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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

REPORT

OF THE EXPERT GROUP MEETING ON

CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA -PACIFIC REGION

ORGANIZED BY UNDP, UNIDO AND
RESEARCH INSTITUTE OF HIGHWAY
MINISTRY OF COMMUNICATIONS
PEOPLE'S REPUBLIC OF CHINA

BEIJING, 29 - 31 MARCH, 1994

This document has not been edited

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I. INTRODUCTION

In accordance with Project Document DP/RAS/89/057 "Regional Network on Control and Regulatory Measures Concerning Motor Vehicle Emissions" UNDP/UNIDO in cooperation with Research Institute of Highway, Ministry of Communications, People's Republic of China organized an Expert Group Meeting on Consideration of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia-Pacific Region. The Meeting was held on March 29 -31, 1994 in Beijing.

The Meeting was the third in the series of four meetings to be held under the project DP/RAS/89/057. This one was devoted to the considerations in the setting of automotive fuel and 2-stroke oil standards with regard to the control of vehicular emissions and to providing a route to the gradual harmonization of these standards within the Region.

The main objectives of the Meeting were as follows:

1. **Development objectives**

   To initiate, develop and promote the cooperation among countries of the Asia-Pacific Region in the field of fuel quality standardization, to set up a regional network that will lead to the gradual harmonization of key fuel quality characteristics for reference fuels for emission testing, and ultimately, to a harmonization of the qualities of marketed fuels.

2. **Immediate objectives**

   a) To provide a forum for exchange of information on the present status of automotive fuels and 2-stroke oil specifications and quality control procedures, the planned changes in automotive fuels environmental qualities, and the automotive fuels supply infrastructure (including imports);
   b) To identify common priorities for critical fuel properties which can be harmonized;
   c) To gain acceptance of common test methodology and standards construction, and to assess the benefits of common regional standards;
   d) To review the draft "Guidelines on Consideration of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia-Pacific Region" and to adopt its terms.

II. AGENDA

The agenda of the meeting is enclosed in Annex 1.

III. PARTICIPANTS

Participants were:

- representatives of the following countries which have declared their participation or their interest in the project: China, Hong Kong, India, Indonesia, Iran, Republic of Korea, Malaysia, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Thailand and Vietnam.
- UNDP/UNIDO staff,
- technical consultants.

The full list of participants is given in Annex 2. The updated list of the national focal points for the project is enclosed in Annex 3.

IV. OPENING ADDRESSES

The Meeting was opened by Deputy Director of Research Institute of Highway, Ministry of Communications, People's Republic of China. Opening addresses were delivered by Vice-Minister, Ministry of Communications, People's Republic of China, UNDP Assistant Resident Representative and UNIDO Representative.

V. PRESENTATION OF THE CONSULTANT'S PAPER

The UNIDO Consultant in Fuel and Lubricant Specifications for Motor Vehicle Emission Control presented a paper based on the draft "Guidelines on Consideration of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia-Pacific Region". The presentation was composed of two parts.

The first part included:

- an outline of overall emission strategy, and the role of fuel standards and fuel quality control,
- an overview of external fuel specification activities,
- the relationship of gasoline quality with pollutant emissions from vehicles equipped with SI engines, including exhaust emissions, and evaporative emissions,
- the major diesel fuel influences on pollutant emissions from vehicles equipped with CI engines,
- the effect of 2-stroke oils and their additives.

In the second part of his paper, the consultant presented:

- outline strategy for improving fuel quality in the Region,
- considerations in the content of fuel standards,
- general standard construction, fuel grade structures,
- fuel quality limits and test methods,

- quality control in the market,
- detailed specifications for both leaded and unleaded motor gasolines,
- detailed specifications for automotive diesel fuels,
- 2-stroke oils options.

OVERALL EMISSION STRATEGY

An emission strategy is only one tool of a number of tools available for the maintenance or improvement of ambient air quality in urban areas. Air quality is thus the focus, emission strategy one tool, and vehicular emission strategy, including fuel standards and quality control, only one part of this tool. It is essential that an inventory of those harmful contributors to ambient air quality, together with their sources, is clearly defined before such a strategy is embarked upon. A coherent vehicular emission control strategy is inordinately expensive, impacting not only on the capital and revenue expenses of both the motor and oil industries, but also on the capital and revenue necessary to set up and maintain an infrastructure that ensures continued compliance.

Very important are the socio-economic implications of a vehicular emissions regime of any potential impact. Many factors contribute to this, but two appear to be of overwhelming importance in several, but not all, countries involved in this project. These factors are:
- composition of the "private" vehicle population,
- contribution of the heavy vehicle parc.

To achieve a reduction in vehicular emissions from the privately owned sector of the vehicle parc in a reasonably short time period, is much dependent on the emission strategy for the worst emitters amongst the existing vehicles. In most countries of the Region, the proportion of gross emitters is very high, including a vast population of two- and three-wheeled vehicles powered by two-stroke engines. This worst emitter population is generally owned by the poorest sector of the community, and thus prone to the least maintenance, and the cheapest fuel/lubricant options available.

Allowing this population to continue, or even to grow, in an uncontrolled manner, could more than negate any emission control strategy applied to other vehicle sectors. It would be difficult to eliminate, or even reduce, the worst offenders in the short term, although that would be the approach to show real gains in air quality. It will be necessary to 'contain' the existing population by the regulation of fuel/lubricants used in the vehicles, and by in-use inspections, and to 'control' the emissions performance of new vehicles (of course, also with regulations on the fuel/lubricants).

Vehicular emissions of particulate matter (PM) and NO_x are largely from the diesel heavy duty sector. Many of the heavy duty vehicles observed were ancient, both in design and longevity, and badly maintained. This sector poses severe socio-economic problems because of the direct relationship between the costs of transportation, either for the distribution of goods, or for the carriage of people, and the consumer price indices. The ability of carriers to generate capital for the replacement of obsolete vehicles, and to maintain their condition throughout their working life, must be addressed as part of the overall air quality strategy.

THE CONTRIBUTION OF FUEL QUALITY

The dominant factor which determines the emission of the 'controlled' pollutants (CO, HC, NO_x, PM) is the engine design and condition, and differences between individual vehicles of the same make and model often exceed the differences between makes and/or models. Fuel quality does play a role however, which becomes more critical as new vehicles are produced to meet tighter emissions limits.

There are some features of fuel quality that do have a direct impact on emissions, irrespective of the vehicular contribution, and these relate to the composition of the fuel, both hydrocarbon and non-hydrocarbon. There is thus a direct and fairly immediate benefit to air quality obtainable by regulating these constituents.

Fuels for SI engines. It is vital that all future production of SI engines has suitable metallurgy for valves and valve seats to accommodate the use of unleaded motor gasoline, irrespective of the time-scale envisaged for the introduction of catalytic converters to meet more stringent controlled emission limits. These engines, without converters, can still accommodate leaded fuel, where unleaded fuel is not available, but delays in their introduction put back any potential phase-out of leaded motor gasoline by the turnover life of vehicles in a given market.

For leaded motor gasolines, every effort should be made to reduce the maximum lead content to 0,15 gPb/l at the earliest opportunity. For all motor gasolines, the benzene content should be controlled at a maximum of 5 %(V/V), and in the longer term, perhaps even lower.

There will be benefits to the emission of regulated pollutants from tighter control of limits, and particularly tolerances, on a number of other fuel properties and constitution,and for new engines, these benefits may be considerably enhanced by a close matching of fuel quality with engine design features. These properties include:

i) Density - closer tolerances will contribute to lower HC and CO emissions;

ii) Volatility - closer tolerances lead to better driveability (lower HC), and controlled maximum volatility also reduces evaporative losses;

iii) Composition - the use of oxygenates has a beneficial effect on CO emission;

iv) Additives - there are many effective engine system cleanliness additives available. The main objective of this type of additive is to maintain the engine in 'as-new' condition, and thus not increase in emissions with time and the malfunctions associated with deposits.

Fuels for CI engines. A major contributor to both particulate matter (PM) and SO_x emissions is the sulfur content of the fuel, and this needs to be regulated. The level chosen should be part of a coherent strategy of sulfur and particulate emissions from all fuels, and the specific contribution of vehicular emissions to this total. Maximum levels of between 0,50 %(m/m) and 0,20 %(m/m) would seem to be reasonable in the short to medium term, with lower levels down to 0,05 %(m/m) being considered only when both the environmental and economic circumstances dictate and/or allow.

There is potential for very good matching of engine design features and fuel quality in CI engines, but only limited advantage can be taken of this. The key to the matching is tight tolerances on some of the fuel properties, enabling engine settings to be optimised, e.g. smoke stops and fuel pump settings, but the natural variations in these qualities from a variety of feedstocks, makes the imposition of extremely tight tolerances impracticable in most instances.

The most noticeable emissions from CI engines are smoke, both white on start-up and warm-up, and black during running. The dominant contributor to white smoke is ignition quality. Significant reductions do start above about 48 cetane number. For black smoke, the prime contributor is density, with ignition quality again being a strong influence. Density maxima are being reduced world-wide in response to increasing evidence that values above 865 kg/m^3 dramatically increase smoke and particulate emissions. Higher densities also increase CO emissions.

Other fuel properties that influence emissions and performance include:

i) Viscosity - minimum to protect fuel pumps from lubricity failure, and maximum to ensure good droplet formation and fuel/air mixing;

ii) Volatility - front-end to ensure ignition, and back-end to reduce CO and HC (and to restrict the availability of PAH in the fuel, which may be directly related to PAH in particulates);

iii) Carbon residue/ash - to control injector/port/valve deposits which may lead to erratic combustion;

iv) Additives - a similar range of additives to those for SI engines is available.

OUTLINE STRATEGY FOR IMPROVING FUEL QUALITY

The minimum requirements necessary to implement an effective automotive fuel quality strategy should include the following major elements:

i) A National Standard, which may be the national implementation of a Regional Standard, of which at least the properties of fuels contributing directly to environmental air quality degradation, are legally binding;
ii) An infrastructure for the monitoring of automotive fuel quality for conformance to the National Standard;
iii) A standardised regime for the monitoring of automotive fuel quality, including a focal point, sampling regimes for various types of outlet, and testing regimes for both random and programmed compliance testing.

The approach of individual countries towards a 'harmonised' or 'target' fuel quality will be to determine their position between 'lowest' and 'target' qualities, and to plan a structured route and time-scale, dependent upon their individual capacity for change. For vehicles with SI engines, the major priority is to ensure the correct metallurgy for valves and valve seats, and then introduce some, if only limited, availability of unleaded motor gasoline at the earliest opportunity. The introduction of low-emission vehicles recommended in "Guidelines for New Motor Vehicle Emission Control in the Asia-Pacific Region" can only be integrated with the availability of these fuels.

PETROLEUM FUEL STANDARD

The published, widely available, normally National (or pan-National), fuel standard, is only the visible tier of three standards, and this helps to explain the long lead times in implementation of radical changes to existing standards.

The first tier of these is the 'homologation' fuels, which are those upon which engine design is based. Although not full standards, they contain the essential features for the engine designer to optimise his configuration for thermal efficiency and durability, and thus needs to be known at least 5 years in advance of the implementation of new National Standards.

The second tier is the 'reference' fuels, upon which both type approval and in-use testing for performance and emissions will be based. These specifications are slightly fuller than the homologation fuel specifications, but normally have the same limiting values, albeit with different tolerances, for the critical properties. These reference fuels are those quoted in the emissions regulations, and as such are the key to successful emissions strategy.

The final tier is the National Standards. It is not simply a table, or tables, of limiting values, but describes an organised means of reproducible checking for compliance, as well as a coherent description of market requirements for the benefit of end-users.

QUALITY CONTROL IN THE MARKET

It is essential that adequate policing of the quality of petroleum fuels is carried out in the market place. The exertion of quality control in the market requires a considerable infrastructure. Since the National Standard applies at the point of custody transfer of the product to the end-user, in practice this means the external monitoring of product qualities is carried out both at depots/terminals for deliveries to commercial and industrial users, and at retail sites for deliveries to individuals.

It is totally impracticable to fully monitor any large proportion of sites on a regular basis, and thus some form of statistical approach is necessary. In practice, this means a large number of samples will be collected for a 'short test' examination, looking at a few of the simplest yet most sensitive tests, and a few samples will be subjected to more extensive testing, with a relatively small number actually undergoing a full test against all the properties specified in the National Standard.

SPECIFICATIONS

Given the fact that the situation and conditions in each country, and thus the starting point, are different, the three-level approach to the harmonization of fuel standards in the Region, and thus fuel quality is recommended:

- "lowest" requirements that should be introduced at the earliest opportunity,
- intermediate requirements,
- target requirements being the ultimate goal in the harmonization process.

The target 'premium' quality will be that represented by the quality illustrated in the two major world-wide reference fuels for emission, consumption and power measurement, namely CEC RF-08-A for unleaded premium gasoline, and CEC RF-03-A for automotive diesel fuel. A single climate is to be considered for the specifications, and they will be targeted to an ambient temperature of $25^{0}C$ to $35^{0}C$.

As regards motor gasolines, specifications are presented for both leaded and unleaded types. Four grades, differing in terms of octane number, are identified (in parenthesis target research/motor octane number):

- for two-stroke engines (82/-),
- regular (90/80),
- premium (95/85),
- super (98/87).

