5.2.20 Paper Products Factory (B)

1) Name of facility surveyed — Boiler (No. 1)

2) Specification of facility

Model	Water-tube type package boiler
Capacity	9.5 ton/hr
Draft and ventilation	Forced draft
Size of furnace	$1{,}428^{W}$ x $3{,}612^{D}$ x $2{,}553^{H}$
Number of burner	1 unit (heavy oil burner)
Furnace pressure	Unknown
Ancillary facility	None

3) Specification of burner

Model	Steam atomization type
Type of fuel	Heavy oil
Fuel consumption	870 l/hr (estimated)
Fuel pressure	6.0 kg/cm^2g
Atomizing pressure	7.3 kg/cm^2g (steam)

4) Analytical data of flue gas

(Stack sampling data) 13:00/Load at 80% of rating

NOx (ppm)*	204	Particulate matter (g/Nm^3)	0.034
O_2 (%)	6.6	Flue gas temperature (°C)	345
CO (%)	<0.05	Combustion chamber outlet O_2 (%)	–
CO_2 (%)	9.6		

(Emission)

	kg/hr
NOx	2.5
SO_2**	45
Particulate	0.23

* Converted to oxygen concentration of 5%

** Calculated from analytical value of fuel

5) Observation

This boiler is used to generate steam to heat drums for production of corrugated fiberboard. The boiler is operated from 10:00 on Monday to 14:00 on Saturday continuously with total 124 hours per week.

Two units of the water-tube package boiler made by Combustion Engineering were installed in 1963, and are operated alternately by the 3-months period.

Water supply to the boilers are made directly from the hot-water tank, and air preheaters are not provided.

This plant is one of a few plants having the Orsat analyzer for measurement of CO, O_2, and CO_2 among those surveyed in this Study. The plant seemed to be highly concerned with heat control

The steam atomization type burner is used, and its performance is satisfactory during normal operation with no stack smoke observed. The NOx concentration was 204 ppm as converted to 5% O_2, which is considered standard for a burner without NOx control.

The O_2 content was slightly high at 6.5 - 6.8% in the normal operation. As a result of closing of air damper to set the O_2 content to 5.0 - 5.4%, the NOx concentration became 188 ppm, about 7% down. Because of burner and boiler construction, the air ratio could not be decreased further.

As NOx reduction measures, the use of low-NOx burner to decrease the air ratio and the use of desulfurized heavy oil to reduce the SOx and fuel NOx generation are recommended.

6) Countermeasures

i) Retrofitting of the boiler

(a) Low air ratio combustion through continuous monitoring of the flue gas O_2

(b) Installation of low NOx burners

ii) Fuel change

(a) Mixed combustion with 50% heavy oil and 50% diesel or natural gas up to the supply start of desulfurized heavy oil

(b) When supply of desulfurized heavy oil is started, it should be used exclusively (100%)

(c) Emulsified combustion of desulfurized heavy oil should be taken into consideration after thorough demonstration tests.

7) Expenses for boiler retrofitting

Retrofitting for low NOx burner installation, low air ratio combustion, and for mixed combustion of heavy oil and diesel

i) Foreign portion

			(US$)
(a)	Survey and design	1 set	5,400
(b)	Burners (900 l/hr)	1 set	70,000
(c)	Combustion control system and electric instrumentation	1 set	23,100
(d)	Package and freight	1 set	11,300
(e)	Travelling	1 set	4,400
(f)	Unexpected expenses (5% of the above)		5,710
	Sub-total		119,910

ii) Local portion

(g)	Burner removal and installation	1 set	1,600
(h)	Local installation on-site supervision	1 set	1,600
(i)	Test operation and adjustment	1 set	800
(j)	Electric instrumentation installation work	1 set	4,700
(k)	Customs and other taxes	1 set	29,410
(l)	Warehouse, customs clearance, and land freight (incl. IVA)	1 set	1,810
(q)	IVA (15% excl. k + l)		1,890
	Sub-total		41,810
	Total		US$ 161,720

Note: There is one more boiler which is the similar type as the boiler No. 1 burning the same fuel. The similar retrofitting works are considered necessary for this boiler..

8) Summary of control measures

Table 5.2.20 summarizes the control measures for the Paper Products Factory (B).

Table 5.2.20 Summary of Control Measures for the Paper Products Factory (B)

		Current Status	Control measures		
			A	B	C
Fuel type		Heavy oil	Heavy oil 50% Diesel 50%	Desulfurized heavy oil 100%	Desulfurized heavy oil 100%
Combustion method		–	–	–	Emulsified combustion
Fuel Consumption	Heavy oil (10^3m^3/yr)	2.844	1.422	2.844	2.844
	Diesel (10^3m^3/yr)		1.422		
Emission (ton/yr)	NOx	1.27	0.71	0.91	0.71
	SO_2	170.64	99.54	45.29	45.39
	PM	0.839	0.671	0.671	0.503
Reduction ratio (%)	NOx		44	28	44
	SO_2		41	73	73
	PM		20	20	40
Equipment cost	Furnace retrofit, etc.		323.44	323.44	323.44
	NOx, SO_2 telemeter		–	–	–
Running cost (approx.)(1,000US$/yr)					
Facility depreciation (15 yrs)			21.6	21.6	21.6
Interest (first 5 yrs: 8%)			25.9	25.9	25.9
Maintenance cost (5%)			16.2	16.2	16.2
Heavy oil		220.6	110.3	–	–
Diesel		–	292.6	–	–
Desulfurized heavy oil		–	–	309.6	–
Desulfurized heavy oil emulsion		–	–	–	377.3
Total (1,000 US$/yr)		220.6	466.6	373.3	441.0

Alternative B: Applicable after the start of supplying desulfurized heavy oil.
Alternative C: Emulsified combustion should be taken into onsideration after thorough demonstration tests.

5.2.21 Metal Products Factory (A)

1) Name of facility surveyed — Heating furnace for casting billet

2) Specification of facility

Model	Pusher furnace
Capacity	4.7 ton/hr
Draft and ventilation	Forced draft
Size of furnace	$2{,}560^{W}$ x $10{,}550^{D}$ x $1{,}200^{H}$
Number of burners	Two units (natural gas burner)
Furnace pressure	Approx. atmospheric pressure
Furnace temperature	1,100 ~ 1,300°C
Ancillary facility	None

3) Specification of burner

Model	Cone mix type
Type of fuel	Natural gas
Fuel consumption	1,000 m^3/hr
Fuel pressure	0.8 kg/cm^2g

4) Analytical data of flue gas

(Stack sampling data) 12:00/Normal operation

NOx (ppm)*	130	Particulate matter (g/Nm^3)	–
O_2 (%)	3.4	Flue gas temperature (°C)	925
CO (%)	<0.05	Combustion chamber outlet O_2 (%)	–
CO_2 (%)	9.3		

(Emission)

	kg/hr
NOx	0.85
SO_2**	–
Particulate	–

NOx at rated operation is estimated to be 200 ppm (1.31 kg/hr).

* Converted to oxygen concentration of 5%

** Calculated from analytical value of fuel

5) Observation

This is a pusher-type heating furnace for hot rolling of billets (80x80x2,000 mm) to produce bar steels for reinforcement. Advance of the billets and flow of combustion gas from two burners are in opposite direction. Loading and unloading with the pusher are made manually.

Operation is intermittent, at 16.5 hours per day, with breaks for meals. There is an opening for inspection and cleaning in the wall opposite to the opening for unloading. Manipulation of the former opening causes a substantial change in the air ratio. The furnace wall is made of refractories with thickness of 350 - 400 mm. Though the temperature of the outer wall surface is low at 43 - 47°C, the loss of accumulated heat is very large in this type of furnace operating intermittently. The heat accumulation amount under the steady-state temperature is calculated to be equivalent to over 1,000 hours of fuel gas input. Operation of 16.5 hours a day will not bring about a steady-state temperature of the furnace wall. But reduction of the weight of the furnace wall may achieve a considerable degree of energy saving. It is also possible to shorten the start-up period in the morning.

The flue gas was discharged with a high temperature of 930°C. In this case also, energy saving of 20 - 30% may be easily achieved by installing the simple recuperator.

Introduction of draft control will also prove effective in preventing air intrusion from the above mentioned opening for inspection and cleaning.

Though assessment of the furnace alone is impossible due to the connection with the rolling mill, not only degradation of heating efficiency, but also increase in the scale loss is possibly induced by the multiplying effect of the unnecessarily high furnace temperature and the excessively high O_2 content due to the air intrusion.

The unit fuel consumption of this furnace is approximated at $1,400 \times 10^3$ kcal/ton though this value may not be accurate because of inadequacies in fuel gas measurement and heat control data. It is evident from comparison with the unit fuel consumption in Japan for wire rod heating furnaces being around 300×10^3 kcal/ton (Iron and Steel Handbook) that the heating efficiency of this furnace is low.

The NOx concentration was 130 ppm as converted to 5% O_2, which is considerably low due to lack of air preheating. No particular NOx reduction measure seems to be necessary, but employment of some energy saving measures will lead to reduction of fuel consumption and reduction of NOx emissions. It is therefore recommended that the two-stage combustion type

low-NOx burner and the heat exchanger for waste heat recovery be adopted in combination.

6) Countermeasures

(a) Installation of the two-stage combustion type low NOx burners

(b) Installation of a heat exchangers for waste heat recovery

7) Expenses for facility retroffiting

Installation of two stage combustion type low NOx burners and a heat exchanger for waste heat recovery.

i) Foreign portion

			(US$)
(a)	Survey and design	1 set	19,300
(b)	Low-NOx burner	2 units	58,500
(c)	Waste heat recovery heat exchanger (incl. heat-resistant piping, and expansion joint)	1 set	153,900
(d)	Local work on-site supervision	1 set	23,100
(e)	On-site instruction for test operation	1 set	7,700
(f)	Package and freight	1 set	6,000
(g)	Travelling	1 set	17,200
(h)	Unexpected expenses (5% on above)		14,300
	Sub-total		300,000

ii) Local portion

			(US$)
(i)	Burner removal and installation	1 set	800
(j)	Duct fabrication	1 set	7,700
(k)	Duct installation	1 set	2,000
(l)	Air heater foundation work (steel frame, concrete, steel bar)	1 set	6,200
(m)	Test operation and adjustment	1 set	800
(n)	Customs and other taxes	1 set	61,320
(o)	Warehouse, customs clearance, and land freight (incl. IVA)	1 set	8,130

(p)	Duct, etc. freight, crane rental	1 set	2,000
(q)	IVA (15% excl. n + o)		3,000
	Sub-total		91,950
	Total		US$ 391,950

Note: In this factory, there is another heating furnace of the similar type and capacity using the same fuel as the surveyed furnace, and the same countermeasures are considered to be required.

9) Summary of control measures

Table 5.2.21 summarizes the control measures for Metal Products Factory (A).

Table 5.2.21 Summary of Control Measures for Metal Products Factory (A)

		Current Status	Counter measures
Fuel type		Natural gas	Natural gas
Fuel Consumption	Natural gas ($10^6 m^3$/yr)	7.07	5.66
Emission (ton/yr)	NOx	7.7	5.4
	PM	- (1)	
Reduction ratio (%)	NOx		30
	PM		20
Equipment cost (1,000 US$)			783.9 (2)
Running cost (approx.)(1,000 US$/yr)			
Facility depreciation (15 yrs)			52.3
Interest (first 5 yrs: 8%)			62.7
Maintenance cost (5%)			39.2
Natural gas		589.2	471.7
Total (1,000 US$/yr)		589.2	625.9

Note: (1) Measurement was not possible because of the high temperature of the exhaust gas.
(2) Installation expenses (US$ 391,950) for low NOx burners and heat exchanger for waste heat recovery for the two heating furnaces.

5.2.22 Metal Products Factory (B)

1) Name of facility surveyed — Aluminum melting furnace

2) Specification of facility

Model	Reverberatory furnace
Capacity	20 ton/hr
Draft and ventilation	Forced draft
Size of furnace	$3{,}960^{W} \times 3{,}860^{D} \times 1{,}715^{H}$
Number of burner	One unit (natural gas burner)
Furnace pressure	-1 ~ -2 mmH_2O
Furnace temperature	820°C
Ancillary facility	None

3) Specification of burner

Model	Cone mix
Type of fuel	Natural gas
Fuel consumption	264 m^3/hr (estimated)
Fuel pressure	4.75 kg/cm^2g (primary)

4) Analytical data of flue gas

(Stack sampling data) 15:30/Load at 75% of rating

NOx (ppm)*	32	Particulate matter (g/Nm^3)	0.13
O_2 (%)	6.8	Flue gas temperature (°C)	890
CO (%)	<0.05	Combustion chamber outlet O_2 (%)	-
CO_2 (%)	7.3		

(Emission)

	kg/hr
NOx	0.10
SO_2**	-
Particulate	0.22

* Converted to oxygen concentration of 5%

** Calculated from analytical value of fuel

5) Observation

This is a reverberatory type aluminum melting furnace with a natural gas burner. Aluminum ingot produced in this furnace is annealed and withdrawn to manufacture aluminum sashes. The plant is confident about competitiveness of the quality of their product in the international market.

The process from loading of raw materials to casting of ingots is completed in about eight hours. The NOx concentration in the flue gas was nearly

constant although there were some variations in the furnace operation. During certain operation stages such as loading of raw materials and addition of additives for sludge removal, smoke and soot were generated due to impurities from scrap materials and additives, deteriorating the neighboring and working environment. In this sense, control measures against smoke and soot are more necessary than NOx reduction measures.

6) Countermeasures

(a) Installation of a hood on the furnace opening

(b) Installation of a a bag filter or an EP on the furnace flue outlet

7) Expenses for installation of bag filter

i) Foreign portion

		(US$)
(a) Survey and design	1 set	5,400
(b) Bag filter	1 set	65,400
(c) Blower	1 set	12,300
(d) Local work on-site supervision	1 set	3,100
(e) On-site instruction for test operation	1 set	3,100
(f) Travelling	1 set	10,000
(g) Unexpected expenses (5% on above)		5,000
Sub-total		104,300

ii) Local portion

		(US$)
(h) Duct fabrication	1 set	7,700
(i) Foundation work	1 set	600
(j) Installation work	1 set	4,700
(k) Test operation and adjustment	1 set	800
(l) Work vehicles	1 set	1,600
(m) Customs and other taxes	1 set	22,000
(n) IVA (15% excl. m)		2,200
Sub-total		38,900
Total		US$ 143,200

Note: Since freightage for bag filters differs with freight package conditions, their freightage from the shipping place to the destination and customs expenses are not estimated here.

