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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REPORT OF THE EXPERT GROUP MEETING ON

CONTROL AND REGULATORY MEASURES CONCERNING MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION

organized by UNDP, UNIDO and

Korea Institute of Science and Technology (KIST)

Seoul, 21-24 August 1990

This document has not been edited.

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1. Introduction and Participants

In order to develop the project document for the proposed regional project DP/RAS/89/057 - Regional Network on Control and Regulatory measures Concerning Motor Vehicle Emissions - UNDP/UNIDO organized an expert group meeting in co-operation with the Korea Institute for Science and Technology. Participants were the representatives of all proposed participating countries (except for Indonesia), UNDP/UNIDO staff and a technical consultant, refer to annex 1. The agenda of the meeting is enclosed in annex 2.

2. Presentation of the Consultant's Report

The consultant presented his paper "Regulatory Measures Concerning Motor Vehicle Emission Control - Technical Background, Present State and Possibilities for a Regional Co-operation in the Asian Region" (annex 3). While the first part of this paper had the purpose to set all participants on common grounds in terms of the technical matter and terminology, the second part was a summary of the results of the fact finding mission the consultant had carried out prior to the meeting. During this mission he had visited all of the involved countries except - due to lack of time - India and Sri Lanka. The purpose had been to determine the state of motor vehicle pollution and the state of related control measures in the respective countries as well as the organizational structures of the concerned authorities. The conclusion of this report is as follows:

a) Despite the comparibly low degree of motorization the air pollution caused by motor vehicle traffic is already severe in most Asian cities.

b) The basic reasons for the excessive pollution are missing standards for new vehicles and the bad condition of the in-use vehicles despite, to a certain extent, existing periodical inspection requirements.

c) To improve the situation the following measures are needed:

- introduction of new or upgrading of existing inspections making them more effective regarding the emissions;

- implementation of type approval systems incorporating emission standards regarding the actual mass emissions;

- upgrading of fuel quality standards and introduction of unleaded gasoline;

- suitable policies to support the training of mechanics, make spare parts available at reasonable prices, encourage the use of low smoke oils etc..

d) A regional co-operation could not only result in information and experience exchange but also an increased market power, making it easier to force the supplier of vehicles and fuel to comply with future standards.

3. Presentation of the Country Papers by the Country Representatives

The country papers were presented by the country representatives and had been prepared on the basis of the discussion with the consultant during his fact finding mission. They are listed below in the order in which they were presented, all papers are enclosed as annexes.

Korea (annex 4)

Title: Motor Vehicle Emission Control in Korea

Author: Mr. Kang-Rae Cho, Director of the Motor Vehicle Emission Research Laboratory, National Institute of Environmental Research (NIER)

Presented by: Mr. J. Dong, Senior Researcher, NIER

China (annex 5)

Title: Vehicle Emission Pollutant Control and Technical Measures in China

Authors: Mr. Ma Hua, Mr. Li Guoxiang and Mr. Shu Mingxing, Researchers in the Highway Research Institute of the Ministry of Communications

Presented by: Mr. Shu

Singapore (annex 6)

Title: Country Report of Singapore

Author: Mr. Pang Mun Hung

Presented by: Mr. Pang

Philippines (annex 7)

Title: Country Report

Authors: Mr. Hermogenes C. Fernandez, Chief, Transportation Regulations Officer, Land Transportation Office, Department of Transportation and Communications

Mr. Arnel H. Luz, Senior Environmental Management Specialist, Department of Environment and Natural Resources

Presented by: Mr. Luz

Malaysia (annex 8)

Title: Regional Network on Control and Regulatory Measures Concerning Motor Vehicle Emissions

Authors: Mr. Azlan Bin Abu Samah, Assistant Technical Director, Technical and Inspection Division, Ministry of Transportation

Mr. Aminuddin Ishak, Environmental Control Officer, Mobile Sources Unit, Department of Environment, Ministry of Science, Technology and Environment

Presented by: Mr. Azlan

Sri Lanka (annex 9)

Title: Expert Group Meeting on Motor Vehicle Emission Standards

Author: Mr. D.D.J.Wijesundara, Commissioner of Motor Traffic

Presented by: Mr. Wijesundara

Thailand (annex 10)

Title: Motor Vehicle Emissions in Thailand

Authors: Mr. Suvidh Voravisuthikul, Chief of Transport Engineering Division, Land Transport Department, Ministry of Transport and Communication

Mr. Santad Koompalum, Head of Sub-Section Motor Vehicle Emissions, Office of the National Environment Board

Presented by: Mr. Suvidh

Hong Kong (annex 11)

Title: Vehicle Emission Control in Hong Kong

Author: Mr. Ling Wai-ming, Vehicle Emission Control Section, Environmental Protection Department

Presented by: Mr. Ling

India (annex 12)

Title: Country Paper for India

Author: S. Raju, Deputy Director of The Automotive Research Association of India

Presented by: Mr. Raju

4. Discussion of Possible Project Objectives

As most important long term objectives the following were identified:

a) common mass emission standards for new vehicles,
b) common fuel quality standards,
c) common procedures for periodical inspections of in-use vehicles,
d) development of practical policies to improve the maintenance of vehicles.

From a regional project dealing with these issues benefits could be expected in terms of information and experience exchange, technology transfer within the participating countries and support for the responsible national authorities. The first two items appear to provide additional benefits in terms of an increased market power.

In order to pave the way for the above measures in the individual countries it was decided that the outputs of the proposed project should be recommendations regarding the above issues. It was also decided to establish a regional network consisting of national focal points in each country and one main focal point in order to promote the co-operation and co-ordination.

ANNEX 1

MOTOR VEHICLE EMISSIONS PARTICIPANT LIST

COUNTRY	NAME	TITLE & ORGANIZATION
China	Mr. Ma Hua	Researcher, Prevention of Air Pollution caused by motor vehicle Emission in Highway Research Institute of the Min of Communications
	Mr. Li Guo Xiang	Vice Researcher, Prevention of Air Pollution caused by motor vehicle Emission in Highway Research Institute of the Min of Communications
	Mr. Shu Ming Xin	Associate Researcher, National motor vehicle emission control policies in Highway Research Institute of the Min of Communications
Hong Kong	Mr. Wai-Ming Ling	Ag. Senior Environmental Protection Officer, Environmental Protection Dept.
India	Mr. S. Raju	Dep. Director, The Automotive Research Association of India, Pune
Korea	Dr. Park Won-Hoon	KIST-Head of Air Pollution Control Lab
	Mr. Oh Sae-Zong	KIST-Head, Thermal Engine Lab
	Dr. Ahn Kyu-Hong	KIST-Sr. Researcher, Chem.Engg.Div.
	Dr. Ha Dae-Hong	Kist-Sr. Researcher, Mech.Engg.Div.
	Dr. Shim Sang-Kyu	KIST-Sr. Researcher, Air Pollution Control Lab
	Mr. Cho Kang-Rae	Dir, Motor Vehicle Emission Research Lab
	Dr. Dong Jong-In	Researcher, " (NIER)
	Dr. Lee Sung-Won	Researcher, Korea Transport Institution
	Mr. Koh Ki-Won	Daewoo, Head of Engine Testing Dept.
Malaysia	Mr. Azlan Abu Samah	Asst Dir., Technical Division, Road Transport Dept.
	Mr. Aminuddin Ishak	Environmental Control Officer, Dept. of Environment

COUNTRY	NAME	TITLE & ORGANIZATION
Philippines	Mr. Hermogenes Fernandez	Chief, Transportation Regulatory Officer, Land Transportation Office, Dept. Transportation & Communications
	Mr. Arnel Luz	Environment Mgmt Specialist, Environmental Mgmt Bureau, Dept. Environment & Natural Resources
Singapore	Mr. Pang Mun Hung	Exec. Engineer & Head of Mechanical Inspection Div., Registry of Vehicles
Sri Lanka	Mr. D.D.J. Wijesundera	Commissioner of Motor Traffic
Thailand	Mr. Santad Koompalum	Environmental Officer Air & Noise Pollution Section Environmental Quality Standard Div. Office of the Nat'l Environment Board, Min of Science, Technology & Energy
	Mr. Suvidh Voravisuthikul	Director, Transport Engineering Division, Land Transport Department

UN STAFF

UNIDO	Mr. H. Carstensen	Consultant
UNIDO	Dr. H. Seidel	Sr. Industrial Development Officer
UNIDO	Mr. A. Parinpour	Coordinator of Regional Projects in Asia & Pacific
UNDP	Mr. J. Guijt	Resident Representative
UNDP	Mr. R. Garcia	Deputy Resident Representative

ANNEX 2

Agenda

Tuesday		
21 August 1990	09.00 - 12.00	Registration
	14.00 - 15.00	Opening Session
	15.00 - 18.00	Presentation of International Consultant's report
Wednesday		
22 August 1990	09.00 - 12.00	Presentation of participants country papers
	14.00 - 18.00	Discussion of country issues
Thursday		
23 August 1990	09.00 - 12.00	Discussion on modalities for regional co-operation
	14.00 - 18.00	Continuation of discussion and presentation of recommendations to be drafted for the meeting report.
		Conclusion of meeting.
Friday		
24 August 1990		Study visit to the Motor Vehicle Emissions Laboratory of the Ministry of Environment.
		Visit to a Korean car manufacturer (Hyundai).

ANNEX 3

Hartmut CARSTENSEN
UNIDO Consultent

Institute for Internal Combustion Engines
and Automotive Engineering
Technical University of Vienna, Austria

Getreidemarkt 9
A-1060 Vienna

Tel.: 43-222-58801-4913
Fax.: 43-222-566294

UNDP/UNIDO Project DP/RAS/89/057/C

Regulatory Measures Concerning Motor Vehicle Emission Control

Technical Background, Present State and Possibilities for a Regional Co-Operation in the Asian Region

Presented at the expert group meeting in Seoul

at the Korea Institute of Science and Technology (KIST)

21 - 24 August 1990

Conclusions

* Despite the comparibly low degree of motorization the air pollution caused by motor vehicle traffic is already severe in most Asian cities.

* The basic reasons for the excessive pollution are missing standards for new vehicles and the bad condition of tne in-use vehicles despite the to a certain extent existing periodical inspection requirements.

* To improve the situation the following measures are needed:

  - introduction of new or upgrading of existing inspections making them more effective regarding the emissions

  - implementation of type aproval systems incorperating emission standards regarding the actual mass emissions

  - upgrading of fuel quality standards and introduction of unleaded gasoline

  - suitable policies to support the training of mechanicians, make spare parts available at reasonable prices, encourage the use of low smoke oils etc..

* A regional co-operation could not only result in information and experience exchange but also in an increased market power making it easier to force the supplier of vehicles and fuel to comply with future standards.

Table of contents

1. Introduction

The growing vehicle poulation causes worldwide problems with increasing air pollution. This is especially true for all large cities with their high population- and consequently high traffic densities.

2. Emissions Considered

The exhaust emissions of all engines running on fossile fuels mainly (approx. 98%) consist of carbondioxide (CO_2) and water (H_2O), which are considered to be harmless for nature and human beings although the increasing CO_2 production is one of the main causes of the "Green House Effect", the global warming.

The remaining share of exhaust emissions is generally considered to be toxic and mainly consists of the following components:

- Carbon Monoxide (CO)
- Hydro Carbons (HC)
- Nitric Oxides (NO_x)
- Particulate Matter (PM)
- Sulphur Dioxide (SO_2)
- Lead (Pb)

CO and HC emissions derive from an incomplete combustion and are caused either by a general or by a local lack of Oxygen in the combustion chamber. CO is a direct toxic for human beings as it blocks the oxygen transport by the blood. HC affects the respiratory tract, may cause cancer and adds to the production of photooxidants and tropospheric ozone, both of which are harmful to nature and human beings.

NO_x consists of two natural components of the ambient air. It is simply the product of a reaction which takes place as soon as air is exposed to such high temperatures as occur during the combustion. NO_x also affects the respiratory tract of human beings, adds to the formation of photooxidants and causes in combination with SO_2 acid rain.

PM mainly consists of unburnt carbon particles and is a product of the incomplete "droplet combustion" which especially occurs in Diesel engines. However certain species of HC and other side products of the combustion add to these carbon particles and make them harmful especially to human beings as they are small enough to be deposited in the deepest recesses of the lung and are suspected to be carcinogens. Besides that PM is the cause of the visible and smelling black smoke of Diesel engines.

The formation of SO_2 occurs whereever fuels containing sulphur are burnt. SO_2 is in combination with NO_x the main cause of acid rain.

Similarly the lead emissions only depend on the lead content in the fuel. Subsequent high ambient lead levels affect especially the health and development of children.

3. Contributions of Different Engine Types and Technical Solutions

3.1 Gasoline 4-Stroke Engines

Gasoline 4-stroke engines are mainly used for passenger cars and light duty vehicles. Because of their combustion system they produce considerable amounts of the gasous CO, HC and NO_x emissions but almost neglectable PM and because of the low sulphur content of gasoline neglectable SO_2 emissions. They do, however, account for the lead emissions which derive from knock resistance increasing lead additives in gasoline fuels.
Compared to completely uncontrolled conditions the emissions of 4-stroke engines can be reduced by roughly up to 50% by optimizing the engine design. The introduction of catalytic converters, which requires the use of unleaded fuel can further reduce the emissions by up to 90%. However, in any case a proper maintenance is necessary to avoid extremely increasing CO and HC emissions of in use vehicles.

3.2 Gasoline 2-Stroke Engines

Gasoline 2-stroke engines are mainly used for smaller motorcycles as they are common in the Asian region. They cause lower NO_x emissions but up to 15 times the HC emissions of comparable 4-stroke engines. Additionally they cause white smoke consisting of unburnt lubricant oil droplets. Their fuel economy is only about half of that of 4-stroke engines.
While the white smoke emissions can be reduced considerably by using special low smoke oils and proper oil/fuel ratios there is only one solution for reducing the HC emissions to acceptable levels, the use of catalytic converters. However, due to possible deterioration of such equipment the switch to 4-stroke engines for motorcycles would be the better way.

3.3 Diesel Engines

Diesel engines are the main source of power for commercial vehicles. Heavy trucks and buses are generally equipped with this type of engine because of its outstanding fuel economy compared to all other engines. Diesel engines cause considerably lower gasous emissions in terms of CO, HC and NO_x compared to 4-stroke gasoline engines and produce no lead emissions. However they are the main source of traffic caused PM resp. black smoke and SO_2 emissions. While the latter only depend on the sulphur content of the fuel all other and especially the PM emissions depend on the following factors:

- setting of the full-load-stop adjustment screw
- condition and therefore maintenance of the whole engine and especially of the fuel injection equipment
- matching of quality of the fuel used and the fuel for which the engine tuning was designed
- engine design

The use of catalytic converters with Diesel engines is by far not as effective as with gasoline engines, is, however, recently being conducted by some German car manufacturers. The main possibilities for

improving the emissions of Diesel engines are the optimization of the parameters combustion chamber design, injection system design, charge motion and others. Additionally the use of super- or turbochargers and intercooling is of special advantage. Compared to uncontrolled Diesel engines the emissions can be reduced by at least 50 % by such measures. For extremely low PM emissions, however, PM traps may be required. Such trap systems have been under development for a long time and are presently introduced by some manufacturers.

For special purposes Diesel engines may also be converted to gas fuel (LPG or CNG) and be equipped with catalytic converters providing extremely low exhaust emissions at the expense of higher fuel consumption.

4. Regulatory Measures to Control Motor Vehicle Emissions

Regulatory measures to control vehicle emissions have to focus on the following issues:

1) Control of the actual emissions of new vehicles in terms of mass emission per travelled km by implementation of type approval systems

2) Control of the fuel quality

3) Control of the maintenance of in-use vehicles in order to assure that these remain in the same technical condition as when they were new

4.1 Emission Control of New Vehicles

4.1.1 Test Procedure

The target of the emission control of new vehicles must be the limitation of the actual mass emissions per travelled distance in terms of g/km during actual operation of the vehicles. Since the operation conditions and therefore the actual emissions depend on the vehicle load, traffic, drivers behaviour etc. it is necessary to identify typical and representative driving conditions for the individual types of vehicles as cars, motorcycles and trucks. This has been done in the past by various countries or groups of countries, such as USA, Japan or the ECE, which have developped representative driving cycles or test modes.
The vehicles to be tested are put on chassis dynamometers and operated according to the specified drivingcycle. During the whole test the exhaust gases are collected, diluted with air in order to stop any post reactions, the volume of the whole gas/air mixture is measured as it is pumped off and a small probe of the mixture is taken and pumped into large plastic bags. After the end of the test the concentrations of the individual components are determined using special analyzers for each one of them. From the volume of the air/gas mixture and from the individual concentrations the individual mass emissions can be detected and consequently be related to the distance travelled during the test leading to test results in terms of mass emission per travelled distance in g/km. Finally these test results are compared to the limits specified in the exhaust gas regulations in the respective country. This whole procedure usually is referred to as test procedure.

For Diesel vehicles an additional free acceleration smoke test should be conducted in order to determine the limit for later checks of the respective vehicle type (refer to section 4.2.1).

4.1.2 Type Approval or Certification System

Since such test procedures are very cost intensive in terms of equipment and manpower not all new vehicles are tested but instead one vehicle of each specific type. Aside from the test results all technical details of the checked vehicle relating to the exhaust emissions are recorded and included in the test report. The manufacturer (or importing company) presents this report to the respective governmental authority and obtains a certificate for this one specific type of vehicle (in general one specific chassis, one specific engine type with a specific power, ...). Finally the manufacturer has to guarantee, that all vehicles of this type sold are technically equal to the tested vehicle and would therefore also comply with the required regulation. This whole procedure usually is referred to as type approval or certification.

In most cases the necessary type approval tests are carried out in the country of origin of the vehicles as most governments do accredit well known manufacturer- and manufacturer independant test facilities in foreign countries.

In order to make sure that the manufacturers really supply the market with complying vehicles most countries conduct Conformity of Production Tests. For this purpose the relevant governmental authorities by random choose specific vehicles out of certain batches of vehicles and have these vehicles tested. Incase they fail the manufacturer or importing company is fined severely.

4.1.3 Required Exhaust Gas Test Laboratories

The test laboratories required depend on the kind of vehicles to be tested. There are three groups:

1) passenger cars and light duty vehicles require a chassis dynamometer

2) motorcycles require a special chassis dynamometer

3) heavy duty vehicles require engine test benches as not the whole vehicles but only the engines are tested in multimode tests. The test results and emission standards therefore are determined in terms of mass emission per performed work in g/kWh.

Additionally for all types of vehicles a Constant Volume Sampling System (CVS) and exhaustgas analyzers for the components to be measured are required.

Due to the type approval system only a very small exhaustgas test laboratory capacity is required. Austria for example has an annual market of some 300.000 vehicles and has only two public laboratories. Both of these are located at technical universities and are also used for research work. This system works very well since on the one hand the universities have enough well trained personnel to perform such

tests and on the other hand the universities are supplied with the equipment and can use it for research as well.

4.2 Emission Control of In-Use Vehicles

As mentioned above the determination of the actual emission is too complicated and expensive to be conducted on in-use vehicles. Therefore the task of all in-use vehicle control measures must be to control the maintenance to assure that the vehicles remain in the same technical condition concerning the emissions as when they were new.

4.2.1 Inspection System

This task can only be achieved by the implementation of an inspection system which requires all types of vehicles to be inspected periodically regarding all emission relevant issues.

This inspection should for all motor vehicles include a check of:

- visible smoke due to engine deficiencies such as bad piston rings, bad valve shaft sealings etc.
- air filter
- idle RPM

Additional checkpoints for all gasoline vehicles should be:

- the concentration of CO at idle according to manufacturer specification, but not higher than 4.5 % by volume
- a visual check of all hoses and other fuel injection system or carburettor related parts
- the spark advance according to manufacturer specification
- the duty angle of the ignition system
- the low and high voltage ignition current
- a visual check of the whole ignition system including the breaker points (if any), the ignition coil, the distributor, the spark cables and the spark plugs

Since the CO-Test can only be conducted at idle this emission test cannnot determine the actual emissions during operation. However the idle systems of carburetors and gasoline injection systems are especially sensitive while the high load systems are rather stable. Consequently it can be asssumed, that if the vehicle passes all the above mentioned checkpoints it still produces similar emissions as when it was new.

A general test of the HC emission cannot be recommended because no suitable HC testing units are available. Those HC testing units that are available (NDIR Type) generally have an unsufficient accuracy due to their physical measuring principle. They may show readings anywhere between 20 and 80 % of the real value as detected by laboratory equipment (Flame Ionization Detector Type).

For vehicles with catalytic converters the special problem is to find out if the catalyst and the air/fuel ratio control system work properly. To my knowledge Austria will be the first country worldwide to include a test procedure solving this problem in the annual inspection. For this purpose on the one hand the air/fuel ratio control system will be checked using a (compared to laboratory analyzers) low cost four component exhaust gas testing unit, which calculates the air fuel ratio based on the measurement of mainly CO, CO_2 and O_2, and on the other hand the efficiency of the catalyst will be checked by an accurate CO measurement. The test is performed at a high idle speed of appr. 3000 RPM in order to assure that the catalyst's temperature is above the light off temperature.

Additional checkpoints for all diesel vehicles should be:

- the injection timing
- the smoke emission at free acceleration, preferably determined by the BOSCH Filter Method, limits according to type approval result (refer to 4.1.1) but not higher than 50 %
- the sealing of the full-load-stop adjustment screw

The latter checkpoint is of particular importance as the setting of this screw has two effects: An increase of the full load setting increases the maximum fuel delivery rate and therefore slightly increases the maximum power output, but at the same time extremely increases the smoke emission. Therefore all owners and drivers of Diesel vehicles may tend to tune this screw for more power hereby extremly increasing the smoke emissions during everyday operation and to tune it for low smoke emissions before presenting the vehicle to the required inspection. To avoid this, the full-load-stop adjustment screw setting must be sealed and the sealing must be checked during inspection. Without the sealing the whole procedure of the smoke test would be rather questionable.

It should be noted that the free acceleration smoke test for diesel engines is no means to determine the actual emission during operation, because the free acceleration is a completely different mode of operation than the actually occurring modes during normal operation. If, however, during the type approval process the individual free acceleration smoke limit has been determined as mentioned above (section 4.1.1) then it is later possible to check in-use vehicles if they are still in a similar condition by comparing their free acceleration smoke emission to that of the approved vehicle.

4.2.2 Enforcement by Road Side Tests

In addition to the mandatory periodical inspection police or other agencies should be given the authority to check vehicles that seem to smoke excessively. Such tests can either be conducted as on the spot tests or by calling such vehicles up and requesting them to report to a test center within a short period of time.
The issues to be checked could basically be the same as for the mandatory periodical inspection, but the most important would be for Diesel engines
- the check of the sealing of the full-load-stop adjustment screw
- the smoke test at free acceleration,

for all engines

- the check for visible smoke due to engine deficiencies

and for 2-stroke engines

- the check for excessive visible white smoke due to use of unsuitable oil or too high oil/fuel ratios.

4.3 Control of the Fuel and Lubricant Quality

The fuel and the lubricant quality, the latter especially for 2-stroke engines has an important part to play in the control of emissions.

4.3.1 Diesel Fuel

For Diesel fuel the following requirements are to be demanded in order to cut down emissions:

- high Cetane Numbers
- low content of Aromats
- low ash content

in order to improve the combustion and reduce emissions in general and

- low sulphur content

because this directly determines the SO_2 emission. Finally, rather narrow tolerances should be established for the

- density and the boiling curve
- viscosity

because these affect the actual fuel metering of the injection pumps. In other words, an engine which has been designed and tuned for a fuel with a certain density may smoke severely when it is operated with a fuel having a much higher density.

4.3.2 Gasoline

For gasoline engines the

- Octane numbers should be high

to allow a knock free combustion despite high compression ratios which are required for a high fuel economy.

