11.7.2 Future Air Pollution Condition (2005) (without control measures)

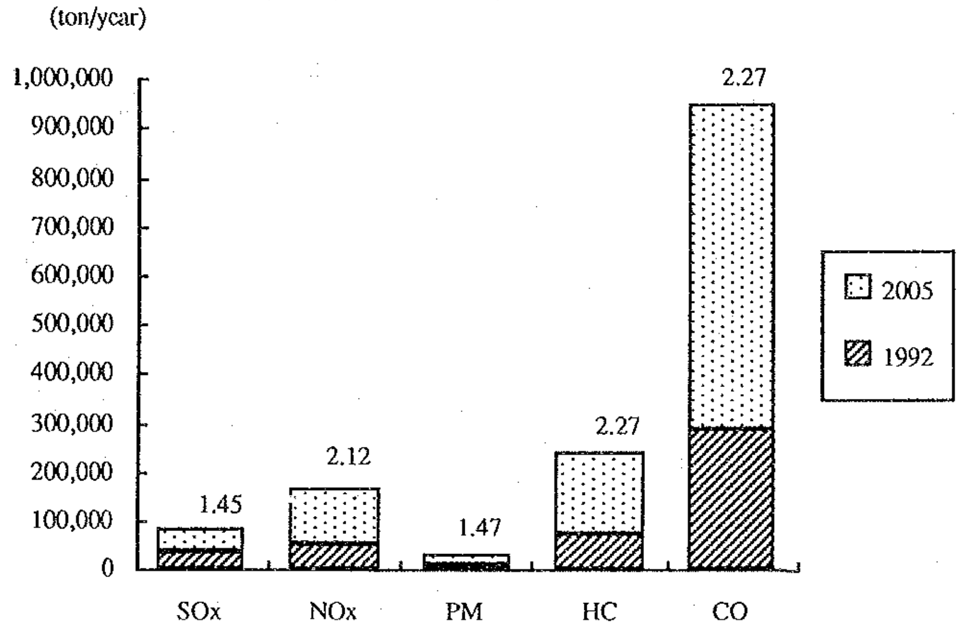
It is important to grasp an ambient air quality in 2005 (the target year of the Guidelines). There are two simulation cases on future air quality condition; "2005 without control measures" and "2005 with control measures". In the first case, conditions in 2005 were simulated based on the assumption that the present transportation system and road network will continue to the same however with an increase in traffic volume. In the second case, the assumption that the proposed transportation master plan reported in "JICA, 1987: Klang Valley Transportation Study" will be completed by 2005, and some control measures against mobile sources and stationary sources recommended in the Study would have been enforced. The contents of the master plan include introduction of modern public transportation systems such as Light Rapid Train (LRT) System and Mass Rapid Transit (MRT) Railway System, construction of many new roads and improvement of existing roads.

Though the master plan was not made for air pollution control, however it will become one of the most effective measures against air pollution.

(1) Air Pollution Load

The estimated future air pollution load in KVR in the year 2005 without control measures are given in Tables 11.8 and 11.9 and their graphical presentations are shown in Figs. 11.12 and 11.13. Increase in emission for each pollutant is quite apparent when Figs. 11.8 and 11.12 are compared. The magnitude of the increase between 1992 and 2005 is shown in Fig. 11.11, which shows that the increase is 1.45 times for SOx, 2.12 times for NOx, 1.47 times for PM, 2.27 times for HC and 2.27 times for CO.

Fig. 11.11 Pollutants Increasing Ratio Between Present (1992) and Future (2005) without Measures



The regional distributions of pollutant load in 2005 are given in Table 11.10 and their graphical presentation is shown in Fig. 11.14. Klang district is expected to have a remarkable increase in air pollution load, where installation of new power plants are planned.

Table 11.8 Future Air Pollution Load by source (2005) (without control measures)

	SOx	NOx	PM	HC	CO
Factories	41,323	30,453	10,586	—	—
Power stations	30,040	26,038	2,423	—	—
General factories	11,283	4,415	8,163	—	—
Motor vehicles	7,079	82,199	7,359	166,720	659,223
Airplanes	360	574	123	—	—
Ships	2,836	1,840	365	—	—
Households	--	226	62	—	—
Total	**51,598**	**115,292**	**18,495**	**166,720**	**659,223**

Unit:(ton/year)

Fig. 11.12 **Future Air Pollution Load by Source (2005) Without Control Measures**

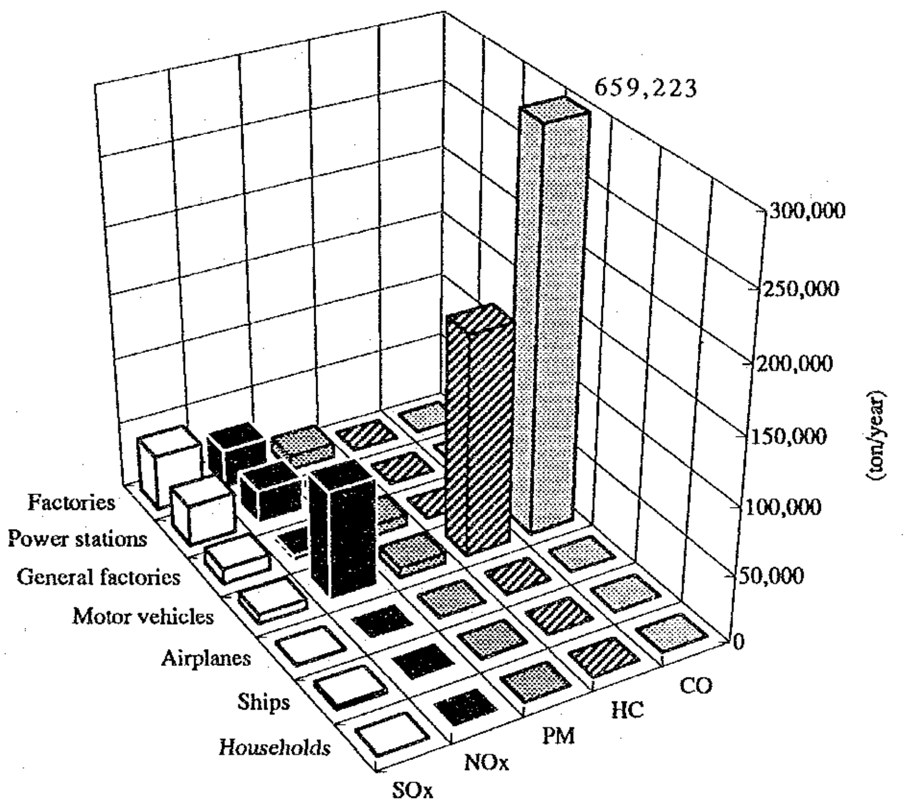


Table 11.9 Future Air Pollution Load by Vehicle Type (2005) (without control measures)

	SOx	NOx	PM	HC	CO
Motorcycle	16	1,634	1,670	116,787	189,348
Motor Car	71	35,226	837	30,470	308,837
Van	218	8,246	260	3,502	64,891
Taxi	521	3,722	451	2,529	30,097
Mini Bus	408	1,191	345	1,161	1,938
Medium/Large Bus	1,540	8,749	1,672	2,578	7,388
Small Truck	7	5,102	56	3,950	44,790
Medium/Large Truck	2,352	7,253	1,034	3,572	5,883
Lorry/Trailer	1,946	11,076	1,034	2,171	6,051
Total	**7,079**	**82,199**	**7,359**	**166,720**	**659,223**

Unit:(ton/year)

Fig. 11.13 Future Air Pollution Load by Vehicle Type (2005) (without control measures)

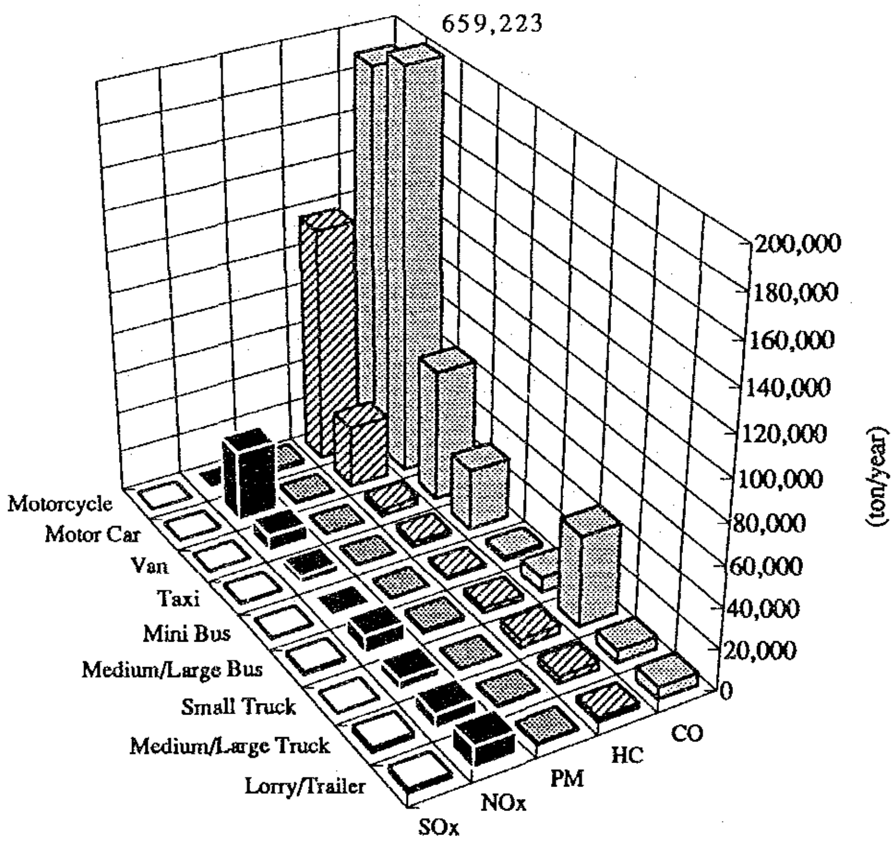
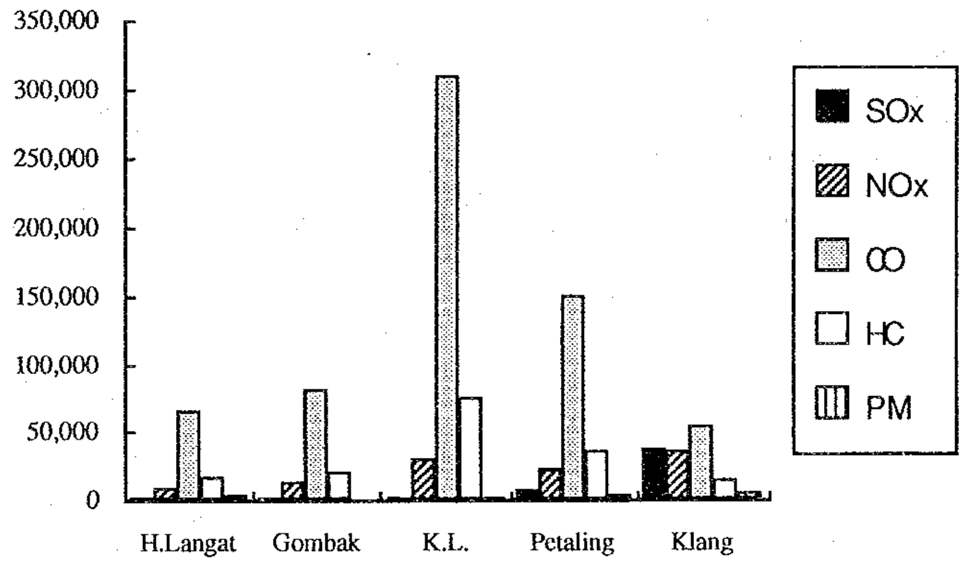