8) Reduction ratio

Fuel consumption : 10%
NOx : 5%
PM : 50%

9) Summary of control measures

Table 5.2.22 summarizes the control measures for Metal Products Factory (B).

Table 5.2.22 Summary of Control Measures for Metal Products Factory (B)

		Present Status	Control measures
Fuel type		Natural gas	Natural gas
Equipment		–	– Hood on the opening – Bag filter
Fuel Consumption	Natural gas ($10^6 m^3$/yr)	2.97	2.83 (10% fuel saving)
Emission (ton/yr)	NOx	1.0	0.95
	PM	2.2	1.1
Reduction ratio (%)	NOx		5
	PM		50
Equipment cost (1,000 US$)			143.20
Running cost (approx.)(1,000US$/yr)			
Facility depreciation (15 yrs)			9.5
Interest (first 5 yrs: 8%)			11.5
Maintenance cost (5%)			7.2
Natural gas		247.5	235.8
Total (1,000 US$/yr)		247.5	264.0

5.2.23 Food Products Factory

1) Name of facility surveyed — Boiler for processing (No. 2)

2) Specification of facility

Model	Water-tube boiler
Capacity	45.4 ton/hr
Draft and ventilation	Forced draft type
Structure and size of furnace	$1{,}920^{W}$ x $5{,}310^{D}$ x $3{,}600^{H}$
Number and layout of burner	1 unit (heavy oil burner)
Furnace pressure	100 mmAq
Ancillary facility	Air preheater

3) Specification of burner

Model	Steam pressure atomization type (Y-jet)
Type of fuel	Heavy oil
Fuel consumption	3,400 *l*/hr (estimated)
Fuel pressure	13 kg/cm^2g
Atomizing pressure	12 kg/cm^2g (steam)

4) Analytical data of flue gas

(Stack sampling data) 14:30/Load at 80% of rating

NOx (ppm)*	202	Particulate matter (g/Nm^3)	0.21
O_2 (%)	4.8	Flue gas temperature (°C)	235
CO (%)	<0.05	Combustion chamber outlet O_2 (%)	–
CO_2 (%)	11.5		

(Emission)

	kg/hr
NOx	10
SO_2**	260
Particulate	4.9

NOx at rated operation is estimated to be 220 ppm (11.0 kg/hr).

* Converted to oxygen concentration of 5%

** Calculated from analytical value of fuel

5) Observation

Two boilers are used in parallel for generation of process steam. A drain recovery system is attached. The load during normal operation is low at about 50%. The boiler has an air preheater and the flue gas temperature was 205°C at the normal load and 262°C at the 80% load.

The burner is the steam-atomization type and the NOx concentration, as converted to 5% O_2, was 180 - 190 ppm. When measurement was made at the 100% load while shutting down one boiler, the NOx concentration at 5% O_2 was 202 ppm.

NOx reduction measures to be considered include (1) operation with maintaining the appropriate O_2 level and (2) use of flue gas recirculation or low-NOx burner.

6) Countermeasures

i) Retrofitting of the boiler

(a) Automatic control of air ratio

(b) Installation of flue gas fan for flue gas recirculation and installation of low NOx burners

ii) Fuel change

(a) Mixed combustion with 50% heavy oil and 50% diesel or natural gas up to the supply start of desulfurized heavy oil

(b) When supply of desulfurized heavy oil is started, it should be used exclusively (100%)

(c) Emulsified combustion of desulfurized heavy oil should be taken into consideration after thorough demonstration tests.

iii) Continuous monitoring of the flue gas by installing the NOx, SO_2 telemeters

7) Expenses for boiler retrofitting

Retrofitting for flue gas recirculation, low NOx burner installation, and for automatic control of air ratio

i) Foreign portion

		(US$)
(a) Survey and design	1 set	19,300
(b) Burners (3,000 *l*/hr)	1 set	103,900
(c) Flue gas recirculation fan (120 m^3)	1 set	25,400
(d) Combustion control system and		

	electric instrumentation	1 set	77,000
(e)	Automatic air ratio controller	1 set	46,200
(f)	Local joint work	1 set	23,100
(g)	On-site instruction for test operation	1 set	7,700
(h)	Package and freight	1 set	13,500
(i)	Travelling	1 set	17,200
(j)	Unexpected expenses (5% of the above)		16,700
	Sub-total		350,000

ii) Local portion

(k)	Burner removal work	1 set	1,600
(l)	Duct fabrication	1 set	53,900
(m)	Burner, duct, fan installation	1 set	7,300
(n)	Trial operation on-site attendance	1 set	800
(o)	Customs and other taxes	1 set	76,300
(p)	Warehouse, customs clearance, and land freight (incl. IVA)	1 set	5,420
(q)	IVA (15% excl. o + p)		9,540
	Sub-total		154,860
	Total		US$ 504,860

8) Installation of the NOx, SO_2, O_2 telemeter

Expenses for telemeter instrumentation system on the flues of No. 1 and No. 2 boilers

i) Foreign portion

			(US$)
(a)	Survey and design	1 set	6,200
(b)	NOx, SO_2, O_2 instrumentation	2 sets	118,600
(c)	Auxiliary units	2 sets	41,100
(d)	Data logger	1 set	17,900
(e)	Installation work on-site supervision	1 set	8,500
(f)	On-site instruction for test operation	1 set	4,700
(g)	Package and freight	1 set	25,900

(h)	Travelling	1 set	11,900
(i)	Unexpected expenses (5% of the above)		11,740
	Sub-total		246,540

ii) Local portion

			(US$)
(j)	Materials	1 set	4,200
(k)	Survey assistant	1 set	1,300
(l)	Installation expenses	1 set	4,400
(m)	Trial operation on-site adjustment	1 set	1,400
(n)	Vehicle rental	1 set	2,200
(o)	Customs and other taxes	1 set	41,690
(p)	Warehouse, customs clearance, and land freight	1 set	3,250
(q)	IVA (15% excl. o + p)		2,030
	Sub-total		60,470
	Total		US$ 307,010

(Telephone installation work and central reception system are not included.)

9) Summary of control measures

Table 5.2.23 summarizes the control measures for the Food Products Factory.

Table 5.2.23 Summary of Control Measures for the Food Products Factory

		Current Status	Control measures		
			A	B	C
Fuel type		Heavy oil	Heavy oil 50% Diesel 50%	Desulfurized heavy oil 100%	Desulfurized heavy oil 100%
Combustion method		–	–	–	Emulsified combustion
Fuel Consumption	Heavy oil (10^3m^3/yr)	17.4	8.7	17.4	17.4
	Diesel (10^3m^3/yr)	0.91	9.61	0.91	0.91
Emission (ton/yr)	NOx	63	36	46	36
	SO_2	1,062	634	300	300
	PM	21.9	17.5	17.5	13.1
Reduction ratio (%)	NOx	–	43	27	43
	SO_2	–	40	72	72
	PM	–	20	20	40
Equipment cost (1,000US$)	Furnace retrofit, etc.		1,009.72	1,009.72	1,009.72
	NOx, SO_2 telemeter		307.01	307.01	307.01
Running cost (approx.)(1,000 US$/yr)					
Facility depreciation (15 yrs)			87.8	87.8	87.8
Interest (first 5 yrs: 8%)			105.3	105.3	105.3
Maintenance cost (5%)			65.8	65.8	65.8
Heavy oil		1,349.4	674.7	–	–
Diesel		187.3	1,977.6	187.3	187.3
Desulfurized heavy oil		–	–	1,893.9	–
Desulfurized heavy oil emulsion		–	–	–	2,308.2
Total (1,000 US$/yr)		1,536.7	2,911.2	2,311.1	2,754.4

Alternative B: Applicable after the start of supplying desulfurized heavy oil.
Alternative C: Emulsified combustion should be considered adoption after thorough demonstration tests.

Note: (1) Boiler loading rate is assumed to be 50%.
(2) Facility retrofitting cost is for 2 boilers.

5.2.24 Alcoholic Drinks Factory

1) Name of facility surveyed — Power generation boiler (No. 2)

2) Specification of facility

Model	Water-tube boiler (tangential firing)
Capacity	63 ton/hr
Draft and ventilation	Forced draft
Size of boiler	$4{,}700^{W}$ x $4{,}156^{D}$ x $8{,}534^{H}$
Number and layout of burner	4 (one each at boiler corners)
Furnace pressure	+150 mmAq
Ancillary facility	Air preheater (30 → 200°C)

3) Specification of burner

Model	Gas-Oil mixed combustion; Gas: lance type, Heavy oil: Y-jet type
Type of fuel	Heavy oil (only heavy oil is used at present)
Fuel consumption	5,400 l/hr
Fuel pressure	5 kg/cm^2g
Atomizing pressure	6 kg/cm^2g (steam)

4) Analytical data of flue gas

(Stack sampling data) 15:30/Load is approx. 97% of rating

NOx (ppm)*	232	Particulate matter (g/Nm^3)	0.41
O_2 (%)	4.3	Flue gas temperature (°C)	178
CO (%)	<0.05	Combustion chamber outlet O_2 (%)	2.5
CO_2 (%)	12.0		

(Emission)

	kg/h
NOx	31
SO_2**	310
Particulate	25

* Converted to oxygen concentration of 5%.

** Calculated from analytical value of fuel

5) Observation

This is a beer brewery of the largest beer manufacturer in Mexico. Because of its proximity to the center of the metropolitan area, its pollutant emission must be given serious attention; its emissions of both NOx and particulate matter are quite large. In addition to this boiler burning heavy

oil, there are also two natural gas burning boilers (100 ton/hr and 27 ton/hr) in operation for power generation, and one 80 ton/hr boiler under construction; the total fuel consumption of all these boilers is quite large.

All the boilers in this plant are of the tangential firing type, in which one burner each is installed at the four corners of the boiler. This creates a swirling fire ball in the combustion chamber. Thus it is nicknamed the fireball combustion system. Generally, this combustion method gives lower NOx generation than the front-firing method. Inspection is required on leaks within the air preheater. The combustion chamber load is relatively high at 540,000 kcal/m^3hr. Judging from the low O_2 concentration of 2.5% at the outlet of the combustion chamber, this boiler is operated under the nearly optimum level of air ratio.

6) Countermeasures

i) Retrofitting of the boiler

(a) Air preheater repair

(b) Continuous monitoring of the flue gas O_2 for low air ratio combustion

ii) Fuel change

Change of heavy oil to natural gas

iii) Continuous monitoring of the flue gas by installing NOx, SO_2, Ox telemeters.

7) Expenses for boiler retrofitting

Retrofitting for flue gas recirculation, low air ratio combustion, and for air repair

i) Foreign portion

		(US$)
(a) Survey and design	1 set	15,400
(b) Flue gas recirculation fan	1 set	30,000
(c) Combustion control system and electric instrumentation	1 set	46,200

(d)	Local work on-site supervision	1 set	23,100
(e)	On-site instruction for test operation	1 set	7,700
(f)	Package and freight	1 set	11,900
(g)	Travelling	1 set	17,200
(h)	Unexpected expenses (5% on above)		7,600
	Sub-total		159,100

ii) Local portion

			(US$)
(i)	Dust fabrication (incl. heat insulation)	1 set	115,400
(i)	Duct and fan installation	1 set	30,800
(k)	Electrical instrumentation work	1 set	11,500
(l)	Trial operation on-site attendance	1 set	2,300
(m)	Customs and other taxes	1 set	22,500
(n)	Warehouse, customs clearance, and land freight (incl. IVA)	1 set	2,360
(o)	Duct, etc. freight, crane car rental	1 set	2,000
(p)	IVA (15% excl. m + n)		24,300
	Sub-total		211,180
	Total		US$ 370,280

8) Installation of the NOx, SO_2, O_2 telemeters for constant monitoring of the flue gas

Expenses for telemetric monitoring of NOx and O_2 for No. 1, 3, 4 boilers and SO_2, NOx and O_2 for No.2 boiler

i) Foreign portion

			(US$)
(a)	Survey and design	1 set	9,400
(b)	NOx, SO_2, O_2 instrumentation	4 sets	162,300
(c)	Auxiliary units	1 set	79,000
(d)	Data logger	1 set	17,900
(e)	Installation work on-site instruction	1 set	8,500
(f)	On-site instruction for trial operation	1 set	4,700
(g)	Package and freight	1 set	51,800

(h)	Travelling	1 set	12,400
(i)	Unexpected expenses (5% on above)		17,300
	Sub-total		363,300

ii) Local portion

			(US$)
(j)	Materials	1 set	8,400
(k)	Survey assistant	1 set	1,800
(l)	Installation expenses	1 set	8,200
(m)	Trial operation and adjustment	1 set	2,400
(n)	Vehicle rental	1 set	3,300
(o)	Customs and other taxes	1 set	70,760
(p)	Warehouse, customs clearance, and land freight	1 set	5,810
(q)	IVA (15% excl. o + p)		3,620
	Sub-total		104,290
	Total		US$ 467,590

(Telephone installation work and central reception system are not included.)

9) Summary of control measures

Table 5.2.24 summarizes the control measures for Alcoholic Drinks Factory.

Table 5.2.24 Summary of Control Measures for Alcoholic Drinks Factory

		Present Status	Control measures
Fuel type		Heavy oil	Natural gas
		Natural gas	
Combustion mode		Mixed combustion	
Fuel Consumption	Heavy oil (10^3m^3/yr)	40.6	0
	Natural gas (10^6m^3/yr)	54.0	86.4
Emission (ton/yr)	NOx	408.1	217.2
	SO_2	2,436	0
	PM	136.1	0
Reduction ratio (%)	NOx		47
	SO_2		100
	PM		100
Equipment cost (1,000 US$)	Facility retrofitting		1,110.84 (Note)
	Nox, SO_2 telemeter		467.59
Running cost (approx.)(1,000 US$/yr)			
Facility depreciation (15 yrs)			105.2
Interest (first 5 yrs: 8%)			126.3
Maintenance cost (5%)			78.9
Heavy oil		3,148.6	–
Natural gas		4,499.8	7,200.0
Total (1,000 US$/yr)		7,648.4	7,510.4

Note: Retrofitting expenss (US$ 740,560) for the 100-ton/hr boiler (30-year old) and the 27-ton/hr boiler (36-year old) are included.