- The Oxygen content must be limited

in order to assure correct fuel metering. For the sake of low respective emissions the

- aromat content and
- lead content

must be limited. An additional impact of the lead content is due to the fact, that unleaded fuel is an inevitable requirement for the operation of catalytic converters. Furthermore other properties like the sulphur content, the Reid vapour pressure etc. must be controlled.

4.3.3 Lubricant for 2-Stroke Engines

The quality of the lubricant oils for two stroke engines has an extreme influence on the white smoke emissions of such vehicles, because the white smoke mainly consists of droplets of unburnt lubricant oils. So called low smoke oils can be burnt to a much larger extent during the combustion and can decrease the emission of visible white smoke by up to 75 %. Therefore the use of such oils should be encouraged or even made mandatory.

5. The Present State of the Motor Vehicle Pollution Control in the Visited Asian Countries

5.1 Vehicle Population and its Contribution to Air Pollution

Compared to the Western World where the number of passenger cars per 1000 inhabitants approaches the value of 500 the motorization in the visited Asian region still is quite low. However, in most of the capitals there is heavy traffic. Table 1 shows the total numbers of motor vehicles per 1000 inhabitants in the visited countries and their capitals:

China	4	Beijing	50
Philippines	22	Manila	75
Indonesia	46	Jakarta	
Hong Kong	66	Hong Kong	66
Korea ROK	72	Seoul	92
Thailand	120	Bangkok	257
Singapore	210	Singapore	210
Malaysia	300	Kuala Lumpur	>300

Table 1: Number of registered motor vehicles per 1000 inhabitants in the visited countries and in their capitals

Only in three countries data were to be obtained concerning the contribution of the motor vehicle emissions to total air pollution in the whole country or in the capital:

	CO	HC	NO_x	PM	SO_2
Korea ROK	25	57	85	8	8
Malaysia	50	95	36	8	1
Manila	94	82	73	60	11

Table 2: Contribution in % of the motor vehicles to total air pollution in Korea, Malaysia and in the capital of the Philippines, Manila

Although there are considerable differences it can be assumed, that motor vehicles are the main source of CO, HC, NO_x and PM and a minor source of SO_2 in all larger cities. Except for the share of the PM this would correspond with former experiences from Western countries. However, Diesel vehicles in most Asian cities do have excessive black smoke resp. PM emissions, especially in Manila, Jakarta and Bangkok. Therefore the higher share of traffic for PM seems to be reasonable.

Compared to the gasous emissions CO, HC and NO_x, PM emissions are much better noticeable for human beings and directly cause unconvenience in terms of bad visibility, smell, dirt etc.. Besides the PM once emitted may stay suspended in the ambient air for long time. Therefore in all visited countries the black smoke of Diesel vehicles respectively the PM emission is considered to be the most urgent problem concerning motorvehicle pollution.

Furthermore the defiencies of many engines of all types regarding the piston rings, valve shaft sealings etc. cause them to emit excessive blue smoke.

Except for China, Hong Kong and Singapore between one and two thirds of all motor vehicles are motorcycles, the majority of which is powered by 2-stroke engines. They cause especially in Bangkok excessive white smoke emissions making these emissions the problem number two.

The following sections will deal with the measures that have been taken by the individual governments to improve the situation.

5.2 Emission Standards for New Vehicles

To this point only three of the visited countries have implemented standards for new vehicles which require a type approval test according to section 4.1 : Korea, Singapore and Hong Kong.
Indonesia intends to implement a type approval system by the end of the year, however, the projected emission tests are those that generally are used for inspection purposes (free acceleration smoke test for Diesel and CO concentration at idle for gasoline engines) and therefore will be no restriction for any manufacturer.

5.2.1 Motorcycles

No standards for motorcycles have been implemented yet, however Singapore is considering the adoption of such standards in the near

future because of the fact, that almost 20 % of its vehicle population consists of high polluting 2-stroke motorcycles.

5.2.2 Passsenger Cars, Light Duty Vehicles and Trucks

Table 3 shows the relevant emission standards in the three countries:

	passenger cars and light duty vehicles with gasoline engines		all vehicles with Diesel engines	
	test mode	limits	test mode	limits
Korea	FTP 75	US'83/'84	Jap. 6-mode	Jap.'77/'78
Singapore	ECE-City	ECE 15.04	ECE 6-mode	ECE 24.03
Hong Kong	ECE-City	ECE 15.02	ECE 6-mode	ECE 24

Note: Hong Kong also accepts corresponding UK- or Australian standards

Table 3: Emission Standards for new passenger cars and light duty vehicles in Korea, Singapore and Hong Kong.

Korea is most advanced having adopted the US'83 Regulation for cars and the corresponding US'84 Regulation for Light Duty Vehicles, both of which require the use of catalysts for gasoline vehicles. The standards for Diesel vehicles are less severe compared to those of some Western countries although they limit the three gasous emissions CO, HC and NO_x and the smoke emission at full load.

Singapore and Hong Kong basically have adopted the European Legislation. For gasoline powered vehicles the gasous emissions of CO, HC and NO_x are limited, but no catalysts are required as these limits can be complied with without such equipment. While the ECE 15.04 until recently was valid in most European countries, the ECE 15.02 is a former, even less stringent version. For Diesel powered vehicles only the smoke is limited using a full load test.

5.3 Periodical Inspection of In-Use Vehicles

All visited countries have implemented periodical inspections which mainly deal with the roadworthiness of vehicles but also include a smoke check for Diesel vehicles and in some countries a CO check for gasoline vehicles. Motorcycles in general are not inspected. There are differences ragarding the types of vehicles that are inspected, the frequencies of the tests, the methods of measuring the smoke (BOSCH Filter Method and Hartridge Smokemeter) and the limits:

	types of vehicles tested	frequency of tests in years	limits for gasoline CO Vol.%	limits for diesel Smoke	remarks
Korea (ROK)	all	0.5 - 2	4.5	50 % B	
	new models		1.2	50 % B	
Hong Kong	all except priv. cars	1	-	50 HSU	to start Sept.1990
Singapore	all	0.5 - 2	4.5	50 HSU	
Malaysia	all except priv. veh.	0.5	-	50 HSU	
Indonesia	all except priv. cars	0.5	4.5	50 % B	not executed miss. equip.
Philippines	all publ.veh.& f. hire trucks	0.5 - 1	6	48 % B	to start 1991
Thailand	all except priv. cars		6	50 % B	
China	all	1	4.5 - 6	50 % B	

HSU .... Hartridge Smoke Units
% B .... Bosch Smoke in %

Table 4: Inspection regulations for motor vehicles (except motorcycles) in the visited countries

Although there are smoke tests in all countries the smoke problem remains quite severe. The most important raeson for this might be the fact, that nowhere the full-load-stop adjustment screw is sealed (refer to sect. 4.2.1).

5.4 Enforcement by Road Side Checks

In almost all the visited countries the same emission tests as those performed during periodical inspection are also conducted at random road side checks. Incase the vehicles fail the drivers and in some countries additionally the owners of the vehicles are fined. However the enforcement in most countries seems to be unsufficient due to a lack of manpower and equipment.

5.5 Physical Facilities

5.5.1 Emission Laboratories

Of all visited countries Korea is the only one with a public exhaust emission laboratory with a chassis dynamometer which is suitable for the conduction of type approval tests for cars and light duty vehicles.
In Thailand and Malaysia there are such laboratories but only under the control of local manufacturers or assembly plants.

5.5.2 Inspection Centers

The following table indicates by whom the inspections are carried out in the individual countries:

	inspection carried out by workshops / governmental agencies	number of centers and remarks
Korea (ROK)	licensed workshops	
Hong Kong	Environmental Protection Department	1 under constr.
Singapore	licensed workshops	3
Malaysia	Ministry of Transportation	
Indonesia	Ministry of Communication and local authorities	218, but only 155 well equipped
Philippines	Department of Communication and Transportation	4 under constr.
Thailand	Ministry of Transport and Communication	
China	licensed workshops	

Table 5: Affiliation and number of the inspection centers in the visited countries

There seems to be an urgent need for further or better equipped inspection centers in Thailand, Indonesia, Malaysia and the Philippines.

5.6 Fuel quality

The following fuels are available in the visited countries:

	leaded Gasoline				unleaded Gas.		Diesel		market-share of Diesel %
	Regular		Premium		Reg.	Prem.			
	lead	RON	lead	RON	RON	RON	CN	sulphur	
Korea	0.32	86	0.32	95	91		45	0.4	80
Hong Kong		98				95 from Apr. '91		0.5	72
Singapore	0.15	92	0.15	98	intended		45	0.5	33
Malaysia	0.15	85	0.15	97	85 voluntarily	97	47	1.0	66
Indonesia		88		92	-	-			
Philippines	0.6	81	0.84	93	-	-	40	0.9	
Thailand	0.4	83	0.4	95	-	-	47	0.5	
	0.15	until 1993							
		MON		MON					
China	0.35	70	0.45	85	-	-			

Table 6: Fuel qualities in the visited countries:
Research Octane Numbers RON, Motor Octane Numbers MON,
Cetane Numbers CN,
lead in g/l and sulphur in % of mass

The high market shares of Diesel in Korea, Hong Kong and Malaysia are remarkeable and point at the consequent high Diesel smoke emissions.

6. Proposals for and Benefits of a Regional Co-Operation

6.1 Common Inspection/Maintenance Systems

Since the improvement of the maintenance of the in-use vehicles seems to be the most urgent problem throughout the region the inspection systems must be improved. For this task a co-operation in the areas of

- developping suitable check procedures
- personnel training
- organizational structures

could be useful although there naturally is less interference between neighbouring countries regarding the inspection systems than regarding e.g. the fuel quality.

6.2 Common Fuel Quality Standards

As mentioned in section 4.3 the fuel quality has two important impacts on the emission control: first it directly affects the emissions and second it affects the design of the engines. While the first impact only affects the respective country the second impact does affect the whole region regarding

- cross border travelling and

- market power: the larger the market for equally designed and equipped vehicles is, the easier it is to demand clean vehicles from the suppliers. In turn the suppliers have bear less development costs and can more easily export their products to different countries.

Therefore the implementation of common fuel standards would be a most suitable objective for a regional co-operation.

6.3 Common Emission Standards for New Vehicles

Common emission standards would bring about the same advantages regarding the market power as stated above.

6.4 Practical Policy Recommendations

Since basically the same problems have to be solved in all involved countries an information and experience exchange between the authorities of the individual countries and the development of practical policy recommendations regarding e.g. the following issues would help to improve the situation:

- taxation of vehicles and spare parts, because as long as spare parts and new vehicles are extremely expensive it will be hard to upgrade the general technical condition of vehicles

- supply of public transportation authorities with enough funds to maintain public vehicles properly

- incentives for the training of mechanicians

- incentives for private entrepreneurs to run well equipped workshops with well trained personnel

- incentives for the conversion of Diesel engines to gas fuel

- incentives for the use of low smoke oil for 2-stroke engines

- incentives for the use of 4-stroke engines rather than 2-stroke engines for motorcycles

- creation of a public awareness of the (air) pollution problem

7. Ongoing Co-Operation in the ASEAN Countries

The group of the ASEAN countries has already started a co-operation at a workshop held in Singapore in Dec. 1989 with the title "Workshop on Control of Vehicular Exhaust Emission in the ASEAN Region". The following conclusions from this meeting were drawn:

- the importance of the establishment of data bases in the respective countries and later of a regional data base was recognized

- the adoption of common ASEAN standards for the emission control was favoured
- a lack of expertise and appropriate testing laboratories was recognized
- the formation of a sub-committee under the aegis of the ASEAN Experts Group on the Environment (AEGE) was recommended.

ANNEX 4

MOTOR VEHICLE EMISSION CONTROL IN KOREA

Kang-Rae Cho

Director
Motor Vehicle Emission Research Laboratory
National Institute of Environmental Research
Republic of Korea

ABSTRACT

Despite relatively small number of motor vehicles in Korea compared to those of other developed countries, air pollution caused by motor vehicle exhaust emissions becomes a serious problem due mainly to such factors as high mileage, high percentage of diesel vehicles, and high concentration of motor vehicles in such a metropolitan area as Seoul.

By the implementation of standardized control over vehicle exhaust emission since 1980, automobile industries in Korea have manufactured gasoline vehicles that can meet strict exhaust emission standards of Japan and the United States of America. In addition, by the introduction of such programs as type approval for prototype motor vehicles, performance warranty, and recall during useful life of vehicles, and inspection and maintenance for in-use vehicles, Korean government tries to decrease exhaust emissions by motor vehicles.

Due to high peroentage of diesel vehicles and high levels of particulate matters and nitrous oxides in their emissions, emphases are placed upon the development of emission control technologies for diesel vehicles and the amendment of permissible emission standards in current emission control program of Korea.

1. INTRODUCTION

Air pollution caused by motor vehicle exhaust emissions is a serious problem that many cities in the world are confronting with. In Japan, the practice of major motor vehicle emission control programs from the 1970s resulted in the improvement of air quality to an amenity level in many cities including Tokyo. However, due to continued increase of motor vehicles in number, ambient concentrations of nitrous oxides, the precursors of photochemical smog, are increasing again in recent years. It is my understanding that the government of Japan is taking measures to cope with this problem.

In my country, the government has implemented two major motor vehicle emission control programs, *i.e.*, the production of low emission vehicles equipped with three way Catalytic Converter for vehicles using gasoline and for passenger cars using LPG (Liquified Petroleum Gas) and the regulation of exhaust emissions of diesel vehicles. Despite these programs, rapid increase in the number of motor vehicles deteriorates the quality of ambient air in

major cities of Korea.

This paper was prepared to briefly present the current status of control technologies in decreasing air pollution caused by motor vehicle exhaust emissions in Korea.

2. MOTOR VEHICLE EMISSIONS AND AIR POLLUTION

2.1. Contribution Rates and the Current Status of Air Pollution by Motor Vehicles

Although air pollutants emitted from motor vehicles vary depending on the type of automobiles and fuels used, they are carbon monoxide (CO), nitrous oxides (NO_x), and unburned hydrocarbon (HC). Diesel vehicles emit such particulate matter as smoke in addition to these.

In 1987, contribution rates of air pollutants by motor vehicles were 25% of CO, 85% of NO_x, 57% of HC, 8% of SO_2, and 8% of particles. Among them, those of CO, NO_x, and HC were quite high. The reason for lower contribution rate of CO by motor vehicles than those of foreign countries was attributed to the fact that major portions of CO are emitted from domestic burning of briquettes in Korea.

Although contribution rate of particles by motor vehicles was quite low (8% of the total), the rate of particles including suspended particulates would have been far higher than that. It is because they, as very fine respiratory particles, remain suspended in the air for a long time without being washed out or deposited. Diesel particles raise a special health concern because they are very small in size (averaging about 0.2 microns) and up to 10,000 chemicals may be absorbed on the surface of them. Diesel particles also are very high light absorbers and scatterers and therefore have the potential to be especially harmful to visibility.

Air pollution levels in major cities and ambient air quality standards of Korea in 1987 are shown in Table 1. Among them, the level of total suspended particulates (TSP) exceeds ambient air quality standard in most of the cities. Although annual averages of the levels of the other pollutants did not exceed the standards, 24-hour averages of them frequently exceeded the standards. Especially, particular measures should be taken on high concentrations of ambient oxidants during the summer, which frequently exceeded the standard of 24-hour averages.

2.2. Emission Rates of Air Pollutants by Motor Vehicles

The number of motor vehicles increased rapidly from 530,000 in 1980, to 2,040,000 in 1988, and to 2,500,000 in 1989, in accordance with rapid economic development of Korea.

The number of vehicles, daily driving distance, fuel economy, daily vehicle kilometers traveled (VKT), and daily fuel consumption by the type of vehicles are shown in Table 2. The amounts and relative ratios (%) of exhaust emissions by the type of vehicles calculated using the data on mileage and

Table 1. Air Pollution Levels at Major Cities of Korea in 1987

(unit : ppm)

Cities	NO_2	O_3	CO	HC	TSP
Seoul	0.033	0.010	3.2	2.7	175 ug /m³
Inchun	0.034	0.010	5.0	2.3	163 ug/m³
Pusan	0.024	0.013	2.1	2.9	197 ug/m³
Daegu	0.027	0.011	2.3	2.5	146 ug/m³
Ulsan	0.031	0.013	1.8	-	190 ug/m³
Ambient Air Quality Standard	0.05	0.02	8	3	150 ug/m³

emission factor of air pollutants in 1988 are shown in Table 3. While the majority of taxi use LPG and passenger cars and motor cycles use gasoline, the majority of the other automobiles use diesel fuel.

In 1988, the ratios in the number of vehicles using gasoline (excluding motorcycles), diesel fuel, and LPG as fuel were 48%, 46%, and 6%, respectively. By the amount of fuel consumed, the ratios were 21%, 64%, and 15%, respectively. By driving distance, the vehicles using gasoline, diesel fuel, and LPG occupied 33%, 45, and 22% of total vehicle kilometers traveled (VKT), respectively. This shows the clear evidence for higher contribution of diesel vehicles than the other types of vehicles to air pollution in Korea.

Mileage and emission rates of air pollutants by the type of vehicles are shown in Figure 1. While gasoline vehicles, LPG taxies, and motorcycles are mainly responsible for CO and HC, buses and trucks using diesel fuel are mainly responsible for NO_x. SO_x and TSP are mainly emitted from diesel vehicles. This indicates that adequate measures of exhaust emissions should be taken for gasoline and LPG vehicles to control CO and HC and for diesel vehicles to control NO_x and TSP in Korea.

As the concentration of suspended particulates exceed ambient air quality standard on annual basis and the concentrations of oxidants frequently exceed the standards of 24-hour averages, measures should be taken to decrease particulate matters (the sources of suspended particulates) and NO_x and HC (the precursors of oxidants) in Korea.

.e 2. Current Status of the Number of Vehicles, Vehicle Kilometers Traveled and Fuel Consumption by the Type of Vehicles (1988)

Type of Vehicle		No. of Vehicle		Driving Distance km/day	Fuel Economy km/l	V K T (x10³ veh. km/day)		Fuel Consumption kl/day	
		Seoul	Korea			Seoul	Korea	Seoul	Korea
Passenger Car		497339	986133	62	10.8	30835	61140	2855	5661
Taxi		49670	131866	310	9.91	15398	40878	1554	4125
Jeep		3734	10894	64	7.5	239	697	32	93
Bus	City	8280	22922	338	2.84	2799	7748	986	2728
	Inter city	-	10412	344	3.33	-	3582	-	1076
	Rental & Sightseeing	1689	5620	191	3.45	323	1073	94	311
	Express	-	1923	592	2.74	-	1138	-	415
	Small	61025	172137	64	9.90	3906	11017	395	1113
	Others	8483	46580	40	3.19	339	1683	106	584
	Subtotal	79477	259600	-	-	7367	26421	1581	6227
ırck	1ton or less	97320	399815	75	10.72	7299	29986	681	2797
	1.1ton to 3ton	32305	125308	77	6.31	2487	9649	394	1529
	3.1ton to 7.9ton	8944	53289	105	3.05	939	5595	308	1834
	8ton or more	13879	79437	162	2.20	2248	12869	1022	5850
	subtotal	152454	657847	-	-	12973	58099	2405	12010
Motor cycle		140472	1066841	13.7	38.25	1924	14616	50	382
Total*		778940	2035448	-	-	66812	187235	8427	28116
Grand Total**		919412	3102289	-	-	68736	201851	8477	28498

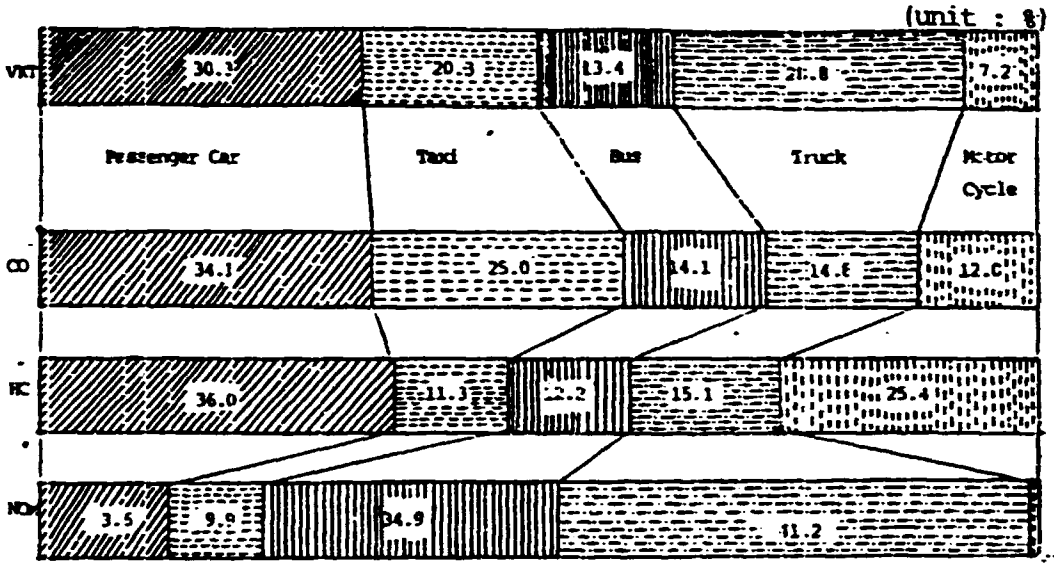
* Motor cycle excluded

** Motor cycle included

Table 3. Exhaust Emissions by the type of Vehicles (1988)

Area	Vehicle Type	Air Pollutant Emission									
		CO		HC		NOx		SO_2		P.M	
		ton/ year	%	ton/ year	%	ton/ year	%	ton/ year	%	ton/ year	%
Korea	Taxi	206039	25.0	13267	11.3	292595	9.9			2059	5.4
	Passenger Car	281016	34.1	42193	36.0	40727	13.6	1049	2.7	3771	10.0
	Bus	116001	14.1	14248	12.2	104607	34.9	14372	37.0	13911	36.8
	Truck	121477	14.8	17659	15.1	23410	41.2	23363	60.1	17438	46.1
	Motor Cycle	98908	12.0	29715	25.4	1174	0.4	64	0.2	619	1.6
	Total	823441	100	117082	100	299213	100	38848	100	37798	100
Seoul	Taxi	77611	27.7	4998	13.6	11148	13.6	-	-	776	8.2
	Passenger Car	141725	50.0	21279	57.7	20540	25.1	529	6.0	1902	20.2
	Bus	26672	9.6	3362	9.1	25104	30.7	3561	40.5	3296	35.0
	Truck	22374	8.0	3298	9.0	24746	30.4	4694	53.4	3370	35.7
	Motor Cycle	13120	4.7	3912	10.6	154	0.2	8	0.1	81	0.9
	Total	281402	100	36849	100	81692	100	8792	100	9425	100

Figue 1. Mileage and Emission Rates of Air POllutants by the Type of Vehicle



3. MOTOR VEHICLE EMISSION CONTROL STRATEGIES

3.1. Emission Control Strategies for New Vehicles

Since the establishment of Environment Administration of Korea in 1980, emission standards for new vehicles are set as shown in Table 4 and strict standardized control over exhaust emissions was implemented to gasoline and LPG vehicles similarly to U.S.A. and Japan. Despite the setting up of the emission standards for gasoline fueled light-duty trucks and heavy-duty vehicles, that are not implemented because the vehicles are not manufactured by the industries of Korea.

As is shown in Table 4, 10 mode test procedures were adopted for passenger cars and light-duty trucks from 1980 to June, 1987, and CVS-75 test procedures from July, 1987, which were similar procedures to those of U.S.A. With the adoption of CVS-75 test procedures, control over evaporative hydrocarbons was initiated from 1987.

Useful life of a new motor vehicle is set to 80,000km or 5 years in the standard. By introducing performance warranty or recall programs from 1990, the performance of exhaust control device of a motor vehicle will be guaranteed for its useful life.