As regards diesel fuels, only a single 'premium' grade is considered. The properties have been tailored towards only a moderately environmentally sensitive market. The extremes, in terms of environmental severity, of the US West Coast, or Sweden, have not been considered appropriate to any countries participating in this Project.

Provision has been made for both cetane number and cetane index. This is to allow, but control, the use of ignition improving additives, and to protect the 'base' quality of the fuel being treated.

A sulfur content of 0,20 %(m/m) has been chosen as basically the lowest level at which a balance between environmental considerations and desulfurising costs on medium-high sulfur crude oils can be struck. There is not only a monetary cost in this, since there is a strong risk of substituting disproportionate quantities of CO_2 for smaller and smaller reductions in SO_x.

2-STROKE OIL OPTIONS

The generation of meaningful 2-stroke oil specifications is very difficult, firstly because the 'real' properties required have no standardised methodology, and secondly because a wide range of materials have been found to be suitable.

The major assessment of the effectiveness of these 2-stroke oils therefore is likely to be by means of engine tests, and thus via a route of oil type-approval. The engines chosen will be representative of those available locally, since there is a vast amount of manufacturers of these engines, and world-wide coverage is unlikely, and it is likely that at least two, and may be up to five engines will be required. The reason for the multiplicity of engines is because of the different engine sensitivities to the characteristics under examination, and a need to achieve differentiation in the test results. For those countries with substantial 2-stroke engine populations, this does mean an infrastructure of testing facilities, although within the Region, it may be possible to achieve some agreement on reciprocal recognition. There should certainly be agreement on base motor gasoline quality for testing (reference fuel), oil/fuel ratio for testing, range of properties required for type approval, and perhaps some form of classification and labelling system. A regional reference oil would certainly aid in acceptance of reciprocal type-approvals.

The consultant's paper is not enclosed to this report as it was distributed to the participating countries in November, 1993.

VI. PRESENTATION OF THE COUNTRY PAPERS

The country papers were presented by country representatives. They were concentrated on the following topics:

- the automotive fuels and 2-stroke oils standards prevailing in respective countries, together with planned changes,
- current legislation with regard to automotive fuels and 2-stroke oils,
- fuel consumption and its breakdown by grade and vehicle categories,
- current fuel and 2-stroke oil prices, taxes and incentives.

The country papers are listed below in the order in which they were presented, all papers being enclosed as Annexes.

1. China
Title:
Automotive Fuel Quality Standards and Vehicle Emissions in China
Presented by:
Mr Zhang Chengquing
Research Institute of Petroleum Processing,
China Petroleum Co.

(Annex 4)

2. Hong Kong

Title:
Automotive Fuel Quality in Hong Kong
Presented by:
Mr Kong Ha, Mr Alex Ng
Hong Kong Environmental Protection Department

(Annex 5)

3. Indonesia
Title:
Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions
Presented by:
Mr Muhammed Yusuf
Directorate General of Land Trnsportation, Ministry of Communication
(Annex 6)

4. Iran

Presented by:
Ms Paimaneh Hasteia
Air Quality Control Co.

(Annex 7)

5. Korea

Title:
Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emission in the Republic of Korea
Presented by:
Mr Ung Su Choi
Korea Institute of Science and Technology
Mr Juh Wuan Choi
Korea Petroleum Quality Inspection Institute

(Annex 8)

6. India

Title:
Impact of Fuel Quality on Vehicular Emission in India
Presented by:
Mr N.Bagchi
Ministry of Environment and Forests

(Annex 9)

7. Malaysia

Title:
Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions
Presented by:
Mr Yaakob Sidikin
Petronas, Fuel & Special Product

(Annex 10)

8. Nepal

Title:
An Introduction to Motor Vehicle Air Pollution and Fuel Quality and Standards in Nepal
Presented by:
Mr Om Bahadur Shrestha
Thapathal Engineering Campus, Tribhuvan University

(Annex 11)

9. Pakistan

Presented by:
Mr Asif F. Khan
Pakistan Environmental Protection Agency

(Annex 12)

10. Philippines

Presented by:
Mr Juan A. Magarro, Jr.
Department of Transportation and Communications, Land Transportation Office

(Annex 13)

11. Singapore

Presented by:
Mr Lee Kheng Seng
Strategic Planning and Research Department, Ministry of Environment

(Annex 14)

12. Sri Lanka

Presented by:
Mr T. L. Peiris
Department of Motor Traffic

(Annex 15)

13. Thailand

Title:
Automotive Fuel Quality Standard in Thailand
Presented by:
Ms Preeyaporn Vivekaphirat
Fuel Oil Division, Department of Commercial Registration

Title:
Two-Stroke Engine Oil in Thailand. Trends in Quality Development
Presented by:
Mr Sawaeng Boonyasuwat
Research and Development Center, Petroleum Authority of Thailand

(Annex 16a and b)

14. Vietnam

Presented by:
Ms Nguyen Hong Ha
Hanoi Office for Standardization, Measurement and Quality Control

(Annex 17)

VII. DISCUSSIONS ON SELECTED TOPICS

The Meeting selected for discussion the following topics related to automotive fuels and 2-stroke oils:

i) Control of emissions, both regulated and unregulated, from 2-stroke engines through better fuel/oil quality and infrastructure,

ii) Way forward in achieving better automotive fuel quality and harmonization,

iii) Technical standards for fuel additives.

Fuel and oil quality does affect the emissions, in particular unregulated emissions (smoke, PAH, benzene, odour) from 2-stroke engines. One of the ways to address the problem is to ban 2-stroke oils of unknown, inferior quality and to allow the use of only type-approved oils. A comprehensive infrastructure of testing facilities is required for this purpose. Therefore, the regional cooperation, e.g. in the form of an agreement on reciprocal recognition of oil type-approval, will be of great advantage for countries with substantial population of 2- and 3-wheeled vehicles equipped with 2-stroke engines.

It was generally agreed that there is scope for regional cooperation in both the setting of harmonized fuel specifications for a range of properties affecting motor vehicle emissions and the test methodology used for the definition of fuel properties. To attempt to cover recommendations for fuels quality within the Region in a harmonized manner, a long-term strategy is required providing step-wise improvements in individual countries towards an overall target quality for each fuel type and grade.

Much attention should be paid to the integration of vehicle design and fuel quality improvements. The introduction of lower-emission vehicles should be timed with the availability of enhanced quality fuels. Only such a policy will allow countries of the Region to take full advantage of vehicular emission technology development.

The outcome of the discussion was used for reviewing the draft "Guidelines on Consideration of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia-Pacific Region".

VIII. REVIEW OF THE DRAFT "GUIDELINES" AND ADOPTION OF ITS TERMS

The Meeting reviewed in great detail the draft "Guidelines on Consideration of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia-Pacific Region". The particular attention was paid to the following topics:

- fuel standards and quality control as a component of overall emission strategy,
- the contribution of fuel quality to emissions,
- outline strategy for improving fuel quality,
- quality control in the market,
- specifications for both motor gasoline and diesel fuel,
- 2-stroke oils.

The Meeting recommended to introduce to the draft "Guidelines" several amendments of editorial character. The Meeting adopted the terms of "Guidelines" and recommended to use them as a basis for the regional and national strategy for improving fuel quality.

IX. VENUE OF THE NEXT MEETING

The next meeting will be devoted to policies for regional approach on motor vehicle emission control in the Asia-Pacific Region. It will be the last one in the series of four meetings planned under the project. The activities of the project have to be fully completed in 1994. This Meeting was informed that the possibility of hosting the next EGM is now under consideration at the national focal points for the following countries:

- Iran,
- Korea,
- Thailand.

The proposed dates for the fourth EGM are November 29 - December 1, 1994. The venue and the dates will be fixed at UNIDO headquarters and confirmed at a later date.

X. CONCLUSIONS AND RECOMMENDATIONS

1. The "Guidelines on Considerations of Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emissions in the Asia- Pacific Region" prepared under the project DP/RAS/89/057 "Regional Network on Control and Regulatory Measures Concerning Motor Vehicle Emissions" should form a basis for regional cooperation in the setting of harmonized fuel quality standards and in the laying down of the strategy for the improvement of fuel quality in the Region.

2. There is a scope for the implementation of an effective regional automotive fuels quality strategy. The minimum requirements necessary to implement this strategy include the following major elements·

- common methodology and property descriptions for the definition of fuels characteristics,
- regional standards,
- an infrastructure for monitoring of fuels quality,
- a standardized regime for the monitoring of quality.

3. In order to achieve the maximum impact on air quality with the minimum usage of resources, the fuels and vehicles should be looked at as a single coherent system. The introduction of lower-emission vehicles desirable for effective addressing motor vehicle related pollution in most countries of the Region has to be integrated with the availability of fuels of enhanced quality for spark ignition and compression ignition engines. A strategy is required for the control of the quality of 2-stroke oils used in engines powering 2- and 3-wheeled vehicles. It is recommended that this strategy includes an element of mandatory type-approval of oils marketed.

4. For vehicles with spark ignition engines, it is regarded as the major priority to ensure the engine metallurgy compatible to run on unleaded gasoline, to reduce the lead content to 0.15 g/l and to ensure some, if only limited, availability of unleaded gasoline meeting the harmonized common requirements at the earliest opportunity. For vehicles with compression ignition engines priority should be given to the reduction of sulfur content to 0.20% and to the improvement of ignition quality of diesel fuels in most countries.

5. A precondition for the effective required regional cooperation and common approach to motor vehicle related pollution is to ensure the sustainable operation of the network of the national focal points beyond the end of the Project DP/RAS/89/057. The main focal point and the focal points of participating countries are requested to consider measures required for this purpose.

Annex 1

AGENDA
of Expert Group Meeting

Tuesday
29th March 1994

Registration

Opening Session

a) Inauguration of the Meeting by Deputy Director, Research Institute of Highway Mr Chen Guo-Jing
b) Address of Vice-Minister, Ministry of Communications Ms Zheng Guang-Di
c) Address of UNDP Assistant Resident Representative Ms Setsuko Yamazaki
d) Address of UNIDO Representative, Mr Hans Seidel
e) Adoption of Agenda
f) Election of the Chairman and Rapporteur

Presentation of draft guidelines by UNIDO consultant

Part I: Overview of external specification activities and the major fuel quality influences on motor vehicle emissions

Part II: Options for change and suggestions for the region

Presentation of country papers by participants

Wednesday
30th March 1994

Presentation of country papers by participants (cont'd)

Discussion on selected topics

Review of the draft guidelines and adoption of their terms

Thursday
31st March 1994

Review of recommendations and conclusions for the final report of the Meeting

Venue of next Expert Group Meeting and its agenda

Closing remarks by the co-Chairman of the Meeting, UNIDO Representative, Mr Hans Seidel

Technical visit to Research Institute of Petroleum Processing

LIST OF PARTICIPANTS

CHINA

SU MING XIN
Associate Research Fellow
Research Institute of Highway
No.48 Beisanhuan Middle Road Beijing, China
Tel: 2013399-2910
Fax: 2014130
Telex: (01)6516

GUO YI MING
Associate Research Fellow
Research Institute of Highway
No.48 Beisanhuan Middle Road Beijing, China
Tel: 2013399-2910
Fax: 2014130
Telex: (01)6516

CHAG CHENG QING
Technical Director
Senior Engineer
Research Institute of Petroleum Processing
Standardization Division
18 Xue Yuan Road P.O. Box 914-21
Beijing 100083 P.R. China
Tel: 2012259
Fax: 2012261
Telex: 222381 DADI CN

HONG KONG

ALEX K. Y. NG
Ag. Principal Environmental Protection Officer
Environmental Protection Department, Hong Kong
Government
33/F, Revenue Tower, 5 Gloucester Road, Wan Chai
Hong Kong
Tel: 5946300
Fax: 8278040

KONG HA
Senior Environmental Protection Officer
Environmental Protection Department
Air Services Group
33/F, Revenue Tower, 5 Gloucester Road, Wan Chai
Hong Kong
Tel: (852)5946414
Fax: (852)8278040

INDIA

B. SENGUPTA
Sr. Scientist & Head Pollution Control Implementation Division (II)
Central Pollution Control Board
(Ministry of Environment & Forests)
Parivesh Bhavan C.B.D-CUM-Office Complex
East Arjun Nagar, Delhi-1 0032
Tel: 2221995(D), 2217213(4LINES)
Fax: 011-221 7079
Telex: PCON 66440

THAVARAJ CHANDINI
Joint Director
Ministry of Environment and Forests
Min. Env. & Forests, CAO Complex, New Delhi-110003
Tel: 4361669 Ext. 537
Fax: 011-4360678

N. BAGCHI
Director
Ministry of Environment and Forests
703 Paryavaran Bhavan, CGO Complex Lodi Road,
New Delhi-110003, India
Tel: 011-436-2663; 011-436-3577
Fax: 011-436-0678

INDONESIA

M. YUSUF
Director of Land Transport Safety and Means Engineering
Directorate General of Land Transport
Jl. Jend.Sudirman 77-Jakarta Selatan
Indonesia 12190
Tel: (62-21) 570667
Fax: (63-21) 570624
Telex: 44723 KFPD IA

IRAN

PAIMANEH HASTAIE
Managing Director
Air Quality Control Co.
56 Nikoughadam St., Northen Sohrewardi Ave.
Teheran 15518 IRAN
Tel: (+9821)864593-861599-864457
Fax: (+9821)865180