5.2.25 Public Bathhouse

1) Name of facility surveyed — Boiler (No. 1)

2) Specification of facility

Model	Flue and smoke tube type
Capacity	1.56 ton/hr
Draft and ventilation	Natural draft
Size of furnace	610^{ϕ} x $3{,}000^{L}$
Number of burner	One unit (heavy oil burner)
Furnace pressure	-1 ~ -2 mmH_2O
Ancillary facility	None

3) Specification of burner

Model	Steam atomization burner
Type of fuel	Heavy oil
Fuel consumption	100 l/hr
Fuel pressure	Unknown
Atomizing pressure	5.2 kg/cm^2g

4) Analytical data of flue gas

(Stack sampling data) 13:30/Load at 80% of rating

NOx (ppm)*	190	Particulate matter (g/Nm^3)	0.15
O_2 (%)	10.5	Flue gas temperature (°C)	170
CO (%)	0.25	Combustion chamber outlet O_2 (%)	–
CO_2 (%)	6.0		

(Emission)

	kg/hr
NOx	0.41
SO_2**	5.8
Particulate	0.24

NOx at rated operation is estimated to be 200 ppm (0.43 kg/hr).

* Converted to oxygen concentration of 5%

** Calculated from analytical value of fuel

5) Observation

This smoke tube boiler for public bathhouse is operated daily from 6:00 to 20:00. As the steam atomization burner is operated manually, black smoke is generated at the times of ignition and change in combustion load. The combustion chamber load was small and the NOx concentration was high despite the high air ratio. This may be due to faulty atomization by the burner. *Employment of automatic control is recommended because*

reduction of smoke and soot rather than NOx is necessary. It can be done at the time of renewal of boiler in the future since it is very old.

6) Countermeasures

i) Regular monitoring of the O_2 level with a portable O_2 meter for operation at the appropriate air ratio.

ii) Fuel change

(a) Mixed combustion with heavy oil and 50% diesel or natural gas up to the supply start of desulfurized heavy oil

(b) When supply of desulfurized heavy oil is started, it should be used exclusively (100%)

(c) Emulsified combustion of desulfurized heavy oil should be taken into consideration after through demonstration tests.

7) Expenses

O_2 meter : US$ 2,400

(This amount does not include the customs duty, customs clearance expenses, domestic freight, etc.)

8) Reduction ratio

i) Before supply of desulfurized heavy oil (50% heavy oil and 50% diesel)

NOx : 30%

SO_2 : 41%

PM : 20%

ii) When desulfurized heavy oil is exclusively used

NOx : 10%

SO_2 : 73%

PM : 20%

iii) Emulsified combustion of desulfurized heavy oil

NOx : 44%

SO_2 : 73%

PM : 40%

5.3 Summary

5.3.1 Outlines of Proposed Measures

Equipment-related control measures proposed based on the diagnostic survey are summarized in Table 5.3.1

Table 5.3.1 Equipment Related Control Measures Proposed

Control Measure	Number of establishments (facilities) applied	
Reduction of combustion chamber loading	3	(8)
Burner nozzle renewal	1	(1)
Low-NOx burners	10	(25)
Exhaust gas recirculation	11	(25)
Tow-stage combustion	2	(5)
Off-stoichiometric combustion	3	(6)
In-furnace denitation combustion	2	(8)
Installation of precalciner	1	(2)
Heat insulation of furnace ceiling	3	(8)
Bag filter	2	(4)
Electrostatic precipitator (EP)	4	(10) *
Air preheater	1	(2)
Combustion control instruments	8	(18)
HC reduction measures	1	
Simple repair by owner	2	
Automatic O_2 analyzer	9	
Portable O_2 analyzer	5	
Others	2	

Note: * Excludes 8 boilers in 2 power plants.

For fuel change or improvement in the facilities using heavy oil exclusively, the following 3 cases are considered.

Case A: Mixed burning with diesel or natural gas in the 50:50 ratio:
Until the supply start of desulfurized heavy oil

Case B: Use of desulfurized heavy oil:
After the supply start of desulfurized heavy oil and when its emulsification is not feasible.

Case C: Use of desulfurized and emulsified heavy oil:
After the supply start of desulfurized heavy oil and when its emulsification is feasible, except glass plants remaining in Case B

5.3.2 Effects and Costs

The pollutant reduction effects by introduction of desulfurized heavy oil and its emulsion are assumed to be as shown in Table 4.4.3.

The estimated pollutant reduction to be achieved through the combined effect of the fuel change and facility improvements at the 25 object establishments are summarized in Table 5.3.2.

Table 5.3.2 Pollutant Reduction Effects in the 25 Establishments

			NOx	SO_2	PM
Present emission (1,000 ton/yr)			11.1	44.1	7.3
Emission after implement-	Fuel	A	6.6	29.2	2.5*1
ation of proposed	improvement	B	6.8	14.0	0.7*1
measures (1,000 ton/yr)	case	C	5.8	14.9	1.6*1
	Fuel	A	40	34	66
Reduction ratio (%)	improvement	B	39	68	90*2
	case	C	48	66	78

Note: *1: Reduction of PM by 3,400 ton/yr by the proposed relocation of one factory is accounted.
*2: EPs are installed in Power Plant (A).

As shown in the Table, the combination of the transient fuel change and facility improvement in Case A is expected to reduce NOx emission by 40%, SO_2 emission by 34%, and PM emission by 66%. In Case B, use of desulfurized heavy oil and installation of EPs in Power Plant (A) will reduce the SO_2 and PM emissions further. But the NOx emission will rather increase above the level of Case A. In Case C, where desulfurized and emulsified heavy oil is used, some more reduction is expected in NOx at 48%.

The expenses for the facility improvements are estimated to be as follows, excluding unestimative expenses such as in-house works, autonomous improvements and factory relocation.

Case A: NOx reduction measures and others
US$ 86,449,000

Case B: Installation of EPs in Power Plant (A)
US$ 77.381,000

Case C: Installation of heavy oil emulsifier in Poweer Plant (A)
US$ 2,113,000

CHAPTER 6 AIR POLLUTION CONTROL PLANNING FOR OTHER STATIONARY SOURCES

CHAPTER 6 AIR POLLUTION CONTROL PLANNING FOR OTHER STATIONARY SOURCES

6.1 Sources Investigated by the Detailed On-Site Questionnaire

6.1.1 Object Establishments and Facilities

Among the 97 establishments surveyed through the detailed on-site questionnaire, the 72 which remained after the study covered in Chapter 5 are the objects in this section. The breakdown by their types of industry is as shown in Table 6.1.1.

Table 6.1.1 Breakdown of the 72 Establishments by Types of Industry

Type of industry	Number
Food	8
Leather	1
Paper and its products	8
Chemical products	13
Petrochemical products	4
Coal and petroleum products	1
Rubber and plastic products	4
Non-metallic mineral products	6
Basic metals	7
Metal products	3
Transportation equipment	1
Other manufacture	1
Public bath	10
Sports center	1
Hospital	1
Hotel	2
Total	72

Broadly classified, 58 are factories, and 14 are service and commercial establishments. There are 180 furnaces covered by the survey as shown in Table 6.1.2. And there were additionally 16 electric furnaces operated in 6 establishments.

Table 6.1.2 Facilities Investigated by Detailed On-site Questionnaire

Capacity / Type of Furnace	Large	Medium	Small	Micro	Total
Industrial boiler	6	19	46	44	115
Dryer	3	0	9	6	18
Metal melting	1	0	1	1	3
Metal heating	0	5	4	0	9
Ceramic	2	3	10	0	15
Glass melting	6	5	0	0	11
Aggregate dryer	0	0	0	2	2
Heating	1	0	2	2	5
Others	0	2	0	0	2
Total	19	34	72	55	180

6.1.2 Planning Approach

(1) *Selection of Survey Objects*

In the detailed on-site questionnaire survey, the following features were examined through the simple measurement of the operational status of the combustion facility and the visual inspection of its appearance, with reference made to specifications and operation control records of the facility including fuel consumption, as prepared by the surveyed establishments.

(a) Is the fuel consumption appropriate to the rated capacity of the facility?

(b) Is the facility equipped with operation control instruments?

(c) Is the air ratio proper?

(d) Is the smoke and soot concentration in the flue gas controlled at an appropriate level?

(e) Is the generated heat effectively utilized?

(f) Is there any structural defect harmful to (d) and (e)?

On the basis of the survey results, control measures were studied for 48 establishments, after eliminating 64 furnaces in a total of 24 establishments: 13 establishments that need no measure, 4 under relocation plan, 3 under facility retrofitting or change, 2 in that no measure is possible, and 2 with no reliable data.

(2) Control Measures to be Applied

Control measures are selected from those applied to the sources subjected to the diagnostic survey considering similarity in type of combustion facilities, fuel used, facility size, and operation conditions. As the types of facility not covered by the diagnostic survey program, there are 15 kilns in 4 establishments and 2 gas turbines in 1 plant, and they are all among the eliminated 24 establishments.

Considering that there are many small to medium sized establishments, efforts have been made to select measures that give high pollutant reduction at limited facility investment costs, with emphasis given to the rationalization of operation control.

With respect to fuel change, it is assumed that the current heavy oil is replaced by the desulfurized heavy oil after the start of its supply.

6.1.3 Control Measures

(1) Outline of Control Measures

The twelve measures, as shown in Table 6.1.3, are selected as facility improvement measures for the object facilities.

Table 6.1.3 Facility Improvement Measures

Kind of facility improvement measure	Number of establishments applied (number of facilities)	Unit Cost (US$)
Reduction of combustion chamber loading	3	-
Steam atomizing system	3 (3)	2,200
Burner nozzle renewal	3 (6)	4,700
Fuel preheater	3 (5)	200
NOx measurement device	3	13,600
Combustion control instruments	1 (2)	52,000
In-furnace denitration and flue gas recirculation	1 (2)	66,000
Thermometer for air preheating	1	1,500
HC removal system	1 (paint factory)	63,000
Increase of fuel atomizing air pressure	1	-
Simple repair by owner	4	-
Portable O_2 meter	33	2,400

For fuel change or improvement in the facilities using heavy oil exclusively, the following 3 cases are considered.

A: Mixed burning of heavy oil and diesel or natural gas in the 50:50 ratio:

Until the supply start of desulfurized heavy oil

B: Exclusive burning of desulfurized heavy oil:

After the supply start of desulfurized heavy oil and when its emulsification is not feasible

C : Emulsified combustion of desulfurized heavy oil:

After the supply start of desulfurized heavy oil and when its emulsification is feasible, except glass plants remaining in the case B

The pollutant reduction effects by introduction of desulfurized heavy oil and its emulsion are assumed to be as shown in Table 6.1.4.

Table 6.1.4 Pollutant Reduction Effects of Desulfurized Heavy Oil

	NOx (%)	SO_2 (%)	PM (%)
Current heavy oil	0	0	0
Desulfurized heavy oil	10	73	20
Desulfurized & emulsified heavy oil	30	73	40

In addition to the above concrete measures in improvement of facility and fuel, future measures at the time of facility renewal and recommendation for operational control are also taken into consideration. These are summarized in Tables 6.1.5 (1) through (12) for each establishment.

Table 6.1.5 (1) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 1

Name of Establishment Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
Chemical Products Factory (A) (detergent, cooking oil, soap)	1-1	Water tube boiler	15	Steam	1,400			Diagnostic survey conducted. See Sec. 5.2.4.						
	1-2	Water tube boiler	15	Steam	1,130									
	1-3	Water tube boiler	20	Steam	1,725									
	1-4	Water tube boiler	6	Steam	416									
	1-5	Water tube boiler	5	Steam	382									
	1-6	Heat medium boiler	3.5	Oil	122									
	1-7	Heat medium boiler	35	Oil	45									
	1-8	Heat medium boiler	12	Oil	336									
	1-9	Heat medium boiler	5	Oil	45									
	1-10	Heat medium boiler	1.5	Oil	56									
	1-11	Dryer	10	Detergent	350									
	1-12	Dryer	10	Detergent	350									
	1-13	Dryer	60	Detergent	182									
POLAQUIMIA, S.A. DE C.V. Chemical (herbicide, incecticide, glycolester)	2-1	Water tube boiler	3.3	Steam	272			1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter. It should be done simultaneously with ②, since smoking takes place even at an O2 concentration of 5.2 %. ② Since the boiler is outworn and no new low NOx burner can be installed, a steam injection should be employed.	O2 meter 2,400 2,200x2	6,800	20	—	30	—
	2-2	Water tube boiler	4	Steam	227									
	2-3	Heat medium boiler	Small capacity	Oil	47									
PROCTOR & GAMBLE DE MEXICO, S.A. DE C.V. Chemical (detergent, soap)	3-1	Water tube boiler	22.7	Steam			1,125	1) Modification of combustion facility ① Since the boiler control instrumentation is fully equipped with meter for CO, CO2 & O2, with the exception of fuel atomization pressure gauge, nothing special is required.						
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30	41	20	—
											10	73	20	—
											44	73	40	—
BANOS RIO BLANCO Bathhouse	4-1	Smoke tube boiler		Steam	Alternate use	Diesel		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter. ② Replacement of the burner nozzle for optimum atomization and reduction of PM.	2,400 4,700x2	11,800	—	—	40	—
	4-2	Smoke tube boiler		Steam		Diesel								
HARINAS Y GRASAS XALOSTOC, S.A. Food (feeds : processed bone, blood and grease of animals)	5-1	Water tube boiler	2.5	Steam			250	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter. ② Repair of the boiler front door to prevent heat loss by tertiary air entry.	2,400 Self-repair	2,400	35	18	0	18
	5-2	Water tube boiler					Spare							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30	41	20	—
											10	73	20	—
											44	73	40	—
POLIESTERES BAYER, S.A. Petrochemical (polyester, agricultural chemicals)	6-1	Heat medium boiler	700,000 * * kcal/hr	Oil		40		None						
CIBA GEIGY MEXICANA, S.A. DE C.V. Chemical (medicine, dyeing agent, insecticide)	7-1	One-through blr.	1.5	Steam	1-2 of 4 operating	92		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	30	7	0	7
	7-2	One-through blr.	1.5	Steam		92								
	7-3	One-through blr.	1.0	Steam		80								
	7-4	One-through blr.	0.5	Steam		40								
Petrochemical Products Factory (B) (polyester fiber, nylon)	8-1	Water tube boiler	40	Steam			3,142	Diagnostic survey conducted. See Sec. 5.2.10.						
	8-2	Water tube boiler	40	Steam	Spare		3,142							
	8-3	Smoke tube boiler	13	Steam			416							