Table 11.10 Pollution Loads by District in Kelang Valley Region (2005) (without measures)

Unit: ton/year)

	SOx	NOx	PM	HC	CO
H.Langat	2,280	10,645	3,546	18,237	66,004
Gombak	1,756	13,936	1,423	21,112	81,257
K.L.	2,976	30,788	3,047	75,182	308,851
Petaling	7,646	22,612	3,558	35,809	149,460
Klang	36,939	36,617	6,829	16,381	53,650
KVR	51,597	114,598	18,403	166,721	659,222

Fig. 11.14 Pollution Load by District in KVR in 2005
(without control measures)



(2) Ambient Air Quality in the Future (2005) (without control measures)

Figs. 11.5(1) through (3) show the ambient air quality for SO_2, NO_2, and CO in 2005 when no control measures are taken.

The areas where the simulated concentration do not satisfy the target value were expected to increase. The air quality in the area ranging from KL to PJ, especially inside of KL was expected to worsen.

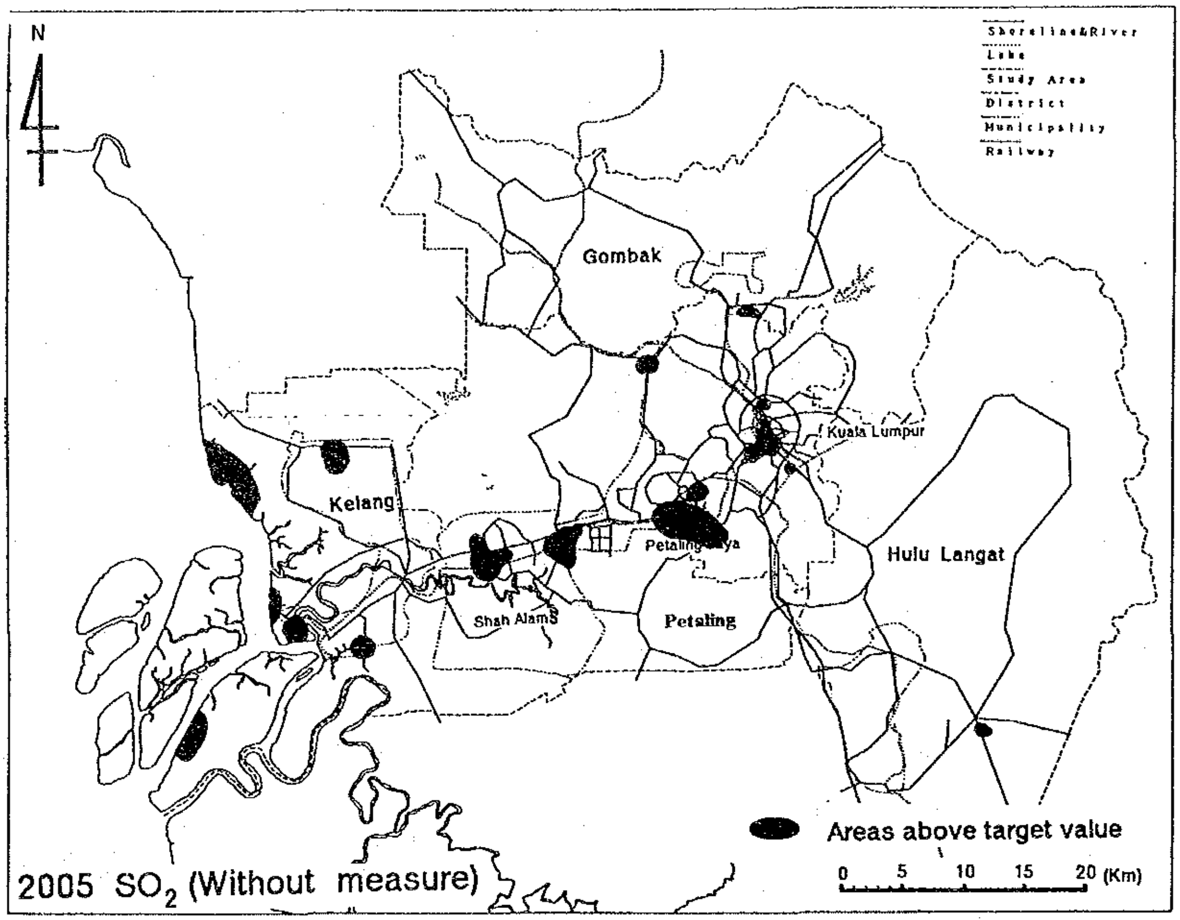


Fig. 11.15 (1) Simulated SO_2 Concentration in 2005 (without measures)

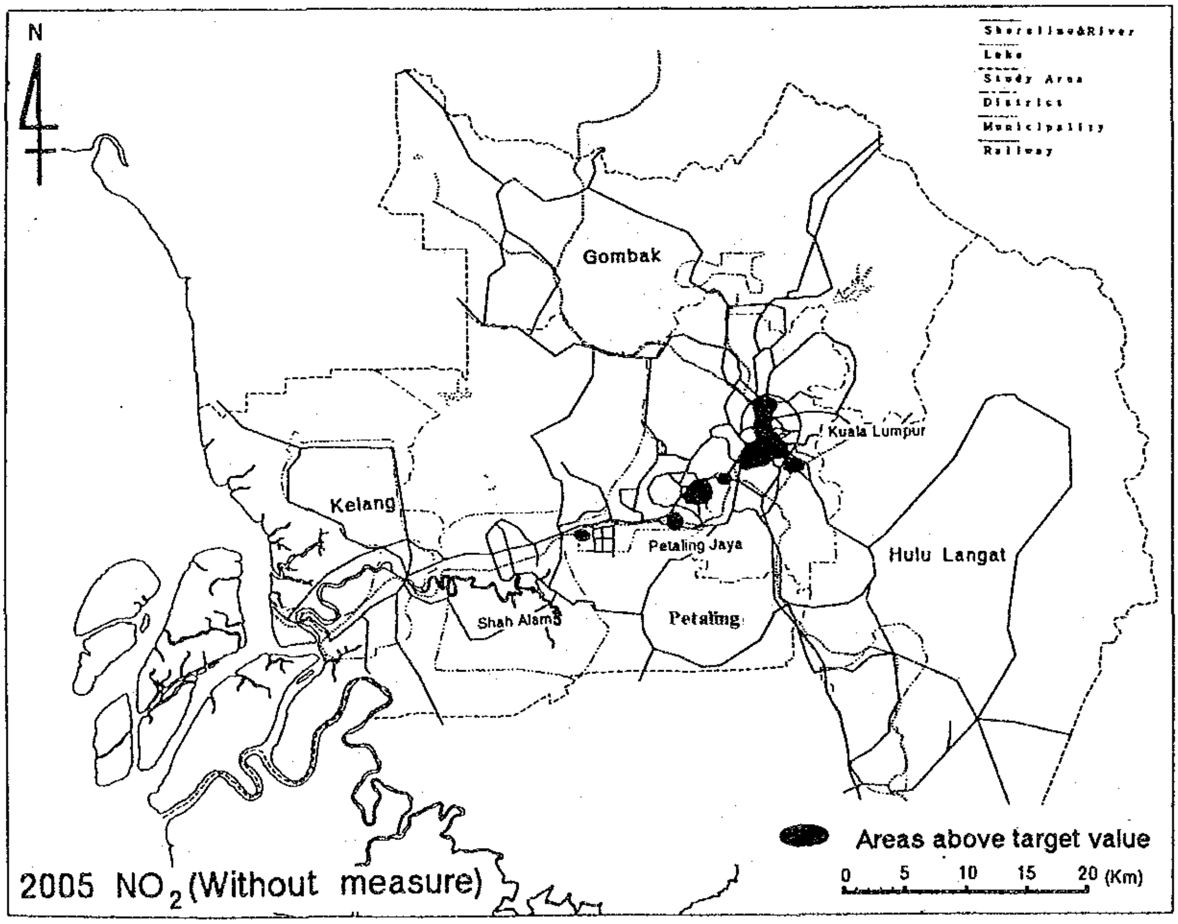


Fig. 11.15 (2) Simulated NO_2 Concentration in 2005 (without measures)