M. NAKHJAVAN
Expert
Teheran Vehicle Technical Inspection Bureau
Municipality Bldg. No. 3 N. Iranshahr St.
Teheran, Iran
Tel: (98)-21-8834147
Fax: (98)-21-8834147

M. SOLTANIEH
Consultant
Air Quality Control Co.
56 Nikoughadam St., Northen Sohrewardi Ave.
Teheran 15518 IRAN
Tel: (+9821)864593-861599-864457
Fax: (+9821)865180

REP. OF KOREA

KYU-HONG AHN
Head, Environmental System Group
Environment Research Center
Korea Institute of Science and Technology
P.O. Box 131, Cheongryang, Seoul Korea
Tel: 02 963-0392
Fax: 02 969 0230
Telex: KISTROK K27380

JUHUUAN CHOI
Manager, Testing & Research Dept.
Korea Petroleum Quality Inspection Institute
Mt. 34-2, Baeckyun-Dong, Bundang-Gu, Sungnam-Si
Kyungzi-Do, KOREA 462-430
Tel: 0342-41-0167
Fax: 0342-46-8749

UNGSU CHOI
Principal Research Scientist
Tribology Group
Korea Institute of Science and Technology
Hawolgok-Dong 39-1, Songbuk-Gu, Seoul
136-791, Korea
Tel: 962-8801 Ext: 4652 or 4622
Fax: 02-962-6459
Telex: KISTROK K27380

MALAYSIA

YAAKOB SIDIKIN
Head, Fuel & Special Products Section
Product Development Department
Petronas Dagangan Berhad
11th Floor, Menara 1, Faber Towers, Jalan Desa Bahagia,
Taman Desa Off Jalan Klang Lama, P.O. Box 150,58700
Kuala Lumpur
Tel: 03-7893512 D/L, 03-7821242
Fax: 03-7822930, 7830212

MARZUKI MUKHATAR
Environmental Control Officer
Dept. of Environment, Malaysia
13th Floor, Wisma Sime Darby, Jln Raja Laut 50662 Kuala Lumpur
Malaysia
Tel: 03-2938955 EXT 279
Fax: 03-2937655

NEPAL

OM BDR SHRESTHA
Lecturer
Institute of Engineering Thapathali Campus
P.O. Box 4751, Kathmandu, Nepal
Tel: 228517, 212369, 217230, Res: 526515
Fax: 977-1-229393

POORNA P. MANANDHAR
Act. Director General
Nepal Bureau of Standards & Metrology
Balaju, Kathmandu, Nepal
Tel: 272689, 272818, RES. 222218

HARI LAL RAJBAHAK
Act. Director General
Department of Transport Management,
Ministry of Works and Transport
NAYA Baneswar Kathmandu Nepal
Tel: 228893

PAKISTAN

ASIT J. KHAN
M. Engg. (U.S.A.), Director General
Government of Pakistan
Pakistan Environmental Protection Agency
44-E, Office Tower, 3rd Floor
Blue Area, Islamabad
Tel: of.f 217882, res. 280731

PHILIPPINES

ZENAIDA YGNACIO MONSADA
Chief, Energy Resources Supply Administration Division
Energy Industry Administration Bureau
Department of Energy
9/F SSS Building, Ayala Ave. cor. Herrera St.
Makati, Metro Manila, Philippines 1200
Tel: (63-2)810-8302/810-8604
Fax: (63-2)819-59-14/817-86-03

HERIBERTA C. DOMINGO
Sr. Transportation Development Officer
Dept. of Transportation and Communications
Land Transportation Office
East Avenue, Diliman Q.C.
Tel: 9219075

JUAN A. MAGARRO, JR
Executive Director, Lt. Col. Reserve PA
Regional Vice-President VFP-SDAI.RI
Deputy Secretary General
Dept of Transportation and Communications
Land Transportation Office
East Avenue, Quenzon City
Tel: 9210293
Fax: 9219073

SINGAPORE

NG YOOK KOONG
BSc(Hons), Dip B.A.PEng.
Head, Vehicle Engineering Division
Registry of Vehicles
Sing Ming Drive Singapore 2057
Republic of Singapore
Tel: 4505260
Fax: 4522661

LEE KHENG SENG
Executive Engineer (Research & Development)
Strategic Planning & Research Department
Ministry of The Environment
Environment Building 40, Scotts Road #11-00
SINGAPORE 0922
Tel: 7327733
Fax: 7319922

SRI LANKA

T. L. PEIRIS
Assistant Commisioner Technical
Department of Motor Traffic Ministry of Transport
& Highways
Department of Motor Traffic
Colombo 05
Tel: 692275

M. R. DIYADASA
Assistant Commisioner
Department of Motor Traffic
Colombo 5
Tel: 692994
Fax: 694338

THAILAND

SUVIDH VORAVISUTHIKUL
B. Eng., LL. B Director
Transport Engineering Division Land Transport
Department
BANGKOK 10900, THAILAND
Tel: 272-5334
Fax: (662)314-1180

SAWAENG BOONYASUWAT
Executive Director
Research & Development Center Head Office
Petroleum Authority of Thailand
555 Vibhavadi Rangsit RD.,
Bangkok 10900, THAILAND
Tel: 537-3011-2
Fax: (662)537-3498
Telex: 72054 PTT TH

PREEYAPORN VIVEKAPHIRAT
Head of Quality Control
Fuel Oil Division, Department of Commercial Registration
78/13 Rama 6 road, Phayathai, Bangkok 10400
Tel: 279-3064

VIETNAM

NGUYEN HONG HA
Expert
Hanoi Office for Standardization, Measurement and Quality Control
89 Nguyen Thai Hoc Str. Hanoi, SRV
Tel: (84-4) 252928

UNDP

SETSUKO YAMAZAKI
Assistant Resident Representative
UNDP
2 Dondqijie Sanlituan Beijing 100600, China
Tel: 86-1 532-3731
Fax: 86-1 532-2567

THORE HANSEN
Programme Officer (JPO)
UNDP
2 Dongqijie Sanlituan Beijing 100600, China
Tel: 532-3731 ext.399
Fax: 532-2567

UNIDO

HANS H.SEIDEL
Senior Interregional Adviser
Engineering Industries Branch
UNIDO
P.O. Box 300 A-1400 Vienna, Austria
Tel: 21131 ext. 3760
Fax: 2309766

TIMOTHY BERRYMAN
UNIDO Consultant in Fuel and Lubricants Specifications for
Motor Vehicle Emission Control
Unit 4A,DP House, The Ring, Bracknell
Berkshire.RG12 1AX, UK
Tel: (0344)301456
Fax: (0344)302547

STANISLAW RADZIMIRSKI
UNIDO Consultant in Vehicle Exhaust Emission Control
Motor Transport Institute
03-301 Warszawa, Poland
Tel: (4822)110944
Fax: (4822)110906
Telex: 813316 ITS PL

CHINA (NONVOTING DELEGATES)

Mr. IU QIPING
Senior Engineer
Research Institute of Petroleum Processing
18 Xue Yuan Road
P.O. BOX 914
Beijing 100083, P.R. China

Ms. LI JING YU
Senior Engineer
Technical Supervising Department Production & Management
Coordinatig Division
CHINA PETROCHEMICAL CORPORATION
A 6 Huixin Dongije, ChaoYang, Beijing, China
Postcode: 100029
Telex: 210625 SNPEC CN
Fax: 4229601
Cable: Beijing 0029

Ms. LI PEI
Engineer
Division of Air Pollution Control
National Environmental Protection Agency of China
No. 115 Nan Xiaojie Xizhimenmei, Beijing, China
Postcode: 100035
Tel: 8329911-3607
Fax: 86-01-8328013

Mr. PIAO ZHONGXUAN
Senior Engineer
Environmental Protection Research Division
Research Institute of Highway
The Ministry of Communications
No. 48 Beisanhuan Middle Road Beijing, China
Postcode: 100088
Tel: 2013399-2903
Fax: 2014130
Telex: (01) 6516

Mr. XU BAMIN
Deputy Chief Engineer
Senior Engineer (Analogous to Professor)
China Automotive Technology and Research Center
P.O. BOX 59 Tianjin, China
Postcode: 300162
Tel: 86-22-4373100
Fax: 86-22-4370843

Mr. YUAN YING
Senior Engineer
Emission Control Research Department
Beijing Automotive Research Institute
No. 85 Yujiafen, Chengshousi
Fengtai District, Beijing, China
Postcode: 100078
Tel: 7625111-3411
Fax: 7629458
Telex: 82601

Ms. YUAN YING
Engineer
Emission Laboratory
Beijing Automotive Research Institute
No. 85 Yujiafen, Chengshousi
Fengtai District, Beijing, China
Postcode: 100078
Tel: 7625111-3315
Fax: 7629458
Telex: 82601

Mr. WANG SHUIPING
Deputy Chief Engineer
Department of Transport Administration
The Ministry of Communications, P.R. China
No. 10 Fuxing Road, Beijing, China
Postcode: 100845
Tel: 3265544-2329
Fax: 3273943
Telex: Minocom 8663

Mr. WANG WEI
Editor
China Environment News
No. 15 Xiaoxiluong Jie, Cuong Wen District, Beijing, China
Tel: 7013772
Fax: 7013779

Mr. LI ZHEN CHUAN
Engineer
Department of Restructuring Economic System
The Ministry of Communications P.R. China
No.10 Fuxing Road, Beijing, China
Postcode: 100845
Tel: 3266933
Fax: 3273943

Mr. ZHANG XIAOJIE
Project Official
Department of Foreign Affairs
The Ministry of Communications, P.R. China
Postcode: 100845
Tel: 3265544-2422
Fax: (861)3273943
Telex: 22462

Mr. WANG JIANLIANG
Editor & Reporter
China Communications News
No.2 Panjiapuo Hutong, Chao Yang Nen Wuai, Beijing, China
Postcode: 100020
tel: 5002782
Fax: 5002782
Telex: 4356

Annex 3

NATIONAL FOCAL POINTS

CHINA

Mr. Piao Zhong xuan
Deputy Director
Highway Research Institute
Ministry of Communications
48 Bei San Huan Zhong Road
Beijing 100088, China
Tel: 201 3399 (Ext.2903)
Fax: 201 4130

HONG KONG

Mr. Kong Ha
Senior Environmental Protection Officer
Vehicle Emission Control Section
Environmental Protection Department
Air Service Group
33/F., Revenue Tower
5 Gloucester Road
Wanchai, Hong Kong
Tel: (852) 594 6414
Fax: (852) 827 8040

INDIA

Mr. N. Bagchi
Director
Ministry of Environment and Forest
703 Paryavaran Bhavan
C. G. O. Complex, "B" Block, Lodhi Road
New Delhi - 110 003, India
Tel: (011) 436 2663, (011) 436 3577
Fax: (011) 436 0678

INDONESIA

Mr. M. Yusuf
Director of Land Transport Safety
and Means Engineering
Directorate General of Land Transport
Jl. Jend. Sudirman 77 - Jakarta Seletan
Indonesia 12190
Tel: (62-21) 5706667
Fax: (62-21) 5706624
Telex: 44723 KFPD IA

IRAN

Ms. Paimaneh Hastaie
Managing Director
Air Quality Control Co.
56 Nikoughadam St,
Northern Sohrevardi Ave.
Teheran 15518, Iran
Tel: (9821) 864993, 861559, 864457
Fax: (9821) 865180

KOREA

Mr. Kyu-Hong Ahn
Environment Research Center
Korea Institute of Science and Technology
39-1 Hawolgok-Dong, Sungbuk-Gu
Seoul 136-791, Republic of Korea,
Tel: (822) 963 0392
Fax: (822) 969 0230
Telex: KISTROK K27380

MALAYSIA

Mr. Tan Meng Leng
Dept. Director general (Operation)
Dept. of Environment
Ministry of Science, Technology and Environment
13th Floor, Wisma Sime Darby
Jalan Raja Laut
50662 Kuala Lumpur, Malaysia
Tel: (603) 2938955
Fax: (603) 2931480

NEPAL

to be nominated

PAKISTAN

Mr. Asif S. Khan
Director General
Pakistan Environmental Protection Agency
44-E Office Tower, Blue Area,
Islamabad, Pakistan
Tel: 92-51-217882

PHILIPPINES

Mr. Juan A. Magarro, Jr.
Executive Director
Dept. of Transportation and Communications
Land Transportation Office
East Avenue
Quenzon City, Philippines
Tel: (632) 921 9071
Fax: (632) 921 9072

SINGAPORE

Mr. NG Yook Kong
Head of Vehicle Engineering Division
Registry of Vehicles
Sing Ming Drive
Singapore 2057
Tel: 4505260
Fax: 4522661

SRI LANKA

Mr. A. W. DAMIEN PERERA
Commissioner of Motor Traffic
Dept. of Motor Traffic
Elvitigala Mawatha
Colombo 05
Tel: (941) 698 717
Fax: (941) 694 338

THAILAND

Mr. Suvidh Voravisuthikul
Director of transport Engineering Division
Land Transport Department
Phaholyothin Rd. Bangkhen
Bangkok 10900, Thailand
Tel: (662) 272-5334
Fax: (662) 314-1180

VIETNAM

to be nominated

Prepared for Expert Group Meeting on Consideration of Automotive Fuel Quality Standards and their Effect on Motor Vehicle Emissions in the Asia-Pacific Region, Organized by United Nations Industrial Development Organization (UNIDO), Beijing, China, March, 1994

Automotive Fuel Quality Standards and Vehicle Emissions in China

Guo Yiming, Research Institute of Highway
Ministry of Communications,
People's Republic of China

Zhang Chengqing, Research Institute of
Petroleum Processing,
China Petrochem Co.