Table 6.1.5 (2) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 2

Name of Establishment Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
BANOS COSTA DEL SOL Bathhouse	9-1	Smoke tube boiler		Steam	Alternate use		107	1) Modification of combustion facility						
	9-2	Smoke tube boiler		Steam			107	① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400					
								② Because the fuel temperature is low, a fuel preheater should be installed. (A ribbon heater with thermometer and thermostat is also usable.)	200x2	2,800	20	3	0	3
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
BANOS COACALCO Bathhouse	10-1	Water tube boiler		Steam			11	1) Modification of combustion facility						
								① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.						
								② Colosure of superfluous openings to prevent heat loss by tertiary air entry.	2,400	2,400	40	22	0	22
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
Asphalt Plant (asphalt mix)	11-1	Rotary kiln	250	Aggregate		1,360		Diagnostic survey conducted.						
	11-2	Rotary kiln	250	Aggregate		1,360		See Sec. 5.2.12.						
	11-3	Rotary kiln	200	Aggregate		1,000								
INDUSTRIAS DE HULE GALGO Rubber & plastic product (tire tube)	12-1	Smoke tube boiler	2.55	Steam			28.4	1) Modification of combustion facility						
								① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	20	3	0	3
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
VIDRIERA MEXICO, S.A. Non-metallic mineral product (glass bottle)	13-1	Glass melting furnace tank oven	8.6	Glass Cullet 75%	1,282			1) Modification of combustion facility						
	13-2	Glass melting furnace tank oven	8.6	Glass Cullet 75%	1,282			① When NOx concentration is high, the volumetric furnace load should desirably be reduced. (around 70,000 kcal/m3hr. When heat amount is insufficient for the intended process, electric heater free from NOx generation can be used as a supplement.)						
	13-3	Glass melting furnace tank oven	8.6	Glass Cullet 75%	1,282				NOx meter					
	13-4	Glass melting furnace tank oven	8.6	Glass Cullet 75%	1,282			② Combustion control to prevent abnormally high NOx concentration using a NOx meter.	13,600	13,600	30	—	0	—
	13-5	Glass melting furnace tank oven	8.6		1,282	Not operating								
Rubber Products Factory (tire)	14-1	Water tube boiler	10	Steam			500	Diagnostic survey conducted.						
	14-2	Water tube boiler	6.4	Steam		Not operating		See Sec. 5.2.17.						
	14-3	Hot water boiler	0.1	Hot water		Diesel								
CENTRO DEPORTIVO CHAPULTEPEC, A.C. Public sports center (polyester, nylon)	15-1	Water tube boiler	9.0	Steam	13hr/day		307	1) Modification of combustion facility						
	15-2	Water tube boiler	5.0	Steam	3hr/day		185	① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	20	4	0	4
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
Petrochemical Products Factory (A) (polyester fiber, nylon)	16-1	Water tube boiler	14	Steam	500			Diagnostic survey conducted.						
	16-2	Water tube boiler	14	Steam	Not operating			See Sec. 5.2.9.						
	16-3	Water tube boiler	28	Steam			2,083							
	16-4	Water tube boiler	41	Steam	2,500									

Table 6.1.5 (3) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 3

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of Fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Indi-vidual (US$)	Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
INDUSTRIAS RESISTOL, S.A. Chemical (ABS resin, latex, sodium phosphate)	17-1 17-2	Water tube boiler Water tube boiler	11.8 12.5	Steam Steam	200 Not operating			Factory relocated by the administrative order.						
NOVAQUIM, S.A. Chemical (oxidation inhibitor, stabilizer)	18-1 18-2	Smoke tube boiler Smoke tube boiler	4.7 4.7	Steam Steam	Alternate use		168 168	1) Modification of combustion facility ① The structure permits no retrofitting.						
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
Metal Products Factory (B) (aluminumsash, racket, tube)	19-1 19-2 19-3 19-4 19-5 19-6 19-7 19-8 19-9 19-10	Melting furnace Melting furnace Melting furnace Melting furnace Melting furnace Heat treating fce. Heat treating fce. Heat treating fce. Heat treating fce. Heat treating fce.	20 1.75 1.75 1.75 1.75	Aluminum Aluminum Aluminum Aluminum Aluminum Aluminum Aluminum Aluminum Aluminum Aluminum	227 20 20 20 20 36 36 36 36 36			Diagnostic survey conducted. See Sec. 5.2.22.						
FUNDICION CHORNE Basic metals (cast iron)	20-1	Cupola	1.5	Scrap iron	Coke: 500 kg/day			Factory to be relocated.						
BANOS TACUBAYA Bathhouse	21-1 21-2	Smoke tube boiler Smoke tube boiler	1.27 1.27	Steam Steam	Alternate use		170 170	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	35	18	0	18
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
BANOS NAUCALPAN Bathhouse	22-1 22-2	Smoke tube boiler Smoke tube boiler	0.6 0.6	Steam Steam	Alternate use		80 80	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	15	3	0	3
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
Glass Factory (C) (glass bottle)	23-1 23-2 23-3 23-4 23-5	Glass melting furnace tank oven Glass melting furnace tank oven Glass melting furnace tank oven Decorating furnace (12 furnaces) Annealing furnace (17 furnaces)	16.7 8.3 8.3	Glass Cullet 55% Glass Cullet 55% Glass Cullet 55% Glass Glass	2,160 1,500 800 2,980			Diagnostic survey conducted. See Sec. 5.2.16.						
Chemical Products Factory (D) (NaOH, Cl2, NaClO)	24-1 24-2 24-3 24-4	Water tube boiler Water tube boiler Smoke tube boiler Smoke tube boiler	7.7 7.7 3.8 3.8	Steam Steam Steam Steam	363 363 Spare Spare			Diagnostic survey conducted. See Sec. 5.2.7.						
GENERAL PRODUCTOS CO., S.A. DE C.V Chemical (Na2S204, ZnO, SO2 Soln.)	25-1 25-2 25-3 25-4	Smoke tube boiler Smoke tube boiler Smoke tube boiler Smoke tube boiler	7.8 7.8 4.7 3.1	Steam Steam Steam Steam	686 686 208 208	3 of 4 operating		None						

Table 6.1.5 (4) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 4

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of Fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Indi-vidual (US$)	Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
IDEAL STANDARD, S.A. Non-metallic mineral product (Sanitation porcelain)	26-1	Tunnel kiln	403,200 *	Ceramic	245			None						
	26-2	Tunnel kiln	403,200 *	Ceramic	245									
	26-3	Tunnel kiln	296,000 *	Ceramic	180									
	26-4	Tunnel kiln	296,000 *	Ceramic	180									
	26-5	Downdraft kiln	453,600 *	Ceramic	500 * kcl/hr									
	26-6	Infrared burner	30,200-60,600 kcal/hr			800	burners							
FCA. DE PAPEL SAN RAFAEL Paper & its product (paper)	27-1	Black liquor boi.	12.5	Steam	Black liquor		3,280	1) Modification of the Black liquor boilers ① The black liquor boiler is equipped with an Electro-static Precipitator for dust control. Since the company did not permit the diagnostic survey, no details of EP is available. Judging from the change in smoke meission resulting from a temporary interruption of EP operation, its soot precipitation efficiency must be good. On the basis of the chracteristics of EP, also fine dust such as Na2O4 is thought to be well removed. The black liquor contains 3.5% S, and this is presumably recovered together with chemicals such as NaOH. (In Japan, 98% is recovered in this way.) With respect to NOx, the concentration is considered to be low, based on the composition and combustion method for the black liquor. From the above, no further measure is considered to be needed, provided that the EP is maintained sufficiently. For the future, adoption of a furnace with high S recovery rate is recommended at the time of replacement.						
	27-2	Black liquor boi.	20.5	Steam	Black liquor		4,480							
	27-3	Water tube boiler	34.0	Steam			416							
	27-4	Water tube boiler	60.0	Steam			2,017							
	27-5	Water tube boiler	60.0	Steam			3,600							
							3,500							
								2) Fuel change for the water tube boilers ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil.			30 10	41 73	20 20	– –
FCA. DE PAPEL MEXICO Paper & its product (recycled paper)	28-1	Water tube boiler	20.8	Steam			1,250	1) Modification of combustion facility ① Upgrading of the combustion control instruments including currently failing ones to secure optimum combustion. ② In-furnace denitration and flue gas recirculation.	52,000×2 66,000×2	236,000	30	0	20	–
	28-2	Water tube boiler	20.8	Steam			1,250							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	– – –
HACO MEXICANA, S.A Chemical(Fe2O3)	29-1	Smoke tube boiler	3.8	Steam			266	1) Modification of smoke tube boiler ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter; after the completion of maintenance works.	2,400	2,400	30	7	0	7
	29-2	Roasting furnace		Pigment		83								
	29-3	Drying furnace		Pigment			Total							
	29-4	Drying furnace		Pigment			88							
	29-5	Drying furnace		Pigment										
	29-6	Drying furnace		Pigment				2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	– – –
Paper Factory	30-1	Water tube boiler	16	Steam			750	Diagnostic survey conducted. See Sec. 5.2.18.						
	30-2	Water tube boiler	14	Steam			600							
Glass Factory (B) (glass wool, glass fiber)	31-1	Melting furnace	1.3	Glass	535.6			Diagnostic survey conducted. See Sec. 5.2.15.						
	31-2	Melting furnace	0.9	Glass	495.2									
	31-3	Melting furnace	0.7	Glass	569.1									
	31-4	Water tube boiler	3.1	Steam	2,300	Alternate use								
	31-5	Water tube boiler	3.1	Steam	2,300									

Table 6.1.5 (5) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 5

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of Fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Individual (US$)	Investment Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
PASTEURIZADORA LA LAGUNA Food (dairy products, milk, yogurt)	B2-1 B2-2	Smoke tube boiler Smoke tube boiler	2.6 2.6	Steam Steam	Alternate use		42 42	1) Modification of combustion facility ① Since PM generation is expected due to defective fuel atomization, the burner nozzle should be renewed.	4,700x2	9,400	0	0	30	—
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
VIDRIO PLANO DE MEXICO, S.A. Non-metallic mineral product (plate glass, glass for automobile)	B3-1 B3-2	Glass melting furnace tank oven Glass melting furnace tank oven	3.3 15.8	Glass Cullet 30% Glass Cullet 30%	2,050 3,618			1) Modification of combustion facility ① When NOx concentration is high, the volumetric furnace load should desirably be reduced. (around 70,000 kcal/m3hr. When heat amount is insufficient for the intended process, electric heater free from NOx generation can be used as a supplement.) ② Combustion control to prevent abnormally high NOx concentration using a NOx meter.	13,600	13,600	30	—	0	—
Paper Products Factory (A) (Recycled paper)	B4-1 B4-2 B4-3 B4-4 B4-5	Water tube boiler Smoke tube boiler Smoke tube boiler Smoke tube boiler Smoke tube boiler	9.4 7.8 7.8 7.8 7.8	Steam Steam Steam Steam Steam		Not operating	902 283 283 283	Diagnostic survey conducted. See Sec. 5.2.19.						
METALURGICA ALMENA Basic metals (copper, brass, bronze castings)	B5-1 B5-2 B5-3 B5-4 B5-5	Crucible furnace Electric furnace Electric furnace Electric furnace Electric furnace	600 * 600 * 600 * 600 * 600 *	Scrap & ingot *:kg/charge	18,300	Elec. 11 kwh/kg Elec. 11 kwh/kg Elec. 11 kwh/kg Elec. 11 kwh/kg		1) Modification of the crucible furnace ① Repair of the damaged hood to improve the efficiency of recuperator.	Self-repair					
BANOS LA NARANJA Bathhouse	B6-1 B6-2 B6-3 B6-4 B6-5 B6-6	Smoke tube boiler Smoke tube boiler Hot water boiler Hot water boiler Hot water boiler Hot water boiler	0.8 0.8	Steam Steam Hot water Hot water Hot water Hot water	Alternate use	55 55 Diesel Diesel Diesel Diesel		None						
BANOS XOLALPA Bathhouse	B7-1 B7-2	Smoke tube boiler Smoke tube boiler	1.0 0.8	Steam Steam		Spare	130 130	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	30	9	0	9
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
BANOS GABIS Bathhouse	B8-1 B8-2	Smoke tube boiler Smoke tube boiler	0.4 0.6	Steam Steam		Not operating	51 51	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter. ② Because the fuel temperature is low, a fuel preheater should be installed. (A ribbon heater with thermometer and thermostat is also usable.)	2,400 200x2	2,800	35	15	0	
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	
MEDIDORES AZTECA, S.A. Basic metals (brass cast.	B9-1	Electric furnace	69 kg/hr	Ingot		Elec. 1.2 kwh/kg		None						