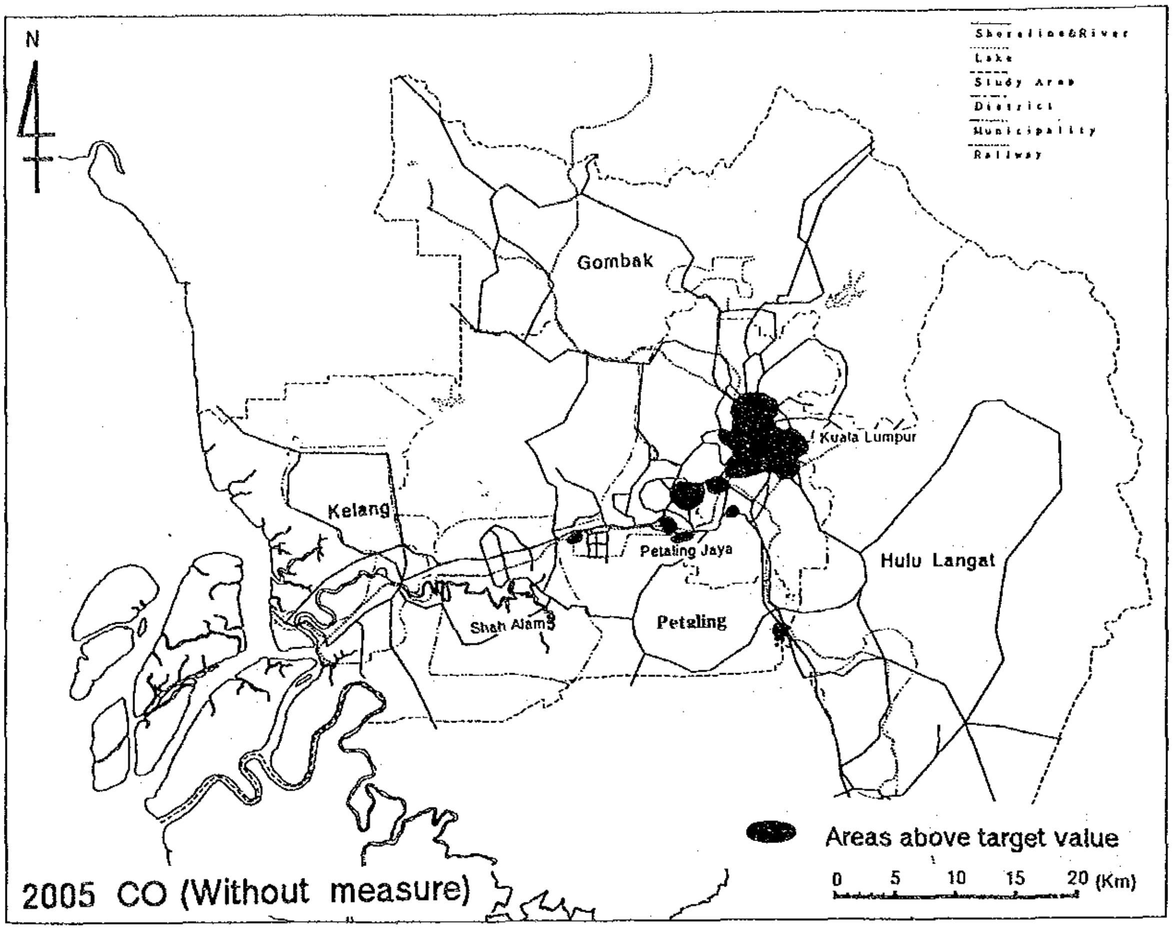


Fig. 11.15 (3) Simulated CO Concentration in 2005 (without measures)

11.8 Control Measures against Pollution Sources

11.8.1 Stationary Sources

The following measures must be taken to reduce air pollution load from stationary sources in 2005.

(1) Thermal Power Stations

According to our estimate, in 1992 the contribution to the total emission by the two (2) thermal power stations in the located area is 55%, 23% and 16% for SOx, NOx and PM, respectively. Therefore, it is considered effective to take the necessary measures for the thermal power plants especially for SOx control. The following measures are recommended "A" power sataion.

1) No. 1 Boiler
Fuel conversion from fuel oil to natural gas.

2) No. 6 Boiler
Fuel conversion from coal to natural gas.

(2) General Factories

Since the simulation results showed that high SOx concentration is distributed not only in the areas where the thermal power stations are located but also in other areas such as Petaling Jaya and Shah Alam. The contribution by general factories are calculated to be 30%, 5% and 56% for SOx, NOx and PM, respectively. So, the following measures for general factories are recommended, which are considered to be quite effective for PM control as well.

- Heavy fuel oil in facilities with fuel consumption of 150kg/h and over in Petaling Jaya and Shah Alam should be converted to natural gas. In other areas, heavy fuel oil in facilities with 200kg/h and over should be converted to light fuel oil.

- Gas fuel should be the principal consideration for new facilities.

- Efficiency of electric precipitator, dust collectors (cyclone) should be improved.

- Extension of stack

- Old wood combustion boilers should be replaced with new ones.

- It is necessary to facilitate the combustion management and energy conservation by employing licensed combustion engineers.

11.8.2 Mobile Sources

(1) Exhaust Gas Control

SOx, NOx and PM generated by motor vehicles in 1992 are 9% and 67% and 26% of their total amount (Table 11.6). HC and CO are generated mainly by motor vehicles. Fig. 11.16 shows the contribution by the different types of vehicles. SOx and PM are generated mainly by large vehicles such as lorry/trailer, medium/large truck and medium/large bus. NOx is generated by light duty vehicles such as motor car, van and taxi, and CO and HC are generated by motorcycle and motor car. It is therefore recommended that necessary measures should be taken with regard to each type of vehicle. According to the results of SPM analysis, necessary measures be taken for diesel vehicles to control PM.

In this aspect, the following measures are recommended.

1) Enforcement of exhaust gas control

   - Regulation 91/441/EEC should be enforced on light duty petrol vehicles to reduce air pollution load.

   - Motorcycles with 2-stroke engine should be replaced with 4-stroke engine, and smokeless lube oil should be used in 2-stroke motorcycles.

   - Introduction of CNG taxi.

2) Restriction of light duty diesel vehicles
   It is necessary to control the registration of new diesel vehicles such as motor car, van and taxi and expedite change of engine type from diesel to petrol. Strong enforcement should be made on the taxis, because their daily driving distance is considered to be very long and most of them are old with diesel engines.

3) Fuel control

The following measures are proposed to be taken.

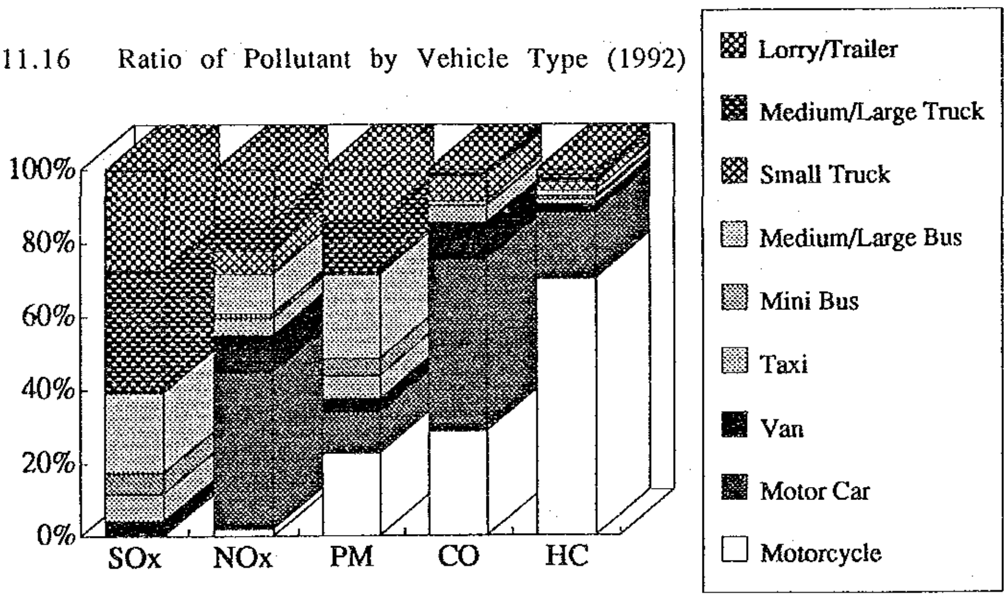
- To increase the use of unleaded petrol from the present level of about 50% to 80 - 90%.
- To decrease the sulphur content in diesel oil from 0.3% to 0.2%.

4) Improvement of Public Transportation System

The measures proposed in "The Transportation Master Plan in the Klang Valley Transportation Study, JICA (1987)" should be implemented. The measures are as follows.

- Introduction of Mass Transit Railway System
- Introduction of Light Rapid Train System
- Improvement of bus system
- Road network plan

Fig. 11.16 Ratio of Pollutant by Vehicle Type (1992)



11.8.3 Future Air Pollution Condition (2005) (with control measures)

(1) Air Pollution Load

If the measures proposed in the previous section are taken, the air pollution load in KVR in 2005 will become as shown in Table 11.11 and Fig. 11.17. The annual total pollutant loads is 27,000 tons for SOx, 85,000 tons for NOx, 12,000 tons for PM, 104,000 tons for HC and 320,000 tons for CO. The annual vehicular air pollution load by vehicle type is shown in Table 11.12 and Fig. 11.18.

(2) Reduction Amount and Rate of Pollutant

Table 11.13 shows the possible total reduction amounts of pollutants by implementing the recommended measures by 2005.

By implementing the measures, the annual total pollution load in 2005 is expected to be reduced by 24,500 tons (reduction rate; 48%) for SOx, 30,000 tons (26%) for NOx, 6,900 tons (37%) for PM, 338,000 tons (51%) for CO and 63,000 tons (38%) for HC.

Table 11.14 shows change of air pollution load from all sources between 1992 and 2005. Emission of all pollutants except SOx and PM is expected to increase even when the control measures are taken.

11.8.4 Evaluation of Control Measures

Fig. 11.20 shows the distribution of concentration of pollutants such as SO_2, NO_2 and CO which are plotted based on the results of simulation for the case with the recommended measures. The areas where the ground level concentrations will exceed the target value in 2005 without control measures, will diminish with proposed measures, according to the simulation study. Although the amounts of NOx and CO generated by vehicles are considered to have increased remarkably comparing with that in 1992 as mentioned in Section 11.8.3, the overall pollution situation is found to improve because of the following reason:

- The measures included in the Transportation Master Plan will effectively disperse traffic volume in KVR and ease traffic congestions on the currently congested roads and in the areas despite of the increase of the total traffic volume in the Region.