Shu Mingxin, Research Institute of Highway
Ministry of Communications,
People's Republic of China

In recent years, China was seen one of the countries with the greatest growth rate of motor vehicle population in the world. As the results of which there are more road vehicle fuel consumptions, more vehicle-produced air pollution and hence more demand for high quality fuels and control of vehicle emissions. A series of national standards for auto fuel and vehicle emissions have been issued. And some new emission control standards are going to be enacted.

1. Motor Vehicle Development

1.1 Vehicle population

In the last ten years great changes have been taken place in China's automobile industry. Both of the production capability and product output have been developed rapidly with variety of vehicle types and with more heavy and light duty vehicles than before. A summary of commercial vehicle output and population in China is shown in table 1, and the expected vehicle output by types in 1994 shown in table 2. The output in 1994 shall reach 1.3 - 1.35 million, and the total population shall reach 10 million in 1995.

Table 1 Commercial vehicle output and population (1986-93)

Year	Output	Population
1986	372000	3574000
1987	473000	4123000
1988	647000	4644000
1989	587000	5113000
1990	509000	5514000
1991	620000	6110000
1992	1000000	6748000
1993	1200000	7947500

Table 2 Expected vehicle output by type in 1994

Type	Output (1000)	Type	Output (1000)
Mini car	100 - 120	Light truck	280 - 300
Mini truck	50 - 60	Medium truck	280 or so
Passenger car	300 or so	Bus & coach	100 - 120
Mini bus	180 - 200	Heavy truck	40 - 60

1.2 Parameters of major type of automotive engines

Despite great development of automobile industry in China the performances of domestic made automotive engines are relatively poor in comparison with those from developed countries. For example about 24% of medium sized vehicle engines' compression ratio is within the range of 7.2 - 7.7, and there are still a lot with compression ratio less than seven. There is almost no clean devices for emission control in the existing vehicles, which usually use conventional ignition and carburetor in their fuel system. Therefore, high fuel consumption and serious emission pollutants are common problems. The major technical parameters of home-made vehicle engines are shown in table 3. The average fuel consumption is 5.7 liter per hundred kilometer for diesel powered vehicles, and 7.9 l. per hundred ton-kilometer for gasoline powered vehicles. The diesel powered vehicles, which have the advantage of greater powers, is poor in cool starting performance; therefore they are more used in southern hilly areas, mineral areas, iron and steel works, usually special vehicles and heavy goods vehicles. By the end of 1989 diesel powered vehicles in China only accounted for 15.5% of all the commercial vehicles.

Table 3 Major parameters of home-made vehicle engines

Vehicle	Vehicle type	Engine type	Cylin. dia. & stroke	Volume (L.)	Cm. ra.	F.C. g/kw.h	F.C. (*)
Minicar	Jiling	JL 368Q	68.5 x 72	0.797	8.7		4.4
	Changhe	DA 462	62 x 66	0.797	8.7	299.2	6.5
	Jiling	JL 462Q	62 x 66	0.797	8.7	299.2	5.8
Car	Santana	JV	81 x 86.4	1.781	8.5	285	12.8
	Audi	100	81 x 86.4	2.2	10		
	Cherokee	498		2.466	8.6		
	Peugeot	XNIA	88 x 81	1.971	8		13.8
Light truck	Beijing	492 QA2	92 x 92	2.446	7.4	306	13.8
	Beijing	492 QA	92 x 92	2.445	7.2	319.6	
	Yaojin	4102 Q1	102 x 105	3.432	17	242.1	13
	Yaojin	NJ136A2	92 x 92	2.45	7.8		13.5
Medium truck	Dongfeng	EQ6100-1	100 x 105	5.42	6.8	306	28
	Jiefang	CA 6102	101.6 x 114	5.56	7.7	285.7	26
	Dongfeng	EQ6102-1		5.638		diesel	18
	Jiefang	6110-2		6.842		diesel	19
Heavy duty truck	Huanghe	6135Q	135 x 150	12	17	224	24
	Steyer	WD-615.61	126 x 130	9.726	16	210	31
	Steyer	WD-615.67				204	32
	Hongyan	NTC 290	139.7 x 162	14	15	218	
	Hongyan	6130	135 x 140	11.15	17		

Cm.Ra.: compression ratio; F.C.: fuel consumption; *: L/100km

2. Automotive fuel production and quality standards

2.1 Motor gasoline production

The output of motor gasoline has been over 25 million ton per year, with high growth rate in the past ten more years mainly for domestic use and with small part for export. Classified motor gasoline outputs from 1985 to 1992 are listed in table 4.

Table 4 Classified motor gasoline output and % shares

Year	Output (mil.ton)	Percentage share (%)			
		66# MON	70# MON	90# RON	93# 97# RON*
1985	14.3	0.37	87.23	10.56	1.68
1986	16.3	0.48	83.48	14.27	1.77
1987	17.0	0.37	73.84	24.46	1.33
1988	18.6	0.31	67.74	30.82	1.13
1989	20.1	0.14	65.04	33.50	1.32
1990	21.3	0.03	62.72	34.86	2.39
1991	23.2	-	50.80	38.29	2.91
1992	25.8	-	54.21	42.81	2.99

Due to the development of vehicle type particularly the truck engine performances, different auto fuels have been developed. For instance, before 1978 for trucks with compression ratio of 6.0 - 6.2, 66# gasoline is used; after 1978, for trucks with compression ratio of 6.4 -7.2, 70# gasoline is used; after 1986, for trucks with compression ratio of 7.2 - 7.6, 70# gasoline is used at first and then 90# gasoline is used. For light passenger car usually with compression ratio above 8.0 - 9.5, 90# to 97# gasoline are mainly used.

2.2 Motor gasoline quality standards

National uniform motor gasoline standard in China was issued for the first time in 1959. Before 1986 fuels were classified according to motor octane number (MON). Since 1986 it has been changed to research octane number (RON). The standard was modified three times. At present gasoline is classified into three grades according to national standard GB484-93, i.e. RON90, RON93, and RON97. There also exists trade standard in China which is known as SH 0112-92, which is for the major product MON70.

To improve auto fuel quality, more RON90 gasoline shall be produced. It is expected that RON90 gasoline shall be the major product by the year of 2000, and the output of RON97 gasoline shall also be increased gradually. At the moment MON70 gasoline still account for quite a part of the total output, but it shall be gradually cut down year by year.

Table 5 Standards for MON 70# gasoline & actual test results

Test items	Trade standard SH 0112-92	Actual test result	Test method	
			Standards in China	Correspondents
MON	min. 70	72.0	GB/T 503	ASTM D2699
Lead, g/l	max. 0.35	0.10	GB/T6535	ISO 2083
Distillation			GB/T 255	-
10% recovered	max. 79 °C	64		
50% recovered	max. 145 °C	102		
90% recovered	max. 195 °C	161		
End point	max. 205 °C	193		
Residue	max. 1.5%(v/v)	1.0		
Residue & los	max. 4.5%(v/v)	3.0		
RVP, kpa			GB/T 257	-
Winter	max. 80	52		
Summer	max. 67			
Existent gum	max. 5 mg/100ml	2.1	GB/T 509	-
Induc. period	min. 480 min.	502	GB/T 256	-
Sulfur,	max. 0.15%(m/m)	0.011	GB/T 380	lamp method
Copper corrosion, 50 °C,3h	max. 1 class	1	GB/T5096	ASTM D130
Reaction	neutral	neutr.	GB/T 258	-
Acidity, (mgKOH/100ml)	max. 3	0.1	SH/T0116	-
Water & Impurities	nil	nil		

Table 5 and table 6 show the standard and some actual test results for RON 90# and MON 70# gasoline. National standard GB484-93 is the standard for leaded gasoline, with lead limit 0.35 g/l for 90# gasoline and 0.45 g/l for 93# and 97#. In fact lead content in 90# gasoline is below 0.25 g/l, with RVP at about 60 kpa, and with benzene content below 5%.

2.3 Unleaded motor gasoline

Unleaded gasoline accounts for quite a part of the gasoline output in China with share of 46%. Quality specifications for unleaded gasoline 90#, 93# and 95# are set by trade standard which is shown in table 7. At present unleaded gasoline is available at fuel stations in some big cities such as Beijing, Shanghai, and Guangzhou, but the sales volume is small, despite the nearly fifty percent share of unleaded gasoline. It is because that most part of the unleaded gasoline is MON 70# and quite amount of the unleaded gasoline RON 90#,93# and 95# are exported to other countries. Table 5 shows classified gasoline products shares in 1992.

On the whole it is the strategic target of the oil refinery industry in China that to increase product share of RON 90# grade gasoline, gradually reduce MON 70# grade gasoline output, and to eliminate leaded gasoline eventually. With more strict national standard for vehicle emission control, the motor gasoline quality have to be improved, e.g. to reduce RVP, reduce benzene (< 1%), and olefine content.

Table 6 Standard for RON 90# gasoline & actual test results

Test items	National standard GB484-93	Actual test result	Test method	
			Standards in China	Correspondents
Anti-knock test				
RON	min. 90	90.8	GB/T5487	ASTM D2699
Anti-knock index	min. 85	85.5	GB/T 503	ASTM D2700
Lead content, g/l	max. 0.35	0.22	GB/T6535	ISO 2083
Distillation			GB/T6536	ASTM D86
10% recovered, °C	max. 70	56		
50% recovered, °C	max. 120	104		
90% recovered, °C	max. 190	174		
End point, °C	max. 205	199		
RVP, kpa			GB/T8017	ASTM D323
Winter	max. 88	57		
Summer	max. 74	-		
Existent gum, mg/100ml	min. 5	1.9	GB/T8019	ISO 6206
Induction period, minute	max. 480	876	GB/T8018	ASTM D525
Sulfur, %(m/m)	max. 0.15	0.005	GB/T 380	lamp method
Copper corrosion, 50 °C 3h, class	max. 1	1	GB/T5096	ASTM D130
Acidity, mgKOH/100ml	max. 1	0.1	SH/T0116	
Water & impurities	nil	nil		
Doctor test	pass	pass	SH/T0174	ISO 5275

Table 7 Standard SH0041-93 for un-leaded gasoline

Test items	Limits			Test method	
	90#	93#	95#	Standard in China	Correspondent
Anti-knock test					
RON, min.	90	93	95	GB/T5487	ASTM D2699
(RON+MON)/2, min.	85	88	90	GB/T 503	ASTM D2700
Lead, g/l, max.	0.013			GB/T8020	ASTM D3237
Distillation				GB/T6536	ASTM D86
10% recovered, C,max.	70				
50% recovered, C,max.	120				
90% recovered, C,max.	190				
End point, C,max	205				
Residue, %(v/v), max.	2				
RVP, kpa				GB/T8017	ASTM D323
1 Sep.- 29 Feb., max.	88				
1 Mar.- 31 Aug., max.	74				
Gum, mg/100ml, max.	5			GB/T8019	ISO 6206
Induction period, minute, min.	480			GB/T8018	ASTM D525
Sulfur, %(m/m), max.	0.15			GB/T 380	lamp method
Doctor test,	pass			SH/T0174	ISO 5275
Mercaptan sulfur %(m/m),max.	0.001			GB/T1792	ASTM D3227
Copper corrosion, (50 C, 3h),class,max.	1			GB/T5096	ASTM D130
Acidity, mgKOH/100ml	nil			GB/T 259	-

Table 8 Classified gasoline products % shares in 1992

Classification		% share	Classification		% share
Leaded 54%	MON 70#	26.1	Un-leaded 46%	MON 70#	28.1
	RON 90#	27.2		RON 90#	15.6
	RON 93#, 97#	0.7		RON 93#, 97#	2.3

2.4 Diesel fuel production and quality standards

Diesel fuel output is more than that of gasoline in China, with annual output over 30 million ton. Most of diesel fuel are light fuel, with small amount of heavy fuel. The national uniform technical requirements for diesel fuel were issued in 1962. Since China is such a large country with great differences in climate from place to place, the light diesel fuel is classified into six grades in the current national standard GB 252-87, i.e. +10#, 0#, -10#, -20#, -35#; and three classes, i.e. premium class, first class, and qualified class are distinguished for each grade based on iodine number and oxidation property etc. Table 9 and 10 show light diesel fuel national standard GB 252-87 and actual test results.