The quality of parts related to exhaust control systems are enhanced through type approval tests for prototype cars and audit tests and surveillance tests for mass production cars. These standards are applied to

Table 4. Emission Standard for New Vehicles

Type of Vehicle		Model year	Test procedure	Pollutants					
				CO	NOx	HC			Smoke
						Exhaust	Evaporation	Crankcase	
Gasoline and LPG Cars	Passenger Car	1980	10Mode	26g/km	3.0g/km	3.8g/km	-	0g/cycle	-
		1984.7	10Mode	18	2.5	2.8	-	0	
		As of July 1987	CVS-75	2.11	0.62	0.25	2.0 g/test	0	
	Light-Duty truck	1980	10Mode	26	3.0	3.8	-	0	
		1984.7	10Mode	18	2.5	2.8	-	0	
		As of July 1987	CVS-75	6.21	1.43	0.50	2.0 g/test	0	
	Heavy-Duty vehicle	1980	6 Mode	1.6%	2200ppm	520ppm	-	0	
		1984.7	6 Mode	1.6%	2200ppm	500ppm	-	0	
		As of July 1987	Transient Mode	15.5 g/b.hp-hr	10.7 g/b.hp-hr	1.3 g/b.hp-hr	4.0 g/test	0	
Diesel Vehicle		1980	Full load	-	-	-	-	-	50 %
		1984.7	6 Mode	980ppm	1000/590 ppm	670ppm	-	-	50 %
		1988 & later	6 Mode	980ppm	850/450 ppm	670ppm	-	-	50 %

imported cars as well as domestic cars.

As was mentioned previously, diesel vehicles occupy 46% of total motor vehicles in number and their contribution rates for air pollutants, especially by NO_x and particulate matters, are very high. Consequently, diesel exhaust emission standards will be amended as is shown in Table 5. To reduce exhaust emissions of them by diesel vehicles, the following control methods are under consideration; the change of current fuel to LPG for light-duty diesel vehicles and the use of such alternative fuel as alcohol. This amendment of diesel exhaust emission standard will become effective about in June, 1990.

3.2. Inspection and Maintenance Program

To control exhaust emissions for in-use vehicles, permissible emission standards, set as is shown in Table 6, are applied through periodic and roadside inspections.

As is shown in Table 7, safety performance and exhaust emissions for in-use motor vehicles are tested once in every 6 month to 2 years depending on the type of motor vehicles in periodic inspection.

In addition to periodic inspection, to make sure of the post inspection and maintenances, random roadside inspections are carried out either by full-time inspection teams belonging to branch offices under the Ministry of Environment or by temporarily organized cooperative inspection teams between city or provincial administrative and prosecuting authorities. In inspection, vehicles that exceed the standards are subject to maintenance order, with or

Table 6. Emission Standards for In-use Cars

Type of Vehicle \ Pollutants		CO	HC	Smoke	Remark
Gasoline & LPG Cars	1979- 1984.6	4.5%	-	- -	
	1984.7-1987.7	4.5%	1200ppm	- -	
	As of July 1987.8	4.5%	1200ppm	-	Old model car
		1.2%	220ppm	-	New model gasoline car
		1.2%	400ppm	-	New model LPG car
Diesel Cars	1979- Present	-	-	50%	

* Test Method ; CO/HC : Idling (NDIR)

Smoke : Free Acceleration (opacity)

Table 7. Types of Motor Vehicle Subjected to Inspection and the Interval of Inspection

Classification		Period of Validity of Motor Vehicle Inspection Certificate
Private Passenger Cars	Used vehicles less than 10 Years	2 years
	Used vehicles not less than 10 years	1 years
Commercial Passenger Cars		1 years
Light Duty Truck	Used vehicles less than 10 years	1 years
	Used Vehicles not less than 10 years	6 Months
Other Motor Vehicle	Used Vehicles less than 2 years	1 years
	Used Vehicles not less than 2 years	6 Months

Table 8. Penalty Provisions of Roadside Inspection Program

Pollutant	Standard	Extent of Exceedance	Penalty Provision
Smoke	50% or less	51-60%	Maintenance Order
		61% and greater	Maintenance Order and Fine
Carbon Monoxide	4.5% or less	4.6-9.0%	Maintenance Order
		9.1% and greater	Maintenance Order and Fine
Hydrocarbons	1200 ppm or less	greater than 1200 ppm	Maintenance Order

without accusation. The driver of the accused vehicle is fined to the maximum of ₩1,000,000 for it. In case of a company owned vehicle, both the owner and the driver of the vehicle are fined to the maximum of ₩2,000,000 in total.

In addition to these inspections, drivers and mechanics are fully informed of the effects of exhaust emissions to air pollution and adverse effects of air pollution to human health and they are advised to make thorough jobs of the inspection and maintenance of vehicles.

To reduce the amount of smoke emitted from city buses with long daily driving distance, the application of smoke-reducing device by LPG fumigation, smoke filtering, and fuel additives are currently evaluated. As for the application of LPG fumigation devices, pilot tests are being carried out for 10 city buses in Korea.

3.3. Fuel Quality

Three types of gasoline are currently available in Korea: leaded regular gasoline (octane number 86RON/79MON), unleaded premium gasoline (octane number 95RON/87RON), and unleaded regular gasoline (octane number 91RON/83MON). Lead contents of leaded gasoline and unleaded gasoline are currently limited to 0.32g/l (TEL 0.3ml/l) and 0.013g/l, respectively. Although diesel fuel with cetane number not lower than 45 and sulfur content (wt %) not higher than 0.4 is currently supplied, the standard of sulfur content in diesel fuel will be lowered to not higher than 0.2 wt %.

Recently, with increasing supply of automobiles with fuel injection systems and the needs for the addition of detergents in gasoline for them, oil refinery companies are mixing these additives to gasoline. Consequently, the Ministry of Environment makes it a compulsory procedure to register fuel additives to it in Korea.

4. CONCLUSIONS

Despite strict regulation, maintenance, and inspection programs in Korea, the quality of ambient air in major cities is not drastically improved.

To propel the policy actively in decreasing the level of air pollution caused by motor vehicle exhaust emissions in Korea, emphases are placed upon such control programs as steady application of strict exhaust emission standards and the development of emission control technologies for diesel vehicles and the improvement of fuel for motor vehicles.

ANNEX 5

VEHICLE EMISSION POLLUTANT CONTROL AND TECHNICAL MEASURES IN CHINA

Ma Hua, Li Guoxiang, Shu Mingxin

The Highway Research Institute, the Ministry of Communications

The People's Republic of China

Agust 1990

VEHICLE EMISSION POLLUTANT CONTROL AND TECHNICAL MEASURES IN CHINA

1. Current Status of Vehicle Emission Pollutant Control in China

1.1. Organizations Concerned with Motor Vehicle Emission Pollution and Their Functions and Competences

'People's Republic of China Evironment Protection Act' was promulgated in September 1979, 'Ambient Air Quality Standard' in September, 1983 and 'Ambient Air Protection Act' in 1987. To enforce these statutes the measurement of vehicle emission pollutants is listed as one of the major items in a mandatory vehicle inspection system supervised by the road safety department, the Ministry of Public Security. In the past few years great considerations and necessary investments were made in environment protection. Correspondent administrational systems have been established in four organizations concerned with motor vehicle emission pollution, i.e. the environment protection, transport, and automobile industry. The functions of and the relationships between these organizations are shown in figure 1.

1). The National Environment Protection Bureau (NEPB)

The National Environment Protection Bureau is directly under the State Council Environment Protection Commission and is responsible for the promulgation of standards concerned with vehicle emission pollution in accordance with environment protection laws. The Chinese Research Accadamy of Environment Science (CRAES) is a research institute under the NEPB. The standards are usually drafted by the institute together with the Highway Research Institute of the Munistry of Communications (MOC) and the research institute of the China National Automobile Industry Corporation (CNAIC) authorized by NEPB.

2). The China National Automobile Industry Corporation

The research institutes under the CNAIC are envolved in the research work concerned with the improvement of vehicle emissions, concentrating on those of new vehicles, including vehicle standards for industrial use, and are among those authorized by NEPB to draft the standards about vehicle emission.

3). The Ministry of Communications

The Highway Research Institute under the Ministry of Communications is envolved in the research work concerned with vehicle emission control and technical measures, with emphasis on those of in-use vehicles, including methods, inspection procedures, specifications, instruments and equipments. It is also one of those authorized by NEPB to draft the standards about vehicle emission.

4). The Ministry of Public Security (MOPS)

There is a traffic safety enforcement system in China supervised by the Ministry of Public Security. The mandatory vehicle inspection system is its principle component. Every purchased vehicle has to be checked before registration to see if the vehicle is produced by licenced manufacturer and saled by licenced saler, and inspected according to the vehicle safety and environment protection standards. Parking space is also a prerequisite of the registration. Every in-use vehicle has to go through an annual inspection in a pointed workshop licenced by the traffic safety department

of the local public security bureau. If a vehicle fails to pass the inspection it should be adjusted or repaired before the next inspection until it gets the qualified certification. The inspection items include: 1. appearance; 2. techometer and odometer; 3. performance of side skid; 4. brake performance; 5. emission pollutant; 6. horn and head light; 7. chassis. The emission pollutants of CO and HC under idle speed mode and the smoke from diesel engine vehicle under free acceleration mode are measured in the inspection.

New vehicle is inspected according to the automobile product quality assessment method' (industrial standard). In-use vehicle is inspected according to the in-use vehicle safety standard and emission satndard for pollutants from motor and the measurement method.

Traffic police of the local public security bureau is responsible for random roadside vehicle test to pick up unqualified vehicles.

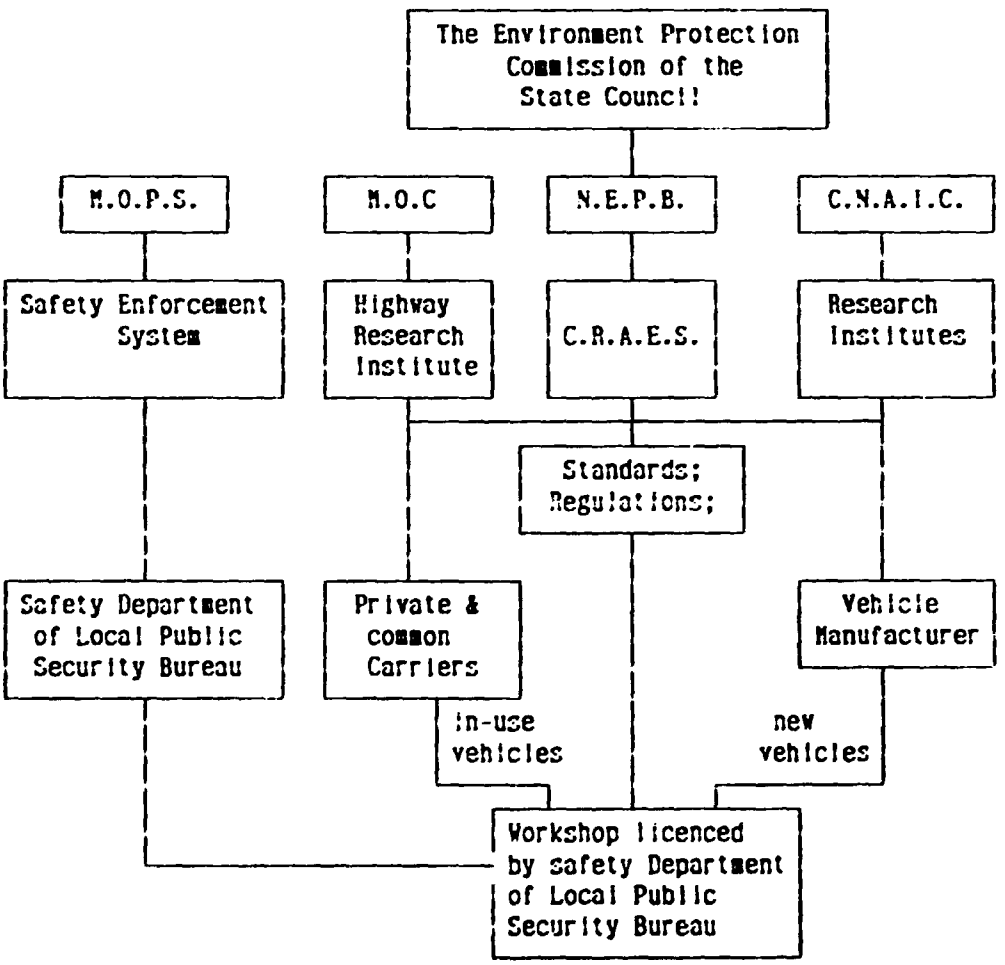


Fig. 1 Organizations concerned with emission control

1.2. Vehicle Population, Fuels, and Vehicle Emission Pollutant Contribution to Total Manmade Pollution

Vehicle population in China is relatively low in comparison with that in developed countries. However it is increasing rapidly with an average growth rate of 15.5%, from 2,604,096 in 1984 to 4,643,839 in 1988. Most of the vehicles, about 73% of the total, are made in China. Besides motor vehicles, there are quite a lot of farm-use tractors running on road for transport purpose. The breakdown of vehicle population is listed in table 1.

Table 1. The breakdown of vehicle population in 1988

Classification of Vehicles	Number	Average Seat or Tonnage	Diesel engine powered truck
Heavy duty truck	2,280,456	5 tons	
Light truck	808,462	1.4 tons	
Bus	299,376	41 seats	
Minibus & car	1,004,397	8 seats	
Special truck	89,563	6.4 tons	
Others	161,585		
Total	4,643,839		741,873
Motorcycle	3,023,941		
Big & medium Tractor	1,403,396		
Small tractor	2,512,670		

Most vehicles, more than 80% of the total, are powered by gasoline. Gasoline fuel for automobile-use are leaded, and can be classified into three grades, i.e. 90#, 93#, 97# (named according to the octane number), with the lead content no less than 0.35 - 0.45 g/l, by the latest National Standard. At the moment most gasoline available at the market is mixed gasoline with the octane number equivalent to 70# and 85# at an average price of $ 0.35 /l. Several refineries in China are capable of producing unleaded gasoline by national standard. But it is still not available in the market. Now a national standard for unleaded gasoline is going to be enacted to increase the supply of unleaded gasoline and to improve vehicle emission. Major home-made gasoline fuels and the indicators are shown in table 2.

Table 2. Major gasoline fuel and the indicators

Indicators	Leaded gasoline			Unleaded gasoline	
R O N	90	93	97	90	95
RON + MON / 2	85	89	92	85	90
Lead: g / l	0.35	0.45	0.45	0.013	0.013

About 20% of the vehicles are powered by diesel engine (excluding farm use tractors). Light diesel fuel is classified into three grades by national standard. Each grade can be sub-divided into six types by condensate point. Light diesel fuel and the major indicators are listed in table 3. Few gasoline and diesel fuel are imported from abroad.

Table 3, Light diesel fuel and the indicators

Indicators	Grades	Light diesel					
		10#	0#	-10#	-20#	-35#	-50#
Octane number > =	High quality	45					
	First class	45					
	Qualified	45					
Sulphur % > =	High quality	0.2					
	First class	0.5					
	Qualified	1.0					
Condensate C > =	High quality	10	0	-10	-20	-35	-50
	First class						
	Qualified						

Motor vehicle pollutant contribution to total manmade pollution in the country as a whole is still not available at the moment. However some area surveys and multi-mode tests have been conducted by the Highway Research Institute to look into the contribution to the total manmade pollution in particular area and the contribution of different types of vehicles under particular multi-mode conditions. More research work on this subject is underway in the institute. Table 4 and table 5 show some of the findings in the survey of Beijing urban area (within the third ring road) and the multi-mode test in 1989.

Table 4, Motor Vehicle Emission Pollutant Contribution to Total Manmade Pollution in Beijing Urban Area (within the third ring road)

Pollutant	Winter time	Summer time	Annual average
C O	26.1 %	58.5 %	39.1 %
N O$_x$	38.0 %	55.3 %	46.2 %
H C	62.7 %	85.7 %	74.8 %

Table 5, Emission Pollutant of Different Vehicles under Different Multi-mode Conditions

Type of vehicle	test mode	CO (g/km)	HC (g/km)	NO (g/km)
Motorcycle	--	9.89	6.38	--
Passenger car	15	35.27	3.15	0.90
Minibus	15	28.15	2.95	2.10
Light truck	15	59.33	7.72	4.25
Heavy truck	18	57.17*	15.17*	11.76*
Diesel truck	13	3.51*	1.18*	13.06*

* g/kw.h

Since the establishment of vehicle emission pollutants test system in the capital Beijing, where there are 17 licenced inspection workshops with 30 inspection lines, the proportion of the vehicles which are up to the standards have been increased substantially from 50% in 1986 to 95% at present. However the situation in different provinces and cities are quite different from place to place.

2. Works Conducted on Vehicle Emission Pollutant Control

Purification of the emission from the vehicles in China started in 1974, when the project that 'The fault diagosis instruments for motor vehicles' was conducted in the Highway Research Institute, including carbon monoxide analyzer and the sampling probe. Vehicle emission pollutants were measured under different conditions, such as idle speed, different ignition advanced angles, different load, full load, on the conditions of different water and oil temperatures, etc. to find out the relationships between the emission pollutant and the different conditions on engine bench test. Computerized vehicle inspection line, with all the equipments made in China, has been developed by the Highway Research Institute together with the Qinghua University, and put into practical use in workshops in Beijing and some other cities for two years.

Meanwhile the research institute under the CNAIC did some improvements on the passenger car 'Red Flag' by crankcase sealing, adjusting carbuleter, using ignition retarding device, twice injection system and using catalyst converter etc. which made the emission pollutants down substantially from original 77.3 g/km to 0.60 g/km for CO; 13.5 g/km to 0.47 g/km for HC; and 3.24 g/km to 0.214 g/km for NO_x.

Based on the experiences of the emission pollutant control in other countries, study of vehicle emission mechanism and development of exhaust purification equipments and test instruments were conducted in the research institute from automobile industry and the Highway Research Institute of the Ministry of Communications as well as in the universities. Carbon monoxide analyzer was developed and used for vehicle inspection. And a proprietary low cost rare earth catalyst converter has been developed by the Beijing Industry University and used for some vehicles.

In 1984 the research institutes under the CNAIC began some research works on the idle speed adjustment, early stage purification inside engine, enforced ventilation for crankcase, carbuleter sealing etc. for several types of vehicles, such as Liberation CA-15, Beijing 212, Shanghai SH 760, Actual driving mode survey in Beijing area and the measurement of vehicle emission pollutants were conducted. Besides to control the emission of HC, crankcase enforced ventilation and anti-evaporation device were developed, on the base of which the standard of 'Motor vehicle crankcase emissions measurement method and limit' was worked out.

During the same period of time, six standards for test and control of both gasoline and diesel engine vehicles emission pollutants were drafted by the Highway Research Institute and other research institutes from the CNAIC, and approved by the Ministry of Urban and Rural Construction and Environment Protection. Before April first 1984, the effective date of the standards, many training courses were held for drivers, maintenance mechanists, vehicle inspection personnels, motor carrier managers etc. to disseminate the knowlage of vehicle emission pollutant control and to guarantee the enforcement of the six standards.

After the enactment of the six standards strict control was first made along the production line of the major automobile works, such as that of CA10 Liberation truck, EQ140 Dongfeng truck, to make sure newly produced vehicles conforming to the standards. Similar measures were taken later by all the vehicle manufacturers. Great amount of comparisons, analysis and research work have been done between those of the similar vehicles made at home and imported from aroad. It is found out that the difference is still great. As such more research work is going on to improve the vehicle emission control. Afterwards more work has been done since 1985, with more standards. The present enacted standards are as follows.

GB5185-85 Terminology and definition of vehicle pollutants
GB5466-85 Measurement method for emission pollutants from motorcycle at idle speed
GB3842-83 Emission standard for pollutants at idle speed from road vehicle with petrol engine
GB3843-83 Emission standard for smoke at free acceleration from road vehicle with diesel engine
GB3844-83 Emission standard for smoke at full load from automotive diesel engine
GB3845-83 Measurement method for pollutants at idle speed from road vehicle with petrol engine
GB3846-83 Measurement method for smoke at free acceleration from road vehicle with diesel engine
GB3847-83 Measurement method for smoke at full load from automotive diesel engine
GB11340-89 Motor vehicle crankcase emissions measurement method and limit
GB11641-89 Emission standard for exhaust pollution from light vehicle
GB11642-89 Measurement method for exhaust pollution from light vehicle

Overall enforcement of national standard for vehicle emission has been carried out since April first 1984, to start with new vehicles in the manufacturers' production line. In July 1986 the Ministry of Communicatios

issued a notice to strengthen the environment protection work, after which vehicle inspection workshops were set up in provinces and big and medium cities, and the existed vehicle maintenance system was reformed with new regulations established. Meanwhile the mandatory vehicle inspection system for all the vehicles was implemented by the safety department of the MPS. Therefore all the vehicles, including new, in-use and imported, are under control by corresponding units. Besides during the special occasions, such as the 11th Asian Games, more random roadside vehicle test by traffic police would be enforced.

3. Policy and Technical Measures for Vehicle Emission Pollutant Control

The target of vehicle emission pollutant control is to upgrade the ambient air quality to the standard. Taking into consideration of the specific conditions in China, it is necessary to adopt different standard limits for newly produced vehicle, in-use vehicle, imported and home-made vehicle. And different measures will also be taken to improve the emission.

Emission purification by improving engine performance, fuel system and ignition system, known as the ante-treatment, should be taken as the major resorts for vehicle emission control. It is the most economic and feasible way get the control. Not only can the emission of CO and HC be reduced but also the fuel consumption. The post-treatment device like the catalyst converter will only be used in exported vehicles and few in-use vehicles.

Control of emission pollutants at idle speed is taken as the major short term program and by home-made standard. All the vehicles, including new, in-use and repaired vehicles from maintenance workshop should conform to the standard. Multi-mode standard for emission measurement method and limit enacted in 1990 is limited for trial implementation in auto manufacturers. To work out the standard for fuel evapulation pollutant limit as soon as possible.

CO and HC should be taken as the major pollutants to be controlled from gasoline motor vehicle in short term program, with NO_x ignored for the time being, which conforms to the characteristics of the vehicles currently used and produced in China and the present emission standards.

Smoke control should be taken as the major measure for diesel engine vehicle. The measurement method and limit of smoke from diesel engine vehicle should be in accordance with emission standard for smoke at free acceleration and full load mode conditions.

After the crankcase emission standard is enacted, proper venting device have to be installed in all the newly produced vehicles first. A limited transision time will be set for currently home-made vehicles to upgrade to the standard. Up to the standard will be the prerequisite before any new type of vehicle being put into production.

The multi-mode emission standard will be gradually enacted and make the emission of CO and HC down substantially with limit requirement of NO_x for newly produced vehicles during the period of 1990 to 1995.

More research work will be needed to control emission pollutant. At the

moment a project of quantitative analysis of vehicle emission pollutant is under way in the Highway Research Institute.

A lot of work has been done on the study of test method for vehicle emission. Specifications suitable for home-made vehicles have been worked out and will be implemented throughout the country.

As for the vehicle emission test equipment, portable analyzers for CO and HC have been developed in China. Systematic analysis equipment has to be imported at present stage.

A project of the assessment of emission purification device is under way in the Highway Research Institute, and several devices will be selected and recommended for practical use.

Several conferences concerned with vehicle emission control were held by NEPB, MOC and CNAIC to discuss the technical policies and measures in the past few years. Similar meetings will be held from time to time in the future.

4. Views on Regional Cooperation

The expert group meeting sponsored by UNIDO is a good beginning for the regional cooperation on vehicle emission pollutant control, which we are very interested in.

An efficient and cooperative structure for vehicle emission control and a well organized mandatory vehicle inspection system, which have been existed in China, are the indispensable basis for the future development as well as for the regional cooperation project.