Table 11.11 Future Air Pollution Load by Source (2005)
(with control measures)

	SOx	NOx	PM	HC	CO
Factories	18,104	27,122	6,279	–	–
Power stations	12,759	22,758	828	–	–
General factories	5,345	4,364	5,451	–	–
Motor vehicles	5,755	55,728	4,775	103,973	321,430
Airplanes	360	574	123	–	–
Ships	2,836	1,840	365	–	–
Households	–	226	62	–	–
Total	**27,055**	**85,490**	**11,604**	**103,973**	**321,430**

Unit:(ton/year)

Fig.11.17 Future Air Pollution Load by Source (2005) with Control Measures

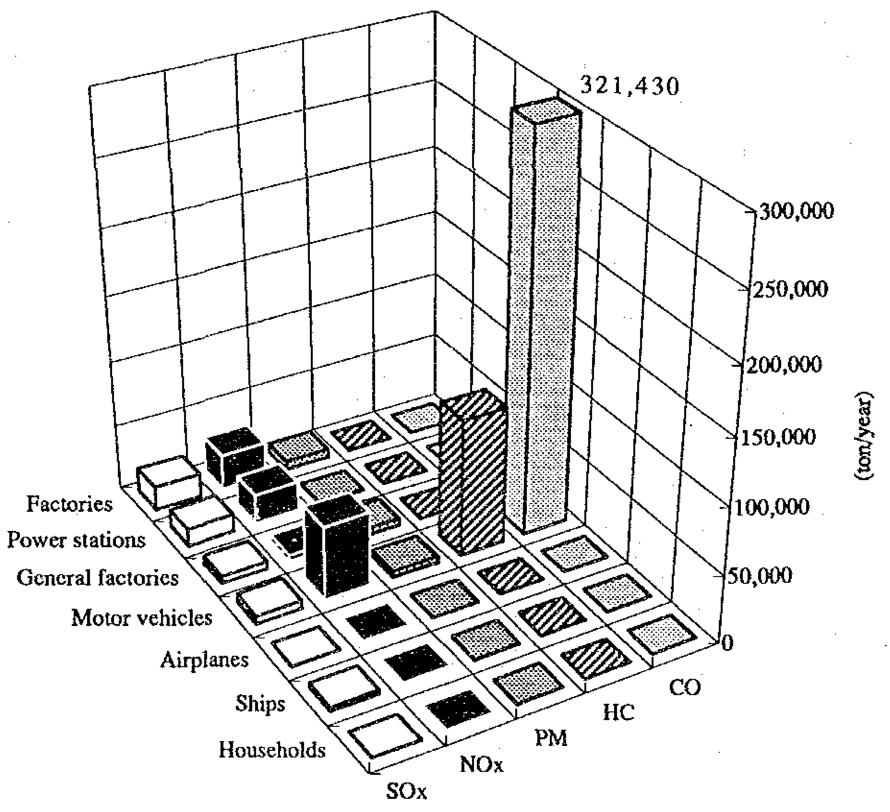


Table 11.12 Future Air Pollution Load by Vehicle Type (2005) (with control measures)

	SOx	NOx	PM	HC	CO
Motorcycle	13	1,121	1,291	82,626	134,979
Motor Car	64	24,334	450	10,804	110,733
Van	229	5,190	187	1,841	32,205
Taxi	573	3,588	226	1,012	8,417
Mini Bus	473	972	246	752	1,323
Medium/Large Bus	1,166	5,335	1,106	1,608	4,299
Small Truck	7	2,930	44	1,810	21,559
Medium/Large Truck	1,321	3,288	368	1,551	2,643
Lorry/Trailer	1,909	8,970	857	1,969	5,272
Total	**5,755**	**55,728**	**4,775**	**103,973**	**321,430**

Unit:(ton/year)

Fig. 11.18 Future Air Pollution Load by Vehicle Type (2005) (with control measures)

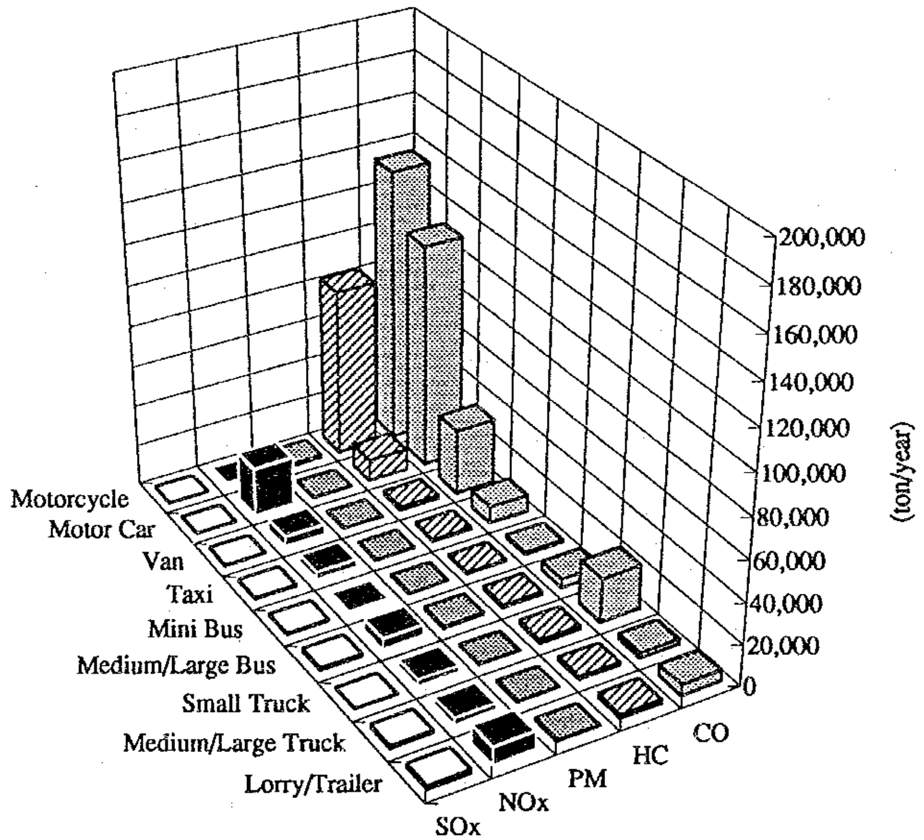


Table 11.13 Reduction of Total Air Pollution Load by Taking Control Measures (2005)

	Pollution Load (ton/year)				
	SOx	NOx	PM	CO	HC
Without measures(A)	51,598	115,292	18,495	659,223	166,720
With measures(B)	27,055	85,490	11,604	321,430	103,973
B/A	0.52	0.74	0.63	0.49	0.62

Table 11.14 Change of Annual Total Air Pollution Load from 1992 to 2005

(Unit: ton/year)

Pollutant	1992	2005	
		without measures	with measures
SOx	35,654 (1.0)	51,598 (1.45)	27,055 (0.76)
NOx	54,454 (1.0)	115,292 (2.12)	85,490 (1.57)
PM	12,605 (1.0)	18,495 (1.47)	11,604 (0.92)
CO	290,407 (1.0)	659,223 (2.27)	321,430 (1.11)
HC	73;445 (1.0)	166,720 (2.27)	103,973 (1.42)

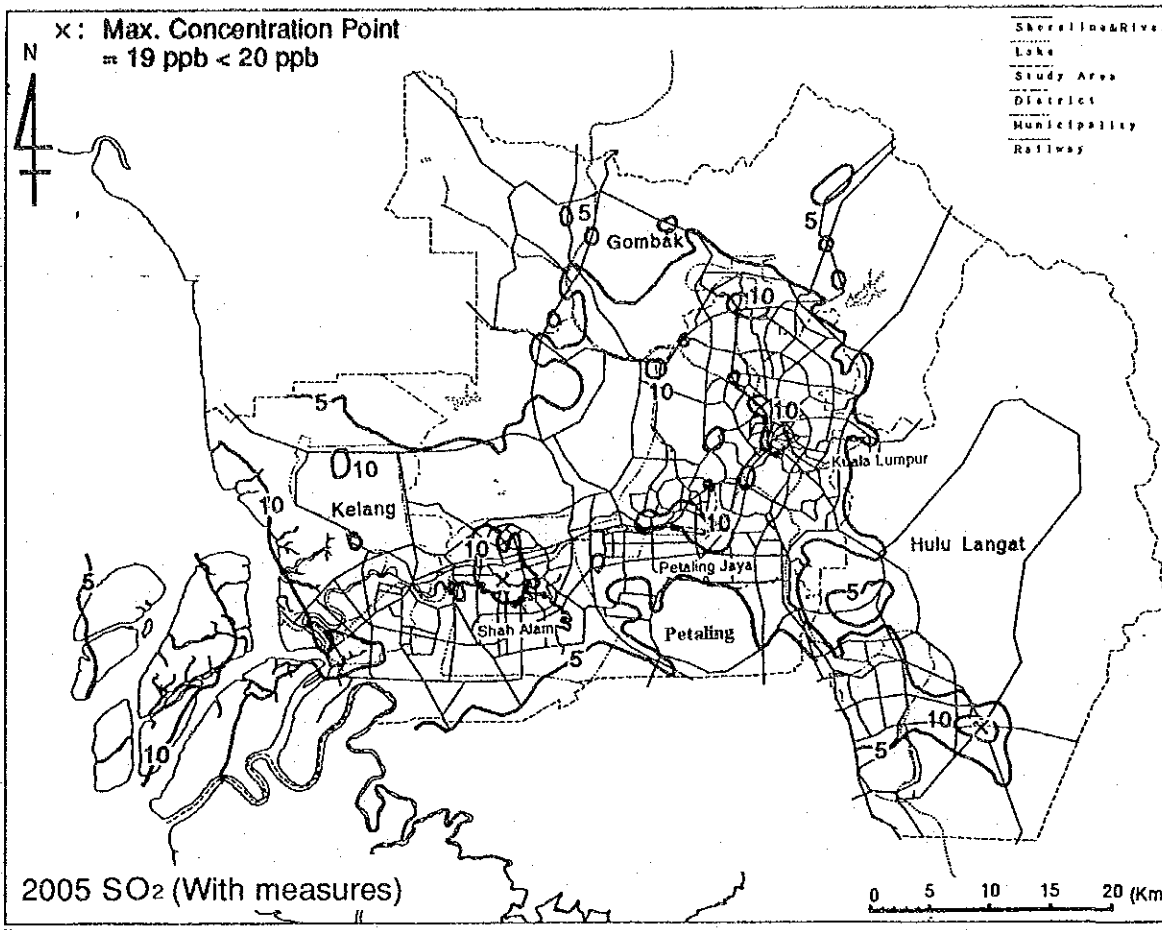


Fig. 11.19 (1) Simulated SO_2 Concentration in 2005 (with control measures)