Table 9 Standard for 0# light fuel & actual test results

Test item	National standard GB252-87	Actual test results	Test method: Standards in China	Test method: Correspondents
Cetane number	45	69	GB/T 386	ASTM D613
Distillation			GB/T6536	ASTM D86
50% recovered, C,max.	300	274(276)		
90% recovered, C,max.	355	310(318)		
95% recovered, C,max.	365	329(328)		
Kinematic viscosity, (20 C), mm/s	3-8	4.5(4.7)	GB/T 265	(ISO 3104)
Carbon residue on 10% residuum, %(m/m),max.	0.3	0.02 (0.03)	GB/T 268	ISO 6615
Ash, %(m/m), max.	0.01	0.002 (0.001)	GB/T 508	ISO 6245
Sulfur, %(m/m),max.	0.2(0.5)	0.02	GB/T 380	lamp method
Impurities	nil	nil	GB/T 511	-
Water, %(m/m), max.	trace	trace	GB/T 260	-
Flash point, (close cup), C, max.	65	77 (81)	GB/T 261	ISO 2719
Copper corrosion, (50 C,3h),class,max.	1	1	GB/T5096	ASTM D130
Acidity,mgKOH/100ml,max.	5	1.1(0.8)	GB/T 258	
Solid. point C, max.	0	-3	GB/T 510	
Reaction,	neutr.	neutr.	GB/T 259	
Density(20 C),kg/m,max.	report	811.6 (814)	GB/T1884	
Colour, code, max.	3.5	0.7(1.8)	GB/T6540	ASTM D1500
Iodine No.,gI/100g,max.	6	3.8	SH/T0234	
Oxidation,mg/100ml,max.	(2.0)	(2)		
Mercaptan sulfur, %(m/m), max.	0.01	0.003	GB/T1792	ASTM D3227
CFPP, C, max.	4	-3	SH/T0248	IP 309

Note: 1. For items with two data, the one with bracket is for the the first class;
2. For items with one datum, it is for both the premium class and first class.

Table 10 Standards for -10# light fuel & actual test results

Test items	National standard GB252-87	Actual test results	Test method: Standard in China	Test method: Correspondents
Cetane number, min.	45	48 (44)	GB/T 386	ASTM D613
Distillation			GB/T6536	ASTM D86
50% recovered, C,max.	300	252(254)		
90% recovered, C,max.	355	305(310)		
95% recovered, C,max.	365	320(323)		
Kinematic viscosity, (20 C), mm /s	3-8	3.5(3.4)	GB/T 265	(ISO 3104)
Carbon residue on 10% residuum, %(m/m),max.	0.3	0.04 (0.06)	GB/T 268	ISO 6615
Ash, %(m/m), max.	0.01 (0.02)	0.004	GB/T 508	ISO 6245
Sulfur, %(m/m), max.	0.5 (1.0)	0.05 (0.04)	GB/T 380	lamp method
Impurities	nil	nil	GB/T 511	
Water, max.	trace	trace	GB/T 260	
Flash point (closed cup), C, max.	65	82 (77)	GB/T 261	ISO 2719
Copper corrosion, (50 C,3h),class, max.	1	1	GB/T5096	ISO D130
Acidity, mgKOH/100ml, max.	5 (10)	0.35 (0.5)	GB/T 258	
Solid. point, C, max.	-10	-13(-12)	GB/T 510	
Reaction, neutral	neutr.	neytr.	GB/T 259	
Density, (20 C), kg/m, max.	report	831(836)	GB/T1884	
Colour, code, max.	3.5	2.2	GB/T6540	
Gum, mg/100ml, max.	(70)		GB/T 509	
Oxidation, mg/ml, max.	2	1.7	SH/T0238	
Mercaptan sulfur, %(m/m), max.	0.01	0.002	GB/T1792	ASTM D3227
CFPP, C, max.	-5	-10 (-9)	SH/T0248	

Note: 1. For items with two data, the one with bracket is for the qualified class;

2. For items with one datum, it is for both the first class and qualified class.

The light diesel fuel 0# accounts for 76% of the total output, with -10# 9%. Heavy fuel 20# accounts for 4%.

China is abundant in crude oil resources with variety of bases, most of which, like Da-Qin crude oil, are low-sulfur, high-wax containing. So most of diesel fuel have high-wax, low-sulfur content. But there still have a few domestic crude oils of higher sulfur content. Especially those imported from the Mid-East usually have high-sulfur content. Therefore the standard limit for sulfur content is wide. The main problem for diesel fuel is that the oxidation property has to be improved, most of which is produced by catalytic cracking process without better refining treatment.

As for two stroke engine oil, a series of products including ERA-I, ERB-II, ERC-III have been developed and used in some cities, and the ERD-IV is being developed at the moment, about which the trade standard is going to be prepared. Motorcycles are mainly used in small cities and rural areas, and strictly controlled in big cities.

3. Current vehicle emission status and standards in China

Along with the growth of motor vehicle population there are more air pollutions. According to the survey, motor vehicle has become a major mobile pollutants' source in cities.

Vehicle emission standards were issued for the first time in China in 1983, the national standard GB 3842-83 Standard for Emission Pollutants from Gasoline Powered Vehicles at Idle Speed, GB 3843-83 Standard for Smoke Emission from Diesel Powered Vehicles under Free Acceleration Mode, GB 3844-83 Standard for Smoke Emission from Diesel Powered Vehicles under Full Load Mode, and corresponding standards for the pollutants measurement method. In 1989 the standards for light vehicle emissions and the measurement method, and the standards for vehicle engine crankcase emissions and the measurement were issued. On the whole the emission standards in China are going to be more strict and shall be harmonized with international standard. A series of national standards GB 14761.1-7-93 for Motor Vehicle Emission Pollutants shall be enacted on May 1st, 1994.

3.1 National standard GB 14761.1 for light vehicle emission

The test method for the emission pollutants measurement shall be in accordance with national standard GB/T 11642 Measurement Method for Light Vehicle Emission Pollutants. The limits of vehicle emission pollutants specified in the standard are shown in table 11 and table 12.

Table 11 Type approval test standard for light vehicle

RW (kg)	CO L1	HC(C equivalent) L2	NOx(NO_2 equivalent) L3
RW ≤ 750	65	10.8	8.5
750 < RW ≤ 850	71	11.3	8.5
850 < RW ≤ 1020	76	11.7	8.5
1020 < RW ≤ 1250	87	12.8	10.2
1250 < RW ≤ 1470	99	13.7	11.9
1470 < RW ≤ 1700	110	14.6	12.3
1700 < RW ≤ 1930	121	15.5	12.8
1930 < RW ≤ 2150	132	16.4	13.2
2150 < RW	143	17.3	13.6

Table 12 Product conformity test standard for light vehicle

RW (kg)	CO	HC(C equivalent)	NOx(NO_2 equivalent)
RW ≤ 750	78	14.0	10.2
750 < RW ≤ 850	85	14.8	10.2
850 < RW ≤ 1020	91	15.3	10.2
1020 < RW ≤ 1250	104	16.6	12.2
1250 < RW ≤ 1470	119	17.8	14.3
1470 < RW ≤ 1700	132	18.9	14.8
1700 < RW ≤ 1930	145	20.2	15.4
1930 < RW ≤ 2150	158	21.2	15.8
2150 < RW	172	22.5	16.3

3.2 National standard GB 14761.2 for gasoline powered vehicle emission pollutants

The test method for the standard is in accordance with the method used in national standard GB/T 14762 Measurement Method for Gasoline Powered Engine Emission Pollutants, and the emission limits are listed in table 13 and table 14.

Table 13 Type approval test standard (g/kw.h)

Enact period	Limits of the emission pollutants	
	CO	HC + NOx
01/01/95 - 31/12/97	54	22
01/01/98 -	34	14

Table 14 Product uniformity test standard (g/kw.h)

Classification	Enact period	Pollutant limits	
		CO	HC + NOx
Gasoline engine got approval after 1/1/95	01/01/96 - 31/12/98	65	26
	01/01/99 -	41	17
Those got approval before 31/12/94	01/01/96 - 31/12/98	96	38
	01/01/99 -	54	22

3.3 National standard GB 14761.3 for gasoline powered engine fuel evaporative pollutants

The test method for the standard is in accordance with national standard GB/T 14762 Measurement Method for Gasoline Powered Engine Evaporative Pollutants, with the standard limits shown in table 15.

Table 15 Standard for gasoline engine evaporative pollutants

Classification	Limits (g/test)
Light vehicle produced after 01/07/95	2
Heavy vehicle produced after 01/07/96	4

As for the light vehicles produced before July 1st, 1995 and the heavy vehicles produced before July 1st, 1996, the environment protection department of the provinces, autonomous regions and the municipalities directly under the center government shall set standards based on the air quality standard requirements, technical and economic conditions, subject to the approval by the people's government of the same level.

3.4 National standard GB14761.4 for motor vehicle crankcase emission pollutants

The measurement method for the standard is in accordance with national standard GB/T 11340 Measurement Method for Motor Vehicle Crankcase Emission Pollutants. The standard can be described as follows:

a. Quantitative: the combined flow measured from the ventilation pipe and the pressure control valve shall not exceed the leakage flow after conversion;

b. Qualitative: no positive pressure shall be measured at the oil scale orifice, when the vehicle mileage is less than 80000 km.

3.5 National standard GB 14761.5 for motor vehicle emission pollutants at idle speed

The measurement method for the standard is in accordance with national standard GB/T 3845 Measurement Method for Gasoline Vehicle Emission Pollutants at Idle Speed, with the standard limits shown in table 16.

3.6 National standard GB 14761.6 for diesel powered vehicle emission smoke under free accelerating mode

The test method for the standard is accordance with national standard GB/T 3846 Measurement Method for Diesel Powered Vehicle Emission Smoke under Free Accelerating Mode, with the standard pollutant limits shown in table 17.

Table 16 Standard for gasoline vehicle emission pollutants

Classification	CO (%)		HC v/v (ppm)*			
			Four stroke		Two stroke	
	Light	Heavy	Light	Heavy	Light	Heavy
Approved before 1/7/95	3.5	4.0	900	1200	6500	7000
Produced before 1/7/95	4.0	4.5	1000	1500	7000	7800
In-use before 1/7/95	4.5	5.0	1200	2000	8000	9000
Approved after 1/7/95	3.0	3.5	600	900	6000	6500
Produced after 1/7/95	3.5	4.0	700	1000	6500	7000
In-use after 1/7/95	4.5	4.5	900	1200	7500	8000

*: measured according to n-hexane equivalent

Table 17 Standard for diesel powered vehicle emission smoke under free accelerate mode

Classification	Smoke (FSN)
Approved before 1/7/95	4.0
Produced before 1/7/95	4.5
In-use before 1/7/95	5.0
Approved after 1/7/95	3.5
Produced after 1/7/95	4.0
In-use after 1/7/95	4.5

3.7 National standard GB 14761.7 for diesel powered vehicle emission smoke under full load mode

The test method for the standard is in accordance with national standard GB/T 3847 Measurement Method for Diesel

Powered Vehicle Emission Smoke under Full Load Mode, with the standard limits of the smoke shown in table 18.

Table 18 Standard for diesel powered vehicle emission smoke under full load mode

Vehicle classification	Smoke (FSN)
New type diesel powered	4.0
Newly produced diesel powered	4.5

4. Policies

4.1 The policy on the replacement of the in-use vehicle

To reduce fuel consumption and emission pollutants the state has set standards for old-type vehicle replacement. According to the national old-type vehicle replacement program, about one million old-type vehicles shall be replaced during the period of 1991-1995, with annual replacement of about 200 thousand.

4.2 Fuel prices and taxes

China is taking up the market economic system. The gasoline price and part of the diesel price are regulated by the market. At present the gasoline price is about 2500 - 3000 yuan per ton; and the diesel fuel price 2000 - 2500 yuan per ton. Since the oil refineries are usually in remotely partited areas with high transport cost, there are great differences for fuel prices in different cities, which is shown in table 19.

Quite a part of farm use diesel fuel is still subsidized by the government, with price only 330 - 370 yuan per ton and annual subsidy up to 840 million yuan.

Since January 1st 1994, a special consumption tax has been levied on some of the commodities, including automotive fuel with duty rate 0.2 yuan/l for gasoline and 0.1 yuan/l for diesel fuel.

Table 19 Fuel prices in some cities in Nov. 1993 (yuan/ton)

City	90# gasoline		70# gasoline		0# diesel fuel	
	Whol.	Retail	Whol.	Retail	Whol.	Retail
Shanghai	2550	2910	2490	2830	2240	2620
Nanjing	2350	2510	2250	2350	1950	1995
Ninbou	2200	2527	1980	2390	1870	1038
Xiamen	2250	2650	2550	2950	1950	2150
Guangzhou	2150	2400	2120	2400	1940	2190
Fuzhou	2380	2560	2150	2670	1900	2250
Shenyang	2700	3050	2600	2940		
Qianguoqi	2950	2300	2750	2250	2250	2030
Wuhan	2400	2450	2250			
Yingchuan	3100	3350	2880	3060	1850	2000
Xining	2950	3000	2850	2890	1920	2035
Lanzhou	2650		2600		1680	
Wulumuqi	2100	2380	2050	2220	1450	1550
Yumen	2450		2400			1650
Tianshui	3032	3335	2880	2930	1880	2052
Kelamayi	1980	2220	1900	2120	1250	1550

Whol.: wholesale

4.3 Environment protection is one of the basic state policy

Great efforts has been made to coup with vehicle emission pollutants in China, from government policies, regulations and standards to scientific research work. In 1990 the "Rules on Motor Vehicle Emission Pollutants Supervision Management" and in 1991 the "Regulations on National Motor Vehicle Emission Pollutants Measurement Management (Interim)" were issued by the National Environment Protection Bureau. The measures for those, from automobile engine production, vehicle application, and maintenance to regulation and enforcement have been taken to strengthen the supervision and control of vehicle emission pollutants, to protect environment and people's health.

