POLLUTION CONTROL FOR THERMAL POWER PLANTS IN THE

JICA