Common measurement standards for vehicle emission pollutants, common standards for certification and common acceptance of certification tests are important conditions for regional cooperation, and should be focused on first. Information and experiences exchanges, transform of technology, practical policy recommendations and implementation of a regional network for coordination and cooperation are also essential for all of us. These are necessary ways to learn from each other's strong points, make up our deficiencies, to avoid unnecessary duplicated work and to promote the friendship.

We are willing to cooperate with international environment protection organizations to contribute to the improvement of our environment. During the visit of Mr. Carstensen, consultent of UNIDO, both Mr. Chang, director of the Science and Technology Bureau of the MOC, and Mr. Piao, deputy director of the Highway Research Institute, expressed their willingness of being the host of the regional network. We already have got some advanced equipments and test facilities, and have enough space and manpower to contribute to the regional cooperation project. We sincerely hope that the regional cooperation will be a success with the support by UNIDO.

COUNTRY REPORT OF SINGAPORE

Prepared by: Mr Pang Mun Hung
Head, Mechanical Inspection Division
Registry of Vehicles
Date : Aug 90

CONTENTS

1 Introduction

Environmental issues relating to vehicular pollution are gaining in importance because of health considerations. The United States have taken the lead by setting very stringent vehicle exhaust emission standards to limit the amount of harmful pollutants that can be emitted into the atmosphere. In Singapore, efforts have been made to maintain the quality of air in our environment. Particular attention has been paid to vehicular pollution to ensure that vehicles do not become a major source of pollution.

2 Current Status

2.1 Motor Vehicle Population

Singapore has a vehicle population of more than half a million vehicles; almost 50% are cars, 23% are motor cycles while another 22% are goods vehicles and buses (see Table 1).

2.2 Motor Vehicle Growth Rate

The growth rate of the motor vehicle population was 5.8% in 1989. The growth rates for the years 1981 to 1989 are shown in Table 2. The rate slowed down and became negative between 1985 to 1987. However the rate picked up again from 1988.

2.3 Motor Vehicles by type of Fuel used

There are basically 2 types of motor vehicles in use in Singapore, viz. petrol (or gasoline) driven and diesel driven vehicles. The numbers of vehicles by different categories of vehicles are shown in Table 3.

2.4 Motor Vehicle Imports

There is no vehicle manufacturing industry in Singapore, except for some manufacturing of trailer chassis and building of bus bodies. Therefore most of the vehicles have to be imported from overseas. There is a relatively wide range of makes and models of vehicles which are largely imported from Europe and Japan (see Table 4).

3 State of the Environment

The main atmospheric pollutants for which motor vehicles are responsible are hydrocarbons, carbon monoxide, nitrogen oxides, and lead from petrol-engined vehicles and smoke (ie. particulate matter) from diesel-engined vehicles.

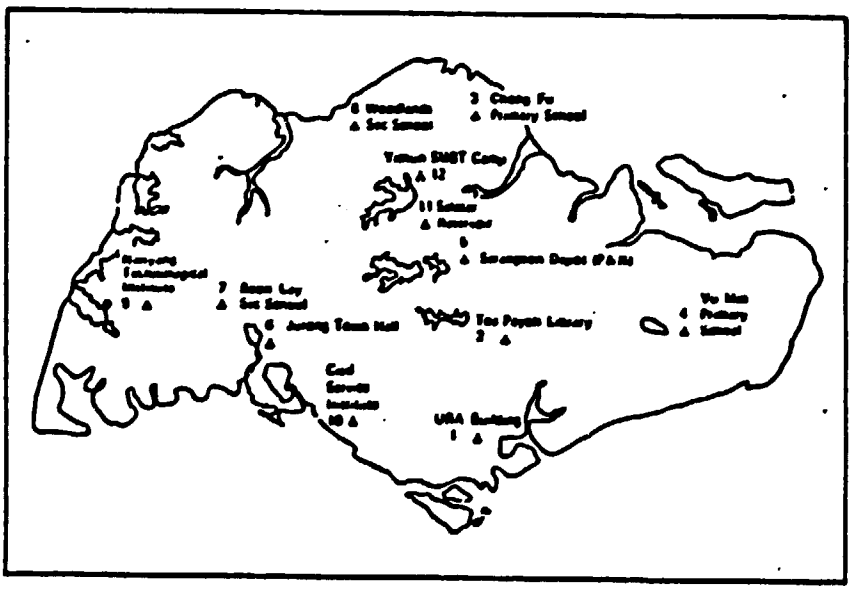
3.1 Ambient Air Quality

The long term goals of the World Health Organisation (WHO) and the primary air quality standards of the United States Environmental Protection Agency (USEPA) are used as guidelines to assess ambient air quality. These guidelines are summarised in Appendix 1.

The ambient air quality is monitored by a network of 12 monitoring stations located in urban, industrial and rural areas (shown in Chart 1). Table 5 shows the types of air pollutants monitored at these stations.

The ambient air quality for 1989 remained good. Levels of pollutants in the air were low and within the guidelines established by WHO and USEPA.

CHART 1 LOCATION OF MONITORING STATIONS (1989)



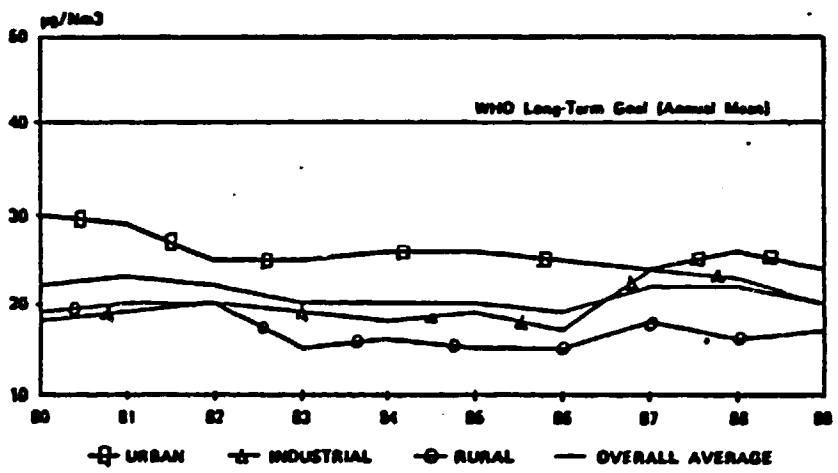
3.2 Particulate Matter

Particulate matter in the atmosphere can be classified as dust, smoke and suspended particles. Dust which comprises larger and heavier particles settles quickly. Its effect is localised. The smaller and lighter particles such as smoke and suspended particles could remain in the atmosphere for a long time and affect larger areas.

The main sources of particulate matter are fuel burning equipment such as boilers and furnaces, motor vehicles and construction activities.

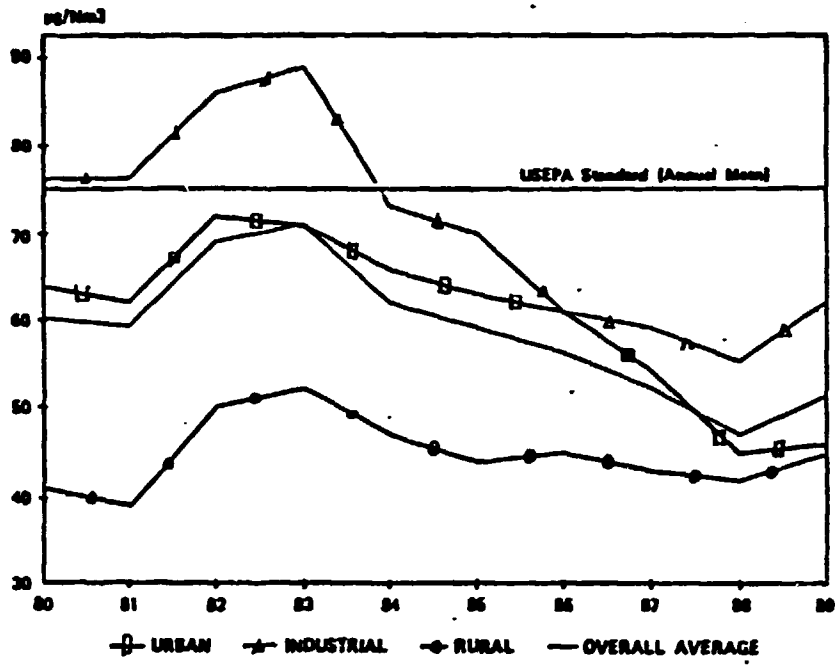
The 1989 smoke levels are summarised in Chart 2. The 1989 smoke levels have remained at about the same levels as in 1988. The overall average smoke level was 20 ug/Nm3 which is well within the WHO long term goal.

CHART 2 ANNUAL AVERAGE LEVELS OF SMOKE



The 1989 levels of suspended particles were slightly higher than the 1988 levels. The overall level of suspended particles was 51 ug/m3 which is within the USEPA standards. A summary of the measurement results of suspended particles in 1989 is given in Chart 3.

CHART 3 ANNUAL AVERAGE LEVELS OF TOTAL SUSPENDED PARTICLES



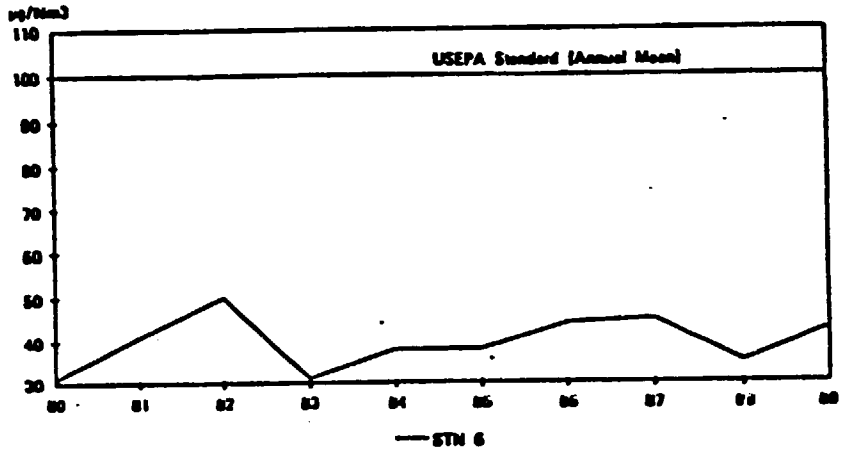
3.3 Oxides of Nitrogen

Nitric Oxide and nitrogen dioxide contribute to the formation of photochemical smog. Photochemical smog reduces visibility and increases the frequency of respiratory diseases.

Major sources of these pollutants include emissions from vehicle exhaust and fuel burning equipment.

The average level of nitrogen dioxide is within the USEPA standard shown in Chart 4.

CHART 4 ANNUAL AVERAGE LEVELS OF TOTAL OXIDES OF NITROGEN AS NO_2



3.4 Carbon Monoxide

Inhaled carbon monoxide deprives body tissues of necessary oxygen. In excessive quantities it can cause oxygen starvation and ultimately death.

The main source of carbon monoxide emission is vehicular emission. Incomplete combustion of fuels such as fuel oil and diesel also causes carbon monoxide to be emitted.

The 1989 levels of carbon monoxide at roadsides were low and are shown in Table 6. These results were well within the WHO and USEPA standards of 9 ppm.

3.5 Lead

Lead compounds are added into petrol as antiknock agents. Vehicular emissions therefore contain lead particulates. Lead behaves as a cumulative poison and causes liver and kidney damage, gastro-intestinal damage, mental health effects in children and abnormalities in fertility and pregnancy.

Ambient and roadside lead levels continue to be low and were similar to those measured in 1988. Table 7 shows the levels of lead measured at various monitoring stations. All the results are within the USEPA standard.

4 Rules and Regulations regarding Motor Vehicle Pollution Control

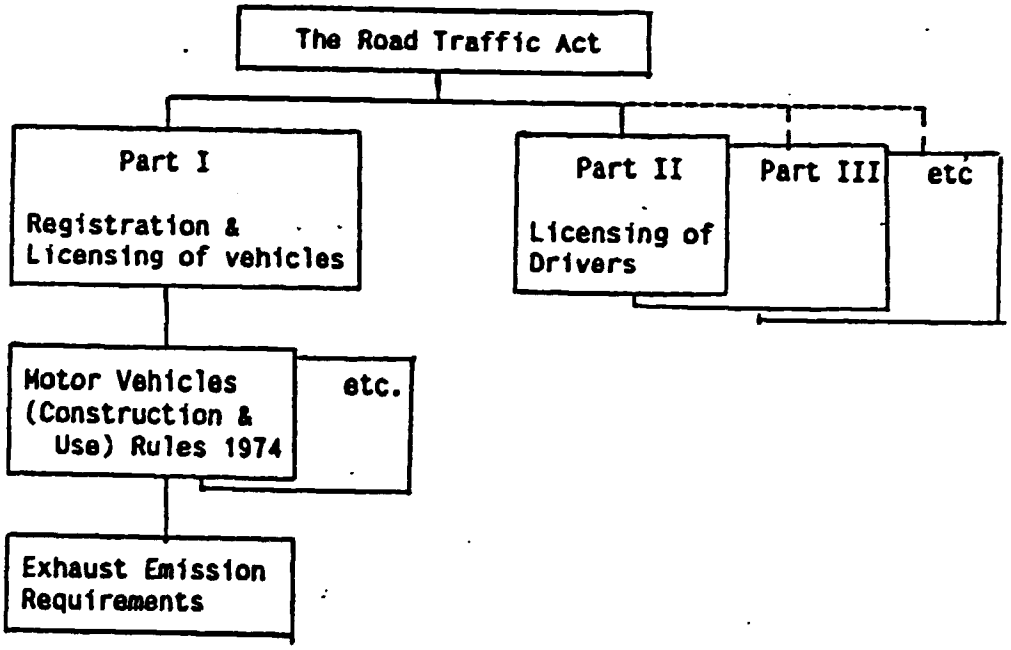
4.1 The Road Traffic Act.

The law governing the control of emission from the exhausts of motor vehicles comes under the Road Traffic Act. The Act provides the power to regulate the safety of the construction of motor vehicles and to impose penalties on those failing to meet such safety requirements.

4.2 The Motor Vehicles (Construction & Use) Rules 1974.

To achieve this objective, subsidiary rules and regulations of the Act are legislated to spell out in more details the standards of requirements for the construction, lighting and safety of motor vehicles. The main rule is the Motor Vehicles (Construction & Use) Rules 1974 which laid down exhaust emission standards of motor vehicles.

A summary of the above relationship among the main Act and its subsidiary rules is shown below:



4.3 Administration of the Rules

The above rules are administered by the Registry of Vehicles (ROV). All new vehicles must undergo a type approval inspection by the Mechanical Inspection Division of the ROV before they can be registered for use on the road. This inspection covers checks on the compliance of the vehicle to requisite exhaust emission standards.

The setting of standards is however done in consultation with the Pollution Control Department (PCD) of the Ministry of the Environment, which oversees air pollution control strategy. The ROV and PCD work closely to monitor and review the adequacy of vehicular exhaust emission standards.

The enforcement on motor vehicle pollution is carried out mainly by the ROV. However, PCD and the Traffic Police assist the ROV in conducting joint operations against smoky exhaust.

5 Vehicular Environmental Pollution Control Measures

5.1 Vehicular Exhaust Emission Standards

Motor vehicles exhaust contributes heavily to road side pollution. Through a policy which provides incentives to keep younger vehicles, Singapore has been able to take advantage of newer vehicle technology to bring in cleaner and more efficient vehicles. However, there is a need to implement stricter standards to ensure that our environment will not be polluted. The table below shows the measures which have been taken for the different categories of motor vehicles:

Exhaust emission requirements for different categories of vehicles

	1984	1986	1991
a. Petrol Vehicles *	ECE 15.03	ECE 15.04	
b. Diesel Vehicles	Free Acceleration (No load) 50 HSU		ECE 24.03
c. Motor Cycles	Idling Test for CO 4.5% by Volume		

* In addition, there is since 1974 a rule requiring all petrol driven vehicles to be fitted with a crankcase ventilating device to eliminate hydrocarbon emissions (accounting for 25% of HC emissions from uncontrolled vehicles) from the crankcase.

5.2 Enforcement

In order to ensure that exhaust emission is under control, it is necessary to carry out enforcement on existing vehicles, ie. those in use. The main purpose is to ensure that all motor vehicles are regularly maintained. There are 2 ways:

a. To require all motor vehicles to undergo compulsory periodic inspection. This is discussed in section 5.4.

b. To carry out road side enforcement.

The ROV conducts daily operation on the road against smoky diesel vehicles. This is done through the use of mobile test vans which are installed with Hartridge smokemeters. Those which cannot meet the legal requirement will be penalised. The penalties ranged from both the owner and the driver being fined to both being charged in court. For those vehicles which exceed 70 HSU, they will be taken off the road for rectification. After being repaired, they must be tested by the ROV before they can be used on the road again.

5.3 Lead Content in Petrol

The lead content in petrol has been progressively reduced. The present maximum permitted lead content in petrol is 0.15 grams per litre. There are currently 2 grades of petrol available, viz. regular and premium.

The authorities are looking into the feasibility of introducing unleaded petrol. This will not only eliminate lead but also enable more stringent exhaust emission standards to be implemented.

For diesel fuel, the authorities are also looking into one with lower sulphur content.

The fuel specifications, pricing and market share are tabulated below:

a. Petrol (Gasoline)

	RON	Lead Content	Price (S$/l)	Market Share
i. Leaded Regular	92	0.15 g/l	1.14	20%
ii. Leaded Premium	97/98	"	1.23	80%

b. Diesel

	Cetane Number	Sulphur Content	Price (S$/l)	Market Share
1. Automotive	45-52 min	0.5% mass maximum	0.55	100%

5.4 Periodic Inspection

All motor vehicles are subjected to compulsory periodic inspection to ensure that they are regularly maintained. The frequency of inspection of different categories of vehicles is shown in Table 8. The ROV authorises 3 private inspection centres, viz. AA Pte Ltd, SAE Inspection Services (SIS) and Vehicle Inspection Company (VICOM) to conduct the inspections on its behalf. The centres have invested in automated inspection equipment to reduce human errors in handling of equipment and therefore achieves better uniformity of judgement.

In 1989, these centres inspected a total of 337,351 vehicles. The results of the defects by stages is shown in Table 9.

5.5 Traffic Management

Traffic Management schemes are generally to reduce traffic congestion by improving traffic flow. Indirectly such schemes help to reduce excessive vehicular pollution caused by massive traffic jams.

Some of the measures that have an indirect impact on vehicular pollution are:

a. Computerised central area traffic control
b. Area Licensing Scheme (ALS)
c. Use of Bus only lanes

a. Computerised central area traffic control

This was implemented in the central area of Singapore in 1980. There is plan to upgrade the system to extend control to other parts of the island. The net effect has resulted in increased travel speeds through the city. This effect is commonly known as the green wave effect.

b. Area Licensing Scheme (ALS)

The ALS was introduced in 1975. This is the first in the world's road pricing scheme which charges vehicle users for congestion cost. This has reduced traffic volume in the central business district areas during the morning peak hours (7.30 - 10.15 am) when people go to work. In Jun 89, the ALS has been modified and extended to the evening peak hours (4.00 - 6.30 pm) as well.

c. Use of Bus only lanes

The use of bus only lanes increases the speed of public service buses travelling within the central business district area during the morning and evening peak hours when the ALS is in operation. This has led to smoother flow and lesser starts/stops for the buses. Indirectly this will help to reduce pollution.

6 Conclusion

We will continually monitor the effectiveness of the measures taken to control vehicular pollution so that the quality of our environment can be maintained. At the same time we will try to take advantage of the rapid development in vehicle technology by requiring new vehicles to be fitted with state-of-the-art pollution control devices. This can be achieved through the introduction of progressively stricter emission standards.

\cp

TABLE 1

MOTOR VEHICLE POPULATION (1981 – 1989)

	ITEM	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CARS									
	i) Private cars & station wagons	143,446	160,757	182,120	195,673	200,032	200,163	201,651	215,928	234,438
	ii) Company cars & station wagons	15,515	16,044	16,992	18,248	18,105	17,558	17,668	18,959	20,010
	iii) Tuition cars & station wagons	888	920	1,090	1,085	1,104	910	956	957	954
	iv) Private hire cars & station wagons	3,506	4,515	4,188	4,159	4,030	3,314	3,081	3,140	3,135
	Sub-Total	163,355	182,236	204,370	219,365	223,271	221,945	223,456	238,984	258,537
2	MOTORCYCLES									
	i) Motorcycles and scooters	126,343	135,339	140,267	133,492	126,337	119,241	115,476	116,476	119,697
3	BUSES									
	i) Omnibuses	3,206	3,219	3,287	3,354	3,597	3,530	3,482	3,410	3,304
	ii) School buses	2,530	2,736	2,733	2,645	2,573	2,427	2,345	2,207	2,047
	iii) Private buses	419	648	866	1,062	1,232	1,271	1,354	1,475	1,615
	iv) Pirvate hire buses	408	507	618	687	779	862	944	1,039	1,174
	v) Excursion buses	243	327	336	356	356	383	458	657	855
	Sub-Total	6,806	7,437	7,840	8,104	8,537	8,473	8,583	8,788	8,995
4	TAXIS									
	i) Public taxis	9,862	10,278	10,668	11,058	10,938	10,677	10,552	10,473	10,652
	ii) School taxis	7	5	5	4	3	0	0	0	0
	Sub-Total	9,869	10,283	10,673	11,062	10,941	10,677	10,552	10,473	10,652
5	EXEMPTED VEHICLES									
	i) Cars and station wagons	1,843	1,814	1,890	1,913	2,038	1,935	2,112	1,957	1,969
	ii) Motorcycles and scooters	1,379	1,540	1,302	1,201	1,227	1,148	1,088	1,094	1,098
	iii) Buses	162	164	164	179	180	165	150	136	131
	iv) Lorries and tippers	1,074	1,128	1,187	1,119	1,046	971	844	918	878
	v) Tractors	190	187	176	168	181	155	155	163	246
	vi) Rollers	481	471	487	470	451	411	354	305	249
	vii) Others	2,454	2,554	2,706	2,872	2,866	2,778	3,326	3,932	4,111
	Sub-Total	7,583	7,858	7,914	7,922	7,969	7,561	8,009	8,506	8,683
6	GOODS AND OTHER VEHICLES									
	i) Goods-cum-passenger vehicles	593	555	8,757	8,959	8,781	8,634	8,562	8,525	8,468
	ii) Light Goods Vehicles	58,645	63,531	59,208	59,940	57,915	55,442	54,211	53,933	53,825
	iii) Heavy Goods Vehicles	25,418	29,173	33,198	38,436	39,298	38,241	38,756	43,183	48,491
	iv) Others	3,213	3,744	4,081	4,042	3,711	3,445	3,519	2,940	2,989
	Sub-Total	87,869	97,003	105,224	111,377	109,705	105,762	105,048	108,581	113,773
	ALL MOTOR VEHICLES (TOTAL)	401,805	440,276	476,288	491,322	486,760	473,659	471,124	491,808	520,537

TABLE 2

MOTOR VEHICLE ANNUAL GROWTH RATE (1981 –1989)

	TYPE OF VEHICLES	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	CARS	8.6%	11.6%	12.1%	7.3%	1.8%	-0.6%	0.7%	6.9%	8.2%
2	MOTORCYCLES	7.9%	7.1%	3.6%	-4.8%	-5.4%	-5.6%	-3.2%	0.9%	2.9%
3	BUSES	7.1%	9.3%	5.4%	3.4%	5.3%	-0.7%	1.3%	2.4%	2.4%
4	TAXIS	4.1%	4.2%	3.8%	3.6%	-1.1%	-2.4%	-1.2%	-0.7%	1.7%
5	EXEMPTED VEHICLES	7.4%	5.2%	-0.6%	0.1%	0.6%	-5.1%	5.9%	6.2%	2.1%
6	GOODS AND OTHER VEHICLES	12.5%	10.4%	6.5%	5.8%	-1.5%	-3.6%	-0.7%	3.4%	4.8%
	ALL MOTOR VEHICLES (TOTAL)	8.2%	9.6%	8.2%	3.2%	-0.9%	-2.7%	-0.5%	4.4%	5.8%

TABLE 3

MOTOR VEHICLES BY TYPE OF FUEL USED (1981 –1989)

YEAR	Cars		Buses		Goods & Other Vechicles	
	Petrol	Diesel	Petrol	Diesel	Petrol	Diesel
1981	183,348	9	307	6,499	58,507	29,362
1982	182,230	6	492	6,945	63,060	33,943
1983	204,365	5	671	7,169	67,260	37,984
1984	219,362	3	819	7,285	70,117	41,260
1985	223,269	2	948	7,589	68,552	41,193
1986	221,943	2	996	7,477	66,222	39,540
1987	223,454	2	1,060	7,523	65,447	39,601
1988	238,980	4	1,159	7,629	68,346	42,235
1989	258,535	2	1,252	7,743	67,549	46,224

Note : Exclude motorcycles, taxis and exempted vehicles.