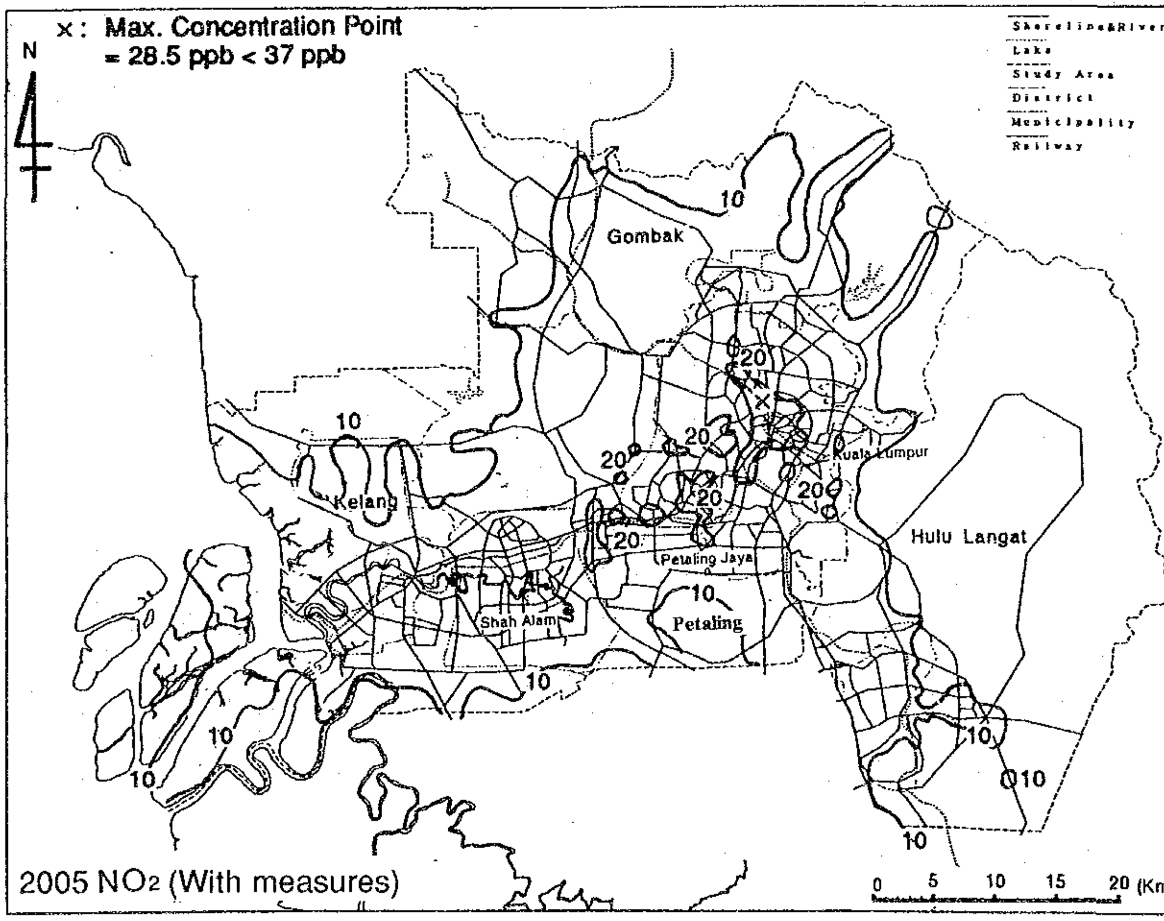


Fig. 11.19 (2) Simulated NO_2 Concentration in 2005 (with control measures)

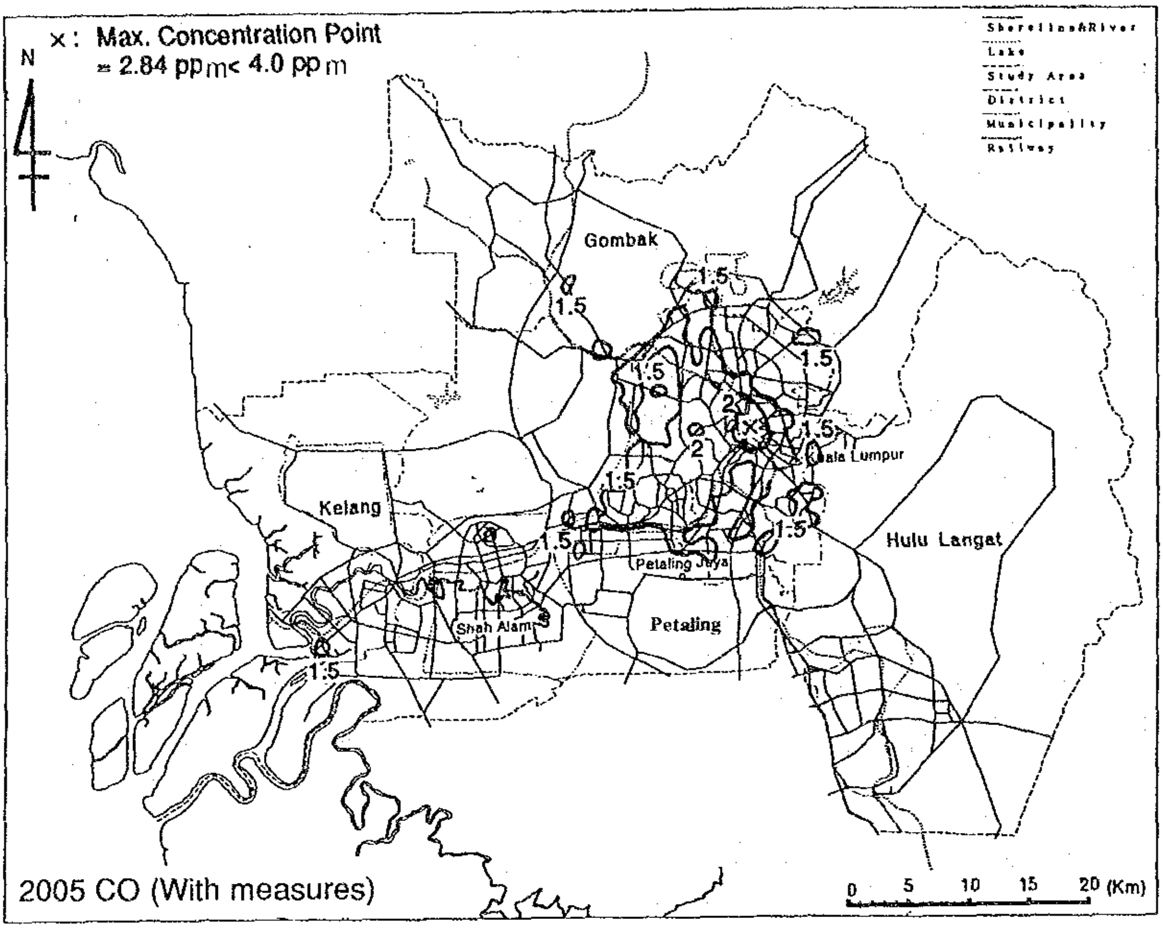


Fig. 11.19 (3) Simulated CO Concentration in 2005 (with control measures)

11.9 Monitoring of Air Quality and Pollution Sources

Monitoring of ambient air quality and pollution sources is conducted to provide the basic data for the most important information on air pollution control.

11.9.1 Ambient Air Quality Monitoring

The location and monitoring items of the ambient air quality monitoring stations were determined based on the result of air pollution simulation and the present and future land use of the Region, as shown in Fig. 11.20. Since the polluted areas are scattered in the Region, it is considered to be unrealistic to cover such scattered areas only by fixed stations. It is, therefore, proposed to utilize the mobile stations effectively hence reducing the number of fixed stations as much as possible. The total number of the monitoring stations is 11 for fixed station and 20 for mobile stations. The observed data should be collected by the telemetric system which is managed by a control center.

11.9.2 Pollution Source Monitoring

(1) Stationary Sources

Since it is considered difficult to monitor all the stationary sources, the monitoring of large-scale factories is recommended to initially. It is also recommended to monitor specially large-scale sources such as thermal power plants by an auto-monitoring system (controlled by a central monitoring center) and the large-scale and the middle and small-scale factories by on-site investigation (flue gas measurement) conducted once a year and every three years, respectively.

(2) Mobile Sources

It is important to monitor the pollutants by vehicles which are considered to be one of the major pollution sources.

1) Traffic volume monitoring
   In order to measure the amount of pollutants generated by vehicles, it is necessary to conduct periodical investigation on traffic volume and patterns at least at the level of the Study.