Table 6.1.5 (6) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 6

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of Fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Individual (US$)	Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
SALICILATOS DE MEXICO Precision instruments (medical supplies)	40-1	Water tube boiler	7.6	Steam			311	None; relocation currently planned.						
Cement Factory (portland cement)	41-1	Rotary kiln	96	Cement			9,000	Diagnostic survey conducted. See Sec. 5.2.13.						
	41-2	Rotary kiln	96	Cement			9,000							
	41-3	Rotary kiln	25	Cement			2,250							
	41-4	drying furnace	180	Cement	N. gas									
	41-5	drying furnace	180	Cement	N. gas									
	41-6	drying furnace	45	Cement	N. gas									
	41-7	Heat medium boiler	1.3	Oil			H.oil							
	41-8	Heat medium boiler	1.3	Oil			H.oil							
	41-9	Hot water boiler	1.3	Hot water			H.oil							
PAPELERA ATLAS Paper & its product (Recycled paper)	42-1	Water tube boiler	9.6	Steam			400	1) Modification of combustion facility ① Since PM generation is expected due to defective fuel atomization, the burner nozzle should be renewed.	4,700x2	9,400	0	0	80	—
	42-2	Smoke tube boiler	6.4	Steam			270							
	42-3	Smoke tube boiler	2.4	Steam			Spare							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
BANOS LUPITA Bathhouse	43-1	Smoke tube boiler	0.6	Steam	Alternate use		83	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	30	7	0	7
	43-2	Smoke tube boiler	0.5	Steam			83							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
PORCELANITE, S.A. Non-metallic mineral product (tile for building)	44-1	Tunnel kiln	108,000 *	Ceramic	100			None						
	44-2	Tunnel kiln	108,000 *	Ceramic	100									
	44-3	Tunnel kiln	108,000 *	Ceramic	100									
	44-4	Tunnel kiln *	875,000 *	Ceramic	145.7									
		*:hearth roller type		*:kcal/hr										
PRODUCTOS SAN CRISTOBAL Paper & its product (tissues, toilet etc.)	45-1	Water tube boiler	18	Steam	Not operating			1) Modification of the water tube boilers ① Regular combustion control to secure operation at optimum air ratio. ② Installed of a preheated air thermometer for enforced combustion control.	1,500	1,500	10	—	0	2
	45-2	Water tube boiler	35	Steam	1,681									
	45-3	Water tube boiler	45	Steam	2,162									
	45-4	Dryer		Paper	363									
	45-5	Dryer		Paper	250									
	45-6	Dryer		Paper	242									
	45-7	Dryer		Paper	467									
	45-8	Dryer		Paper	854									
CIA. HULERA TORNEL Rubber & plastic product (tyre, tube)	46-1	Smoke tube boiler	2.6	Steam		180		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	10	2	0	2
	46-2	Smoke tube boiler	1.6	Steam		112								
	46-3	Smoke tube boiler	1.3	Steam		Diesel	Not ope							
	46-4	Smoke tube boiler	0.8	Steam		Diesel	Not ope							
	46-5	Heat medium boiler	5,040kcl/hr			Diesel								
Alcoholic Drinks Factory (beer)	47-1	Water tube boiler	100	Steam	Mixed combus.		3,333	Diagnostic survey conducted. See Sec. 5.2.24.						
	47-2	Water tube boiler	63	Steam	6,250									
	47-3	Water tube boiler	27	Steam	2 of 3 operation									
	47-4	Water tube boiler	82	Steam	Not operating									
BANOS TACUBA Bathhouse	48-1	Smoke tube boiler	0.6	Steam	Alternate use		43	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	25	5	0	5
	48-2	Smoke tube boiler	0.3	Steam			27							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —

Table 6.1.5 (7) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 7

Name of Establishment Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
CARTONAJES ESTRELLA Paper & its product (carton)	49-1 49-2 49-3	Water tube boiler Water tube boiler Water tube boiler	35 60 112	Steam Steam Steam	Not operating Not operating 8,500			None						
FUNDIDORA Y LAMINADORA ANAHUAC Basic metals (angle steel, channel steel)	50-1 50-2	Heating furnace	10	Billet	539			1) Modification of combustion facility ① The factory has a furnace retrofitting plan for energy saving. (When a recuperator is adopted.)			0	—	0	20
ACEROS AHUEHUETES Basic metals (steel bar)	51-1 51-2	Heating furnace Smoke tube boiler	6	Billet Steam			400 H.oil	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	55	42	0	42
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil.			30 10	41 73	20 20	— —
Public Bathhouse	52-1 52-2	Smoke tube boiler Smoke tube boiler	1.3 1.3	Steam Steam	Alternate use		71 71	Diagnostic survey conducted. See Sec. 5.2.25.						
ACEROS CORSA Basic metals (steel for sash)	53-1 53-2	Heating furnace Electric furnace	12 30	Billet Scrap	610			None						
DU PONT Chmical (Freon 11,12,22)	54-1 54-2	Smoke tube boiler Smoke tube boiler	4.6 4.6	Steam Steam	360 360	Alternate use		None						
Metal Products Factory (A) (bar steel, angle steel)	55-1 55-2 55-3	Heating furnace Heating furnace Electric furnace	10 8 25 ≠ ≠ ton/charge	Billet Billet Scrap	634 634 Elec. 7,500 kwh/chaege			Diagnostic survey conducted. See Sec. 5.2.21.						
FUNDICIONES FIERRO-MEX Basic metals (bar steel, angie steel)	56-1 56-2	Heating furnace Heating furnace	6 4.5	Scrap Scrap			360 320	1) Modification of combustion facility ① Adoption of a recuperator desirable at the time of the furnace renewal.						
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil.			30 10	41 73	20 20	— —
Petroleum Refinery	57-1	Water tube boiler 5 units	56	Steam	1,880-2,700		353-450	Diagnostic survey conducted.						
	57-2	Water tube boiler	120	Steam	6,000		783	All refining operations were closed on March 18, 1991 by the Executiv Order.						
	57-3	Packaged boiler	55	Steam	2,090		273	See Sec. 5.2.3.						
	57-4	CO boiler	124	Steam	4,530		1,055							
	57-5	Heating furnace	117	Petroleum	4,270									
	57-6	Heating furnace	59	Petroleum	2,140									
	57-7	Heating furnace	45	Petroleum	1,600									
	57-8	Heating furnace	4.3	Petroleum	140									
	57-9	Heating furnace	12	Petroleum	400									
	57-10	Heating furnace	14	Petroleum	470									
	57-11	Heating furnace	49	Petroleum	810									
	57-12	Heating furnace	29	Petroleum	270									
	57-13	Heating furnace	31	Petroleum	810									
	57-14	Heating furnace	19	Petroleum	780									
	57-15	Heating furnace	50	Petroleum	4,050									
	57-16	Heating furnace	10	Petroleum	250									
ANDERSON CLAYTON, S.A. Food (dressing, etc.)	58-1 58-2 58-3 58-4	Water tube boiler Water tube boiler Drying oven Drying oven	0.9 0.4 400 kg/hr 450 kg/hr	Steam Steam	Alternate use L.P.G 7 l/hr L.P.G 8 l/hr	27 27		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	25	7	0	7

Table 6.1.5 (8) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 8

Name of Establishment Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
FUNDICIONES DE HIERRO Y ACERO Metal product (wheel truck for railroad)	59-1	Electric furnace	15 *	Scrap	Elec.	859 kwh/charge		None						
	59-2	Electric furnace	4 *	Scrap	Elec.	800 kwh/charge								
	59-3	Electric furnace	4 *	Scrap	Elec.	800 kwh/charge								
			* ton/charge											
	59-4	Annealing furnace	4.4	Casting of iron	420									
	59-5	Heating funace			Not operating									
	59-6	Cupola			Not operating									
FUNDIDORA DE ACEROS TEPEYAC Basic metals (cast iron)	60-1	Electric furnace	2.5 *	Scrap	Elec.	500 kwh/charge		1) Modification the annealing furnaces ② Repair of the furnace door to reduce energy loss by tertiary air entry. The quantitative evaluation of the fuel saving effect by prevention of tertiary air entry is difficult. Assuming a combstion efficiency of 50%, the reduction of oxygen concentration from 8.5% to 2.1% will result in 11% saving.	Self-repair					
	60-2	Electric furnace	6.0 *	Scrap	Elec.	500 kwh/charge								
	60-3	Electric furnace	3.5 *	Scrap	Elec.	500 kwh/charge								
	60-4	Electric furnace	6.0 *	Scrap	Elec.	500 kwh/charge								
	60-5	Electric furnace	2.5 *	Scrap	Elec.	500 kwh/charge								
	60-6	Electric furnace	6.5 *	Scrap	Elec.	500 kwh/charge								
	60-7	Annealing furnace	40 *	Casting of iron	459.7									11
	60-8	Annealing furnace	20 *		554.5									
	60-9	Annealing furnace	4 *	Casting of iron	173.5									
			*:ton/charge											
FORD MOTOR COMPANY Transportation equipment (vehicle engine, car body assembly)	61-1	Drying furnace	0.6-3.2	Mold	50-60			1) Reduction of hydrocarbon ① Hydrocarbon vapor generated from the painting process, should be ducted for direct burning treatment. (The volume is assumed to be 5,000m3/hr) A burner, temperature controller and a blower should be istalled. (Since prices for incinerator and duct vary widely depending on the installation site, they are execluded from the estimate.) Other combustion facilities are satisfactorily controlled, and no special measure is needed.	53,000	53,000	HC : 90 %			
	61-2	Hot water boiler	1-3.5	Hot water	16-88									
	61-3	Air heater		Air	80									
	61-4	Electric furnace	8	Scrap	Elec.	600 kwh/charge								
	61-5	Annealing furnace		Casting of iron										
Chemical Products Factory (B) (agricultual chemicals, etc.)	62-1	Smoke tube boiler	2.6	Steam			84	Diagnostic survey conducted. See Sec. 5.2.5.						
	62-2	Heating furnace	100,000*	Oil		10								
			*:kcal/hr											
INDUSTRIAS UNIDAS, S.A. Insulator (ceramics) Non-metallic mineral product (ceramics, wireless telephone, electric parts)	63-1	Electric furnace	0.25	Brass				Since no data were available from the factory, no detail is known.						
	63-2	Electric furnace	0.25	Brass										
	63-3	Hardening kiln	0.50	Brass	N. gas									
	63-4	Tunnel kiln	0.33	Ceramic	132									
	63-5	Tunnel kiln	0.33	Ceramic	132									
	63-6	Tunnel kiln	0.17	Ceramic	70									
3M DE MEXICO, S.A. Others (sponge,brush)	64-1	Smoke tube boiler	12	Steam			330	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	25	7	0	7
	64-2	Smoke tube boiler	9	Steam			Spare	2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil.			30 10	41 73	20 20	— —
Food Products Factory (cooking oil, pasta, shortening) shortening)	65-1	Water tube boiler	45.4	Steam	Alternate use		2,000	Diagnostic survey conducted. See Sec. 5.2.23.						
	65-2	Water tube boiler	45.4	Steam			2,000							
	65-3	Heat medium boiler	504,000 *	Oil		58.8								
	65-4	Heat medium boiler	504,000 *	Oil		58.8								
			*:kcal/hr											
ESMALTES Y COLORANTES, S.A. Non-metallic mineral product (Glaze for tile, pigment)	66-1	Melting furnace	0.42	Glass	139			Note; relocation currently planned.						
	66-2	Melting furnace	0.42	Glass	139									
	66-3	Drying furnace		Pigment	Butane	25kl/mon total								
	66-4	Spray type dryer		Pigment		Under testing								
	66-5	Baking furnace	200kg/charge											

Table 6.1.5 (9) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 9

Name of Establishment Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
Chemical Products Factory (E) (plant oil, soap)	67-1	Water tube boiler	3.8	Steam			208	Diagnostic survey conducted. See Sec. 5.2.8.						
	67-2	Water tube boiler	2.6	Steam			Spare							
	67-3	Heat medium boiler		Oil		175								
Glass Factory (A) (glass bottle, crystal glass, umber glass)	68-1	Glass melting furnace tank oven	12	Glass Cullet 55%			1,350	Diagnostic survey conducted. See Sec. 5.2.14.						
	68-2	Glass melting furnace tank oven	12	Glass Cullet 55%			1,350							
	68-3	Glass melting furnace tank oven			Under repair		H.oil							
	68-4	Glass annealing furnace			L.P.G	625	l/hr							
Thermoelectric Power Plant (A)	69-1	Water tube boiler No.1	476	Steam	1,717		1,950	Diagnostic survey conducted. See Sec. 5.2.1.						
	69-2	Water tube boiler No.2	503.5	Steam	1,998		2,450							
	69-3	Water tube boiler No.3	503.5	Steam	1,959		2,000							
	69-4	Water tube boiler No.4	900	Steam	5,600		3,125							
Thermoelectric Power Plant (B)	70-1	Water tube boiler	150	Steam	2,278		10,246	Diagnostic survey conducted. See Sec. 5.2.2.						
	70-2	Water tube boiler	150	Steam										
	70-3	Water tube boiler	350	Steam	3,480		26,400							
	70-4	Water tube boiler	350	Steam										
FUNDICION DE FIERRO Y METALES Basic metals (cast iron)	71-1	Cupola	800 ± ± kg/charge	Scrap	Coke :	1,285	kg/day	None The cupola is using high quality U.S. made coke.						
Chemical Products Factory (C) (paint)	72-1	Smoke tube boiler	2.35	Steam	110	Alternate use		Diagnostic survey conducted. See Sec. 5.2.6.						
	72-2	Smoke tube boiler	1.56	Steam	100									
ORGANIZACION QUIMICA MEXICANA Food (food additives, zinc chloride)	73-1	Smoke tube boiler	1.3	Steam			18.0	1) Modification of combustion facility						
	73-2	Smoke tube boiler	1.6	Steam			19.4	① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	25	6	0	6
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
PRODUCTOS NUTRICIONALES Food (food additives)	74-1	Smoke tube boiler	0.63	Steam		29		1) Modification of combustion facility						
	74-2	Smoke tube boiler	0.63	Steam		29		① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter. ② Periodical checking and cleaning of the burner nozzle to improve fuel atomization.	2,400	2,400	20	3	0	3
POLIMEROS (POLIESPUMAS DE MEXICO) Petrochemical (styrol poirmer container, building material)	75-1	Smoke tube boiler	7.6	Steam			350	1) Modification of combustion facility						
	75-2	Smoke tube boiler	5.1	Steam			100	① Addition of a portable 02 meter to the present instrumentation to secure operation at an optimum air ratio.	2,400	2,400				
								2) Fuel change						
								① Use of heavy oil 50% + diesel 50% mixture.			30	41	20	—
								② Use of desulfurized heavy oil.			10	73	20	—
								③ Use of emulsified and desulfurized heavy oil.			44	73	40	—
Paper Products Factory (B)	76-1	Water tube boiler	9.5	Steam	Alternate use		440	Diagnostic survey conducted. See Sec. 5.2.20.						
	76-2	Water tube boiler	8.2	Steam			440							