TABLE 4

CAR & STATION WAGON POPULATION (EXCLUDING EXEMPTED VEHICLES) BY MAKE AS AT 31 DECEMBER 1989

	Make	No of Vehicles	%
1	Toyota	49,958	19.32
2	Honda	42,630	16.49
3	Nissan	24,168	9.35
4	Mitsubishi	21,157	8.18
5	Mazda	20,317	7.86
6	Mercedes Benz	16,695	6.46
7	Datsun	15,948	6.17
8	Daihatsu	10,630	4.11
9	Hyundai	10,581	4.09
10	Ford	9,001	3.48
11	Suzuki	7,017	2.71
12	BMW	5,325	2.06
13	Subaru	4,295	1.66
14	Volvo	3,495	1.35
15	Alfa Romeo	2,546	0.98
16	Fiat	1,775	0.69
17	Renault	1,630	0.63
18	Lada Vaz	1,457	0.56
19	Volkswagen	1,063	0.41
20	Audi	900	0.35
21	Peugeot	893	0.35
22	Austin	833	0.32
23	Citroen	782	0.30
24	Jaguar	681	0.26
25	Isuzu	570	0.22
26	Proton Saga	538	0.21
27	Seat	502	0.19
28	Holden	422	0.16
29	Morris	396	0.15
30	Saab	346	0.13
31	Porsche	310	0.12
32	Opel	221	0.09
33	Lancia	195	0.08
34	MG (MGB)	172	0.07
35	Skoda	166	0.06
36	Daimler	136	0.05
37	Talbot	119	0.05
38	Other makes having less than 100 cars	667	0.26
	Total :	258,537	100

TABLE 5
POLLUTANTS MONITORED AT AMBIENT AIR MONITORING STATIONS (1989)

Station Number and Name	Pollutants Monitored						
	Total Acidity	Smoke	Suspended Particles	Dust Fallout	Oxides of Nitrogen	Sulphur Dioxide	Ozone
Urban							
1 URA Building	★	★		★	★		
2 Toa Payoh Library	★	★	★	★			
3 Chong Fu Primary School	★	★					
4 Yumin Primary School	★	★	★	★	★	★	★
5 Serangoon Subdepot (P&R)	★	★	★	★	★	★	
Industrial							
6 Jurong Town Hall	★	★	★	★	★	★	★
7 Boon Lay Secondary School	★	★	★	★			
8 Woodlands Secondary School	★	★	★	★	★	★	
9 Nanyang Technological Institute	★	★			★	★	
10 Civil Service Institute		★			★	★	
Rural							
11 Seletar Reservoir			★	★			
12 Yishun SBMT Camp	★	★	★	★			★

TABLE 6
CARBON MONOXIDE LEVELS (PPM)

Site	Time Interval (Hours)					
	0700 – 1500		1500 – 2300		2300 – 0700	
	1988	1989	1988	1989	1988	1989
CID (Robinson Road)	2	2	2	2	1	1

PPM = Parts Per Million

TABLE 7
LEAD MONITORING

Monitoring Stations	Average Lead Concentration in $\mu g/Nm^3$		
	1987	1988	1989
Ambient			
1 Toa Payoh Library	–	0.2	0.2
2 Parks & Recreation Serangoon Depot	0.3	0.2	0.1
Roadside			
1 Southern Environmental Health Office	0.5	0.3	0.2
2 Central Fire Station	–	–	0.4

Table 8 COMPULSORY MOTOR VEHICLE INSPECTION

Type of Vehicle	Frequency		
	Below 3 years	3 to 10 years	10 years & above
All motorcycles and scooters	Nil	Annually	Annually
All cars and station-wagons	Nil	Biennially	Annually
All tuition cars	Annually	Annually	Annually
All private hire cars	Annaully	Annually	NA *
All public service vehicles			
Taxis	6-monthly	6-monthly	NA *
SBS buses	6-monthly	6-monthly	6-monthly
TIB buses	6-monthly	6-monthly	6-monthly
CSS buses	6-monthly	6-monthly	6-monthly
Other buses	Annually	Annually	6-monthly
All light goods vehicles (MLW 3,000 kg & below)	Annually	Annually	6-monthly
All heavy goods vehicles (MLW 3,001 kg & above)	Annually	Annually	6-monthly
All other heavy vehicles	Annually	Annually	6-monthly

Note: * Life span of all private hire cars and taxis are 7 years.

Table 9 Breakdown of defects by stages

Year	Type of vehicles	Above Carriage	Under Carriage	Side-slip Test	Brake Test	Exhaust Emission	Headlight Test
1988	Cars	10.2	8.8	5.6	6.3	30.9	94.3
	Motorcycles	6.4	-	1.2	2.6	11.5	98.3
	Taxis	11.9	9.5	3.6	2.5	6.1	90.4
	LGVs	45.3	23.3	7.8	7.9	39.1	95.1
	HGVs	67.6	52.9	4.8	24.5	17.9	79.1
	SBS Buses	0.2	0.4	0.02	0.2	0.1	0.3
	TIB Buses	3.0	4.1	0.1	3.1	0.5	28.4
	CSS Buses	3.4	7.3	6.0	4.5	1.7	37.1
	School Buses	86.8	78.2	7.9	23.8	28.6	92.9
	Other Buses	76.7	60.1	4.9	18.5	20.6	89.9
	Others	86.1	80.3	9.4	49.6	29.3	81.9
1989	Cars	9.3	10.8	6.2	6.5	31.4	95.3
	Motorcycles	7.0	-	1.3	2.3	10.9	97.5
	Taxis	6.6	7.7	2.9	2.6	11.5	89.8
	LGVs	37.8	24.8	7.8	8.5	34.6	96.0
	HGVs	68.0	46.7	4.4	23.3	13.0	78.5
	SBS buses	0.2	0.4	0.0	0.2	0.1	0.2
	TIB Buses	4.6	7.1	1.0	3.9	1.9	65.9
	CSS Buses	4.1	4.9	0.0	1.6	0.8	62.3
	School Buses	84.8	75.0	6.1	21.3	21.7	95.9
	Other Buses	79.9	57.9	4.6	16.6	15.7	92.0
	Others	86.5	79.2	7.7	50.4	25.2	92.6

Note:-

1. No headlight aimer test was conducted on SBS buses at SBS depot.
2. No headlight aimer test was conducted on TIB and CSS buses at TIB depot w.e.f. May 88
3. w.e.f. 1989, TIB and CSS buses inspection are conducted at SIS premises.

AMBIENT AIR QUALITY GUIDELINES

Pollutants	Averaging Time	Guidelines Based On US Environmental Protection Agency Primary Air Quality Standards		Guidelines Based On WHO Long Term Goals	
		Con'c	Method	Con'c	Method
GASEOUS POLLUTANTS Sulphur Dioxide	Annual Mean 24 hours	80 $\mu g/m^3$ 365 $\mu g/m^3$	Pararosaniline		
Total Acidity	Annual Mean			60 $\mu g/m^3$ (98% of observation below this limit)	British Standard Procedures (BS 1747 Pt 3, 1963)
Carbon Monoxide	8 hour 1 hour	9 ppm 35 ppm	Non-dispersive Infrared spectrometry	9 ppm 35 ppm	Non-dispersive infrared spectrometry
Nitrogen Dioxide	1) Annual Mean 1 hour not to exceed more than once a month	1) 100 $\mu g/m^3$	Chemiluminescent	2) 0.1 – 0.17 ppm	
Ozone	1 hour 8 hours	12 pphm	Ultraviolet Photometry		
PARTICULATE POLLUTANTS Smoke	Annual Mean			40 $\mu g/m^3$ (98%) of observation below this limit	British Standard Procedure (BS 1747 Pt 2, 1964)
Suspended Particles	Annual Mean 24 hours	75 $\mu g/m^3$ 260 $\mu g/m^3$	High volume Sampling		
Lead	3 months	1.5 $\mu g/m^3$	Atomic Absorption Spectroscopy		

Please refer to Guideline for the Country Papers

a. Contribution of motor vehicles to total manmade pollution:

Not available.

b. Motor vehicle population:

- o Population - Please refer to Country Paper. Table 1 & 3.
- o Average Engine Capacity - Appendix 1
  Average travelled km/year - Appendix 2
- o Contribution of each vehicle groups to traffic caused pollution
  - Not available
- o Growth rate of vehicle population - See country report, table 2.
- o Suppliers of vehicles: Mainly imported. see country paper, table 4.

c. Fuel.

- o Gasoline - See country report.
- o Diesel - see country report.

d. Organisations concerned with motor vehicle pollution and their functions and competence.

- o Pollution Control Department, Ministry of the Environment.
- o Registry of Vehicles, Ministry of Communications & Information.

Please direct any query to the following:

Head, Pollution Control Department
40 Scotts Road
12th Storey, Environment Building
Singapore 0922
Telex RS 39438 PCD
Fax 7319651

Registrar of Vehicles
Sin Ming Drive
Singapore 2057
Telex RS 28901 ROV
Fax 4509291

e. Which standards do exist for the certification of the individual categories of new vehicles?

For petrol (or gasoline) vehicles less than 3500 kg, they must comply with the standards laid down in the ECE 15.04 Regulations. The manufacturer have to issue a compliance certificate and a test report. One car from the first batch of a new model being imported to Singapore for the first time will have to be tested for compliance. The test can be conducted by the manufacturer, any government testing authorities or independent authorities recognised by the Registry of Vehicles (ROV).

f. What kind of mandatory inspection/maintenance systems are there?

Please see country report. Section 5.4.

The tests conducted at the inspection are:

- Above & Under carriage inspection
- Side slip test
- Exhaust emission
- Brake test
- Head light test
- Noise emission test

A copy of the items of inspection is in Appendix 3

g. What kind of road side tests are being performed?

The ROV, Traffic Police and Pollution Control Department enforce on smoky diesel vehicles. Please see country report, section 5.2.

h. What are the basic problems of motor vehicle pollution control?

The main problem is poor maintenance and maintenance that are irregularly and superficially done.

i. What actions are underway to address these problems?

Education of owners/drivers, stiffer penalties and progressively stringent emission standards for all motor vehicles.

j. Interest in a regional project.

For information and experience exchange. Some of the issues that can be looked into are the fuel quality standards and mandatory inspection systems.

MOTORCYCLE AND SCOOTER POPULATION BY CC RATING
(EXCLUDING EXEMPTED VEHICLES)
1981 – 1989

CC Rating	1981	1982	1983	1984	1985	1986	1987	1988	1989
100 cc & below	49,617	46,331	41,724	34,491	29,400	25,613	22,943	21,313	19,645
101 – 200 cc	62,796	73,794	82,847	84,326	83,412	81,183	80,395	81,649	83,266
201 – 300 cc	3,674	3,788	3,960	3,734	3,497	3,322	3,206	3,247	3,719
301 – 500 cc	7,526	8,630	8,932	8,302	7,625	6,948	6,973	8,099	10,762
Above 500 cc	2,730	2,816	2,804	2,639	2,403	2,175	1,959	2,168	2,505
Total	126,343	135,359	140,267	133,492	126,337	119,241	115,476	116,476	119,897

Appendix 1

**CAR & STATION WAGON POPULATION (EXCLUDING EXEMPTED CARS)
BY CC RATING AND TYPE OF OWNER AS AT 31 DECEMBER 1989**

CC Rating	Individual Owner	Company Owner	Private Hire	Total
1000 cc & below	38,808	877	25	39,710
1001 to 1600 cc	160,934	10,598	2,210	173,742
1601 to 2000 cc	27,838	5,799	783	34,420
2001 to 3000 cc	6,757	2,607	114	9,478
3001 cc & above	980	204	3	1,187
Total:	235,317*	20,085*	3,135	258,537

* Tuition cars were included.

Appendix 1
(cont..)

GOODS & OTHER VEHICLE POPULATION
BY TYPE OF BODY AND MAXIMUM LADEN WEIGHT
AS AT 31 DECEMBER 1989

Maximum Laden Wt	Lorries (Steel Body)	Lorries (Wooden Body)	Tippers	Vans	Goods-cum Passengers	Articulated Vehicles	Cement Mixers	Tankers	Others	Total
(1000kg)										
0+	26,121	2,750	4	24,921	8,465	1	2	1	1,147	63,412
3+	18,090	2,799	69	7,199	2	0	1	3	278	28,441
5+	4,828	3,728	552	971	1	0	0	1	149	10,230
7.5+	31	1,342	97	204	0	0	0	7	36	1,717
10+	30	767	966	9	0	3	1	26	11	1,813
12.5+	9	273	59	11	0	0	2	15	22	391
15+	33	1,756	221	7	0	2	7	120	55	2,201
17.5+	10	9	1	0	0	11	6	17	7	61
20+	5	182	9	0	0	7	18	17	9	245
22.5+	15	563	1,460	0	0	6	706	194	83	3,027
25+	0	1	0	0	0	6	0	3	0	10
27.5+	0	0	0	0	0	9	0	13	0	22
30+	0	0	2	0	0	263	0	17	0	282
32.5+	1	0	2	0	0	15	0	2	1	21
35+	0	0	0	0	0	59	0	3	2	64
37.5+	0	0	2	0	0	432	0	3	1	438
40+	0	1	0	0	0	534	0	3	0	538
42.5+	0	0	0	0	0	1	0	0	0	1
45+	0	0	0	0	0	857	0	1	1	859
TOTAL	49,173	14,171	3,444	33,322	8,468	2,206	741	446	1,802	113,773

Appendix 2

Annual Mileage of vehicles

Types of vehicles	Km/year
a. Cars	19,100
b. Motor cycles	12,000
c. Taxis - 2 shifts	138,000
d. Goods vehicles	
Light goods vehicles	21,600
Heavy goods vehicles	26,700
e. Buses	
Public service buses	100,000
Other buses	39,000

Appendix 3

Items For Inspection

The following items will be inspected:

a Brake System
1 Brake pedal
2 Brake linkage
3 Brake hose/pipes/cylinders
4 Hand brake

b Steering System
1 Steering wheel/column
2 Steering column bracket
3 Steering ball joints
4 Steering box mounting
5 Steering idler and sector shaft
6 Power steering

c Suspension
1 Stabilizer/bushes
2 Front suspension joints
3 Rear suspension joints
4 Rear shackle eyes
5 Rear shackle pins/bushes
6 Spring
7 Spring U-bolts/mounts
8 Spring clips
9 Shock absorbers

d Engine and Transmission
1 Engine bracket and mountings
2 Propeller shaft couplings
3 Exhaust pipe and silencer

e Body Work
1 Chassis frame
2 Chassis cross members
3 Body/floor panel
4 Door and hinges

f Road Wheels and Tyres
1 Tyres
2 Wheel mounts/studs

g Electrical Lighting
1 Front lamps
2 Head lamps
3 Rear lamps
4 Stop lamps
5 Front direction indicators
6 Rear Direction indicators
7 Number plate lamps
8 Reflectors

h General Items
1 Windscreen/window glass
2 Windscreen wipers
3 Windscreen washers
4 Horn
5 Fuel tank
6 Fuel tank cap
7 Rear view mirrors
8 Speedometer
9 Seat belts
10 Number plate

Further technical details of the parts to be inspected and inspection standards can be found in the Inspection Manual which will be available for sale at the ROV.

ANNEX 7

Republic of the Philippines
Department of Transportation and Communications
Land Transportation Office
East Avenue Avenue, Quezon City

A N D

Department of Environment and Natural Resources
National Capital Region
M a n i l a

C O U N T R Y R E P O R T

By: **ATTY. HERMOGENES C. FERNANDEZ**
Chief, Transportation Regulations Officer
Land Transportation Office

and

ENGR. ARNEL H. LUZ
Senior Environmental Management Specialist
Department of Environment and Natural Resources
National Capital Region

This Country Report is respectfully submitted to the Expert Group Meeting on Control and Regulatory Measures Concerning Motor Vehicle Emissions in Seoul on 21-24 August 1990.

PREFATORY STATEMENT

The Philippines lies North of the equator, stretching 1,854 kilometers from North to South, with an area of 300,000 square kilometers. The Philippines is divided into three regions, Luzon in the North, the Visayas in the middle and Mindanao in the south, with 7,100 tropical islands. The Philippines has a population of 60 million of Indo-Malay, Chinese, and Spanish stock, of predominantly Christian and Muslim beliefs. Quezon City, which is the Capital of the Philippines is situated in Luzon, is also a part of Metropolitan Manila composing of four (4) cities and thirteen (13) municipalities.

This report will be focused on pollution caused by motor vehicles in Metro Manila where the total number of registered motor vehicles is 588,238 as of December 1989.

Per guidelines set by Dipl.-Ing. Hartmut Carstensen, the following data are hereby given in response to the hereunder issues, to wit:

A. **Contribution of Motor Vehicles to Total Manmade Pollution:**

There are two (2) major sources of air pollution in Metro Manila: industry and motor vehicle. Industry contributes thirty percent (30%) of air pollution and seventy percent (70%) by vehicles or mobile sources.

Present analysis of fuel consumption indicates that motor vehicle contribution to pollution are the following: 50% of particulate matter; 99% of toxic carbon monoxide; 90% of hydrocarbons; and 5% of sulfur dioxide. The balance is from industry, mostly power plants. Previous measurements also show that the local concentration of these pollutants in heavy traffic areas exceed the allowable levels.

B. **Motor Vehicle Population:**

	Total Number	Percentage Powered By Gasoline	Diesel	LPG	Others
MC/TC	191,471	98.3%	1.7%	0%	0%
CARS	382,156	97.6%	2.4%	0%	0%
TB	3,524	10.6%	89.4%	0%	0%
T	105,012	12.1%	87.9%	0%	0%
UV	449,659	56.9%	43.1%	0%	0%

There are no data available on the average engine capacity, average traveled kilometer per year and average lifetime of motor vehicles in the Philippines.

Contribution of each these vehicle groups to the traffic caused pollution

Emission of air pollutants from motor vehicles of all types in Metro Manila (tons/day):

	CO	HC	NOx	PM	SOx
DIESEL	20.905	39.198	57.925	39.198	23.519
GASOLINE	778.95	131.227	43.262	4.326	4.326

Growth rate of vehicle population:

Increase of 12.67% from 1988 to 1989.

Suppliers of vehicles:

Most vehicles in the Philippines are imported. While it is true that there are local assemblers in this country, these assemblers produce mostly the jeepney type vehicles using imported parts.

C. **Fuel**

Gasoline and LPG

	Octane Number	Lead Content [g/l]	Price [US$/l]
leaded regular	01	0.5 g/l	P6.5 ($.27)
leaded premium	95	0.7 g/l	P7.06 ($.30)

Diesel

	Cetane Number	Sulfur Content [g/l]	Price [US$/l]
diesel	40	0.9	P4.96 ($.205)

What chances are there to introduce unleaded gasoline and low sulfur diesel fuel?

The chances are very slim at the moment because of economic constraints now obtaining in the country.

D. **Organizations Concerned with Motor Vehicle Pollution and their Functions and Competences:**

Department of Transportation and Communications - The Land Transportation Office conducts pollution emission tests before registration. Presently, however, emission testing is limited to taxis.

Department of Environment and Natural Resources - Formulates and enforces emission regulation policies.

Constabulary Highway Patrol Group - Assists the LTO-DENR smoke belching campaign.

Please do also specify at least one responsible person for each organization and indicate these persons' full addresses including telephone and telex numbers:

Hon. FULGENCIO S. FACTORAN, JR.
Secretary
Department of Environment and Natural Resources
Visayas Avenue, Quezon City

Hon. MANUEL N. SABALZA
Assistant Secretary
Land Transportation Office
East Avenue, Quezon City

E. **Which Standards do Exist for the Certification of the Individual Categories of New Vehicles?**

They are as follows:

1. British Standard BS AU 141 (a); 1971
2. European Economic Community Directive 72/306/EEC Economic Commission for Europe
3. Australian Design Rule No. 30 Regulation No. 24
4. U.S.A. EPA Federal Regulations Part 85 or Federal Regulation Part 86

5. NPCC Rules and Regulations Implementing P.D. 1181

Emission tests are actually conducted by manufacturers or assemblers. However, it is observed that the foregoing standards are not being strictly followed.

F. **What kind of Mandatory Inspection/Maintenance Systems are There?**

At present, taxis are the only ones mandatorily inspected for smoke emission. It is expected, however, that with the installation of the motor vehicle inspection station system by the Land Transportation Office, all types of vehicles will be inspected before registration in the near future.

G. **What Kind of Road Side Tests are Being Performed?**

It is only the Anti-Smoke Belching Campaign being undertaken by the DENR-LTO-CHPG-MMA. It is the visible smoke emission caused mostly by diesel-fed vehicles that is being checked. For violation of PD 1181 fines imposed range from P200.00 to P1,000.00.

H. **What are the Basic Problems of Motor Vehicle Pollution Control?**

It is seen that the root cause of motor vehicle pollution control problem is the importation of second hand engines and the absence of certification tests.

I. **What Actions are Underway to Address These Problems?**

Installation of Motor Vehicle Inspection Stations in four (4) major areas of Luzon, namely: Pasay MVIS, Quezon City MVIS, Lipa, Batangas MVIS and San Fernando, Pampanga MVIS.

J. **Interest in a Regional Project:**

What benefits could generally be achieved by such a Project?

According to priorities, we expect to derive the following benefits:

1. Information exchange
2. Transfer of technology
3. Practical policy recommendations
4. Implementation of a regional network for coordination and cooperation

Which is (are) the most important objective(s) among the above regional project should focus on?

1. Information exchange
2. Practical policy recommendations

Who would be the direct and indirect beneficiaries of this project?

Direct beneficiaries - Philippines

J. **National Counterpart Support for a Regional Project:**

- which of the national organizations and which persons within these organizations could be the national focal point for the network to be established?

  Environmental Management Bureau of the DENR and the Land Transportation Office of the DOTC.

- would this organization require any support from UNIDO? If so, what type?

  Yes. Finance and Consultancy

- which country should be the host of the network?

  We propose the country that already has a veritable experience on this matter including the capability to provide space, equipment and manpower.

Respectfully submitted by:

ATTY. HERMOGENES C. FERNANDEZ
Land Transportation Office

ENGR. ARIEL H. LUZ
Department of Environment and Natural Resources

COUNTRY REPORT

Regional Network On Control And Regulatory Measures Concerning Motor Vehicles Emmissions

21 - 24th August 1990

AZLAN BIN ABU SAMAH
ROAD TRANSPORT DEPARTMENT
MINISTRY OF TRANSPORT
MALAYSIA.

CONTENTS

1. Introduction

Malaysia, being a developing country, is embarking on a program of industrialization to meet the aspiration of the people for an acceptable standard of living. These activities will simultaneously bring about high rate of urbanization resulting in the growth of motorization which is particularly notable in most of the cities/towns. Moreover, cities/towns are where commercial, industrial and government activities are usually concentrated. With the acceleration of these activities, there is a need for rapid movement of raw materials, finished products and of the people involved. As a result, transport becomes an essential part of the daily activities. The demand for transport is so acute that the number of vehicles coming on to the road has been increasing and there has been a rapid growth of motor vehicles during recent years.