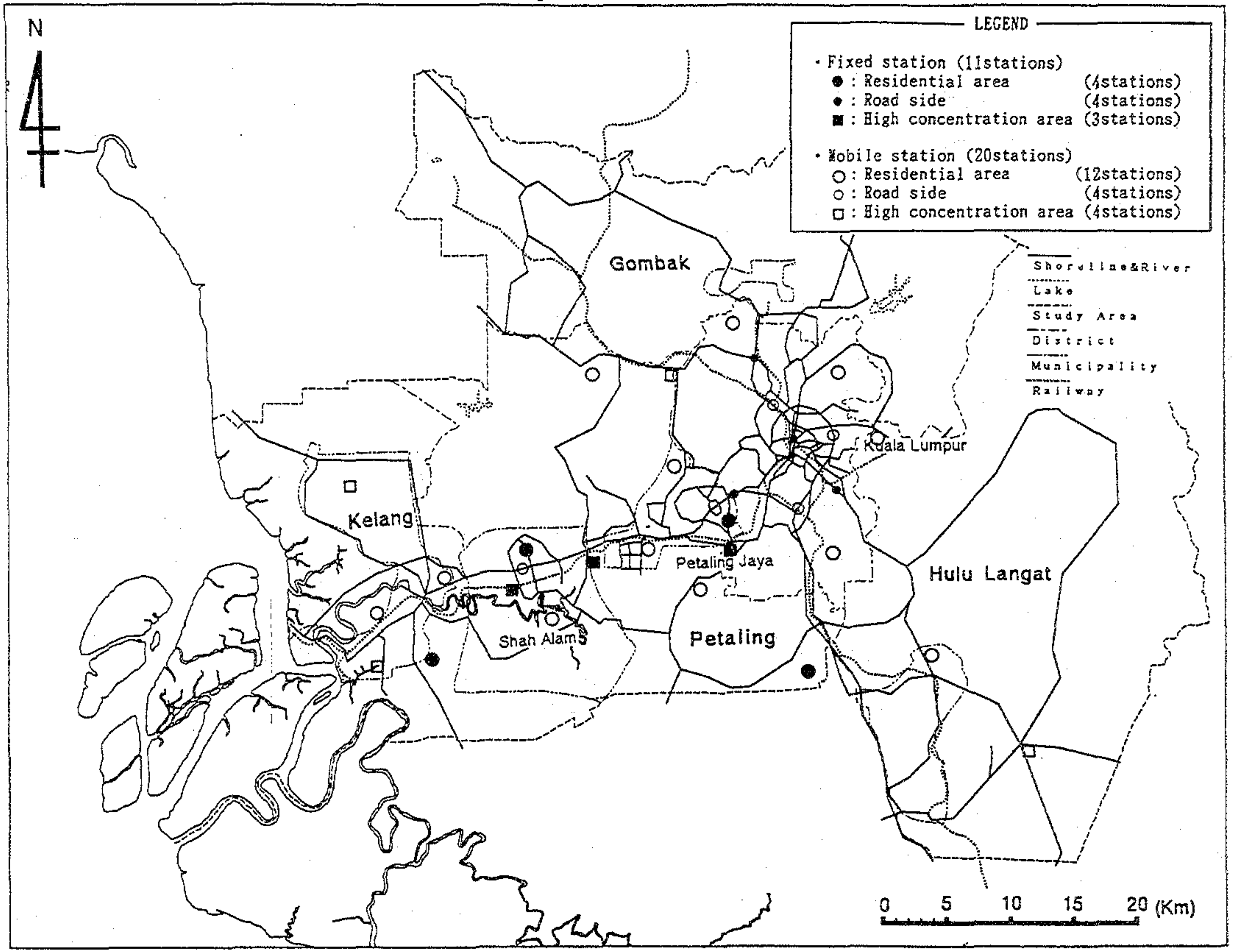


Fig. 11.20 Location Map of Monitoring Stations

2) Update of emission factors

It is necessary to update the emission factors for actual driving mode by chassis dynamometer tests.

11.10 Manpower Development

One of the most important issues is to recruit qualified manpower and staff required for conducting various activities in accordance with the Guidelines. Especially, training of many monitoring engineers and combustion engineers is quite urgent, and it is further necessary to assign engineers of various skills for the central control center towards 2005. These training services are mainly for the officers concerned from government agencies in the initial stage, and will be extended to private sectors. In order to make benefit from such training recognizable, it is recommended that a system be established where certificates are awarded and the level of their professionalism is enhanced.

11.10.1 Combustion Engineer

The combustion training center is proposed to be established in order to train combustion engineers required for executing various measures for stationary sources.

11.10.2 Ambient Air Quality Monitoring Engineer

It is necessary to train engineers who are specialized in the operation and maintenance of monitoring stations, in order to realize the proper ambient air quality monitoring system. A training center should be established to provide training on the operation of various observation and measurement equipment on site. The function of this should also include the collection and analysis of data and information on the latest and up-to-date technologies.

11.10.3 Pollution Source Monitoring Engineer

(1) Stationary Sources

Necessary engineers for factory flue gas measurement will be trained at the combustion training center.

(2) Mobile Source Monitoring Engineer

Engineers for the operation of the chassis dynamometers to be introduced for the investigation on emission factors of vehicles should be trained when the chassis dynamometers are installed.

11.11 Institutional and Organizational Framework for Implementation of the Guidelines

It is necessary to establish the institutional and organizational framework for the implemention of the guidelines as stated below.

11.11.1 Stationary Sources

(1) Combustion Management System

At present there is no regulation on the control of combustion system of factories in Malaysia. Therefore, it is proposed to establish a combustion measurement system which aims at controlling the combustion in factories especially in view of ambient air pollution and energy conservation. Combustion facilities in factories should be operated and managed by licensed combustion engineers.

(2) Financial Support System

A low interest rate fund loan system should be established within the government (national or local) or in some other appropriate organization to support industrial activities related to pollution control and facility modification. Laws or regulations governing this system may have to be established first.

(3) Conclusion of Pollution Control Agreement

To suppress and control pollutant emissions, and to restrict fuel used, a "Pollution Control Agreement" should be concluded between the government (municipal) office in charge and a company concerned.

11.11.2 Mobile Sources

The following measures are proposed for pollution reduction from motor vehicles.

(1) Car Inspection System

All the vehicles should be inspected every two years in the car inspection center in order to keep the exhaust gas below the standard emission value.

(2) Flextime

Severely congested vehicle rush hours in the downtown last only for one to two hours in the morning and around three hours in the evening and main occupants (roughly 80%) are commuters to offices and schools. Therefore it would be effective to reduce traffic at the rush hours if the offices or schools open an different hour or they introduce the flextime system.

11.11.3 Manpower

It is essential to increase qualified manpower in government agencies and private sectors to participate in the activities as outlined in the Guidelines, because the shortage of manpower in DOE is so serious that the present number of manpower in DOE needs to be tripled, and further increase is required if all the measures are to be implemented in accordance with the guidelines as mentioned in Section 11.11.

11.11.4 Establishment of a Comprehensive Air Pollution Control Center

It is proposed that a Comprehensive Air Pollution Control Center be established to organize and promote activities stipulated in the Guidelines which are recommended to be carried out in the following centers; Combustion Training Center, Ambient Air Quality Monitoring Engineer Training Center, Pollution Source Monitoring Center and Ambient Air Quality Central Monitoring Center. The organization of the Center is illustrated in Fig. 11.21, and the principal functions of each Center are summarized below.

(1) Combustion Training Center

a) Objective

The objectives of the Combustion Training Center are:

- to develop own techonologies and to promote pollution control and evergy saving measures, and

- to train combustion engineers and analysis scientists.

b) Facility and Equipment

- Test combustor: one each for liquid and solid fuel (50 to 100 kg/h) with dust collector (cyclone or bagfilter).
- Instruments: analyser for O_2, CO_2, CO, SOx, NOx, and dust flow meter for water, fuel, air, stream thermometer.
- Data processor

c) Space: Lecture room space 100 m^2

d) Capacity: 20 people per section of one to three months

e) Curriculum

- Lecture: technologies of fuel, combustion, furnace, operation and mainatenance, pollution control, techniques, analytical technology

- Practice: combustion, heat balance, energy saving method, analytical technology

f) Administration and Faculty

Academic and industrial, local or foreign: 7 specialists

(2) Ambient Air Quality Monitoring Training Center

a) Objective

The objectives of the Ambient Air Quality Monitoring Training Center are:

- to train personel for operation and maintenance of the monitoring equipment (fixed and mobile stations) for monitoring ambient air quality,

- to train engineers who will participate in the operation of the Central Monitoring Center

- to provide training and facilities for collection of data and information on new technologies relalting to monitoring ambient air quality.

b) Facilitliy and Equipment

- Continuous analysis of SOx, NOx, SPM, O_3, CO and HC
- Meteological continuous analysis

c) Trainer: 3 persons

d) Space

- Office: 50 m^2
- Computer Room: 100 m^2

(3) Pollution Source Monitoring Center

a) Objective

The objectives of the Pollution Source Monitoring Center are:

- to monitor the pollution sources by carring out flue gas measurement of the factories considered important as stationary sources, and provide the basic data for air quality management,
- to train engineers for monitoring pollution sources,
- to monitor pollution levels resulting from motor vehicles by means of chassis dynamometer tests for the emission gas control, and
- to measure the emission factor under actual driving mode using chassis dynamometer, and verify the pollutant emission from motor vehicles.

b) Facility and Equipment

- Monitoring cars for flue gas measurement (NOx, SOx, Dust, O_2)
- Chassis dynamometer

c) Staff

- Stationary source monitoring: 8 persons
- Mobile source monitoring: 5 persons

d) Space

- Chassis dynamometer: 600 m^2
- Training room: 150 m^2

(4) Ambient Air Quality Central Monitoring Center

a) Objective

The objective of the Ambient Air Quality Central Monitoring Center is to collect, through the telemetry system, such data and information as measured and monitored at each monitoring station relating to air quality, meteorology and factory emission, etc. and to provide the relevant organizations in the region with data and information after analysing them.

b) Facitily and Equipment

- Data tranmission system
- Data processing system
- Data exchange system
- Simultaneous information system (street message board)

c) Space

- Office: 50 m^2
- Computer room: 100 m^2
- Stock room: 50 m^2

d) Staff

- Central center: 5 persons
- Maintenance and management of monitoring stations: 7 persons