Table 6.1.5 (10) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 10

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Indi-vidual (US$)	Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
SILICATOS Y DERIVADOS, S.A. Chemical (Sodium silicate, potassium silicate, etc.)	77-1	Glass melting furnace tank oven	8.33	Glass	958			1) Modification of the glass melting furnace ① When NOx concentration is high, the volumetric furnace load should desirably be reduced. (around 70,000 kcal/m3hr. When heat amount is insufficient for the intended process, electric heater free from NOx generation can be used as a supplement.) ② Combustion control to prevent abnormally high NOx concentration using a NOx meter.						
	77-2	Glass melting furnace tank oven	3.33	Glass	Not operating									
	77-3	Glass melting furnace tank oven	0.17	Glass	Not operating									
	77-4	Smoke tube boiler	7.60	Steam	Total		Total							
	77-5	Smoke tube boiler	5.10	Steam	※250		※417							
	77-6	Smoke tube boiler	3.80	Steam	※ Heavy oil use in summer				13,600	13,600	30	—	0	—
GANADEROS PRODUCTORES DE LECHE PURA Food (dairy products)	78-1	Smoke tube boiler	4.7	Steam			109	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	25	4	0	4
	78-2	Smoke tube boiler	4.7	Steam		Not operating								
	78-3	Smoke tube boiler	4.7	Steam			109							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
HOSPTAL 20 DE NOVIEMBRE ISSSTE Hospital	79-1	Smoke tube boiler	12.8	Steam		145		1) Modification of for the incinerator ① Operation at low air ratio with a portable 02 meter to raise the temperature inside the furnace.	2,400	2,400	0	0	20	—
	79-2	Smoke tube boiler	12.8	Steam		145								
	79-3	Incinerator	0.2-0.25			Diesel								
	79-4	Incinerator	< 0.1			Diesel								
					Alternate use									
HOTEL DEL ANGEL Hotel	80-1	Smoke tube boiler	0.47	Steam		17		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	30	8	0	8
	80-2	Smoke tube boiler	0.47	Steam		17								
					Alternate use									
MARIA ISABEL SHERATON Hotel	81-1	Smoke tube boiler	6.3	Steam	Alternate use		171	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter.	2,400	2,400	25	5	0	5
	81-2	Smoke tube boiler	6.3	Steam			171							
	81-3	Smoke tube boiler	6.3	Steam			171							
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
SOSA TEXCOCO, S.A. Chemical (Na2CO3,NaCl)	82-1	Water tube boiler	20	Steam				None						
	82-2	Water tube boiler	20	Steam										
	82-3	Water tube boiler	20	Steam	Total									
	82-4	Water tube boiler	36	Steam	13,688									
	82-5	Water tube boiler	50	Steam										
	82-6	Water tube boiler	50	Steam										
	82-7	Water tube boiler	30	Steam										
	82-8	Water tube boiler	60	Steam										
	82-9	Water tube boiler	50	Steam										
	82-10	Roasting furnace	9.2	Lime stone	Coke : 1,250kg/hr									
	82-11	Roasting furnace (8 furnaces)	4.2	Lime stone	500									
	82-12	Drying furnace (2 furnaces)		Algae	63									
AMERICAN TEXTIL, S.A. DE C.V. Petrochemical (Synthetic fiber)	83-1	Heat medium boiler	6,000 ※	Oil			160	1) Modification of the smoke tube boilers ① Addition of a portable 02 meter to the present instrumentation to secure operation at an optimum air ratio.	2,400	2,400	30	9	0	9
	83-2	Heat medium boiler	1,000 ※	Oil	Not operating									
	83-3	Heat medium boiler	1,000 ※	Oil	Not operating									
			※:Mcal/hr											
	83-4	Smoke tube boiler	6	Steam	Alternate use		153	2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
	83-5	Smoke tube boiler	5	Steam			153							
	83-6	Iron			L.P.G small amount									

Table 6.1.5 (11) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 11

Name of Establishment Type of Industry (Products)	Visit No.	Facility Name	Rating capacity (ton/hr)	Material	Consumption of Fuel N-gas (m3/hr)	Diesel (l/hr)	Heavy oil (l/hr)	Pollution Countermeasures	Investment Indi-vidual (US$)	Facil. Total (US$)	Reduction Ratio (%) (Estimated) NOx	SO2	PM	Fuel
MANUFACTURAS CARGO, S.A. DE C.V. Paper & its product (carton)	B4-1 B4-2	Water tube boiler Gas burner	13.6 625,000 * *:kcal/hr	Steam Paper	Propane : 74l/hr		625	1) Modification of combustion facility ① The factory has a plan of renewing the boiler and the burner. Adoption of a boiler which is fully equipped with combustion control instrumentation and a low NOx burner is recommended at the time of the renewal.			30	0	10	—
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
INDUSTRIAL PAVIMENTADORA, S.A. Coal and petroleum product (asphalt mix)	B5-1 B5-2 B5-3 B5-4	Rotary kiln Rotary kiln Heat medium boiler Heat medium boiler	55 75 504,000 * 630,000 * *:kcal/hr	Aggregate Aggregate Oil Oil		135 135 38.6 38.6		On account of the rotary kilns being out of operation, no detail was known.						
HULE INDUSTRIAL, S.A. Rubber & plastic product (rubber packing)	B6-1 B6-2	Smoke tube boiler Smoke tube boiler	0.77 0.77	Steam Steam		62 62		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	35	8	0	8
Petrochemical Products Factory (C) (phenol)	B7-1 B7-2	Smoke tube boiler Smoke tube boiler	1.92 1.92	Steam Steam	Not operating		53 53	Diagnostic survey conducted. See Sec. 5.2.11.						
AGA DE MEXICO, S.A. DE C.V. Chemical (O2, N2, H2, Ar, N2O, welding rod)	B8-1 B8-2 B8-3 B8-4 B8-5 B8-6 B8-7	Gas turbine Gas turbine Drying furnace Drying furnace Drying furnace Drying furnace Annealing furnace	4,250 Hp 4,250 Hp 2.5ton/5.5hr 2.5ton/5.5hr 2.5ton/5.5hr 10ton/5.5hr 0.85ton/3hr		800 800 Total 50			1) Modification of the gas turbines The factory has a plan to chang the gas turbines to electric moters.						
TAMM Y CIA, S.A. DE C.V. Petrochemical (acrylic, cotton)	B9-1 B9-2	Smoke tube boiler Smoke tube boiler	4.5 3.2	Steam Steam	Alternate use		78 78	1) Modification of combustion facility ① Periodical combustion control with a portable O2 meter to keep a good combustion.	2,400	2,400				
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
CIA. HULLRA ATLAS, S.A. Rubber & plastic product (rubber for automobile)	B0-1	Smoke tube boiler	1.28	Steam		64		1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable O2 meter.	2,400	2,400	30	5	0	5
CORRUGADO Y FIBRA, S.A. Paper & its product (carton)	91-1	Smoke tube boiler	3.2	Steam			39.7	1) Modification of combustion facility ① Increase of atomizing air pressure to improve fuel atomization.						
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
SALES INDUSTRIALES DE MEXICO Chemical (ammonium chloride, zinc chloride, etc.)	92-1	Smoke tube boiler	1.02	Steam			48.7	1) Modification of combustion facility ① Because of the superannuation, retrofitting is considered to be difficult.						
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —

Table 6.1.5 (12) Control Measures for Sources Investigated by Detailed On-site Questionnaire - No. 12

Name of Establishment / Type of Industry (Products)	Visit No.	Facility: Name	Facility: Rating capacity (ton/hr)	Facility: Material	Consumption of Fuel: N-gas (m3/hr)	Consumption of Fuel: Diesel (l/hr)	Consumption of Fuel: Heavy oil (l/hr)	Pollution Countermeasures	Investment: Individual (US$)	Investment: Facil. Total (US$)	Reduction Ratio (%) (Estimated): NOx	SO2	PM	Fuel
TENERIA TEMOLA, S.A. DE C.V. Leather (leather for shoes)	93-1 93-2 93-3	Smoke tube boiler Smoke tube boiler Smoke tube boiler	3.2 0.8 0.8	Steam Steam Steam	16hr/day 3hr/day Spare		122 48 48	1) Modification of combustion facility ① Periodical combustion control with a portable 02 meter to keep a good combustion.	2,400	2,400				
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
SABRITAS, S.A. DE C.V. Food (potato chips, snacks)	94-1 94-2 94-3 94-4 94-5 94-6	Frying oven Frying oven Smoke tube boiler Smoke tube boiler Smoke tube boiler Oven	0.47 0.47 2.6 1.3 1.3	Food Food Steam Steam Steam Food	60 60 195-237 120 120 N. gas			1) Modification of the smoke tube boilers ① Installation of a steam injection system to reduce the high PM concentration for a natural gas burning boiler.	2,200	2,200	20	—	40	—
LA HACIENDA, S.A. DE C.V. Feed (livestock feed)	95-1	Smoke tube boiler	1.9	Steam			70	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter. ② Because the fuel temperature is low, a fuel preheater should be installed. (A ribbon heater with thermometer and thermostat is also usable.)	2,400 200	2,600	40	20	0	20
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
EMPAQUES Y CARTON CORRUGADO, S.A. Paper & its product (carton)	96-1 96-2	Water tube boiler Water tube boiler	6.4 3.8	Steam Steam			550 H.oil	1) Modification of combustion facility ① Periodical combustion control for operation at the appropriate air ratio with a portable 02 meter. ② Increase of atomizing air pressure to improve fuel atomization.	2,400	2,400	10	4	0	4
								2) Fuel change ① Use of heavy oil 50% + diesel 50% mixture. ② Use of desulfurized heavy oil. ③ Use of emulsified and desulfurized heavy oil.			30 10 44	41 73 73	20 20 40	— — —
DOW QUIMICA MEXICANA, S.A. Chemical (insecticide)	97-1 97-2	Smoke tube boiler Smoke tube boiler	3.8 1.3	Steam Steam		329 Not operating		None						

(2) Effects and Expenses

The estimated pollutant reduction to be achieved through the combined effect of the fuel change and facility improvements at the object establishments are summarized in Table 6.1.6.

Table 6.1.6 Pollutant Reduction Effects of the Control Measures for the 48 Establishments

			NOx	SO_2	PM
Present emission (1,000 ton/yr)			4.7	11.2	2.6
Emission after implementation of proposed measures (1,000 ton/yr)	Fuel improvement case	A	3.5	6.5	2.4
		B	3.7	3.2	2.4
		C	3.6	3.2	2.4
Reduction ratio (%)	Fuel improvement case	A	25	42	7
		B	21	71	7
		C	23	71	7

As can be seen, the combination of the transient fuel change (mixed burning with 50% current heavy oil and 50% diesel or natural gas) and facility improvement in the case A is expected to reduce NOx emission by 25%, SO_2 emission by 42%, and PM emission by 7%. When desulfurized heavy oil is exclusively used, although the SO_2 emission will decrease by 71%, NOx will rather increase above the level of the case A, while PM will remain unchanged. When desulfurized and emulsified heavy oil is used, some more reduction is expected in NOx at 23%.

The expenses for these measures are estimated at approximately $460,000 (March 1991 price), excluding those unspecifiable portions of facility improvements resulting from in-house work, autonomous improvement and relocation plan.

6.2 Other Pollution Sources

6.2.1 Object Establishments and Facilities

The establishments for which control measures have been studies so far are mostly large ones covered by the detailed on-site questionnaire and the diagnostic survey. In this section, the establishments not included in the above surveys will be considered. They consist of some 7,000 establishments, broken down as shown below, accounting for 25% each of the total consumption of heavy oil and natural gas at stationary emission sources in AMCM.

1) Establishments surveyed by SEDUE as a part of the present Study; 969 firms, 3,336 furnaces,

2) Establishments included in the SEDUE's existing data base; 371 firms excluding those covered by 1)

3) Establishments covered by the DDF's past survey; 6,070 firms, excluding those covered by the detailed on-site questionnaire and 4)

4) Bathhouses surveyed by the National Bathhouse Association; 203 bathhouses

Among these, 1) and 2) are mostly factories, and 3) and 4) are service and commercial establishments. Two thirds (2/3) of the combustion facilities for the group 1) are industrial furnaces and 1/3 are boilers. Assuming the same ratio for the group 2), the total number of industrial furnaces is 2,400. Assuming that all of the facilities in the groups 3) and 4) are boilers, the total number of boilers is over 7,500.

6.2.2 Planning Approach

The establishments covered in this Section are large in number but their size and the fuel consumption are relatively small. For this reason, the combustion facility improvement measures are not expected to bring about marked pollutant reduction effect, despite considerable amount of work required.

Therefore, facility improvement measures are to be applied to relatively

large establishments only, and the measures having wide applicability are selected from those measures proposed to the establishments covered by the detailed on-site questionnaire. Therefore, the overall effect of the pollutant emission reduction is largely dependent on the supply of desulfurized heavy oil.

There are 10 relatively large establishments (all covered by the SEDUE's surveys) that are next to the top 20 in the pollutant emission (Figure 3.5.5) subjected to the on-site or the diagnostic survey.

The measure most widely proposed for the on-site surveyed establishments is the introduction of a portable oxygen meter, being proposed to 33 firms among the 48 for which control measures were proposed. The real purpose of this measure is to control the generation of NOx by maintaining appropriate air ratio in combustion. For similar purposes, introduction of other simple equipment and simple facility improvement measures are also taken into consideration.

6.2.3 Control Measures

(1) Outline of Control Measures

The simple facility improvement measures for operation control effective in reducing pollutant emission are listed in Table 6.2.1.

Table 6.2.1 Simple Facility Improvement Measures

Measures to be applied	Unit Price (US$)
Steam atomizing system	2,200
Fuel preheater	200
Thermometer for air preheating	1,500
Portable O_2 meter	2,400
Simple repair by owner	-

Fuel change is limited to the heavy oil burning facilities as in the case of large factories. But since majority of the firms are of small size, no transitory stage is considered, and the following two cases

B : Exclusive use of desulfurized heavy oil:

After the supply start of desulfurized heavy oil and when its emulsification is not feasible.

C: Emulsified combustion of desulfurized heavy oil:

After the supply start of desulfurized heavy oil and when its emulsification is feasible.

(2) Effects and Expenses

Since the pollutant reduction effects by simple facility improvement measures are not quantifiable unless the actual situation is known, overall effects of fuel change only are shown in Table 6.2.2

Table 6.2.2 Pollutant Reduction Effects by Fuel Change in 7,600 Establishments

			NOx	SO_2	PM
Present emission (1,000 ton/yr)			5.0	21.0	1.4
Emission after fuel change (1,000 ton/yr)	Fuel change case	B	4.8	7.7	1.2
		C	4.1	7.7	1.0
Reduction ratio (%)	Fuel change case	B	4	63	14
		C	18	63	28

The pollutant reduction effects by changing to desulfurized heavy oil in the heavy oil burning facilities are 4% for NOx, 63% for SO_2, and 14% for PM. When emulsified combustion is adopted in addition, more reduction is expected: 18% for NOx and 28% for PM.