Motor vehicles will, through their exhaust emissions pose potential air and noise pollution problems expecially in congested urban areas if no proper control measures are taken to contain this threat to public health.

The main pollutants emitted by petrol powered vehicles are carbon monoxide (CO), hydrocarbons (HC), oxide of nitrogen (NOx) and lead particulates, while diesel-fuelled vehicles emit black smoke, particulates and some oxides of sulphur (SOx).

2. Vehicle Statistics

By the end of 1989, there are about 5 million registered motor vehicles in Malaysia, of which 92% of the vehicles were petrol driven while the ramaining 8% were powered by diesel. Motorcycles (including mopeds and tricycles) are the biggest share (56.5%) where all are petrol driven vehicle.

In the year 1989, in Peninsular Malaysia alone there were 113508 number of vehicles registered, of which 63% of the engine capacity ranging from 1001 c.c. to 1500 c.c.

Malaysian national car made the highest sale when introduced in 1986 (46.8%) which were petrol driven with engine capacity of 1.3 litre and 1.5 litre.

Japanese made commercial vehicle are still the highest amount of vehicle on the road in Malaysia till 1989, where mostly were diesel vehicle.

3. Control Of Motor Vehicle Emission

Legislation and enforcement are esential to ensure success in the control of vehicular emissions. Legislation should clearly established emission standards, provide the administrators with the authority to carry out initial inspection, routine periodic checks and surprise inspections to ensure compliance and also spell out the punitive action to be taken in cases of non-compliance to the emission standards.

3.1 Standards for Diesel Vehicle Emission

The control of balck smoke emission from diesel vehicles has been implemented since 1978, with the coming into force the Motor Vehicle (Controlof Smoke and Gas Emission) Rules, 1977 which stipulated a limit of 50 Hartridge Smoke Units (HSU) to be the standard for black smoke emission from diesel vehicles. This standards corresponds to a certain smoke density which could be measures with a smokemeter (Hartridge Smokemeter).

3.2 Standards for Petrol Vehicle Emission

To limit the level of lead emitted from petrol vehicles exhaust, the government has introduced and enforced the Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations 1985. Under this Regulations, all petroleum refiners and importers in Malaysia are required to reduce the lead content in petrol from the initial 0.84 grams/liter to 0.4 grams/liter by July 1985 and further reduced to 0.15 grams/liter by 1 Jan. 1990. Enforcement of this regulations is done by taking gasoline (petrol) samples from all oil refineries or storage depots and selected petrol kiosks throughout the country for analysis.

4. Vehicle Inspection

As stipulated in the Road Transport Act, the Director General of a Director of Road Transport Department are empowered to inspect all motor vehicle at any time before registration.

But at present, administratively only commercial vehicle (e.g. taxis, buses, lorries and vans) are required to undergo once in six (6) months vehicle inspection.

Basically there are five (5) types of vehicle inspection done at the Road Transport Office in all states in Malaysia, namely:-

i) Initial inspection - for new vehicle before registration

ii) Re-inspection - for vehicle that fail the initial inspection

iii) Routine inspection - a once in six (6) months inspection

iv) Special inspection - for modified vehicle

v) Accident inspection - for vehicle that involved in accident

At present, either new or used vehicle are been inspected physically only except for smoke test powered by diesel engine.

5. Fuel Supply and Demand

As one can see (apendix 7), Malaysia export 19395 thousand tonnes oil equivalent of crude oil and import 2637 thousand tonnes oil equivalent of petroleum product in the year 1988. The local refinery produce 26.9% of fuel oil, 33.7% of diesel oil and 17.1% of gasoline in the same year.

In terms of selected individual petroleum product, domestic refineries met the following proportions of domestic requirement in 1988:-

Fuel oil	80.2%
Diesel oil	77.5%
Gasoline	56.5%

About 40% of the energy are needed for the transportation.

By comparison, transport sector used more petrol but slightly less diesel than industrial sector. Therefore the annual mean concentration of Pb recorded in the trafficied area are higher compare to the industrialised area.

6. Properties of Gasoline, Diesel and LPG

Both leaded regular and leaded premium for gasoline are having the same amount of lead content (0.15 gram/litre) but different in Octane Number (RON), where the value are 89 and 97 respectively. The properties are also same for unleaded regular and unleaded premium except the lead content is lower (0.013 gram/litre).

For diesel, the minimum and average value for cetane is 47 and 51 respectively with 1% of sulfur content by volume.

Petronas LPG is a mixture of propane and butane. Both fuels, without additives, have a high research octane number (RON) in their purest forms. Propane will have an octane of about 111 and butane about 97.9. LPG will therefore have an octane rating either close or well above that of premium gasoline avaiable in the stations.

7. Control strategy/future plan

At present, most vehicle in Malaysia are petrol driven. Therefore an approach emphasizing more on preventive measure should be taken, ie. by reducing the lead content in gasoline. Lately, two oil company (Petronas and Shell) has taken voluntary step by introducing unleaded gasoline (0.013 gram/litre of lead content)

Beside this, it is anticipated that only good/clean engines are allowed to be marketed/operated on the road. To achieve this, the government should:-

i) have a complete set of regulations to control gaseons emission from both petrol and diesel powered vehicles;

ii) be equiped with its own testing facilities (station) or incorporated with private sector for carrying out vehicular emission testing.

It is proposed that vehicle should undergo type approved testing and to introduced automatic vehicle inspection to ensure vehicle on the road are roadworthy.

8. Conclusion

The air pollution problems in Malaysia are mainly due to the expanding manufacturing activities and urbanization. Emission from motor vehicles are more serious particularly in congested urban areas than those from industrial areas.

The need to control vehicular emission is without doubt urgent and needs no further elaboration. But before such a programme can be embarked, various issues have to be addressed. Issues such as the degree and level of control necessary (for new and old/existing vehicles), the test cycle to be adopted, instrumentations, enforcement strategies and manpower requirement including the technical know how, etc will have to be carefully weighed.

Prevention approach is a key to successful preservation of the air quality. Adequate inspection and maintenance with sufficient testing facilities are essential to reduce excessive discharge of pollutants from motor vehicles.

It is hoped that with the full coorperation of other related agencies, and especially the vehicle owners and operators, the quest to sustain a clean environment (especially in urban areas) for a better quality of life can be achieved.

AAS/nar.

Apendix 1

Number Of Motor Vehicles Registered In Malaysia
As 't 31st December 1989

Type Of Vehicle	Gasoline		Diesel		Total
	No. Of Vehicle	%	No. Of Vehicle	%	
Motorcycles	2848717	100	-	-	2848717
Passenger Cars	1617533	95.7	71837	4.3	1689370
Buses	1564	6.3	23264	93.7	24828
Lorries/Truck	153469	43.9	196268	56.1	349737
Others (excluded 26807 trailer)	16105	12.2	116222	87.8	132327
Totol	4637388		407591		5044979

Apendix 2

Registration Of Motor Vehicles In Peninsular Malaysia
In 1989

Engine Capacity (c.c)	Gasoline	Diesel	Total
less than 1000	4201	2407	6608
1001 - 1500	75072	156	75228
1501 - 2000	14108	509	14617
2001 - 2500	3342	6975	10317
2501 - 3000	729	3980	4709
3001 - 3500	46	651	697
3501 - 4000	22	765	787
4001 - 4500	8	210	218
4501 - 5000	6	335	341
above 5000	10	5076	5086
Total	97544	21064	118608

Apendix 3

Number And Percentage Of The Most Popular Passenger Cars Registered In Peninsular Malaysia

Model	1983	1984	1985	1986	1987	1988	1989
Daihatsu	4240 (4.7%)	5246 (6.0%)	3239 (5.7%)	1589 (3.4%)	711 (2.0%)	966 (1.8%)	1776 (2.4%)
Datsun/Nissan	25920 (28.8%)	23828 (27.4%)	19084 (33.6%)	7599 (16.2%)	3431 (9.7%)	4335 (8.1%)	8653 (11.7%)
Ford	6126 (6.8%)	6508 (7.5%)	4146 (7.3%)	2218 (4.7%)	1094 (3.1%)	550 (1.0%)	1294 (1.8%)
Honda	8985 (10.0%)	11362 (13.1%)	5830 (10.3%)	3697 (7.9%)	2179 (6.2%)	3139 (5.9%)	5876 (8.0%)
Mazda	6594 (7.3%)	5948 (6.9%)	3944 (6.9%)	1817 (3.9%)	1043 (3.0%)	225 (0.4%)	67 (0.09%)
Mercedes Benz	2304 (2.6%)	2214 (2.6%)	1172 (2.1%)	537 (1.1%)	623 (1.8%)	345 (0.6%)	637 (0.9%)
Mitsubishi	8197 (9.1%)	5405 (6.2%)	1994 (3.5%)	796 (1.7%)	21 (0.06%)	16 (0.03%)	59 (0.08%)
Proton	-	-	-	22023 (46.8%)	22852 (64.8%)	39159 (73.2%)	48387 (65.6%)
Toyota	21233 (23.6%)	19290 (22.2%)	13826 (24.3%)	4972 (10.6%)	1514 (4.3%)	2951 (5.5%)	4026 (5.5%)
Volvo	2679 (3.0%)	3605 (4.2%)	1800 (3.2%)	851 (1.8%)	960 (2.7%)	1067 (2.0%)	1574 (2.1%)

Apendix 4

Numbers And Percentage Of The Most Popular Commercial Vehicle Registered In Peninsular Malaysia

Model	1983	1984	1985	1986	1987	1988	1989
Daihatsu	1299 (8.3%)	2011 (10.1%)	2445 (9.1%)	1823 (10.0%)	1823 (14.9%)	2764 (17.7%)	4448 (14.3%)
Datsun/Nissan	4608 (29.4%)	6200 (31.3%)	10983 (41.1%)	5444 (29.8%)	3343 (27.2%)	3697 (23.6%)	7783 (25%)
Ford	2209 (14.1%)	4340 (21.9%)	4488 (16.8%)	2585 (14.1%)	1621 (13.2%)	2895 (18.5%)	6193 (19.9%)
Hino	947 (6.0%)	596 (3.0%)	561 (2.1%)	320 (1.7%)	122 (1.0%)	326 (2.1%)	568 (1.8%)
Isuzu	1050 (6.7%)	1651 (8.3%)	1413 (5.3%)	1035 (5.7%)	1110 (9.0%)	1438 (9.2%)	2344 (7.5%)
M/Benz	785 (5.0%)	694 (3.5%)	616 (2.3%)	629 (3.4%)	472 (3.8%)	424 (2.7%)	466 (1.5%)
Toyota	2628 (16.8%)	2672 (13.5%)	4907 (18.3%)	4509 (24.6%)	2482 (20.2%)	3169 (20.3%)	6902 (22.2%)

Apendix 5

Inspected Item During Vehicle Inspection

STATIC INSPECTION

Injin & Chasi No.
F/Wheel Bearing, K/Pin & Bushes
Rad. Grill & Engine Bonet
H/Lamps & Driec. Indicators Cond.
W/Screen glass, wiper & washes & R/Vision Mirrors
Dvr. Seats, Dvr Cab & Floorboard Condition
Crash Barrier & Link Chains
Coup. Gears, K/Pin, Sty Pin, Chains & L/Gear
Anti-Lighting Chain & Fire Shield
Tipping Equipt & Tipping Pivot Cond.
Semi Treler No. Plate
Ext. & Int. Body Marking & Paintwork
Base Marking, Roof Sign & Yellow Top
Entrence Door & Exit
Rear Bumper & Reg. No. Plate
Mudguards & Mudflaps Cond.
R/Lamps, D/India, Reflec & Pass Ligh Cond.
Body Panel, Wooden D/S & D/TB Cond.
Tyres & Spares and Wheel Cond.
Luggage Booth & Compartment
Passengers Seat Cond.
S/Window, Glass, Seals, Winders & Door Lock
S/First Aid, W/Instrument & Lighting
Floor-board & Closet Cond,
Sty/Belt, Ref/Tri, F/Ext & Lift/Jack.
Steering Joints & Connection
Steering Box & Mounting
Ft/Brake & H/Brake Linkages Cond.
Oil, Leaks, Engine Mounting & Cond.
Ft/Brake M/Pump. W/Cyls & Air Vacuum Tank
F/R/Spring Assy S/absobers & Axle
Main Chasis Frame & Subframe Cond.
Body Mounting & Connection
Prop. Shaft U/Joints & Connection.

SMOKE & ROAD TEST

Smoke Emmision HSU
Elect. Wring, Wst. Sys & Audible Warning
Air/Vacum Warning, Build Up & Control
Mech. H/Brake Condition
Foot Brake Performance
Cluth Pedal & Operation
Transmission & Gear Lever Shift
Engine Performance
Ste/alighment, Dve. Control & S/meter
Taximeter Operation & Condition.

Apendix 6

Table 1: Value of Octane Number, Lead Content And Price

Gasoline	Octane Numbers		Lead Content (gram/litre)	Price (US $/Litre)
	RON	MON		
i) Leaded				
regular	85	-	0.15	$ 0.36
premium	97	97	0.15	$ 0.38
ii) Unleaded				
regular	85	-	0.013	$ 0.36
premium	97	97	0.013	$ 0.36

Table 2: Value of Cetane Number, Sulfur Content And Price

	Cetane Number	Sulfur Content (gram/litre)	Price (US $/Litre)
Diesel	47 (min) 51 (average)	1% (Vol)	$ 0.21

Nota: 1. The price of LPG is US$0.23 per litre.

2. The exchage rate taken as M$2.70 for every US$1.00.

Table 1. Imports and Exports of Oil (in thousand tonnes oil equivalent)

	1986	1987	1988
Net exports of crude oil	18058	17424	19395
Net imports of petroleum products	2393	2366	2637

Table 2. Refinery Output of Selected Petroleum Products (percent)

	1986	1987	1988
Fuel oil	26.1	26.1	26.9
Diesel oil	32.0	32.4	33.7
Gasoline (petrol)	16.2	16.6	17.1

Table 3. Final Energy Use by Sector (thousand tonnes oil equivalent)

	1986	1987	1988
Industrial	4027	4399	4377
Transport	3726	3929	4278
Residential & Commercial	1233	1297	1435
Non-energy	382	358	366
Total:	9368	9983	10456

Apendix 8

Table 1. Final Demand for selected Petroleum Products (thousand tonnes oil equivalent)

	1986	1987	1988
Diesel oil	2803	3026	3275
Gasoline (petrol)	2178	2297	2451
Fuel Oil	489	529	598

Table 2. Final Demand for Diesel Oil (thousand tonnes oil equivalent)

	1986	1987	1988
Industrial	1670	1793	1856
Transport	1133	1218	1380

Table 3. Final Demand for Gasoline (petrol) (thousand tonnes oil equivalent)

	1986	1987	1988
Transport	2162	2274	2438
Industrial	16	23	13

Apendix 9

Presnt State of Environment (1988)
(annual means concentration of TSP & Pb)

	Residential area (ug/m^3)	Commercial Area (ug/m^3)	Trafficied Area (ug/m^3)	Industrialised Area (ug/m^3)
Total suspended particulates (TSP)	62	76	107	92
Lead (Pb)	0.20	0.08	0.8	0.14

Note:

i. Daily recommended Malaysian guideline value for TSP:- 260 ug/m^3.

ii. Annual recommended Malaysia guideline value for TSP:- 90 ug/m^3.

Contact Person

1. Ministry of Transport

Mr. Azlan Bin Abu Samah
Technical Division
Road Transport Department
4th. Floor, Block B, Damansara Complex
Jalan Dungun
50620 Kuala Lumpur.
West Malaysia.

CABLE: 'TRANCO'
TEL: 03-2549044
FAX: 03-2554594

2. Ministry of Environment

Mr. Aminuddin Bin Ishak
Department of Environment
13th. Floor, Wisma Sime Darby
Jalan Raja Laut
50662 Kuala Lumpur
West Malaysia.

TEL: 03-2938955
FAX: 03-2931480
TELEX: MOS TEC MA28154

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7. Perusahaan Otomobil Nasional (PROTON), Malaysia.

ANNEX 9

EXPERT GROUP MEETING IN MOTOR VEHICLE EMISSION STANDARDS

COUNTRY PAPER BY MR.D.D.J.WIJESUNDARA
COMMISSIONER OF MOTOR TRAFFIC
SRI LANKA.

The Control and Regularity Measures Concerning Motor Emissions

A. Contribution of Motor Vehicles to total man made Pollution

There has been a growing awareness amongst the developing nations of the need for control of Motor Vehicle emission as measure of environmental protection. Atmosphere pollution is caused mainly by exhaust emissions from several sources such as vehicle emission, smoke, gases and also grit from industrial base pipes, locomotives etc. The pollution from vehicle emission is mainly found in cities and urban areas where the density of vehicles are mostly concentrated. Pollutions have become a very serious health hazard specially where the vehicle density is high and when annalized have shown that it is due to the pressure of toxic chemicals such as carbon monoxide, lead, sulfer dioxide, oxides of nitrogen unburned hydrocarbons, particulate matters etc.

Effects on Man of Toxic Chemicals in Vehicle Fumes

Carbon Monoxide

Exhaust emission from petrol-powered motor vehicles constitute the most important source of Carbon monoxide (CO) in the atmosphere at breathing level. The rate of emission of CO from this source depends on such variables as the type of vehicle, its mode of operation and its speed. Concentration in urban areas are closely related to the density of trafficand show peaks during 'rush hours'. Concentration fall sharply with increasing distance away from the street.

Carbon monoxide forms strong bonds with the iron atom of the protohaem complex of haemoglobin forming carboxyhaemoglobin (HBCO) thus impairing the oxygen carrying capacity of blood; the dissociation of oxyhaemoglobin is also altered due to the presence of HBCO in the blood thereby further impairing the oxygen supply to the tissues (the affinity of haemoglobin for CC is about 240 times that of oxygen). The effects of health of high concentrations of CO are widely known. Much attention has, however, been given in recent times to possible affects of exposure to low concentrations of CO which result in blood HBCO levels of 10 percent or less. There is now much published evidence to suggest that comparatively low levels of HBCO produced by exposure to low concentrations of CO in ambient air can cause adverse effects to health. Experimental and epidemi-

-logical studies have highlighted several areas of concern.

As CO acts primarily by its interference to oxygen transport and the nervous system is more sensitive to hypoxia than other systems of the body, much work has been done on the effects on sycomotor function by assessing the impairment of vigilance, perception and the performance of fine tasks following exposure to concentrations of CO too low to produce clinical signs and symptoms. There is some suggestion that CO contributes to impairment of psychomotor function. However, the evidence is conclusive and furtherstudies are indicated.

The damaged heart and respiratory systems have been found to be prone to impairment by CO. In patients suffering from angina pectoris, a reduction in the same time of onset of angina on exercise has been demonstrated when the HbCO levels exceed 2.5 percent. Similar effects have been demonstrated in patients with intermittent claudication from peripheral vascular disease, when the onset of pain occured after a relatively shorter duration of exercise. It is likely that others such as anaemic, those with cerebro vascular disease and the elderly may be adversely affected by similar HbCO levels.

It has long been known that elevated levels of HbCO affected the working capacity of healthy individuals; levels of 40-50 percent are known to prevent work entirely. Recent work has shown that limitation of working capacity in healthy subjects appeared at HbCO levels of 4 percent with incapacity increasing with exposure to higher HbCO levels. A tentative range of HbCO concentrations of 2.5 - 3.0 percent is recommended by WHO as the limit for protection of the general population including those with impaired health.

Lead

The contribution of alkyl lead additives in motor fuel accounts for the major part of all inorganic lead emissions. Over 70 percent of this lead is likely to enter the environment immediately after combustion; the rest is trapped in the crank-case and in the exhaust system of the vehicle. The degree of pollution from the combustion of alkyl lead depends on the car density.

Studies have shown that 35 percent of airborne lead inhaled by man deposited in the lungs from whence it is absorbed. A major component of the lead absorbed accumulates in bones and teeth, the amount increasing throughout life. A smaller component is distributed in the soft tissues, including the blood. In the evaluation of lead exposure the concentration of lead

in the blood is relied on as an index of exposure to hazardous conditions both in the occupationally exposed and in the general population. It has been shown that, on continuous exposure, every microgram of lead per m 3 of air would contribute to an elevation of the blood level by about 1.0-2.0 micrograms/dl of blood. Elimination of lead from the body is mainly by urine (76 percent) and the gastro-intestinal tract (16 percent). A small fraction (8 percent) is excreted by sweat, the exfoliation of the skin and the loss of hair. The concentration of lead in deciduous teeth provides a useful long-term record of exposure in children; It has been shown that concentrations of lead in the dentine of sub urban schoolchildren is considerably less than that in urban children who have been exposed to higher concentrations of atmospheric lead. There is increasing interest in the possibility of using hair as an index of exposure.

The biological effect of lead have been characterised in some details; several organs and systems are known to be affected. The haemopoietic system shows effects at much lower blood levels than any other system. Lead interferes with the systhesis of haemoglobin at several enzymatic steps in the biosynthesis of haem, particularly by the inhibition of the enzymes ALAD and haem synthetse, resulting in anaemia.

Sulpher Dioxide and Particulate Matter

The emission of sulpher dioxide and particulate matter from motor vehicles is relatively small when compared to that from domestic and industrial sources.But since these emissions occur close to ground level within the breathing zone, they can contribute appreciably to the total amount inhaled. At points close to mixed traffic, smoke from diesel engines makes a a substantial contribution from petrol powered vehicles is insignificant.

Sulpher dioxide is catalysed by certain other atmospheric pollutants to form sulpher trioxide, sulphuric acid and sulphate -all of which have varying irritant effects on the respiratory system.

Inhale sulpher dioxide is highly soluble in the aquenous surfaces of the respiratory tract and is therefore absorbed in the nose and the upper air ways where it exerts its irritant effects as well; little of it reaches the lungs. In addition to irritation of the upper air ways, high concentrations can cause laryngltracheal and pulmonary oedema sometimes leading to death / Sulpheric acid mist and some sulphates are more powerful respiratory irritants than sulpher dixide and produce similar but more severe effects.

Although controlled exposures to different concentrations have shown varying effects on respiratory function, epidemilogical studies have provided much of the information concerning the effects of exposure to realistic concentrations of sulpher dioxide and suspended particulate matter. The most dramatic effects on mortality have been the sudden increases in the number of deaths that have occured during episodes of exposure in Donora in 1948 and in London in 1952. People with pre existing heart diseases and lung diseases and the elderly were the most affected. In the London episode which lasted five days about three times more than the expected number of deaths occured during and immediately after the event. The levels of sulpher dioxide and smoke were noted to have reached 3700 micrograms/m and 4500 micrograms/m respectively increaee in mortality with increases in concentration of sulpher dioxide and smoke.Evaluation of the findings from these studies has shown that increased mortality among the chronically sick could be expected starting at atmospheric concentrations of sulpher dioxide and smoke of 500 microgrammes/m and 500 microgrammes/m respectively. Morbidity studies, on the other hand have shown that worsening of the conditions of patients with pre-existing respiratory disease could be expected at sulpher dioxide and smoke concentrations of 250 microgrammes/m and 250 microgrammes respectively.

In the general population increase respiratory symptoms and decrease respiratory function as well as an increase incidence of respiratory illnesses in children have been observed. Evaluation of these studies indicate that of sulpher dioxide and smoke of 100 microgrammes/m and 100 microgrammes/m respectively.

The possibility of air pollution being a casual factor in the increased incidence of cancer of the lung has given rise to concern due to the excessive occurance of lung cancer in urban pollutions and the presence of carcinogenic substances such as polycyclic hydrocarbons in suspended particulates. Royal College of physicians reviewed this issue and concluded the evidence for it. It is now generally accepted that explained by the casual role of cigeratte smoking rather than by the presence of carcinogens in ambient air.