AUTOMOTIVE FUEL QUALITY OF HONG KONG

Country Paper
Presented to the Expert Group Meeting on
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United Nations Development Programme

Presented by: Mr. Kong HA and Mr. Alex NG
Hong Kong Environmental Protection Department

Table of Content

List of Table and Figures

1. Introduction

This country paper serves to outline the following items as requested by UNIDO :-

(a) a review of automotive fuels and 2-stroke oils standards prevailing in Hong Kong in April, together with planned changes;

(b) a review of the vehicle population by engine type, size, and emission systems;

(c) data on total fuel consumption and breakdown by grade and vehicle categories;

(d) current fuel and 2-stroke oil prices, taxes and incentives;

(e) a review of the current automotive fuels quality control procedures;

(f) a list of current legislation with regard to automotive fuels and infrastructure.

Since the 2-stroke engines and its emissions are not of significance in Hong Kong in terms of air quality impact, this paper will not address items related to 2-stroke oils.

2. Long Term Vehicle Emission Control

Ambient air quality objectives (AQOs) are being implemented in Hong Kong which are of similar stringency as in the US. (Table 1). Among the pollutants being specified, the Total Suspended Particulate (TSP), Respirable Suspended Particulate (RSP) AND Nitrogen Dioxide (NO_2) are of concern. In urban areas, the TSP and RSP level exceed their respective AQOs while the NO_2 level is at the marginal level. It was estimated that vehicular emission contributed approximately 90% of the fine particulate and 70% nitrogen oxides (NOx) emissions and, thus, are the major source of pollution.

Recognising emissions from motor vehicles are a major cause of air pollution, the Hong Kong government in the 1989 White Paper on Pollution laid down a four-phase strategy to tackle the problem. The strategy involved introducing unleaded petrol (ULP), requiring new light duty vehicles to meet the most advanced international emission standards as a prerequisite to registration, and stepping up controls and enforcement of smoky vehicle legislation. These three phases were completed in 1991.

In a recent re-examination of the strategy, the Government identified the need for the development of a more broad-based vehicle emission control strategy which takes into account the persistent violation of AQOs, the continuing growth in motor vehicle population (UNIDO Country Paper 92, 93), the technological limits in controlling motor vehicle emissions now and in the coming decade, and the increasing public concern over vehicle pollution. The following four options are now under evaluation and portions have been put forward for implementation.

Option 1 - Petrol option for taxis and Public Light Bus (PLBs)

This option is now under feasibility study and is an extension of the measures already implemented including making ULP available. Petrol engines operated on ULP and equipped with catalytic converters emit about 22 times less particulate as well as cancer-causing compounds such as Benzo-(a)-pyrene (BaP). This option will mandate taxis, and public light buses to switch to operate on ULP. Pursuing a petrol option for these vehicles will avail Hong Kong of the much needed incremental improvement in vehicular emission especially at urban black spots. It is estimated that the switch to petrol option would bring about 35 and 1 percent reduction of the present urban emissions of particulate and nitrogen oxides respectively. A number of scenarios are now under evaluation which can see the switch-over be completed in 5 years or as short as three years.

Option 2 - Vehicle emission inspection and maintenance (I/M)

The amount of emissions from motor vehicles depend both on the emission standards to which they are designed and built to, and on the way they are maintained under normal use. While design standards for light duty vehicles are already in place and for heavy duty vehicles are being proposed in the next option, the only sizeable existing effort to control emissions from vehicles during operation is the current Smoky Vehicle Control Programme (results reported in the 1992 UNIDO Country Paper). Although this programme has succeeded in removing most of the very bad gross smoke emitters from the roads, it falls far short of a proper I/M programme which should ensure that all vehicles on the road are well maintained and do not emit excessive emissions, either smoke or other invisible toxic pollutants. It is envisaged that an inspection and maintenance programme for Hong Kong should require that unleaded petrol vehicles over 2 years old pass an annual emission test before the licence is renewed; that diesel vehicles except taxis and PLBs, private or commercial, pass an annual emission test and an anti-tampering inspection; and that taxis and public light buses, due to their high usage, pass an emission test every 3 to 4 months.

Option 3 - Stringent emission/fuel standards

The serious air pollution problems caused by vehicle emissions and the ever increasing traffic volume and thus total emissions have left Hong Kong with no choice but to adopt the most practicable up-to-date stringent vehicle emission standards developed world wide. This third option calls for the adoption of more advanced emission standards for diesel vehicles larger than 2.5 tonnes. USA, Europe and Japan are the three world main vehicle manufacturing regions. The USA has the most stringent standards for heavy duty diesel vehicles, followed by Europe.

The 1990 USA standard is approximately equivalent to the European standard (EURO 1) adopted by all the EEC countries during 1993. Both the USA-1990 standard and the EURO 1 standard will be introduced and enforced in Hong Kong in 1995.

The option specifically is to establish new registration after 1st April 1995 that requires:-

(a) all petrol goods vehicles and buses more than 2.5 tonnes and not more than 3.5 tonnes to meet the relevant US, EEC and Japanese petrol vehicle emission standards while diesel vehicles to meet US and EEC standards as appropriate; and

(b) all petrol goods vehicles and buses more than 3.5 tonnes to meet the relevant US and Japanese petrol vehicle emission standards while diesel vehicles are to meet US and EEC standards as appropriate

The Japanese 94 diesel standards for vehicles over 2.5 tonne is under evaluation and will be included if assessed to be of similar stringency to the US or EEC standards.

It is also considered necessary to specify with these standards for 1995 a smoke standard of 40 Hartridge Smoke Units (HSU) under free acceleration test for diesel vehicles. The proposed limit is equivalent to an opacity of 1.2 absolute light absorption unit (m^{-1}). Table 2 shows the proposed emission standards for various vehicle types to be effective on 1.4.95.

Further development in large diesel emission control technology in US has allowed further tightening of standards in 1994. Europe will follow suit with EURO 2 standard to be implemented in 1996. Hong Kong also plans to adopt these standards in 1997. It is expected that the large diesel standard option when fully implemented in the long run together with the I/M program would bring about 39 and 11 percent reduction from the estimated total emissions of particulate and nitrogen oxides respectively.

In conjunction with the EURO 1 standard, high quality diesel having a low sulphur content not exceeding 0.2 percent is needed and will be introduced in 1995. Higher quality diesel having 0.05 percent sulphur will need to accompany the EURO 2 standard. Details on diesel fuel specifications will be elaborated further in the following sections.

3. Current Fuel Standards and Quality Control

3.1 Unleaded Petrol (ULP)

Under the Air Pollution Control (Vehicle Design Standards) (Emission) Regulations 1991, all petrol vehicles registered on or after 1.1.92 must use unleaded petrol, meet certain emission standards and must be constructed in such a way that a petrol pump dispensing nozzle spout greater than a specified dimensions can not be inserted into its filling pipe.

Under the Air Pollution Control Ordinance PART IVA, which became effective since 1.4.91, Unleaded Petrol must :-

(a) contain not more than 0.013 grams of lead per litre;
(b) contain not more than 0.10% by weight of sulphur;
(c) has a motor octane number of not less than 85.0; and
(d) has a research octane number of not less than 95.0.

The same legislation also requires all petrol stations to sell ULP and dispense ULP using nozzle spouts of specified dimensions. It is also unlawful to supply leaded petrol as ULP and vice verse. There is also an understanding between EPD and oil companies that the benzene for both leaded petrol and ULP will be below 5%.

The above regulations ensure the availability of ULP and low emission ULP vehicles as well as providing safe guards against accidental mis-fuelling.

3.2 Diesel

There is currently no legislation regulating automotive diesel specifications. Under the Air Pollution Control (Fuel Restriction) Regulation 1990, Sulphur is limited to 0.5% by weight for industrial diesel. Since only one grade of diesel fuel is available in Hong Kong, the automotive diesel in the market is similar to the industrial specification. In general, diesel fuel in Hong Kong has a sulphur content between 0.3% to 0.4% with a centane number slightly over 50.

3.3 Quality Control

There is no formal legislation mandating oil companies to conduct fuel sampling confirming compliance. On a voluntary basis, major oil companies provide EPD with ULP test results on the four regulated parameters. From refinery data provided by oil companies, EPD calculated on average for 1993 :-

	ULP
Lead Content (g/l)	<.001
Sulphur (% by weight)	.03
Motor Octane Number	87.30
Research Octane Number	98.50
Benzene (%)	3.70

EPD conducts random fuel sampling and find ULP available at pump complies with specifications. A recent fuel sampling yielded the following averages :-

	ULP	Leaded	Diesel
Cetane Index	---	---	57
Lead Content (g/l)	< .002	.17	---
Sulphur (% by wt)	< .02	< .02	.34
Benzene (% by Volume)	4.2	3.6	.21

The above results show the vehicle fuels available in HK are within specifications proposed in the UNIDO Guideline.

4. Vehicles and Fuel Consumption

As shown in Figure 1, a total of 432,447 vehicles have been licensed to operate on the roads of HK. Figure 2 divides the total vehicle population into diesel and petrol vehicles and into various vehicle classes. During 1993, 431 and 869 million litres of ULP and diesel were sold respectively. While 66% of the vehicles operate on petrol (mainly private cars), they only account for 33% of the total fuel consumption indicating private cars consume relatively less fuel. Figure 2 also shows that most of the commercial vehicles such as taxis, trucks and buses are diesel vehicles and together account for 67% of the total fuel consumption.

Due to the emission standards established for private cars, they are now mostly equipped with electronic control and three-way catalyst. However, most commercial vehicles are equipped with diesel engines which are not state-of-the-art by world standard. This situation is due to change as the new vehicle emission standards become effective during 1995 (Table 2).

5. Fuel Prices and Taxation

Hong Kong government has a long standing policy of taxing petrol fuel at a higher rate than diesel and between ULP and leaded petrol, the tax on leaded petrol is higher as shown:

	Pump Price (HK $)	Tax Included (HK $)
Leaded Petrol	8.53	5.46
ULP	8.14	4.86
Diesel	5.50	2.45

The policy has resulted in majority of commercial vehicles operate on diesel. Whilst only 32% of the vehicles must operate on ULP, ULP accounts for 68% of the total petrol sale (Figure 3) indicating a large number of petrol vehicles which can operate on leaded petrol are being fuelled with ULP either due to the lower ULP price or out of concern for the environment.

6. The Way Forward for Hong Kong

Knowing the importance of diesel fuel quality to the new technology heavy-duty low emission diesel engines in the coming years, Hong Kong environmental Protection Department is proposing higher diesel fuel standards to be implemented simultaneously with stringent diesel emission standards during 1995 and 1997.

Whilst the current ULP specification is a main clause under the Air Pollution Control Ordinance (APCO), a new regulation titled 'Motor Vehicle Fuel' is being proposed under APCO. Modification of fuel specification will take much less time under this new regulation.

Under the new proposed Air Pollution Control (Motor Vehicle Fuel) Regulations to be effective 1.4.95, motor vehicle diesel shall :-

(a) contain not more than 0.20% by weight of sulphur;
(b) have a cetane number of not less than 50;
(c) have a viscosity of 40°C of not less than 2 centistoke and not more than 4.5 centistoke;
(d) have a 90% distillation temperature of not more than 357°C; and
(E) have a specific gravity at 15°C of not less than 0.82 and not more than 0.86.

For 1997, EPD will amend the Motor Vehicle Fuel Regulation to specify the .05% sulphur diesel. Other emission related properties such as cetane number, distillation temperatures may also further amended reflecting advancement in diesel engine technology and world wide standard at the time. The two phase implementation of higher quality diesel will ensure the fuels to be fully compatible with in-use engines and will not accelerate engine wear.

Emissions from petrol vehicles such as Carbon Monoxide, Hydrocarbon are not significant in term of air quality. EPD has not contemplated any changes to the current ULP specifications but will continue to monitor world wide development in air quality standards and ULP vehicle emission standards which call for changes to ULP specifications.

Diesel fuel with even lower sulphur content and other specifications (such as the Swedish City Diesel) which can result in lower emissions are not being implemented due to the limited emission benefits for and possible deterioration impact on engines already in-use.

7. Comments on the Guideline

Hong Kong Environmental Protection Department agrees with the guideline proposed which calls for a lowering of lead content in leaded petrol, the adoption of Unleaded Petrol and low sulphur diesel for all Asian countries as soon as it is practical for a country to do so.

HKEPD has no comments on the 2-stroke oil specifications proposed in the guideline as such fuel and its associated emissions is not an environmental issue for Hong Kong.