Among expenses required to bring about the above effects, the total expenses for facility improvement measures can be estimated to be within US$ 25,000, assuming that one of the measures shown in Table 6.2.1 is applied to the 10 firms.

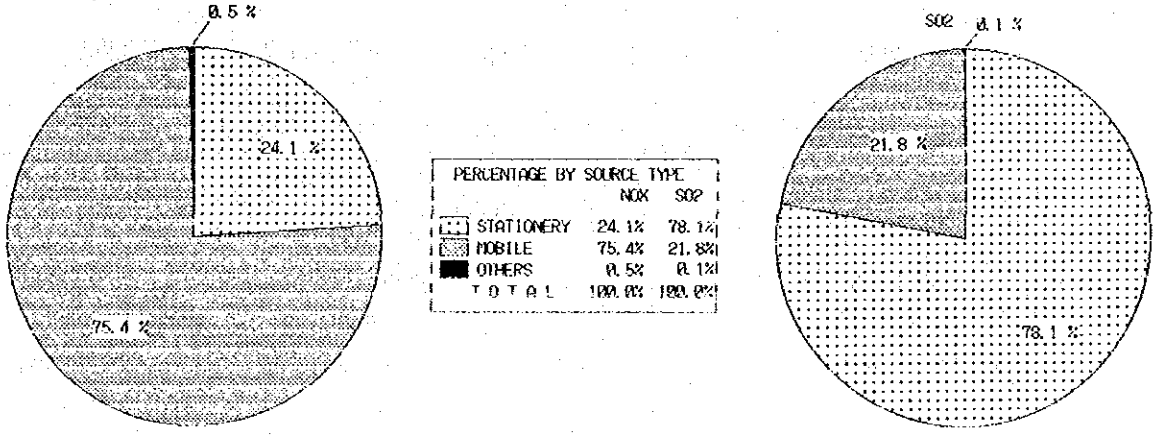
CHAPTER 7 PLAN FOR CONTROL OF STATIONARY AIR POLLUTION SOURCES IN THE METRROPOLITAN AREA

CHAPTER 7 PLAN FOR CONTROL OF STATIONARY AIR POLLUTION SOURCES IN THE METROPOLITAN AREA

7.1 Outline of the Plan

7.1.1 Object Sources for air Pollution Control

According to "Integrated Program Against Atmospheric Pollution in the Mexico City Metropolitan Zone - A Common Agreement, October 1990", the stationary air pollution sources in the metropolitan area account for nearly 3/4 of the total emission of SO_2, and 1/4 of that of NOx as shown in Figure 7.1.1.



NOx Emission SO_2 Emission

Figure 7.1.1 Shares of Stationary Sources in Emission of NOx and SO_2

These pollutants are emitted mainly through fuel combustion. Fuel consumption and the pollutant emission from stationary combustion facilities obtained through this Study's investigation and the SEDUE's past investigation are summarized in Table 7.1.1

Table 7.1.1 Fuel consumption and Pollutant Emission in Stationary Air Pollution Sources (1990)

Fuel Consumption	Heavy oil	($10^3 m^3/yr$)	1,100
	Natural gas	($10^6/m^3/yr$)	3,300
Pollutant Emission	NOx	(10^3 ton/yr)	21
	SO_2	(10^3 ton/yr)	76
	PM	(10^3 ton/yr)	11

A total of about 8,000 establishments are covered by the present Study including 1,400 factories, nearly all the factories having air pollutant emitting facilities in the metropolitan area, and about 70% of the service and commercial establishments in the area having such facilities.

With the large scale establishments preferentially included in the investigation, these 8,000 establishments are considered to represent sufficiently the overall situation of stationary pollution sources in the metropolitan area.

Table 7.1.2 shows the annual emission of NOx and SO_2 from the top ranked 10 establishments covered by the present Study. They are all factories, and the emissions from the top 5 are particularly large.

Table 7.1.2 Large Individual Emission Sources of NOx and SO_2

NOx Emission			SO_2 Emission		
Rank	Source	Nox (ton/yr)	Rank	Sources	SO_2 (ton/yr)
1	Power plant (A)	5,219	1	Power plant (A)	17,460
2	Cement	1,365	2	Cement	12,383
3	Glass sheet	1,154	3	Paper	5,830
4	Power Plant (B)	1,044	4	Power Plant (B)	3,409
5	Glass bottle	1,043	5	Petrochemical (B)	1,803
6	Glass (C)	809	6	Alcoholic drinks	1,747
7	Petroleum refinery	742	7	Petroleum refinery	1,432
8	Paper	533	8	Paper	1,310
9	Glass (B)	471	9	Glass (A)	1,274
10	Chemical	346	10	Petrochemical (A)	1,092

7.1.2 Fuel Improvement Measures

(1) On-going Oil Desulfurization Project

PEMEX has a plan of constructing a hydro-desulfurization plant for heavy oil in the Tula refinery near the metropolitan area. When this project is implemented, a low sulfur heavy oil (S: 0.8%) will be supplied in AMCM and supply of the current heavy oil (S: 3.0 - 3.5%) will be ceased.

This project is one of the themes that were presented in the "Integrated Program Against Atmospheric Pollution in the Mexico City Metropolitan

Zone - A Common Agreement" publisehd in October 1990, and is underway with the common agreement among the authorities concerned including the energy, finance and environmental sectors of the Government. Produced desulfurized heavy oil (DHO) is expected to be used as an effective means of stationary pollution source control, by making available to all consumers including small-to-medium-sized establishments under the present system of fuel supply in Mexico which is unitarily carried out by PEMEX.

When the fuel demand at the time of the operation start of the projected desulfurization plant is assumed to be unchanged from 1990 and the composition of fuel kinds is also assumed to remain unchanged, and the currently used heavy oil is totally replaced by desulfurized heavy oil (DHO), the amount of pollutant emission is estimated to be as shown in Table 7.1.3.

Table 7.1.3 Pollutant Emission Reduction by Changing Current Heavy Oil to Desulfurized Heavy Oil

Pollutant	Emission from stationary sources (1,000 ton/yr)		Reduction ratio (%)	
	Present	Future	Stationary sources	All Sources
NOx	20.8	20.1	5	1
SO_2	76.3	23.2	70	55
PM	11.3	10.3	9	-

The above reduction ratios are based on the assumption that the improvement in the quality of heavy oil will reduce SO_2 emission by 73%, NOx emission by 10%, and PM emission by 20% per unit amount of heat. The total SO_2 emission is expected to decrease to a half.

(2) Fuel Change

The replacement of heavy oil with DHO is postulated as the mainstay in this Study in the medium to long-term fuel improvement measures, while the pollution reduction effect, fuel cost and the PEMEX's policy of natural gas usage are taken into consideration. And the change to diesel or natural gas is limited to special cases. However, since the use of DHO is directed to the reduction of SO_2, and not sufficient in reducing NOx and PM, additional measures are required. As a measure to reduce NOx and SO_2 emissions through fuel improvement, the emulsification of heavy oil is considered.

However, since the effect of this measure is basically dependent on the quality of the oil used and method of combustion, and there are not many examples of practical application in Japan, the result of the principle test conducted in the present Study should be further verified by the commercial scale test in order to assure the effectiveness when applied to Mexican heavy oil.

Since the supply of DHO will start in 1995 according to the current schedule, partial replacement of the current heavy oil by diesel or natural gas is proposed as an interim measure. This means the replacement of the combustion facilities for heavy oil by those for mixed combustion of heavy oil and diesel or natural gas. Therefore, the applicable facilities are limited to relatively large ones. Specifically, this measure is proposed to those establishments where the diagnostic survey or the detailed on-site questionnaire was conducted.

Other fuel change patterns are also considered depending on the situation of individual sources such as that where mixed combustion of heavy oil and natural gas is currently practiced. Specific proposals in fuel change are given in Table 7.1.4.

7.1.3 Managerial Measures

(1) Factory Relocation

Among the 97 establishments surveyed by the diagnostic survey program and/or by the on-site questionnaire program, shut-down of one factory and relocation of one factory were determined through the administrative order. Voluntary relocation is planned by three factories. Although relocation means only the displacement of pollution sources and not reduction of pollutant emission, it is an effective measure for improvement of air quality in AMCM.

In addition, when a huge cost is required in air pollution control by extensive modification of old facilities, renewal of facilities associated with relocation can be more positively evaluated in economical viewpoint. In such a case, factory relocation is a good alternative in air pollution control, and therefore taken into consideration.

Table 7.1.4 Proposed Fuel Change Patterns

Fuel change pattern	Category of applicable pollution sources	Applicable pollution source (Visit No.)
From HO to Case A: HO 50% + D or NG 50% Case B: DHO Case C: DEHO	Establishments surveyed by the diagnostic survey or the detailed on-site questionnaire	40 establishments of the visit number: (3, 5, 8, 9, 10, 12, 14, 15, 16, 18, 21, 22, 28, 29, 30, 32, 34, 37, 38, 42, 43, 48, 52, 65, 67, 68, 73, 75, 76, 78, 81, 83, 84, 87, 89, 91, 92, 93, 95, 96)
From HO to Case A: HO 50% + D or NG 50% Case B and C: DHO	Ditto	Paper (27) Basic metals (51, 56) Other Manufacture (64)
From HO to Case A: HO 50% + NG 50% Case B and C: DHO 50% + NG 50%	Ditto	Cement (41)
From HO to Case A, B, C: D or NG	Ditto	Chemicals B (62)
From NG 80% + HO 20% to Case A: same as present Case B: NG 50% + DHO 50% Case C: NG 50% + DEHO 50%	Ditto	Power Plant A (69)
From NG 80% + HO 20% to Case A: same as present Case B: NG 80% + DHO 20% Case C: NG 80% + DEHO 20%	Ditto	Power Plant B (70)
From HO to Case A: HO (same as present) Case B: DHO Case C: DEHO	Others	Many

Note: 1) HO = heavy oil, D = diesel, NG = natural gas
DHO = desulfurized heavy oil, DEHO = desulfurized and emulsified heavy oil
2) Case A applies for the period before the start of supply of DHO.
3) Case B or Case C is applied after the start of supply of DHO.
4) Case C requires verification of effects of DEHO.

(2) Operation Management

The first effective step in the NOx control is to maintain an appropriate air ratio in combustion. It must be fully understood by operation managers and operators. It is necessary that the administrative authority and company managers cooperate in establishing a guidance system for the dissemination of usage of measuring instruments and the methods of combustion control based on the measurements.

7.1.4 Facility Improvement Measures

(1) Combustion Facilities

The following 23 measures are proposed for facility improvement to the establishments covered by the diagnostic survey or the detailed on-site questionnaire survey, and these measures are also proposed to other pollution sources where the effects are expected.

1) Introduction of operation control and monitoring devices

- Portable oxygen meter (38 establishments)
- NOx meter (3 establishments)
- Automatic oxygen meter (9 establishments)
- Thermometer for air preheating (1 establishments)
- Combustion control meters (installation or improvement) (11 establishments)
- Telemeter for flue gas monitoring (10 establishments)

2) Improvement of combustion system for NOx control

- Low-NOx burner (11 establishments)
- Flue gas recirculation (13 establishments)
- Two-stage combustion (2 establishments)
- Off-stoichiometric combustion (3 establishments)
- In-furnace denitration combustion (3 establishments)
- Steam injection (2 establishments)
- Burner nozzle replacement (4 establishments)
- Reduction of volumetric load of combustion chamber (6 establishments)
- Installation of precalciner (1 establishment)
- Increase of fuel atomizing air pressure (2 establishments)

3) Improvement of combustion efficiency

- In-house repair (5 establishments)
- Improvement of heat insulation of furnace ceiling (3 establishment)
- Installation of fuel preheater (4 establishments)
- Installation of air preheater (1 establishment)
- Installation of recuperator (2 establishments)

4) Flue gas treatment

- Bag filter (2 establishments)
- Electrostatic precipitator (4 establishments)

(2) Pollution Sources Other Than Combustion Facilities

As pollution control measures for non-combustion facilities, hydrocarbon removal measures are proposed to Chemical Products Factory (C) which has been covered by the diagnostic survey. The measures consist of a hydrocarbon incinerator and a leak prevention measure by cooling.

7.1.5 Effects of Control Measures

The proposed measures for fuel improvement and facility improvement for all the stationary sources are summarized in Table 7.1.5.

Table 7.1.5 Summary of Fuel and Equipment Improvement Plans

Case	Power Plant (A)		Other Sources	
	Fuel use	Equipment improvement	Fuel use	Equipment improvement
Present	HO 20% NG 80%	None	Various	None
A	same as above	Low-NOx measures	A in Table 7.1.4	Low-NOx measures and others
B	DHO 50% NG 50%	Low-NOx measures + EP	B in Table 7.1.4	
C	DEHO 50% NG 50%	Low-NOx measures	C in Table 7.1.4	

Note: (1) HO = current heavy oil, DHO = desulfurized heavy oil
DEHO = desulfurized and emulsified heavy oil
NG = natural gas
(2) Case A applies to the period up to the start of supplying DHO.
(3) Case B or Case C applies after the start of supplying DHO.
(4) Case C requires verification of effects of DEHO.

Table 7.1.6 shows the pollutant reduction effect in Power Plant (A) and all the stationary sources for each of the above cases.

Table 7.1.6 Effect of Pollution Control Plans

Source	Case	Pollutant emission (1,000 ton/yr)			Reduction ratio (%)		
		NOx	SO_2	PM	NOx	SO_2	PM
Power Plant (A)	Present	5.2	17.6	2.1	0	0	0
	A	3.6	17.6	2.1	30	0	0
	B	3.8	9.6	0.3	27	45	87.5
	C	3.0	10.6	1.3	42	40	37.5
All stationary sources	Present	20.8	76.3	11.3	0	0	0
	A	15.1	56.7	6.4*	27	26	43
	B	15.3	24.9	4.4*	26	67	61
	C	13.5	25.8	5.1*	35	66	55

*Note : * Includes the reduction of 3,400 ton/yr at one factory for which plant relocation is proposed.*

In the transient Case A, although the emissions of SO_2 and PM can not be reduced in the Power Plant (A), NOx is expected to decrease by 30%, and all the three pollutants are expected to decrease in all the stationary sources combined by at least one-fourth. After the start of supply of DHO, Case C is more advantageous in the reduction of NOx, and Case B brings about more reduction of PM than Case C. Case C requires verification of reduction effect and cost effectiveness of emulsified combustion of DHO, therefore, thorough considerations should be made.