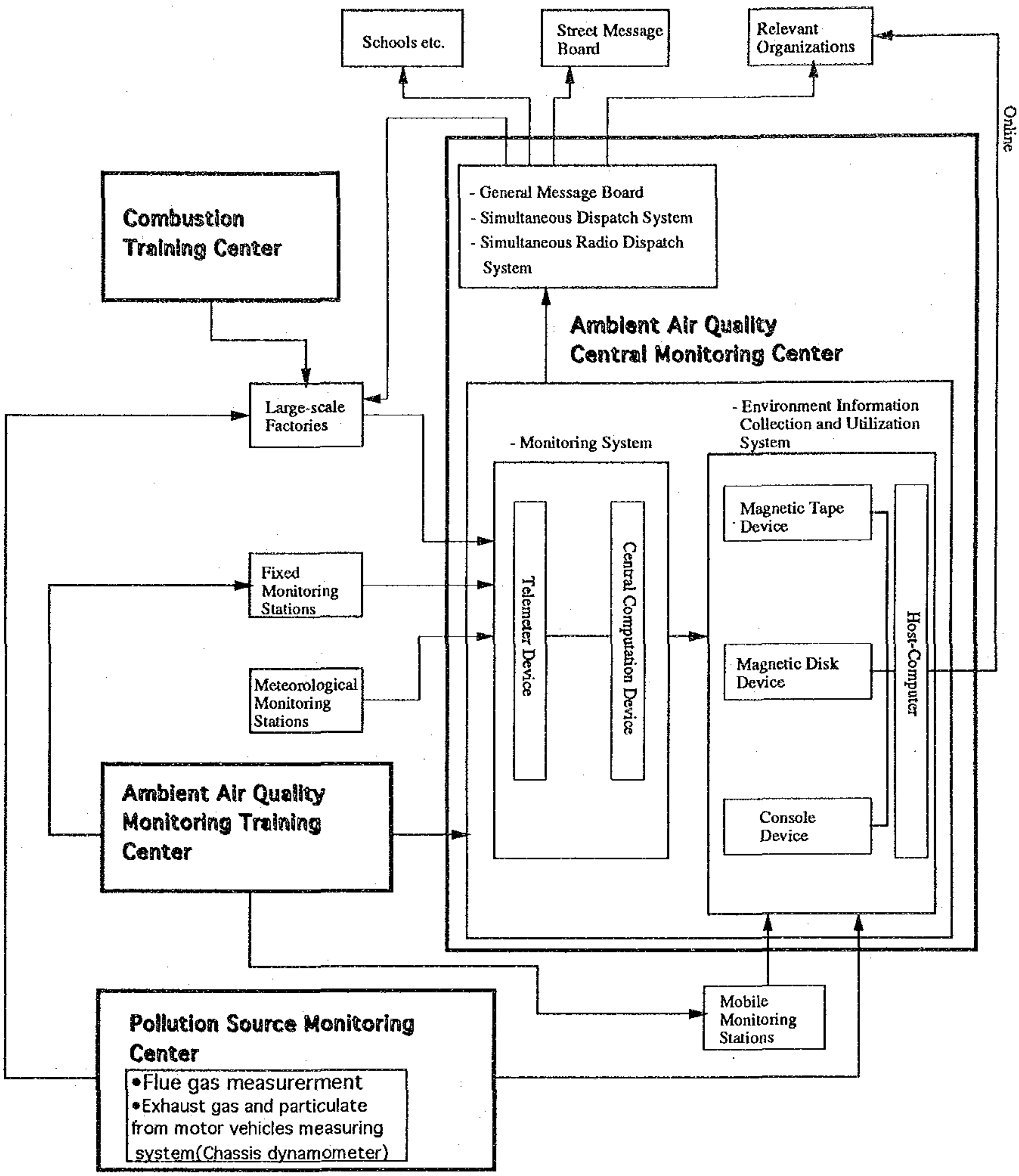


Fig. 11.21 Organization of the Comprehensive Air Pollution Control Centre

11.12 Cost Estimate and Schedule for Air Pollution Control

An outline of the implementation schedule and approximate cost estimates for the Guidelines are as follows. Actual cost for the Guidelines includes so many items. Therefore, mainly the machinery cost was estimated in the Study.

11.12.1 Cost Estimate

(1) Measures against Stationary Sources

General factories

• Combustion control equipment	M\$ 318×10^3
• Fuel conversion cost	M\$ $2,870 \times 10^3$
• Installation of precipitators	M\$ $3,990 \times 10^3$
• Wood combustion boiler	M\$ $3,080 \times 10^3$
Total	M\$ $10,258 \times 10^3$

(2) Measures against Mobile Sources

- Smokeless lube oil M\$ 20/liter. (Cost is about 40% more than normal oil in Japan)
- 4-stroke motorcycle ; Price is about 10% higher than 2-stroke motorcycle
- Catalytic converter for petrol vehicles; M\$ 1,400/unit
- Car inspection system ; 4 offices in KVR M\$ $9,000 \times 10^3$

(3) The Comprehensive Air Pollution Control Center

1) Combustion training center

• Liquid and gas fuel combustion boiler	M\$ $2,108 \times 10^3$
• Wood chip combustion boiler	M\$ $3,292 \times 10^3$
• Measuring equipment	M\$ 265×10^3
Total	M\$ $5,665 \times 10^3$

2) Ambient air quality monitoring training center

- A full set of equipment for fixed stations (SPM, SO_2, CO, NO_2, O_3, NMHC) M$ 760x10^3

3) Pollution source monitoring center

a) Stationary sources

- Dust concentration measuring equipment
- NOx, SOx, O_2 measuring equipment

M$ 240x10^3

b) Mobile sources

- Chassis dynamometer ; Petrol car model M$ 4,000x10^3
  Large diesel car model M$ 8,000x10^3

4) Ambient air quality central monitoring center

• Fixed stations	M$ 14,280x10^3
• Mobile stations	M$ 11,520x10^3
• Central monitoring center	M$ 960x10^3
• Street display boards (2 sets)	M$ 1,600x10^3
Total	M$ 28,360x10^3
	M$ 35,190x10^3
	(see table 11.16)

(including maintenance cost upto 2005)

11.12.2 Schedule

The schedule of taking measures against stationary sources and mobile sources is presented in Tables 11.15 and 11.16, and monitoring plan of ambient air quality and pollution sources is shown in Table 11.17.

Table 11.15(1) Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Stationary Sources)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
Stationary Sources															
(1)Power Station															
1) "A" Power Station						Operation									
No.1(M.F.O,300Mw)			Fuel conversion M.F.O to N.G.(for SOx & SPM reduction)												-
No.2(N.G. ,300Mw)															-
No.3(Coal,300Mw)				Improvement of Electric Precipitatior's Efficiency											-
No.4(Coal,300Mw)															-
No.5(Coal ,500Mw)															-
No.6(Coal, 500Mw)							Fuel conversion Coal to N.G.(for SOx & SPM reduction)								-
No.7(N.G., 500Mw)															-
2) "B" Power Station (N.G. 840MW)		900MW													-
3) "C" Power Station (N.G.)															-
(2)General Factories															
1)Cement Factory			Improvement of Electric Precipitators' efficiency												-
2)Other Factories			Fuel conversion (MFO to N.G) (Facilities with more150kg/h of M.F.O combustion in Petaling.Jaya &Shah Alam)												M$2.9 million
			Fuel conversion (MFO to L.F.O) (Facilitiese with more 200kg/h M.F.O combustion in other areas)												-
						Use of natural gas(new facilities)									
			Dust collector (Cyclone) 3 factories						Dust collector (Cyclone) 3 factories						M$4.0 million
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate

Table 11.15(2) Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Stationary Sources)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
					Extention of stack										M$0.2 million
							Replacement of wood combustion boiler								M$3.1 million
							Combustion management								-
				Energy saving											-
(3)Combustion Training Center															M$5.7 million

Table 11.16 Implementation Plan of Measures against Air Pollution in Kelang Valley Region (Mobile Sources)

Measure	Schedule (1992–2005)	Cost Estimate
1. Motor Vehicles		-
(1) Emission Control		-
1)Combustion Improvement of Motorcycle		-
a) Shift from 2-cycle M/C to 4-cycle M/C	Almost Completion	10% cost up
b) Use of Smokeless Lube Oil	Preparation; Supply and regulation	M$20/liter (40% cost up)
2) Application of EC Regulation		Oxidation catalytic converter
a) Petrol Vehicles	ECE15-04; 91/441/EEC; 3-way catalytic converter	M$1,400/unit cost up
3) Restriction of Diesel Motor Vehicles	Shift from diesel taxi to petrol taxi	-
4) Introduction of CNG Taxi		-
(2) Fuel Control		
1) Unleaded fuel	using ratio 50%; using ratio 80-90%	-
2) Low Sulphur Diesel Fuel	Sulphur content 0.3%; Sulphur content 0.2%	-
(3) Traffic control		
1) Mass Rapid Transit Railway System (MRT)	Transportation Master Plan in 2005 Source; JICA (1987): " KLANG VALLEY TRANSPORTATION STUDY"	-
2) Improvement of Bus System		
3) Road Net Work Plan		
2. Organization & Institution for Motor Vehicles		-
(1) Car Inspection System		M$9.0 million
(2) Introduction of Flexitime System		-

Table 11.17 Implementation Plan of Air Pollution Monitoring in Kelang Valley Region
(Ambient Air Quality and Air Pollution Source Monitoring)

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Cost Estimate
1. Ambient Air Quality Monitoring															
(1) Fixed Station															
1) Residential Area															
a) UPM			○ Replacement												M$2.11mil.
b) P.J.	●						○							○	M$2.69mil.
c) S.A.	●						○							○	M$2.69mil.
d) Klang		○							○						M$2.11mil.
2) Road Side															
a) City Hall		○							○						M$2.69mil.
b) New station				●							○				M$1.65mil.
c) New station					●							○			M$1.62mil.
d) New station						●							○		M$1.59mil.
3) High Concentration Area															
a) New station				●							○				M$1.56mil.
b) New station					●							○			M$1.52mil.
c) New station						●							○		M$1.48mil.
(2) Mobile Station															
1) Existing Monitoring Car															
No.1	●							○							M$2.44mil.
No.2	●								○						M$2.44mil.
2) New Monitoring Car															
No.3			●							○					M$4.32mil.
No.4				●							○				M$4.28mil.
Total															M$35.19mil.
2. Air Pollution Source Monitoring															
(1) Factory Existing								○							
(1) Factory new				●							○				M$ 0.24 mil.
(2) Motor Vehicle			●	Instration of Chassis Dynamometer											M$ 4mil.(Petrol) M$ 8 mil.(Diesel)
3. Central Monitoring Center									●						M$ 35.2 mil.
4. Training Center															
Ambient Air Quality Monitoring Training Center		- - -	- - -												M$ 0.76 mil.