Table 1

Air Quality Objectives of Hong Kong

Pollutant	1 hour (1)	8 hours (2)	24 hours (2)	3 months (3)	1 year (3)
Sulphur Dioxide (SO2)	800	-	350	-	80
Total Suspended Particulates (TSP)	-	-	260	-	80
Respirable Suspended Particulates (RSP)(4)	-	-	180	-	55
Nitrogen Dioxide (NO2)	300	-	150	-	80
Carbon Monoxide	30000	10000	-	-	-
Ozone	240	-	-	-	-
Lead	-	-	-	1.5	-

All Units in micro gram per cubic meter measured at 298 °K and 101.325 kPa

(1) Not to be exceeded more than three times per year
(2) Not to be exceeded more than once per year
(3) Arithmetic means
(4) RSP means suspended particles in air with a nominal aerodynamic diameter of 10 micrometers and smaller

Table 2
HKEPD Vehicle Emission Standards Proposed for 1.4.1995 Implementation

Vehicle Type	Positive Ignition Engine Test Procedure	Positive Ignition Engine Limits	Compression Ignition Engine Test Procedure	Compression Ignition Engine Limits
All Vehicle Type			72/306/EEC Free Acceleration Smoke as amended by 89/491/EEC (light absorption coefficient K, m-1)	K- 1.20
Private Car Taxi	US FTP 75 (g/km)	HC- 0.26 CO- 2.10 NOx- 0.63	US FTP 75 (g/km)	HC- 0.26 CO- 2.10 NOx- 0.63 PM- 0.12
	Japan 10.15 mode (g/km)	HC- 0.39 CO- 2.70 NOx- 0.48	Japan 10.15 mode (g/km) VW < = 1.265 tonne VW > 1.265 tonne	HC- 0.62 CO- 2.70 NOx- 0.72 NOx- 0.84 PM- 0.34
	93/59/EEC Type 1 (g/km)	HC+NOx- 0.97 CO- 2.72	93/59/EEC Type 1 (g/km)	HC+NOx- 0.97 CO- 2.72 PM- 0.14
	maximum mass exceeds 2.500 tonne and designed to carry more than 6 occupants including driver			
	RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72	RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72 PM- 0.14
	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17 PM- 0.19
	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9 PM- 0.25

FTP - Federal Test Procedure
DW - Design Weight RW - Reference Mass VW - Vehicle Weight

Table 2

HKEPD Vehicle Emission Standards Proposed for 1.4.1995 Implementation

Vehicle Type	Positive Ignition Engine Test Procedure	Positive Ignition Engine Limits	Compression Ignition Engine Test Procedure	Compression Ignition Engine Limits
Light Goods Vehicle Light Bus with DW not more than 1.7 tonne	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 0.75	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 0.75 PM- 0.16
	Japan 10.15 mode (g/km)	HC- 0.39 CO- 2.70 NOx- 0.48	Japan 10.15 mode (g/km)	HC- 0.62 CO- 2.70 NOx- 0.84 PM- 0.34
	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72 PM- 0.14
	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17 PM- 0.19
Light Goods Vehicle Light Bus with DW more than 1.7 tonne but not more than 2.5 tonne	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 1.10	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 1.10 PM- 0.28
	Japan 10.15 mode (g/km)	HC- 2.70 CO- 17.0 NOx- 0.98	Japan 10.15 mode (g/km)	HC- 0.62 CO- 2.70 NOx- 1.82 PM- 0.43
	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	HC+NOx- 0.97 CO- 2.72 PM- 0.14
	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17 PM- 0.19
	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9 PM- 0.25

FTP - Federal Test Procedure

DW - Design Weight RW - Reference Mass

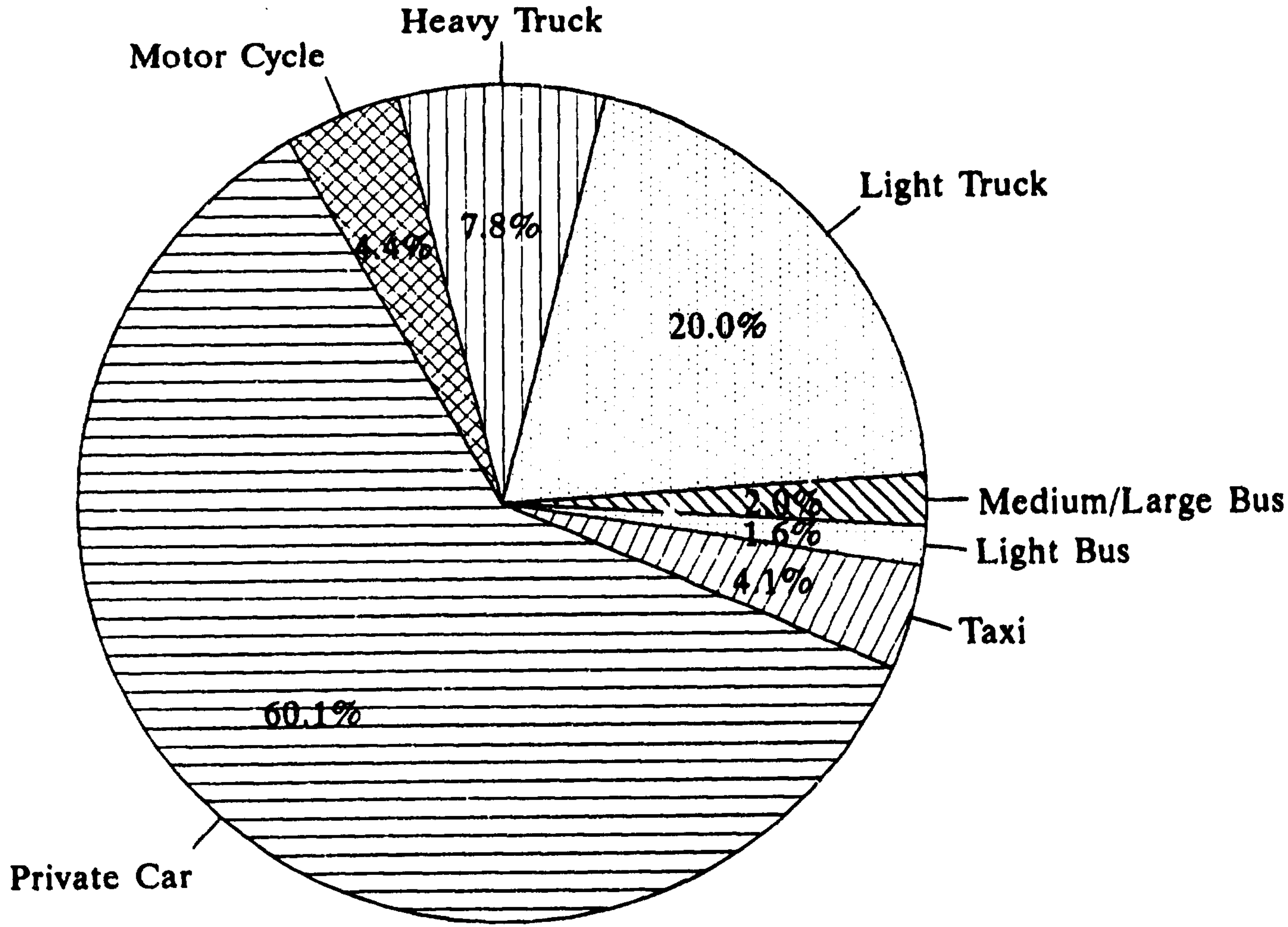
26/03/94

Table 2
HKEPD Vehicle Emission Standards Proposed for 1.4.1995 Implementation

Vehicle Type	Positive Ignition Engine Test Procedure	Positive Ignition Engine Limits	Compression Ignition Engine Test Procedure	Compression Ignition Engine Limits
Light Goods Vehicle Light Bus with DW more than 2.5 tonne but not more than 3.5 tonne	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 1.10	US FTP 75 (g/km)	HC- 0.50 CO- 6.20 NOx- 1.10 PM- 0.28
	Japan HDP 13 mode (g/kWh)	HC- 7.90 CO- 136 NOx- 7.20	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	 HC+NOx- 0.97 CO- 2.72 PM- 0.14
	93/59/EEC Type 1 (g/km) RW < = 1.250 tonne	 HC+NOx- 0.97 CO- 2.72	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17 PM- 0.19
	1.250 tonne < RW < = 1.700 tonne	HC+NOx- 1.4 CO- 5.17	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9 PM- 0.25
	RW > 1.700 tonne	HC+NOx- 1.7 CO- 6.9		
Goods Vehicle Light Bus Bus with DW more than 3.5 tonne	US HDO Transient (g/kWh)	HC- 2.55 CO- 49.7 NOx- 6.70	US HDD Transient (g/kWh)	HC- 1.74 CO- 20.8 NOx- 8.04 PM- 0.80
	Japan HDP 13 mode (g/kWh)	HC- 7.90 CO- 136 NOx- 7.20	91/542/EEC (g/kWh)	HC- 1.1 CO- 4.5 NOx- 8.0
			engine power < = 85 kW	PM- 0.61
			engine power > 85 kW	PM- 0.36

FTP - Federal Test Procedure
DW - Design Weight RW - Reference Mass HDP - Heavy Duty Petrol (Gasoline) HDO - Heavy Duty Otto HDD - Heavy Duty Diesel

Vehicle Population and Types
(31/12/93)



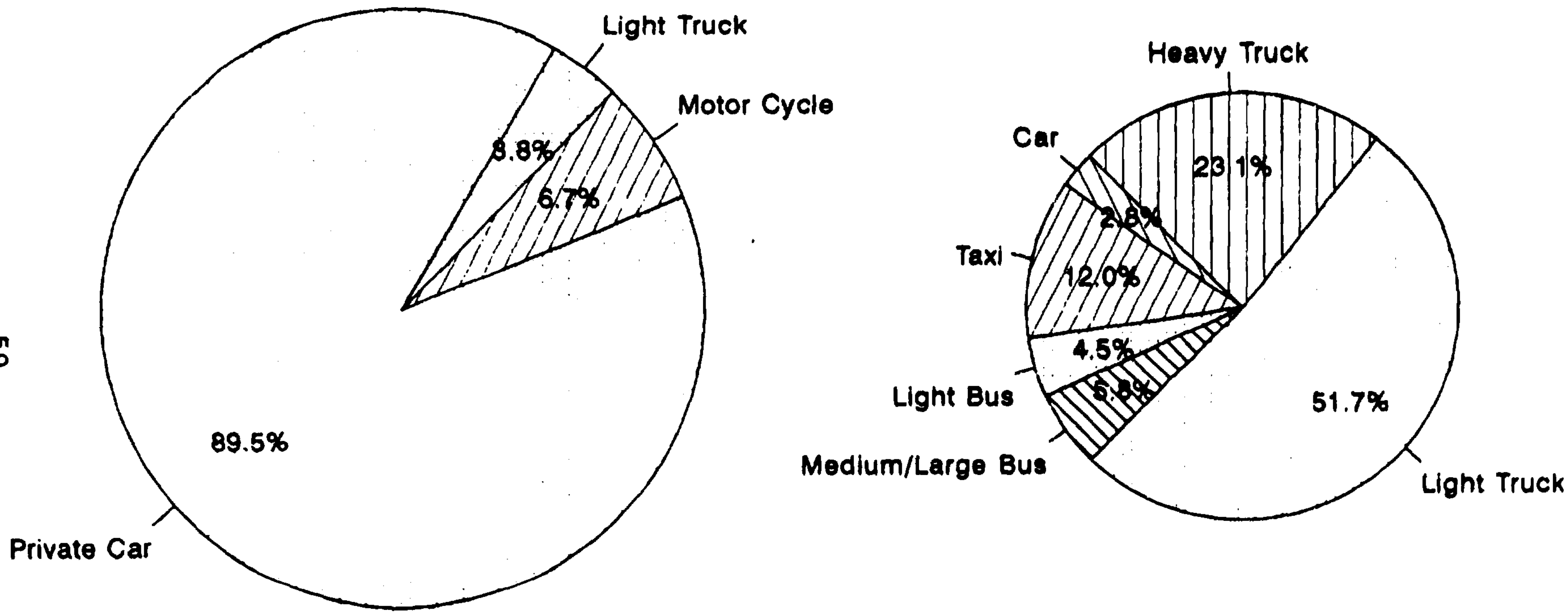
Total: 432,447

Figure 1

VECS-ASO-HKEPD

Petrol and Diesel Vehicle Population and Types

(31/12/93)



Petrol Vehicles: 286,025 (66% of Total)

Diesel Vehicles: 146,422 (34% of Total)