7.2 Capital Requirements and Implementation Schedule

7.2.1 Equipment Investment

(1) Investment Amount

The total amount of investments for facility improvements proposed to the establishments investigated through the diagnostic survey and/or the detailed on-site questionnaire is shown in Table 7.2.1 for the two cases described previously: Case B and Case C.

Table 7.2.1 Investment Amount for Facility Improvements

	Case C : DEHO in Power Plant (A)		Case B : EP in Power Plant (A)	
	Investment (million US$)	Ratio (%)	Investment (million US$)	Ratio (%)
Foreign portion	28.208	33	26.611	16
Local portion	58.241	67	135.106	84
Total	86.449	100	161.717	100

Note: Emulsification of desulfurized heavy oil to make DEHO for the Power Plant (A) is assumed to be carried out by the plant itself in Case C.

The investment amounts shown in Table 7.2.1 are the totals of the estimations for individual establishments for each of which control measures are proposed to each of the surveyed combustion facilities. There are 19 establishments where the estimated investment exceeds US$ 100,000, and 11 establishments, as shown in Table 7.2.2, where the amount exceeds US$ 1 million. As indicated, the establishments where a large investment is required are also emitters of large amount of pollutants.

In the case when EPs are installed in Power Plant (A), the additional investment is about US$ 76 million, making the total for the plant close to US$ 90 million. There considered to be some more establishments, besides those subjected to the detailed on-site questionnaire and the diagnostic survey, where facility improvement is possible and effective. But since they are considered to be rather small establishments, operation improvements by introduction of operation monitoring instruments are more suitable than substantial equipment improvements. Because such improvements require only minor equipment investment, the total investment amount for all the stationary pollution sources is not expected to exceed US$ 100 - 200 million.

Table 7.2.2 Establishments With Facility Investment Exceeding US$ One Million

Rank	Establishments (Visit No.)	Investment (million US$)	Rank in emission		
			NOx	SO_2	PM
1	Cement (41)	45.082	2	2	4
2	Power Plant (A) (69)	13.043	1	1	2
3	Power Plant (B) (70)	6.778	4	4	8
4	Glass (C) (23)	5.819	6	-	11
5	Glass (A) (68)	3.009	13	9	9
6	Glass (B) (31)	2.522	9	-	13
7	Alcoholic Drinks (47)	1.578	11	6	10
8	Chemicals (A) (1)	1.420	21	-	22
9	Petrochemicals (B) (8)	1.350	14	5	19
10	Foods (65)	1.317	32	12	30
11	Petrochemicals (A)(16)	1.058	15	10	29

Note: The investment amount in Power Plant (A) corresponds to the case when emulsification of desulfurized heavy oil is carried out by the plant itself.

(2) Evaluation of Scale of Equipment Investment

To evaluate the scale of the proposed equipment investment, first, the amount of national fixed capital formation was extracted from the economic statistics in Mexico, and then, its equipment investment portion was compared with the amount estimated in this Study for the proposed pollution control measures.

The latest statistic figure for the GDP in Mexico is 494,054,824 million pesos in 1989 according to the temporary report of INEGI, or about US$ 200 billion, as converted by the average exchange rate of that year, i.e. 2,453.2 pesos/US$. Since the figure for the fixed capital formation in that year was not available, its ratio to GDP at 18.9% in 1987, with 13.4% for private and 5.5% for government, was used to estimate the national fixed capital formation in 1989 to be about US$ 38.0 billion.

The breakdown of this fixed capital formation is estimated based on the statistics in 1983 - 1984 as follows:

Domestic : 91.8%

Construction : 63.2%

Transportation equipment : 8.9%

General equipment : 19.7%

Import : 8.2%

Transportation equipment : 1.0%

General equipment : 7.2%

The investment in air pollution control belongs to the general equipment sector whose share in the total fixed capital formation is 26.9% by adding the domestic and the import portions. The amount in the equipment sector is therefore, US$ 38.0 billion x 26.9% = US$ 10.2 billion or about US$ 10 billion.

Of this amount, the total pollution control investment as estimated previously at US$ 100 - 200 million constitutes only 1 - 2%.

For reference, Table 7.2.3 shows the ratios of the investment in air pollution control to the total equipment investment in Japan based on the data from the Ministry of International Trade and Industry (MITI).

Table 7.2.3 Percentage of Air Pollution Control Investment in Total Equipment Investment in Japan (1972 - 1984)

Year	All sectors	Iron & Steel	Petro-leum	Thermal power	Paper & pulp	Non-ferrous metal	Chemical	Machines	Petro-chemical	Textile	Cement	Ceramic
1972	4.7	8.1	8.4	19.9	3.2	7.3	3.9	0.6	3.1	3.0	12.7	6.7
1973	5.8	9.9	15.2	20.8	4.8	9.6	5.2	1.0	6.1	4.0	11.5	12.1
1974	9.8	11.1	30.9	30.2	7.7	8.6	6.0	2.0	10.1	8.0	19.2	9.4
1975	10.5	13.4	26.9	42.9	6.5	8.9	7.1	1.3	10.6	9.0	13.9	7.3
1976	9.4	15.7	18.6	38.9	4.8	7.0	6.8	1.0	7.4	3.2	8.8	6.1
1977	5.1	8.0	3.9	27.7	2.5	7.2	5.0	1.0	6.1	1.5	6.4	7.1
1980	2.5	2.1	4.5	27.0	1.4	1.0	0.4	0.2	0.4	0.7	3.2	2.0
1981	3.3	1.8	2.8	32.8	2.1	0.8	0.5	0.2	0.6	0.5	8.0	1.1
1982	4.3	2.1	3.1	37.4	1.1	0.4	1.9	0.2	1.6	0.8	2.7	1.5
1983	5.7	1.8	3.7	49.4	0.8	0.7	0.8	0.2	0.7	3.0	3.2	0.9
1984	3.6	1.8	1.3	36.7	1.3	0.2	0.7	0.2	0.4	1.7	2.9	1.1

Source: MITI, Japan, "Report of Survey on Equipment Investment for Industrial Pollution Control", 1972-1984.

In Japan, the emission standards for air pollutants were promulgated in August 1973 as required by the Air Pollution Control Law. From that year, equipment investments in air pollution control increased rapidly, and the

percentage of such investments in the total equipment investment was maintained at around 10% for three years. Although the percentage dropped below 5% subsequently, and has been remaining in that level ever since, the thermal power generation sector is an exception, maintaining the high percentage to date.

7.2.2 Organization for Implementation

The control measures recommended in this Study can be broadly classified into the following three categories, all requiring human resources and capital investments.

1) Management improvement measures

2) Fuel change measures

3) Equipment improvement measures

The main responsibility in implementing these measures should naturally be assumed by the enterprisers who own and operate combustion facilities, and the extra expenses for implementing air pollution control measures should be considered as a part of the production or service cost.

In the case of private establishments, however, they may not be positive in implementing the measures because higher cost means lower competitiveness. Considerable amounts of investment proposed to certain types of industry may be heavy financial burdens to them at least temporality. In addition, there are not sufficient number of experts in the air pollution control technology, and individual establishments may not be able to secure these experts by themselves.

To overcome these difficulties, it is desirable to make organizational arrangements that induce enterprisers to make unified efforts and facilitate procurement of equipment funds and introduction of air pollution control technologies. Such organizational function may be assumed by existing associations such as the National Bathhouse Association (CANAIBAL), or if possible, new organizations may be established.

The role of administrative authorities include provision of subsidiary measures in the both aspects of human resources and capital resources to promote implementation of the control measures by enterprisers and to bring about sustained effects of those measures.

As economic incentive measures, the tax reduction systems for plant relocation and acquisition of pollution control equipment were introduced in Mexico and carried into effect for a certain period of time in the past. Recently, a low-interest financing program for such activities has been started and implemented for some types of industry. As additional measures to develop human resources and air pollution control technologies, the following are recommended:

1) Training for combustion control

2) Training for air pollution control

3) Consultation for equipment improvement

4) Training for exhaust gas measurement

5) Leasing of exhaust gas measuring instruments

6) Interest subsidy and favorable taxation on pollution control investment

7.2.3 Time schedule for Implementation

Because the proposed air pollution control measures are classified into two groups, i.e., those to be carried out by the initiative of individual establishments, and those whose implementation is dependent on the availability of desulfurized heavy oil, the overall implementation schedule is proposed to be as follows:

Phase 1 : up to 1995

1) Installation of basic combustion control instruments

2) Training of combustion and air pollution control engineers and technicians

3) Transient fuel change

4) Provision of stimulative measures such as low-interest loans and favorable tax system

5) Installation or leasing of exhaust gas measuring instruments

6) Plant relocation

7) Implementation of the facility improvement measures including low-NOx measures

8) Verification of new control technologies

9) Consolidation of the administrative organizations

Phase 2 : after 1995

1) Fuel change

2) Consolidation of the stimulative measures

3) Implementation of advanced measures for improvement of combustion facilities and combustion methods

7.3 Recommendation

For the effective implementation of the proposed plan for controlling stationary sources of air pollution in the Metropolitan Area of the City of Mexico, the following actions are highly recommended.

(1) Installation of Basic Measuring Instruments in Combustion Facilities

Virtually all of combustion facilities in AMCM are not equipped with a fuel flow meter which is an indispensable tool for effective combustion control. Installation of the flow meter should be made obligatory.

Other basic instruments that are usually not provided include the pressure gauges and the thermometers for fuel and combustion air and the pressure gauge for fuel atomizing steam. If provided, most of them employ percent-scale indicators rather than indicating actual values, making operation monitoring difficult.

Installation of these gauges and meters should also be made obligatory with the indicators showing actual values compensated for barometric pressure.

(2) Provision of Exhaust Gas Measuring Instruments for Monitoring of Pollutant Emitting Facilities

Factories having pollutant emitting facilities of large capacity should be obliged to install continuous measuring devices for the flue gas velocity and concentration of pollutants in the flue gas including CO, CO_2, NOx, smoke and soot, and NOx. A telemetric monitoring system should be established through which the measured data are transferred to a monitoring center of SEDUE.

Establishments having pollutant emitting facilities of small-to-medium capacities should have a flue gas oxygen analyzer for routine measurement. Concentration of CO_2, CO, smoke and soot, and NOx in the flue gas should be also measured at an appropriate interval. The results should be periodically submitted to the responsible government agency.

(3) Guidance for Combustion Control

Guidance should be given to the engineers in stationary sources by the combustion technology specialists on the control of pollutant generation and emission from combustion facilities and on the methods of energy saving. As a first step, importance of the appropriate air-fuel ratio in combustion should be realized by the engineers at the sources. It can be realized through such a practice as measuring concentration of CO, NOx and smoke and soot in the flue gas at varying concentration of oxygen and constructing a chart showing their relationship. Early conduct of this practice with obligatory submission of the result is highly recommended.

(4) Technical Consolidation in the Administrative Sector

1) Establishment of Industrial Pollution Control Assistance Center

It is desirable to establish an "Industrial Pollution Control Assistance Center (IPCAC: tentative name)" attached to SEDUE which assumes a leading role in implementation of the activities stated above by extending assistances and guidances to concerned sectors in control of industrial pollution.

The Government of Mexico has a plan to establish an "Environmental Research and Training Center (ERTC: tentative name)" which deals with various environmental problems including air quality, water quality, solid wastes and hazardous wastes. If ERTC is to be established, IPCAC may be positioned as a part of ERTC.

Functions of IPCAC concerning air pollution include the following:

i) inspection and authorization, selling, renting and leasing of exhaust gas measuring instruments, and technical training for the measurement

ii) technical guidance for industrial pollution control

iii) training of the experts who assume the above roles

2) Fosterage of Personnel for Exhaust Gas Inspection

It is highly important for the administrative sector to know technical realities concerning emissions of pollutants at stationary sources.

Accordingly, it is indispensable for the relevant sections of SEDUE, DDF, and GEM to have competent technical personnel for inspection of the emissions at stationary sources. These personnel should be fostered and reasonably treated, desirably as permanent employees, so that the technical knowledge in this field is accumulated within the administrative sector.

3) Consolidation of Emission Inventory

The existing inventory data for stationary air pollution sources in AMCM are considered to be not adequate in terms of the number of sources covered, data items, and accuracy of the data. Preparation of a comprehensive emission inventory of the Metropolitan Area under cooperation of SEDUE, DDF and GEM is recommended.

(5) Practical Application of Stationary Source Control Technologies

The control technologies of stationary pollution sources proposed in this Study include 1) two-stage combustion type low-NOx burners for heavy oil, and 2) emulsified heavy oil combustion, as well as others including exhaust gas recirculation, two-stage combustion, off-stoichiometric combustion, in-furnace denitration combustion, and burners atomized with natural gas for furnaces with particularly high NOx concentration such as glass melting tank ovens.

Since the desulfurized heavy oil scheduled to be supplied from 1995 will have still a high content of nitrogen, combination of the measures for reducing fuel NOx and thermal NOx is indispensable.

The two-stage combustion type low-NOx burner is effective in reducing fuel NOx, and therefore, its early development is recommended.

Effects of emulsified combustion as a measure to reduce thermal NOx and smoke and soot are technically recognized. But since there are not many practical examples in Japan, a careful study is necessary on the applicability of this technology to the Mexican heavy oil. A laboratory-scale test conducted in the present Study confirmed the effects of this technology. In order to apply the emulsified combustion of the Mexican heavy oil to industrial boilers and furnaces in Mexico, it is necessary to carry out a feasibility study including a pilot-scale test and practical application tests.

(6) Economic Incentives for Pollution Control Investment

Since investments in environmental pollution control generally do not bring about economic benefits to business establishments, it is desirable to introduce economic measures such as financial assistance and tax incentives that indirectly promote such investment. It is desirable that the favorable taxation system once adopted in Mexico be re-introduced and the existing low-interest credit system be consolidated.

(7) Control of Stationary Sources and Mobile Sources

This Study has been concerned with the control of stationary air pollution sources, and priorities have been given to the reductions of NOx and PM emissions. The amount of emission of NOx from mobile sources is said to make up three-quaters of the total emission in AMCM. Against this situation, the Mexican Government has established an emission control program applicable to new automobiles of respective models. Long-term effects are expected if this program is implemented steadily. On the other hand, implementation of the control measure for stationary sources brings about immediate effects although the total NOx emission is smaller than that from mobile sources. Therefore, early implementation of stationary source control measures is highly desirable.