CHAPTER 12 CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 12 CONCLUSIONS AND RECOMMENDATIONS

1. This is the first comprehensive air pollution study in the Kelang Valley Region (KVR). It was conducted with close cooperation between Malaysian and Japanese teams.

   The Study measured annual meteorology and ambient air quality using five fixed monitoring stations (including three existing ones) and two monitoring cars, and four times measurement on upper level meteorology was conducted. The Study also involved surveys of factories by questionnaires, flue gas measurements and fuel analyses, traffic volume surveys and vehicular exhaust gas emission analyses by chassis dynamometer. An air dispersion simulation model was developed using the above results to simulate the 1992 air quality in the KVR and to predict the one in 2005. Finally the Study evaluated control measures to improve the air quality in the KVR and proposed the related guidelines.

2. The results of the Study suggest strongly that the air pollution in the Region is becoming serious. The Kelang Valley Region emits twice amounts of SOx, 0.8 times of NOx and 1.8 times of CO, as compared to Tokyo. The KVR has twice the area and one quarter of the population to those of Tokyo. Hence, the SOx and CO emission amounts in the unit area are identical in both regions. However, the emission amounts per capita in the KVR are 8 times of SOx, 3 times of NOx and 7 times of CO, to those in Tokyo. The actual emission amounts could be larger than the above figures in the KVR, because emissions from open burning are not included. In addition, since wind is very weak and low inversion layers of 50 meters appear frequently, air pollutants tend to accumulate in the Region. Moreover, high temperature and intense solar radiation in the KVR will promote such chemical reactions as photochemical smog formation.

3. The Study monitored higher CO concentrations in KVR than those in Tokyo. Actually some fixed monitoring stations did not satisfy the Malaysian air quality guidelines for PM10 and CO. Particularly, O_3 concentrations at all stations exceeded the guidelines, suggesting the possibility of bad effect on health.

4. Malaysia is one of the most significantly developing countries in the world. Its average annual GDP growth rate is amazingly 6.7% from 1971 to 1990

and is expected to be 7.0% between 1991-2000. This economic growth is particularly apparent in urban areas. The atmospheric deterioration of KVR is foreseeable from its industrialization, population concentration, traffic growth and so on.

5. In fact, the emission amounts of SOx, NOx, PM, HC and CO in the KVR in 2005 will increase by 1.45, 2.12, 1.47, 2.27 and 2.27 times respectively from the 1992 levels, if no countermeasure is undertaken. The simulation study for SO_2, NO_2 and CO showed remarkably enlarged areas where annual average values exceeded the target values in the KVR. These results demonstrate clearly the necessity to strengthen air pollution control measures.

6. Following measures were recommended to prevent the atmospheric deterioration with almost no adverse effects on economic growth. These measures are considered to be practical measures for implementation by the concerned agencies of the Malaysian Government.

1) Stationary Sources

- Power Station

  Power stations in KVR emitted 55% of total SOx, 24% of total NOx and 16% of total PM in 1992. Fuel conversion (fuel oil or coal to natural gas) was recommended as the practical measure. It will contribute to reduction of pollutant amount in comparison with the case of "2005 without measures": SOx 42%, NOx 13% and PM 66%.

- General Factories

  General factories emitted 31% of total SOx , 5% of total NOx and 55% of total PM emission in 1992. Six kinds of measures as follows were recommended. The effect of the measures will be 53% of SOx, 0.1% of NOx and 33% of PM reductions respectively. Proper combustion management will lead to energy saving and pollutant emission reduction. Energy saving by the proposed combustion management, etc. will lead to 10% reduction in fuel consumption.

  - Fuel conversion (fuel oil to light fuel oil/natural gas)
  - Combustion management
  - Use of natural gas (new facilities)
  - Energy saving
  - Enhancement of dust removal
  - Extension of stacks

- Solid Waste Management System

  The Study could not deal adequately with open burning of solid wastes and others directly because of scant information about this practice. But its effect on air pollution in KVR can not be ignored. Though open burning is principally illegal, it is prevalent with solid wastes. Establishment of solid waste management system could reduce open burning to a considerable extent.

2) Mobile Sources

Motor vehicles are the major pollution source among mobile sources in KVR.

The major source is motor cars for CO and NOx, diesel vehicles for PM and SOx, and motorcycles for CO and HC. Accordingly, following measures were recommended, based on the type of vehicle.

- Exhaust Emission Control

  - Installation of catalytic converters to petrol vehicles

    Oxidation catalytic converter can reduce 51% of CO 17% of NOx and 59% of HC from petrol vehicles.

  - Introduction of four stroke motorcycles

    The four stroke motorcycle emit only 14% of PM, 18% of HC, 42% of CO and 58% of SOx in comparison with the two stroke motorcycle.

  - Smokeless lube oil for two stroke motorcycles

    The use of smokeless lube oil into the two stroke motorcycle can reduce black smoke.

  - Quality control of fuel

    Use of unleaded petrol is necessary for oxidation catalytic converter. Reduction of sulphur content in diesel oil from 0.3% to 0.2% is necessary for reduction of SOx and PM.

  - Restriction of light duty diesel vehicles

    Restriction of diesel vehicles is very important to reduce PM and SOx emission. To begin with, the restriction of light duty diesel vehicles, initially targeting taxies and commercial vehicles was recommended.

- Execution of Transportation Master Plan by 2005(*)
  The Transportation Master Plan was prepared to improve the traffic situation in KVR, where the transportation system is exceedingly dependent on motor vehicles, and hence to mitigate the traffic congestion in the Region. The simulated result showed that it will play quite a significant role in mitigating air pollution. Therefore, the realization of this master plan in time, as scheduled is quite essential for improving the air quality in the Region.

  * Source: JICA (1989), Klang Valley Transportation Study

  If the exhaust gas regulation for petrol vehicles and the Master Plan are implemented, vehicular pollutant emission of SOx, NOx, PM, HC and CO in the case of "2005 with control measure" will be reduced by 19%, 32%, 35%, 38% and 51% respectively in comparison with the case of "2005 without measures".

7. The simulation model confirmed that the ambient air quality in 2005 would not deteriorate even under the accomplishment of vigorous economic development plan, if the proposed countermeasures are fully implemented.

8. In order to implement the countermeasures smoothly and to confirm their effectiveness, following supporting actions are essential.

1) Strengthening of DOE's capacity in institution and organization

DOE is one of the most important organizations concerned to air pollution control in KVR. However, shortage of staff is a serious problem at present which may worsen in future. In order to strengthen DOE, recruiting the qualified manpower and staff is a matter requiring urgent consideration.

2) Installment of ambient air quality and source monitoring systems

During the Study, five fixed stations and two monitoring cars were set up in KVR. However they are not adequate to monitor ambient air quality effectively. Eleven fixed stations, 20 mobile stations in all were recommended to be installed by 2005. Vehicle exhaust gas monitoring system with chassis dynamometers and flue gas measurement system for stationary source monitoring were also recommended.

3) Establishment of a combustion management system.

It was proposed to establish a regulation system which aims at controlling the combustion in factories with dual objectives of ambient air pollution control and energy conservation. It is also necessary to establish a system which subsidizes the activities relating to air pollution control.

4) Car Inspection System

It was proposed to establish a car inspection system which aims to keep in-use vehicles in good condition, which will lead to reduce air pollutant emission from them.

5) Foundation of Comprehensive Air Pollution Control Center

Considering the shortage in qualified engineers to participate in the activities for controlling air pollution at present in the country, it is necessary to train such engineers as soon as possible prior to the implementation of the measures which the Study proposed in the guidelines. In order to increase the number of such engineer, it was proposed to establish "the Comprehensive Air Pollution Control Center" in the earliest stage of the implementation. The center will consist of four centers as follows.

- Ambient Air Quality Monitoring Center
- Combustion Training Center
- Ambient Air Quality Monitoring Training Center
- Pollution Source Monitoring Center

The shortage of senior engineers for training such engineers is also a serious problem in the country. Such specialists and experts required for training the national engineers shall be supplemented with foreign expertise as required.

9. Future requirements

- Publishment of enforceable air quality standards

Malaysian Air Quality Guidelines(1989) actually don't have any legal enforcement. Hence, it is necessary to establish Ambient Air Quality Standards to control air pollution fundamentally.

- Study of air pollution effects on public health and ecosystem

According to the result of ambient air quality monitoring in KVR, there may be some people whose health is affected due to air pollution in KL, Shah Alam or Petaling Jaya. It is important to study such air pollution effects on health in particular and ecosystem in general.

- Reconstruction of the simulation model

The simulation result in the Study was based on only one year data. Hence, it is necessary to check the validity of the simulation model after accumulation of air quality and source data for two to three years period.

- Development of simulation model for SPM and HC

Though simulation model for air pollution can apply only to SO_2, NO_2 and CO so far, development of new simulation models for SPM and HC is expected in the future in order to make their quantitative assessment.

- Accurate survey of air quality in high pollution areas and on road sides

The objective of the Study was to clarify the overall situation of the air pollution in and around the city of KL, but not at any particular local point or an area in the city. It is difficult to clarify the local air pollution by the method and the model applied for the simulation. The results of this simulation does not indicate the local situation of any small spot or strip even when the pollution situation thereof exceeds the target value. For instance, pollutant concentration along main roads with heavy traffic may exceed the air quality guidelines. Therefore, the measures proposed herein for 2005 may not guarantee improvement of such local pollution situation. A more detailed study in each area is necessary to identify the pollution situation of such areas. For this objective, the data obtained by the proposed monitoring system can be effectively utilized.

- Study of haze causes

Though the Study did not aim to clarify the cause of haze in the Region, ambient SPM samples were collected and analyzed. However, no haze was observed during the survey period. Nevertheless, it is recommended to carry out study on haze, centering on its chemistry.

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