Motor Vehicle Population

A break up of motor vehicles according to class power sources maintained by the Department of Motor Traffic. The sole government organisation responsible for the maintenance of records legislation standards etc., in Sri Lanka is given in the

annexure for the information of the project participants. The figures available are for the ten year period from 1980 - 1989.

	Average Engine Capacity	Average travelled Km / year	Average life time
Mopeds, Tricycles, Motor Cycles	60 CC	15,000 Km.	10 years
Passenger Cars	1200 CC	36,000 Km.	15 years
Minibuses, light duty trucks, heavy duty trucks, Others	2000 CC	48,000 Km.	10 years

Contribution of each of the vehicle groups to the traffic caused pollution

Vehicle exhaust emissions have been the subject of high level legislation in Europe in the recent past. There had been concern over the effect of 'Acid Rain' and 'Ozone' and had demanded closer control over man made pollution. Combination in Automobile engines is more or less is incomplete the more polluted the exhaust will be. Total combination is generally not possible but it is possible and desireble to reduce emissions of pollutants in the exhaust emissions.

Pollutant concentrations in the exhaust are related directly to the air fuel ratio.

Spark Ignition Engine

The exhaust emission in spark ignition engines, contain both a high percentage of unharmful components as well as those harmful to the environment.The harmful components amounts to about 1% and consists carbon monxide (CO) and Nitrogen oxide (Nox) and Hydrocarbons (HC). CO could be hazardous for human blood and could cause suffocation. Nox could cause throat irritation and HC tends to irritate the eye, nose and throat.

Diesel Engines

It is a fact that much attention is paid by motor manufacturers nowadays to the diesel engines as a reult of steadily increasing petrol prices. The diesel engines also provide better fuel economy than the conventional petrol ones.

With regard to exhaust emissions, diesel engines are

said to be much preferable to spark ignition engines in terms of lesser hydrocarbons and carbon monoxide and are approximately equal in the emission of exodies of nitrogen. However, tests carried out so far have proved emission of exhaust from diesel vehicle is the biggest apparent pollution source than petrol vehicles. Nitrogen Oxide produced Nox by emissions from diesel and petrol engines are observed to be harmful for human life and trees. Ozone a product Nox is a primary cause for tree destruction and a health hazard. The diesel buses operated by the Transport Board of Sri Lanka and private bus operators are the two groups of vehicles which contributes mainly for carbon monoxide, Hydro carbon and oxides of Nitrogen.

Suppliers of Vehicles in Sri Lanka

Local Production		- Nil
Local Assembly	5%	- Indian Makes
Imported	90%	- Japanese Makes
	5%	- Other Makes

C. Fuel

The fuel supplied by the Petroleum Corporation refined at the Refinary at Sapugaskanda in Sri Lanka supplied regular Super Petrol and Auto Diesel.

It is thus apparent that excessive vehicle exhaust emissions have effect not only on health but also on economic aspects. It should be noted as well that a badly belching vehicle may also obscure visibility to the extent of increasing the likehood of traffic accidents. Exposure to carbon monoxide over a period even atlow concentrations tends to cause drowsiness and to slow down reaction times which would also contribute to road hazards. It may also be argued that the frequent occurence of badly belching vehicles may also affect tourism, standards of hygiene and other aspects which are not readily qualifiaole.

Due to high cost of unleaded gasoline the chances of importing non leaded gasoline is very low. There are no fuel production in Sri Lanka. Fuel is imported from Middle East and Eastern European countries.

D. The Organisations concerned with Motor Vehicle Pollution and their functions and Competence

In Sri Lanka there are three organisations responsible

for motor vehicle pollution control.

1. Department of Motor Traffic
2. Central Environmental Authority
3. Police Department

E. Standards that exist for the certification of the individual categories of new vehicles

- who performs certification tests

All vehicles should be tested and a fitness certificate obtained at least once a year. The fitness certificate should be produced at the Registrar of Motor Vehicles before the annual revenue licence is issued. The fitness certificate should incorporate the name of the offical who physically tested the vehicle and be displayed on the windscreen together with the revenue licence. The fitness certificate and the revenue licence should be sufficiently small so as not to obstruct vision. All buses, vans and lorries should be inspected and certified every year.

The fitness certificates are issued by licensed garages. In the inspection,precedures being incorporated are compression testing, fuel injection system and exhaust emission system.

The test procedures as laid down by the Motor Traffic Department -

Emission limits - there is no control due to lack of legislation.

Deterioration factors - due to lack of spare parts for diesel pumps.

Conformity of production testing - is attended by the Department of Motor Traffic.

Evoporative emissions - there is no legislation to control.

F. The Mandatory Inspection and Maintenance System

The mandatory inspections of vehicles are carried out by Examiners of Motor vehicle. Buses, lorries, light commercial vehicles, tractors, trishaws, motor cars, dual purpose vehicles, motor cycles and land vehicles checked at the first registration.

Certificates of Fitness are issued to commercial vehicles only by the approved examiners and Examiners of Motor Vehicles issue certificate of fitness of government vehicles.

G. Vehicle Inspection for Road Worthiness

Road side checks are carried out by Examiners of motor vehicles in collaboration with the Police Department mainly on commercial vehicles regarding the road worthiness of these vehicles and prohibition notices are issued. These vehicles are expected to be repaired and produced within a specific period and prohibition notice is revoked thereafter. The Police Department prosecute these owners of defective vehicles. Penalties are imposed for these offences and the fines go upto Rs. 200/-.

Part IX of the Motor Traffic Act of Sri Lanka provides for the issue of orders of prohibition under sections 194 (2),197 (5), 198 (2) and 201 (2). Such orders of prohibition make it an offence to use the vehicle while the order is in force. However, there is no compulsion for the owner to repair such a vehicle within a specified period or to repair it at all. Therefore it would be possible for the owner to use the vehicle from time to time without detection despite it being under an order of prohibition. Unless the vehicle is detected while being used on the road no action could be taken regarding the failure to rectify the defects specified in the orders of defective vehicles on the road. This has been observed to be on of th cause for fatal accidnts. Hence it is necessary that stringent measures be made to ensure that such vehicles are repaired and examined for road worthiness.

Approval.is therefore sought to take provision in Part IX of the Act to enable the Police to prosecute the owners if the vehicle has not been repaired within the period of two months from the date of the order of prohibition and to enable the Commissioner of Motor traffic to cancel the registration of a vehicle if repairs have not been completed within six months from the date of the order of prohibition.

Recently there has been a marked increase in crimes involving motor vehicles. These are used by criminals and they are also stolen or hyjacked. Section 200 of the Act empowers a Police officer not below the rank of a sergeant to request the person in charge of a lorry or motor tricycle van to produce certain documents, which are required by regulations to be carried in such a vehicle. Regulations could be made under section 200 only in respect of lorries or motor tricycle vans. It is desirable that documents establishing the ownership of the vehicle should be available for immediate inspection by a Police Officer. Therefore approval is required to amend section 200 to:

(a) Empower any Police Officer to take action under this action.

(b) Make a requirement applicable to all classes of motor vehicles and

(c) Require the Certificate of Registration or an extract of the vehicle register issued under Section 17 of that to be carried in the vehicle at all times and made available for inspection by Police Officers.

G. The Basic Problems of Motor Vehicle Pollution Control

This matter has already being discussed in the first page

I. Action taken to prevent the problem of Pollution

In addition to smoke, the exhaust emission may contain carbon monoxide, hydrocarbon particulates, oxide of sulpher, oxides of nitrogen, lead etc. At present criteria of excessive of exhaust emission are those of obscuring visibility while evidence may be obtained by holding a blotting paper to the exhaust emission.

It is recommended that initially some smokemeters be imported for the use of the Department of Motor Traffic, Police Department, SLCTB, Department of Private Omnibus Transport and the Ceylon German technical Training Institute. Preferably these instruments should be of the same make and model to facilitate the setting of standards, training in use etc. Once adequate experience with these instruments is obtained in Colombo further smokemeters may be considered necessary for use in the outstations.

While much improvement of the existing situation should be possible with the use of smokemeters consideration should be given as the next stage for the purchase of equipment to measure rapidly and reliably other selected pollutants such as carbon monoxide. Suitable standards would need to be laid down and staff trained in the operation of these instruments. The instruments may be used for testing in the field and in garages.

Exhaust gas composition is influenced greatly by the shape of combustion chamber, by the valve controls and timimg engine speed, type and quality of fuel used. Tests have proved that spark ignition when fuel injection systems are used, eject less CO than engines with carburators. The percentage of polluted components in exhaust gases could be reduced by a pre set timing, keeping in mind when the engine is under no lead conditions the throttle valve is almost closed and prevents sufficient supply of fresh mixture entering the combustion chamber.

This mixture being too rich and the combustion will be incomplete and misfiring will take place making the exhaust gas to carry high percentage of pollution which drops down by opening the throttle gradually.

This can be avoided if the timing could be set in retard position i.e. about 10 percent after TDC. By this method more heat will be developed in the combustion chambers and thereby help to have complete combustion and to reduce the contents of pollutants in the exhaust gases.

J. The benefits that could be achieved of a project of this nature is to arrive at a common formula

An immediate need is to find practical solutions to the above by utilisation of the resources within the region to the best advantage of all member countries with the sponsorship of the donor organisation .

(a) The training of minimum of four technical officers in advance pollution monitoring and control techniques with the view of setting up nucleus for training and equipping individual divisions throughout the Island for pollution control. Besides regular monitoring and upgrading of the different units could be achieved through this nucleus.

(b) The regional Co-operation Project could also provide the necessary guidelines and assistance for the setting up of a regulatory authority which could promulgate the necessary legislation and act as the policy implementation unit in the enforcement of these pollution control measures.

(c) The required analytical apparatus could be provided in the donorship programme with provision for complete back up services for continued calibration and maintenance of this equipment.

(d) Simultaneously a public awareness programme must be launched to make vehicle owners aware of the far reaching consequences of pollution, that would eventually affect the entire balance of nature.

The Commissioner of Motor Traffic in Sri Lanka should decide in consultation with the Ministry of Transport and Highways of Sri Lanka, national counterpart support for regional project policy matters.

D.D.J.Wijesundara,
Commissioner,
Department of Motor Traffic,
Sri Lanka.

New Registrations - 1980-88 (According to Class of Vehicles)
Department of Motor Traffic.

Class of Vehicle	1980 No	1981 No	1982 No	1983 No	1984 No	1985 No	1986 No	1987 No	1988 No	1989 No
Private & Hiring Cars, Car Trailers	6,730	5,760	5,667	5,470	5,115	6,977	7,297	7,695	8,071	8,772
Motor Cycles	34,725	17,160	10,847	14,431	16,873	22,782	26,593	29,041	27,837	66,696
Private buses	2,658	2,330	96	99	62	91	72	87	89	56
Hiring buses	-	-	2,437	3,649	3,864	3,462	1,709	1,054	774	388
SLCTB	788	24	555	521	325	95	254	85	245	290
Dual Purpose Vehicles	-	-	-	-	-	1,121	3,892	3,234	3,002	3,149
Lorry Tractors	9,323	7,795	6,342	8,125	8,095	7,098	3,247	2,846	2,430	2,414
Lorry Trailers	39	1	2	4	-	1	-	-	-	-
Lorry Other	156	194	103	58	126	103	96	9	30	19
Ambulances	90	56	12	4	14	14	7	46	29	24
Hearses	15	31	18	17	12	5	8	49	7	12
Land Vehicles	5	5	9	10	5	4	9	1	9	2
Land Trailers	2,734	733	600	521	635	664	542	666	50	462
Land Other	3,695	503	503	711	718	543	582	667	371	319
TOTAL	2,818	2,290	2,290	3,356	3,007	2,942	2,566	1,400	1,462	1,872
	53,776	37,391	29,481	37,175	38,863	45,903	46,974	46,884	44,825	84,245

Department of Motor Traffic - Total Vehicle Population (According to class of vehicles)

Class of Vehicle	1980 No.	1981 No.	1982 No	1983 No.	1984 No	1985 No	1986 No	1987 No	1988 No.	1989 No.
Motor Cars	120,273	126,256	131,657	136,853	141,730	148,587	155,224	147,837	155,194	163,779
Motor cycles	79,803	96,856	107,545	121,840	138,632	161,373	187,717	213,441	240,869	307,392
Private Buses	5,752	8,068	96	195	257	348	420	507	596	650
Hiring buses	-	-	10,497	14,143	17,999	21,445	23,024	23,408	24,011	24,323
SLCTB	15,000	15,024	15,579	16,100	16,425	16,516	16,770	13,149	13,370	13,630
Dual Purpose Vehicles	-	-	-	-	-	1,121	5,013	8,247	11,249	14,397
Lorry Proper	55,838	63,479	69,705	77,714	85,701	92,730	95,530	92,998	94,983	97,159
Lorry Tractor	1,245	1,246	1,248	1,252	1,252	1,253	1,283	1,283	1,271	1,27
Lorry Trailer	3,088	3,282	3,385	3,443	3,571	3,674	3,770	3,579	3,609	3,62
Lorry Other	364	420	432	436	450	622	471	517	546	570
Ambulances	540	570	588	605	617	622	630	678	685	697
Hearses	93	88	97	108	112	116	125	126	135	137
Land Vehicle Tractors	37,588	40,661	43,539	47,616	51,278	54,856	58,050	59,390	61,717	64,008
Land Vehicle Trailers	17,209	181,145	18,646	19,357	20,075	20,618	21,195	21,825	22,138	22,417
	337,382	374,110	403,014	439,661	478,099	523,723	569,222	587,515	630,373	714,058

Colombo.

ANNEX 10

MOTOR VEHICLE EMISSIONS IN THAILAND

by

Mr. Suvidh Voravisuthikul

Transport Engineering Div.
Land Transport Department

Mr. Santad Koompalum

Office Of The National Environment Board

ABSTRACT

Air pollution situation in Thailand is serious in Bangkok and major cities, from the high levels of particulate matter, carbonmonoxide and hydrocarbon. Lead level has been relatively constant despite the increasing use of gasoline, due to the government's reduction of lead in the fuel.. This report shows the motor vehicle emissions problem in Thailand and the ways that government performs to solve the problems.

INTRODUCTION

The situation of air pollution in Thailand is considered critical in Bangkok and major cities. The recent surveyed conducted by JICA in 1987 revealed that the particulate matter in Bangkok consisted of about

40% black smoke from Diesel-engine vehicles, which was the largest contributor. In addition, surveys conducted by ONEB's air quality monitoring stations located in Bangkok have particulate matter at an annual average of more than 100 micrograms per cubic metre, which is the ambient air quality standards of Thailand.

The cause of air pollution described is motor vehicles, and in Bangkok alone there are about 1.8 million of them on which about 80 thousand are two strokes engine motorcycles. With the traffic congestion problem and the annual increase of new motor vehicles including about 450,000 motorcycles from 5 manufacturers and 144,300 cars from 12 manufacturers per year. In addition, lack of proper inspection for emissions from these motor vehicles, poor maintenance and operation of the engines, the air pollution condition are already considered serious.

MOTOR VEHICLE POPULATIONS
(As of Dec. 31, 1989)

TYPE OF MOTOR VEHICLE	BANGKOK METROPOLIS	OTHER PROVINCES	WHOLE KINGDOM
ALL TYPE	1,721,586	4,783,434	6,505,020
MOTORCYCLES (incl. 3-wheelers)	644,597 (8.000)	3,508,403	4,153,000 (60.000)
TRUCKS AND BUSES	77,568	289,338	366,906

REGULATIONS AND ORGANIZATIONS CONCERNED WITH MOTOR VEHICLE EMISSIONS

All motor vehicles, under the Land Transport Act, must be registered and inspected by the Department of Land Transport, Ministry of Communications. Buses, trucks and commercial cars will have to undergo inspection

including the black smoke and carbon monoxide.

For motor vehicles under Motor Vehicle Act, are not required to have inspection except for motor vehicles which have not renewed their registration for more than one year, taxi, public motor tricycle, business service car, chartered vans and for hire car.

In use motor vehicles on street are subjected to random spot checks, conducted by the police and Land Transport Department; the violated vehicles in black smoke for Diesel-vehicles or carbonmonoxide for gasoline-vehicles face a fines of 500 BAHT and vehicles must be corrected before the fines are payable. For motorcycles, a fine of 100 BAHT is enforced. At the present, there are about ten random check points per day and more than 20 thousand arrests have been made last year.

EMISSION STANDARDS

POLLUTANT	TEST MODE	LIMITS
BLACK SMOKE	RAPID FREE-ACCELERATION	50% BOSCH UNIT
CARBON MONOXIDE	IDLE	6%

The fuel quality is regulated by the Ministry of Commerce, the specifications of fuel are shown in the table:

GASOLINE	RON	LEAD CONTENT
LEADED REGULAR	83	0.4 g/l (0.15 g/l in 1993)
LEADED PREMIUM	95	0.4 g/l (0.15 g/l in 1993)

DIESEL	CETANE NUMBER	SULFUR CONTENT
LIGHT OIL	47	0.5%

MEASURES CONCERNED WITH EMISSIONS PROBELMS

Due to lack of manpower and instruments to control the air pollution from vehicles, office of the national environment board in 1987, aiming at facilitating the Department of Police and the Department of Land Transport to be able to annually inspect every vehicles and conduct more spot checks on road asked for the approval of the cabinet in the 3-year action plan to solve air pollution from motor vehicles. The cabinet approved the plan on March 17, 1987 and the concerned authorities have received additional manpower and instruments. Even thought the present facilities are still inadequate, more attempts are being made to control the black smoke and carbon monoxide.

CONCLUSION

It is not possible to solve the air pollution problem in the country without cooperation from the public. The year 1989 have been designated by the government to be the year for protection of the environment. The theme is on atmospheric pollution with some emphasis on global change. Public campaign has been launched on black smoke and carbonmonoxide from motor vehicles. Even as the economic growth in the country has been rising more than 10 percent in the past three years, with even greater growth rates of motor vehicles, transportation and industry in the cities and countryside, the air pollution in Thailand and Bangkok is not proportionally increased. The government is taking the right direction

by facing the problem with may produce the actual decrease of pollution in the next few years. Some pollutants, however, will be more difficult to solve. Suspended particulate matter will still be a major problem until the traffic problem can be solved.

ANNEX 11

Expert Group Meeting
on
Control and Regulatory Measures concerning
Motor Vehicle Emission
Seoul, Republic of Korea
21 - 24 August 1990

Vehicle Emission Control in Hong Kong

LING Wai-ming
Environmental Protection Department
Hong Kong Government

Introduction

1. Hong Kong has a population of about 5.8 million at the end of 1989. The land area is 1074 square kilometers, much of which consists of steep hills and uninhabited islands. The area of developed land is only 143 square kilometers. Hence, Hong Kong contains some of the highest density residential areas in the world.

2. There are a number of pollution problems encountered in Hong Kong in respect to air, noise, waster and water as a consequence of, coupled with geographical constraints, the community services and economic activities. The air pollution problem caused by vehicle emission in Hong Kong is considered to be quite unique, on which is this country paper focused.

Vehicle Emissions in Hong Kong - Facts and Figures

3. The total motor vehicle population in Hong Kong is about 350,000 in mid 1990. Running on roads are all imported vehicles powered by either petrol or diesel engines. There are a few electric vehicles but they are not yet market viable. There is no vehicles powered by LPG/LNG or dual-fuel engines in Hong Kong.

4. The ratio of petrol to diesel-engined vehicle population is approximately 10:6. The overall average kilometer travelled per year per vehicle is 19500, of which, in contrary to the population ratio, 35% is done by petrol-engined vehicle while the remaining 65% is done by the diesel-engined vehicles. The petrol-engined vehicles are essentially private passenger cars and motor cycles. About 10% of light goods vehicles are powered by petrol engines. The diesel-engined vehicles are taxis, public light buses, goods vehicles, coaches and city buses. The growth rate for passenger vehicles is about 8% per annum and that of good vehicles is 10% per annum. The growth in motor vehicles is illustrated in Annex I.

5. Hong Kong has three major air pollution problems: sulplur dioxide, nitrogen dioxide and respirable suspended particulates. They have all exceed the limits set in the air quality objectives for

Hong Kong. Motor vehicles are a major source for the latter two. Motor vehicles emit about 75% and 45% of the NOx and RSP emission respectively, and diesel-engined vehicles are the main culprit, as illustrated in Annex II. Based on measured levels of air pollutants over the last three years, as rough estimations, reductions of 60% of NOx and 30% of RSP in total emissions from all sources are required to achieve the objectives. The air quality objectives are shown in Annex III.

Control of Motor Vehicle Emission in Hong Kong

6. The Secretary for Planning, Environment and Land (SPEL) of Hong Kong Government has overall responsibility for policy on environmental protection. He receives assistance in the formulation of new policies and programmes from his colleagues in Environmental Protection Department (EPD). There is also a statutory consultative body on environmental matters - the Environmental Pollution Advisory Committee (EPCOM). The making of new legislation in Hong Kong requires the approval by the Executive Council and/or the Legislative Council.

7. In addition to its responsibilities for formulating policy proposals for consideration by SPEL, the EPD is responsible for enforcing environmental legislation, for monitoring environmental quality, for drawing-up plans for the treatment and disposal of all types of wastes and for advising on the environmental implications of town plans, large new industrial developments and any other major developments, as well as providing a centralised complaints and enquiries service. Several other Government departments play also a role in protecting Hong Kong's environment. The Government structure for air quality management is shown in Annex IV.

8. Current measures to control motor vehicle emission are provided under the Road Traffic (Construction and Maintenance of vehicles) Regulations, which require vehicles to meet exhaust emission standards of the Economic Commission for Europe, UK, USA or Australia and in addition, smoke emissions of in-use vehicles should not exceed 60 Hartridge Smoke Units. The controls of vehicle smoke emissions are exercised through a spotting and call-up/inspection scheme using spotters drawn from the community as well as the police and the EPD staff.

9. Concerning motor vehicle emission control over the next 10 to 20 years, amongst other pollution controls, the Government has set out a more strategic approach in the White paper, a government policy paper, "Pollution in Hong Kong : A Time to Act" published on the 5th June 1989. The White Paper recognised the need for a new attack on vehicle emissions, and outlined a four-point strategy as follows:

- introduction of unleaded petrol (ULP) as soon as possible;
- stringent emission standards for new petrol and diesel vehicles;
- measures to reduce reliance on diesel vehicles; and
- a stronger vehicle smoke control programme.

10. Work began in the second half of 1989 to develop detailed proposal to implement this strategy. The respective discussions and consultations with the oil industry and motor traders in Hong Kong have revealed that there will be no major difficulties in supplying ULP by April 1991 and the subsequent introduction of new emission standards in January 1992. Stronger vehicle smoke control programme is to be achieved by incoporating the established private car

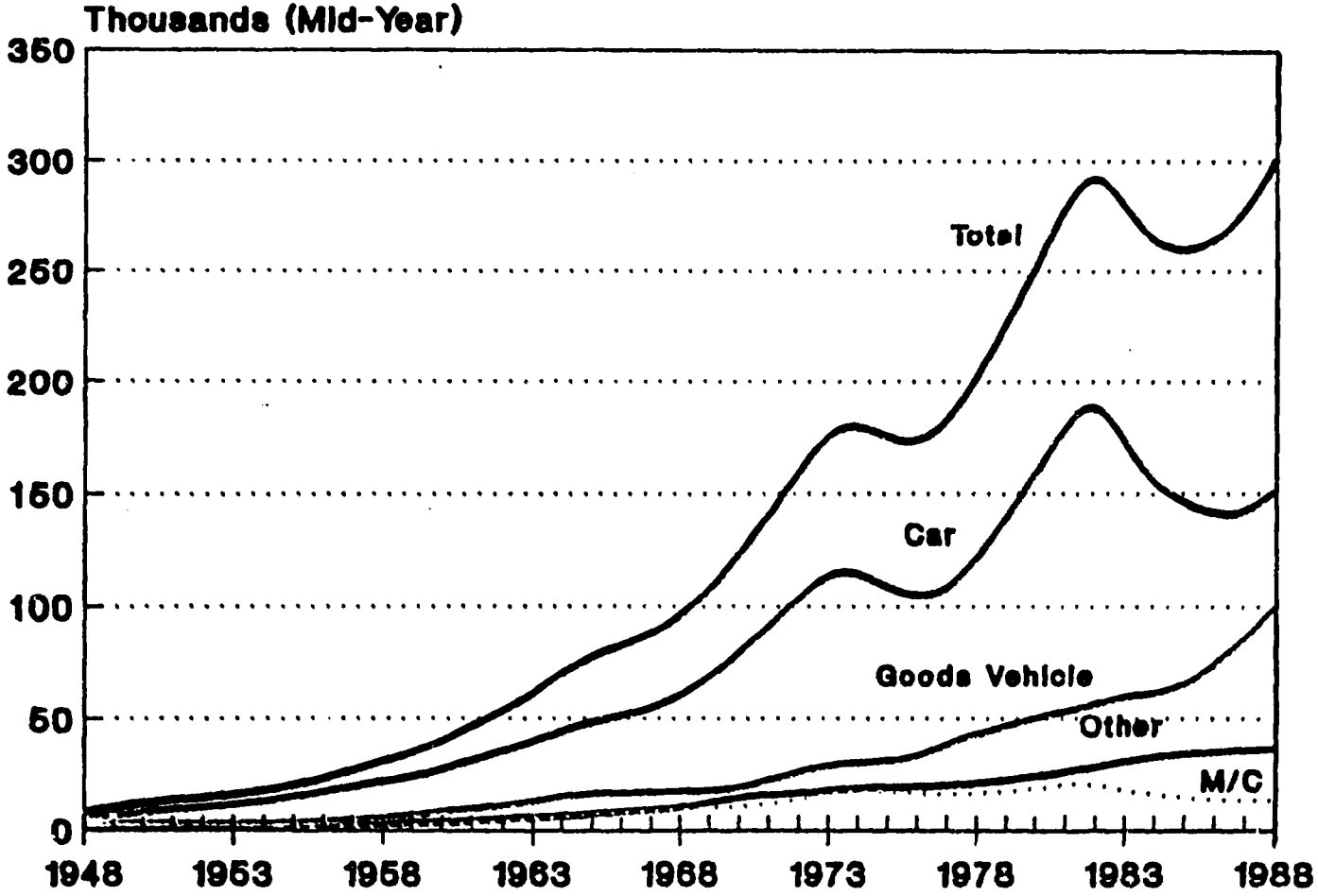
service centres into the legal inspection scheme to provide more testing resources in order to have the smoky vehicles be inspected at the earliest opportunity. Legislative procedures are being taken to amend the Air Pollution Control Ordinance and the Road Traffic Ordinance to provide necessary legal powers. (At present, the Air Pollution Control Ordinance has the provisions only for controlling the stationary sources).

11. The specification of unleaded petrol proposed is 13 mg/L of lead maximum and a Research Octane Number (RON) of not less than 95, amongst other usual petrol specification items.

12. The new vehicle emission standards proposed for light duty vehicles are those in USA regulations, 1984 and Japanese regulations, 1978 or equivalent level of requirements.

Regional Approach in Motor Vehicle Emission Control

13. Hong Kong is very interested in a regional approach in motor vehicle emission control. For instance, common standards in fuel and emissions and common certification system can help to reduce the cost of production, besides to attain the environment compatibility. It will then help to enhance the standard of living of the people and simplify the administrative procedures. Exchange of information and experience as well as transfer of technology at regional level are also useful for the further development of motor vehicle emission control.



GROWTH IN NUMBER OF VEHICLES

ANNEX II

	Licensed Vehicles	Vehicle Kilometres Travelled (VKT)	Emission NOx	Emission RSP
Petrol-engined	62%	35%	18%	2%
Diesel-engined	38%	65%	82%	98%

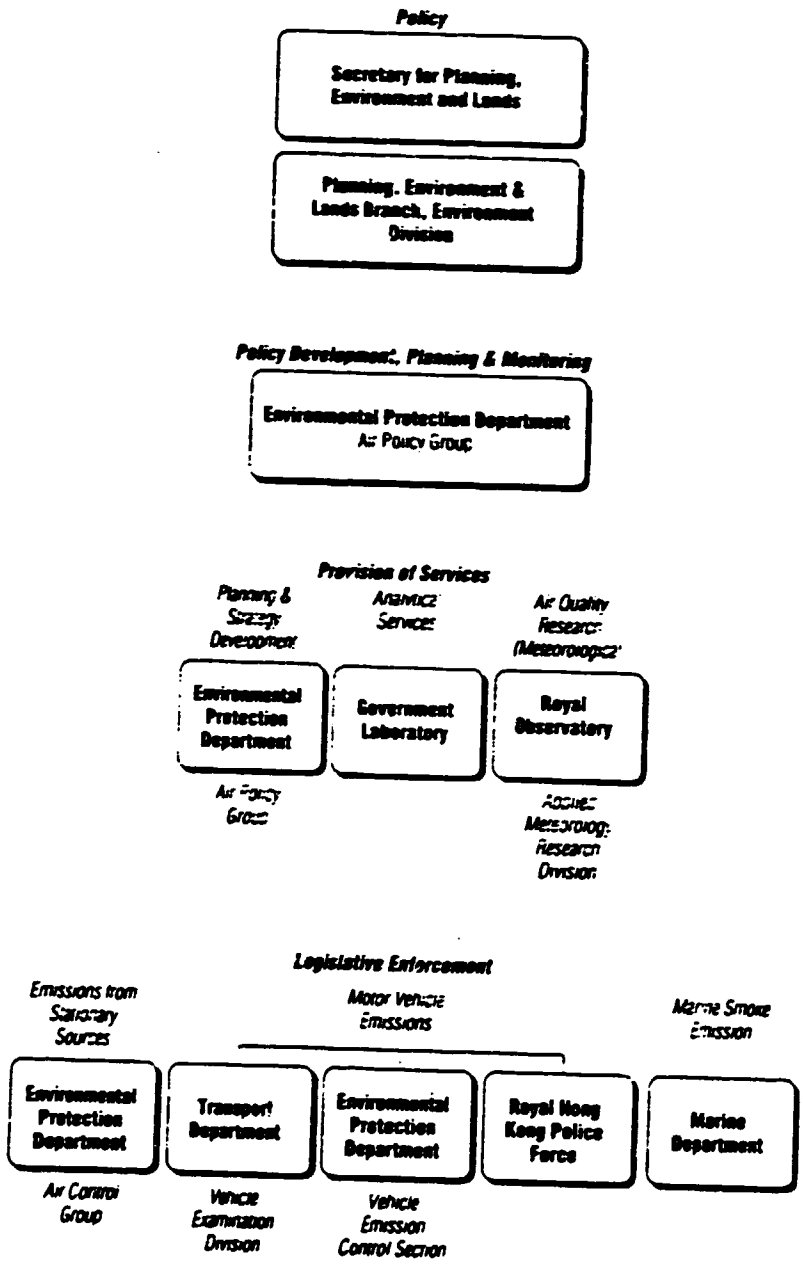
EMISSIONS FROM PETROL-ENGINED AND DIESEL-ENGINED VEHICLES

Pollutant	Concentration in micrograms per cubic metre (i) Averaging Time					Health effects of pollutant at elevated ambient levels
	1 hour (ii)	8 hours (iii)	24 hours (iii)	3 months (iv)	1 year (iv)	
Sulphur Dioxide	800		350		80	Respiratory illness; reduced lung function; morbidity and mortality rates increase at higher levels.
Total Suspended Particulates			260		80	Respirable fraction has effects on health.
Respirable Suspended Particulates (v)			180		55	Respiratory illness; reduced lung function; cancer risk for certain particles; morbidity and mortality rates increase at higher levels.
Nitrogen Dioxide	300		150		80	Respiratory irritation; increased susceptibility to respiratory infection; lung development impairment.
Carbon Monoxide	30000	10000				Impairment of co-ordination; deleterious to pregnant women and those with heart and circulatory conditions.
Photochemical Oxidants (as ozone) (vi)	240					Eye irritation; cough; reduced athletic performance; possible chromosome damage.
Lead				1.5		Affects cell and body processes; likely neuropsy-chological effects, particularly in children; likely effects on rates of incidence of heart attacks, strokes and hypertension.

(i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.
(vi) Photochemical oxidants are determined by measurement of ozone only.

AIR QUALITY OBJECTIVES

ANNEX IV



HONG KONG GOVERNMENT STRUCTURE
FOR
AIR QUALITY MANAGEMENT

COUNTRY PAPER FOR INDIA FOR THE EXPERT GROUP MEETING ON CONTROL AND REGULATORY MEASURES CONCERNING MOTOR VEHICLE EMISSIONS AT SEOUL DURING 21-24 AUGUST, 1990

BY

S RAJU
DEPUTY DIRECTOR
THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA
PUNE, INDIA

BACKGROUND

A. CONTRIBUTION OF MOTOR VEHICLES TO TOTAL MANMADE POLLUTION :

For a large country like India, this type of data will vary from city to city. Coordinated effort to collect data of this nature is still on the way. But data on ambient air quality at major cities such as Delhi, Bombay, Calcutta, Madras etc., is being collected.

B. MOTOR VEHICLE POLLUTION :

1)

	TOTAL NO.	% POWERED BY			
		GASOLINE	DIESEL	LPG	OTHERS
Mopeds	3,000,000	100	-	-	-
Motorcycles, Scooters	6,000,000	100	-	-	-
Three-wheelers	450,000	95	5	-	-
Passenger-Cars	1,500,000	90	10	-	-
LCVs	650,000	35	65	-	-
HCVs	1,000,000	-	100	-	-
TOTAL	12,600,000				

2)

	AVERAGE ENGINE CAPACITY IN CC	AVERAGE TRAVEL KM/YEAR	AVERAGE LIFE TIME IN YEARS
Mopeds	50	5,000	8
Motorcycles/Scooters	150	10,000	12
Three-wheelers	175	50,000	6
Passenger Cars	1000	20,000	15
LCVs	3000	50,000	10
HCVs	6000	100,000	10

3) ESTIMATED VEHICLE PRODUCTION IN 1989 :

Mopeds	--	600,000
Motorcycles/ Scooters	--	1,200,000
3-wheelers	--	65,000
Passenger Cars	--	200,000
LCVs	--	100,000
HCVs	--	85,000
TOTAL	--	2,250,000

Production growth rate is estimated at 15%.
Population growth rate is estimated at 17%.

4) CONTRIBUTION OF EACH OF THESE VEHICLE GROUPS TO THE TRAFFIC CAUSED POLLUTION :

	CO	HC	NOx	PM	SO2
2-wheelers	45%	50%	-	-	1%
3-wheelers	15%	20%	-	-	1%
Passenger-Cars	30%	15%	8%	-	2%
Diesel	15%	15%	92%	100%	96%

C. FUEL

1) GASOLINE :

- 87 RON

- 0.45 g/l lead

- Price = US $ 0.6/l

LPG is not used.

2) DIESEL :

Cetane No. : around 50

Sulpher Content : not more than 0.5%

Price : US $ 0.2/l

3) FUEL SUPPLY :

Local production - about 35%

Imported from - Middle East, USSR

Unleaded gasoline is planned to be introduced from 1995 or so.

Low sulpher content diesel plans are yet to be finalised.

D) ORGANISATIONS CONCERNED WITH MOTOR VEHICLE POLLUTION AND THEIR FUNCTIONS AND COMPETENCES :

1) Ministry of Surface Transport
Transport Bhavan
Parliament Street
New Delhi - 110 001

Mr.P.A. Abraham, Secretary

Mr. B.R.Chavan, Jt. Secretary, Tel. No. 3711873

2) Ministry of Environment & Forests
Paryavaran Bhavan, C.G.O. Complex
Lodi Road
New Delhi - 110 003

Mr.Mahesh Prasad, Secretary

Mr.Mukul Sanwal, Jt. Secretary, Tel. No. 360894

3) Ministry of Indusrry
Udyog Bhavan
New Delhi - 110 011

Mr. N.Verma, Secretary

Mr. N.K.Sabharwal, Jt. Secretary

4) Central Pollution Control Board
(Ministry of Environment & Forests)
Parivesh Bhavan
C.B.D.-cum-Office Complex
East Arjun Nagar
Delhi - 110 032

Dr.K.R.Ranganathan, Member Secretary, Tel No. 2217213

5) The Automotive Research Association of India
Post Box No.832
Pune - 411 004
INDIA

Dr.Pramod A.Paranjpe, Director, Tel No. 331284

Mr.S.Raju, Deputy Director, Tel No. 337180

E. WHICH STANDARDS DO EXIST FOR THE CERTIFICATION OF THE INDIVIDUAL CATEGORIES OF NEW VEHICLES ?

- Who performs certification tests
- Test procedures
- Emission limits
- Deterioration factors
- Conformity of production testing
- Evaporative emissions

1) India is federal. Different states have different motor vehicle rules. Recently the Central Government has enacted a revised Motor Vehicles Act, in which emissions has become a centre subject and it has enacted acts and rules prescribing emission standards. Detailed technical procedures and implementation modus-operandi are being worked out.

2) Idling CO check for petrol vehicles and smoke check for diesel vehicles has been in force in a number of states from 1986. From 1990, these have become mandatory throughout India for new and in-use vehicles. Limits for mass emissions and full load and free acceleration smoke, in addition, will become effective from 1991. Mass emissions for diesel vehicles will become effective from 1992. Details are given in Annexure I.

3) The limits and test procedures for petrol vehicles have been adopted from ECE - R15-04, but modified using an Indian driving cycle, while smoke and mass emissions for diesel vehicles have been adopted from ECE - R24 and 49.

4) At present, no evoparative emissions and deterioration factors/ endurance tests have been prescribed.

5) Conformity of Production tests have been prescribed.

F. WHAT KIND OF MANDATORY INSPECTION/MAINTENANCE ARE THERE ?

- Who checks the vehicles (e.g. licensed workshops)

- Which vehicles are checked

- How often are they checked

- What is checked

1) Annual maintenance check including emission paraneters such as idling CO and smoke by free acceleration by authorised service stations is also envisaged. The details are being worked out.

2) These are to be inspected by Road Transport Authorities under the Ministry of Surface Transport.

G. WHAT KIND OF ROAD SIDE TESTS ARE BEING PERFORMED ?

- Who performs such tests

- Which vehicles are checked

- What is checked

- What penalties have to be paid in case of failure

1) At present, the recent Motor Vehicle Act enables a Traffic Police and Local Vehicle Inspector to check all classes of road vehicles for idling CO for petrol and smoke by free acceleration/full load for diesel vehicles. In cases of failure, fines upto Rs.1,000/- (US $ 60.00) can be levied.

2) However, this is under review. This may be changed that in case of failure, the owner may be asked to adjust the settings and produce a emission certificate from an authorised service station. The fine may be levied, in case he fails to do so.

H. WHAT ARE THE BASIC PROBLEMS OF MOTOR VEHICLE POLLUTION CONTROL ?

1) As explained above, the legislation has planned to start with the onus on the owner. Now it is being reviewed. The onus of the emission control is being shifted to the manufacturers with the type approval and conformity of production checks to be introduced from 1991/1992. However, the onus of maintenance of the vehicle has to be with the owner and this is to be checked during annual maintenance and if needed by road side vehicles.

2) The basic problems of motor vehicle pollution control are :

   i) This calls for continuous and close monitoring of ambient air quality and contribution by motor vehicles and their effects. This also involves emission inventory, simulation models and prediction of the effect of the control measures. A highly technical agency with adequate funding has to be created.

ii) The control systems and modus-operandi are new to everyone concerned - the rule making authorities, implementation authorities and enforcement agencies, the vehicle manufacturers and users. Hence, considerable effort is needed to get educated and educate others in various aspects of emission control.

iii) This involves many groups of people with diverse interests - vehicle manufacturers, users, oil companies, environmentalists, burcaucrats, technical agencies, consumer groups, politicians etc. It takes a very long time to arrive at solutions meeting diverse and many times conflicting view points leading to compromises.

iv) Emission control is complicated, multi-disciplinary and expensive in terms of facilities and expertise.

v) Practical implementation takes long time and calls for well planned long term strategies.

vi) This requires extensive education and training of the various agencies involved.

I. WHAT ACTIONS ARE UNDERWAY TO ADDRESS THESE PROBLEMS ?

1) The necessity of such an agency is being mooted. International assistance - both in terms of funds and expertise will be useful.

2) Efforts are on way to gather experience and also by exchange of information such as Environmental Protection Agency of the USA, Department of Environment of FRG, Japan Automobile Standards Internationalization Center etc. Control techniques are planned to be developed, by indigenous R&D, technical consultancies and collaborations. Experience and information sharing in implementation and enforcement techniques with other countries at this stage, will be of very much use.

3) The process of getting collective opinion on the subject and appointment of a Standing Committee at a national level is in progress.

4) Emission control measures are introduced at a level, commensurate with the absorption level.

5) Long term strategies are being worked out.

6) Plans for education and training are on way.

J. INTEREST IN A REGIONAL PROJECT :

What benefits could generally be achieved by such a project ?

Regionally :

- information exchange
- experience exchange
- transfer of technology

- common standards for certification
- common mandatory inspection/maintenance systems
- common acceptance of certification tests
  common standards for fuel quality
- practical policy recommendations
- implementation of a regional network for coordination and cooperation
- others

Which is (are) the most important objective(s) among the above, the regional project should focus on ?

Who would be the direct and the indirect beneficiaries of this project ?

1) In the order of priority, in our opinion :

   i) Experience exchange

   ii) Information exchange

   iii) Practical policy recommendations

   iv) Common standards for certification

   v) Common acceptance of certification

   vi) Implementation of a regional network for coordination and cooperation

2) Beneficiaries :

   Direct -

   The pollution control enacting and implementing agencies such as Department of Environment, Pollution Control Boards and technical agencies like Automotive Research Association of India.

   Indirect -

   The whole population because of cleaner environs.

K. NATIONAL COUNTER PART SUPPORT FOR A REGIONAL PROJECT :

- Which of the national organisations and which persons within these organisations could be the national focal point for the network to be established ?

  In India : Department of Environment through Director, The Automotive Research Association of India.

- Would this organisation require any support from UNIDO ? If so, what type ?

  Yes - financial

- Which country should be the host of the network ?

  Japan / INDIA

- What contributions are expected from the host country in terms of space, equipment, and manpower ?

  Manpower and Experts

- Is there any link to other recent or present national or regional projects ?

  Yes, it can be a follow-up project of the UNDP/GOI Project 'IND/85/070 Establishment of Automotive Emission Certification Laboratory.'

****

DRAFT GAZETTE NOTIFICATION - SCHEDULE IV (SEE RULE 3)

Standards for emission of smoke, vapour etc. from motor vehicles :

1) Every motor vehicle shall be manufactured and produced so that they will meet the requirements specified below.

2) On and from the 1st day of March, 1990, every motor vehicle shall be so manufactured and produced that they will comply with the following standards :-

a) The carbon mono-oxide (CO) emission of petrol vehicles offered for type approval and selected for conformity of production, when tested as per details given in Annexure I, should not exceed 3% by volume in the case of four wheeled vehicles and 4.5% by volume in the case of two and three wheeled vehicles.

b) The emissions of visible pollutants from diesel vehicles, offered for type approval and selected for conformity of production, when tested as per details given in Annexure II in terms of smoke density when expressed as light absorption coefficient, shall not exceed 2.45/m when checked by free acceleration method and 3.25/m when checked by full load method. The requirements as per free acceleration method are not applicable for vehicles with turbo/super charged engines.

Details of requirements and certification procedures for type approval and conformity of production and test procedures are given in Annexure I for petrol driven vehicles and Annexure II for diesel driven vehicles.

This clause 2(a) will be superceded by the new emission requirements of petrol vehicles from 1st April, 1991, by clause (3) of this Schedule and for diesel vehicle by clause (4) of this schedule.

3) On and from the 1st day of April, 1991, all petrol driven vehicles shall be so manufactured and produced that they will comply with the following standards, when tested as per details and procedures given in Annexure III.

a) Type I Test (verifying the average emissions of gaseous pollutants)

i) Type Approval Test :

A) Two and Three Wheelers

Reference Mass, R(kg)	CO(g/km)	HC(g/km)
1	2	3
$R < 150$	12	8
$150 < R < 350$	$12 + \frac{18(R-150)}{200}$	$8 + \frac{4(R-150)}{200}$
$R > 350$	30	12

B) Four Wheelers

Reference Mass, R(kg)	CO(g/km)	HC(g/km)
1	2	3
R < 1020	14.3	2.0
1020 < R < 1250	16.5	2.1
1250 < R < 1470	18.8	2.1
1470 < R < 1700	20.7	2.3
1700 < R < 1930	22.9	2.5
1930 < R < 2150	24.9	2.7
R > 2150	27.1	2.9

ii) Conformity of Production Tests

A) Two And Three Wheelers

Reference Mass, R(kg)	CO(g/km)	HC(g/km)
1	2	3
R < 150	15	10
150 < R < 350	$15 + \frac{25(R-150)}{200}$	$10 + \frac{5(R-150)}{200}$
R > 350	40	15

B) Four Wheelers

Reference Mass, R(kg)	CO(g/km)	HC(g/km)
1	2	3
R < 1020	17.3	2.7
1020 < R < 1250	19.7	2.7
1250 < R < 1470	22.5	2.8
1470 < R < 1700	24.9	3.0
1700 < R < 1930	27.6	3.3
1930 < R < 2150	29.9	3.5
R > 2150	32.6	3.7

b) Type II Test (Test for carbon monoxide emissions at idling speed)

- both for type approval and conformity of production.

The carbon monoxide content by volume of the exhaust gases emitted with the engine at idling speed must not exceed 3.0% for four wheelers and 4.5% for two and three wheelers.

4) On and from the 1st day of April, 1991, all diesel driven vehicles shall be so manufactured and produced that they will comply with the following standards for visible pollutants, emitted by them, when tested as per the details and procedures given in Annexure IV.

a) The emissions of visible pollutants shall not exceed the limit values of smoke density, when expressed as light absorption coefficient given below for various nominal flows, when tested at constant speeds over full load :

Nominal Flow G (l/s)	Light Absorption Coefficient K (1/m)	Nominal Flow G (l/s)	Light Absorption Coefficient K (1/m)
< 42	2.00	120	1.20
45	1.91	125	1.17
50	1.82	130	1.15
55	1.75	135	1.13
60	1.68	140	1.11
65	1.61	145	1.09
70	1.56	150	1.07
75	1.50	155	1.05
80	1.46	160	1.04
85	1.41	165	1.02
90	1.38	170	1.01
95	1.34	175	1.00
100	1.31	180	0.99
105	1.27	185	0.97
110	1.25	190	0.96
115	1.22	195	0.95
		> 200	0.93

b) The emission of visible pollutants shall not exceed, under free acceleration test, when smoke density is expressed as light absorption coefficient, 2.45/m. This is not applicable for vehicles with turbo/super charged engines.

5) On and from the 1st day of April, 1992, all diesel driven vehicles shall be so manufactured that they comply with the following standards of gaseous pollutants, emitted by them, when tested as per the details and procedures given in Annexure V.

The weighted average mass of carbon monoxide (CO), the mass of hydrocarbons (HC) and the mass of oxides of nitrogen (NOx) emitted during the test shall not exceed the limits given below :

Mass of carbon monoxide (CO)	--	14 g/kWh
Mass of hydrocarbons (HC)	--	3.5 g/kWh
Mass of oxides of nitrogen (NOx)	--	18 g/kWh

6) Each motor vehicle manufactured on and after the dates specified in paragraphs (2), (3), (4) and (5) shall be certified by the manufacturers to be conforming to the standards specified in the said paragraphs and the manufacturers shall further certify that the components liable to effect the emission of gaseous pollutants are so designed, constructed and assembled as to enable the vehicle, in normal use, despite the vibration to which it may be subjected, to comply with the provisions of the said paragraphs.

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