Figure 2

VECS-ASO-HKEPD

Hong Kong Automotive Petrol Consumption

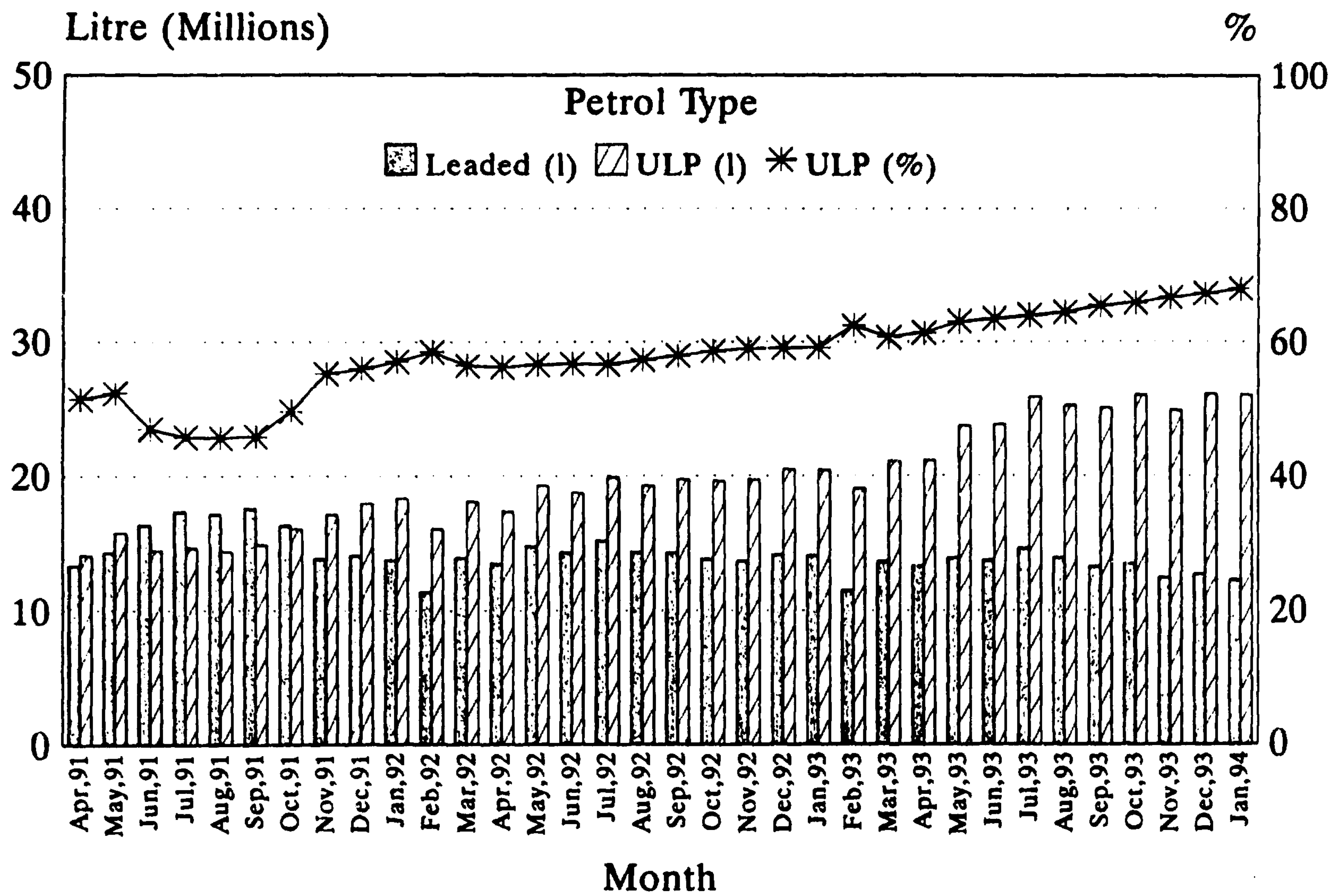


Figure 3

VECS-ASG-HKEPD

COUNTRY PAPER OF INDONESIA

CONTROL AND REGULATORY MEASURES CONCERNING MOTOR VEHICLES EMISSIONS IN ASIA PAQCIFIC REGION

AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS

BY

MUHAMMAD YUSUF
DIRECTOR OF LAND TRANSPORT SAFETY
AND MEANS ENGINEERING
DIRECTRATE GENERAL OF LAND TRANPORTATION
MINISTRY OF COMMUNICATION

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COUNTRY PAPER OF INDONESIA

1. INTRODUCTION

Technology development of engine automotive and increasing number of motor vehicles cause the need of fuel or both quality and quantity. Quality level of fuel used in certain country will not always be fixed for some reasons. Such fuel quality level would be corresponded to the development of engine and the need of clean air and environment.

Motor vehicles as transport modes for any reasons are now indispensable for economic activities and improving people's living standars. These situations causes the increase of car ownerships, particularly in some big cities throughout the country. These number of motor vehicle ownership is estimated would be increased about 10% - 15% per annum. Such condition cause some serious social problems as traffic accident and adverse effect on the environment such as atmospheric pollution, noise, etc. This is clearly that exhaust emission coming from motor vehicles contributes some adverse effects on the environment.

By considering the development of the automotive engine and the efforts on protection of environment, the quality level of fuel need to be improved. To fulfil such situation, PERTAMINA (the State Owned Oil and Gas Company) provides 2 (two) kinds of fuels, i.e. gasoline and diesel fuel.

In order to reduce fuel demand for transportation sector, since 1987 government introduce the use of Bahan Bakar Gas (Gas Fuel) for transport sector in Jakarta.

2. CURRENT CONDITION

Most of motor vehicle in Indonesia use gasoline with octane number varies from 85 to 95. Before 1990, the special gasoline (called premium) has octane number more than 100, contends lighter hydro carbon (HC) or some kind of additive substances such as tetra ethyl lead (TEL). The second largest fuel used in Indonesia is diesel fuel with cetane number between 30 and 60. Standard fuel for diesel fuel vehicle / motor is classified into cetane number. Its cetane 100 standard is n-heksaoctana ($C_{16}H_{34}$), sometimes called n-cetane and standard cetane 0 is alfa-metilnaf-telena ($C_{11}H_{10}$). Quality of the burning of diesel fuel can be determined by adding few certain chemical substance like organic nitrates and peroxide. Addition of 0.5% - 4% acetoperoxide will rise cetane number 10 -35.

As described previously, besides gasoline and diesel fuel, Compressed Natural Gas (CNG) has been introduced in Indonesia as automotive fuel in line with the government policy on conservation and diversification of energy as well as on environmental protection. Although the current use of CNG as an automotive fuel is still in a little amount, there is an evidence that the government certainly intends to encourage the use of CNG. Since many government institutions are involved in the policy implementation, the government through the Ministry of Mines and Energy has established a Coordination Team for the Improvement of CNG use. The institutions or agencies involved in this Team are the Ministry of Mines and Energy, the Ministry of Communications, the Ministry of Finance, the State Owned Oil and Gas Company (PERTAMINA), and the Association of Automobile Manufacturer (GAIKINDO).

Although some efforts have taken to cope with air pollution problems due to the operation of transport sector, there is still strong evidence that transportation sector contributes the the highest percentage on air pollution. It might be illustrated by the result of a survey conducted in big cities of Jakarta, Bandung, Surabaya, and Semarang during the period of 1986 - 1990 as follows:

TABLE 1
CONTRIBUTION TRANSPORT SECTOR ON AIR POLLUTION
IN SEVERAL BIG CITIES
(SURVEY CONDUCTED IN 1986 - 1990)

Pollutant	Transportation	Household	Garbage	Industry
Jakarta				
CO	98.8%	0.1%	1.0%	0.1%
NO_x	73.4%	9.6%	1.1%	15.9%
HC	88.9%	2.2%	7.7%	1.2%
Bandung				
CO	97.4%	0.1%	2.4%	0.1%
NO_x	56.8%	11.2%	3.0%	29.0%
HC	78.5%	2.2%	17.5%	1.8%
Surabaya				
CO	96.8%	0.3%	2.6%	0.3%
NO_x	33.6%	21.5%	1.7%	43.3%
HC	71.0%	7.4%	17.2%	4.4%
Semarang				
CO	98.2%	0.1%	1.1%	No
NO_x	82.5%	15.3%	1.2%	available
HC	87.6%	4.0%	8.4%	cata

3. FUEL SPECIFICATION

From description mentioned above, PERTAMINA provides 2 (two) kinds of fuels, i.e.; gasoline and diesel fuel.

3.1 GASOLINE

In order to reduce tetra ethyl lead content (TEL) in gascline, since May 1990, PERTAMINA only produce 1 (one) type of gasoline which is called Premium. Bensin Super (Super Gasoline) with higher TEL content was not produced anymore.

In the Decree of Director General for Oil and Gas No.18K/72/DDJM/1990 issued on April 20th, 1990 stated that Premium Gasoline must have a minimum research octane number of 88 RON with maximum TEL content of 1.5 ml/AG (0.45 g Pb/liter).

Since Super Gasoline was not produced anymore, any motor vehiclewhich need gasoline with octane number higher than 88 RON might be using Premium Mixture (Premix) gasoline. The type or specification of such gasoline was established by the Decree of Director General of Oil and Gas No.21K/72/DDJM/1990 issued on April 25th, 1990. This Premium Mixture gasoline is produced from Premium gasoline added by methyl tertiary buthyl ether (MTBE) 10% volume with maximum TEL content of 1.5 ml/AG and minimum RON of 91.5.

Gasoline fuel consists of several component with various anti-detonation quality, i.e. component with RON more than 90 such reformat, with medium RON (approximately 70) such as light naphta, and component with smaller RON such as heavy naphta, straight run naphta, etc.

To increase octane number, gasoline fuel added by octane booster as stated below.

- Tetra Ethyl Lead (TEL), $Pb(C_2H_5)_4$
- Methyl Tertiary Butnyl Ether (MTBE), $C_5H_{12}O$

Besides these octane booster, gasoline fuel also added by multi-use detergen additive which give some advantages as follows:

- conserve energy;
- improve driveability of motor vehicles;
- reduce pollutant;
- etc.

The specification of both Premium gasoline and Premium Mixture (Premix) gasoline is illustrated in the table below.

TABLE 2
SPECIFICATION PREMIUM GASOLINE AND PREMIX GASOLINE

CHARACTERISTIC	U N I T	PREMIUM *		PREMIX **		TEST METHOD	
		MIN	MAX	MIN	MAX	ASTM	OTHER
RON	ON	88		91.5		D.2669	
TEL Content	ml/AG		1.5		1.5	D.2547	
Distillation:						D.86	
10% vol.evac.at	°C		74		74		
50% vol.evac.at	°C	88	125***	88	125***		
90% vol.evac.at	°C		180		180		
End Point	°C		205		205		
Residu	% vol		2.0		2.0		
R.V.P	psi		9***		9***	D.323	
Existent Gum	mg/100 ml		4		4	D.381	
Induction Period	min	240		240		D.525	
Sulphur Content	% wt		0.20		0.20	D.1266	
Copperstrip Corrotion 3 hrs/ 122 of	ASTM No.		No.1		No.1	D.130	
Doctor Test or			Neg.		Neg.		IP 30
Alternative Mercaptan Sulphur	% wt		0.0025		0.0025	D.1219	
Colour		Yellow		Orange			
Dye Content	g/100AG	Yellow 0.5		Red 0.5			
MTBE	% vol			10			
Odour		Marketable		Marketable			

Note:
* The Decree of Director General for Oil and Gas Number: 18K/72/DDJM/1990;
** The Decree of Director General for Oil and Gas Number: 21K/72/DDJM/1990;
*** Permitted by using Volatility Adjustment Table.

3.2 DIESEL FUEL

Recently, the involvement of motor diesel in transport sector is increasing. Light Goods Vehicles (light trucks), Heavy Goods Vehicles (Heavy Trucks), Big buses frequently using diesel motor as well as some of private cars, jeeps.

For those vehicles above mentioned, PERTAMINA provides diesel fuel. In the table 3 below illustrates the specification of such diesel fuel based on the Decrees of Director General for Oil and Gas No. 002/F/DM/MIGAS/1979 issued on May 25th, 1979.

TABEL 3
SPECIFICATION OF DIESEL FUEL

CHARACTERISTIC	RANGE MIN	RANGE MAX	TEST METHOD ASTM
Specific Gravity at 60/60 °F	0.820	0.870	D 1298
Colour ASTM		3.0	D 1500
Cetane Number or	45		D 613
Alternative Calculated Cetane Index	48		D 976
Kinematic Viscosity at 100 °F, cSt	1.6	5.8	D 445
Or Viscosity SSU at 100 °F, secs	35	45	D 88
Pour Point, °F		65	D 97
Sulphur Content, % wt		0.5	D 1551/1552
Copper Strip (3 hrs/100 °C)		No.1	D 130
Conradson Carbon Residu, % wt (on 10% vol. bottom)		0.1	D 189
Water Content, % vol.		0.05	D 95
Sediment, % wt		0.01	D 473
Ash Content, % wt		0.01	D 482
Neutrazation Value:			
Strong Acid Number, mg KOH/gr		Nil	D 974
Total Acid Number, mg KOH/gr		0.6	D 974
Flash Point P.M. cc, °F	150		D 93
Distillation:			D 86
Recovery at 300 °C, % vol.	40		

Based on the specification mentioned above, diesel fuel have minimum cetane number of 45, this cetane number illustrates the quality of diesel fuel, the higher cetane number the better quality of such fuel.

Additive substance used for diesel fuel give some advantages, such as:

- improving ignition quality;
- enhancing the performance of the engine;
- reducing the amount consumption of fuel;
- etc.

4. CORRELATION BETWEEN FUEL USED AND EXHAUST EMISSION

Exhaust emission components coming from motor vehicles might be described as follows:

Gasoline:
Carbon Monoxide : CO
Unburned Hydro Carbon : UHC
Hydro Carbon : HC
Nitrogen Oxide : NO_x
Lead Oxide : PbO

Diesel Fuel:
Carbon Monoxide : CO
Unburned Hydro Carbon : UHC
Nitrogen Oxide : NO_x
Sulphur Oxide : SO_x
Particulate
Smoke

The result of Research conducted by automotive experts shows that exhaust emission from motor vehicle is derived from function of a mixture between air and fuel. Figure 1, illustrates the magnitude/level of exhaust emission and consumption of specific fuel as a function a ratio between fuel and air.

From domestic sales of petroleum fuels by sector shows that transportation is the only sector which consume more than 10 billion liter per year since the year of 1987. This situation, of course, will contribute adverse effect on air pollution as illustrated on table 1.

Table 4 below, showing the domestic sales of petroleum fuels by sector from 1987 - 1992.

TABLE 4
DOMESTIC SALES OF
PETROLEUM FUELS BY SECTOR
(MILLION LITER)

YEAR	HOUSEHOLD	TRANSPORTATION	ELECTRIC POWER	INDUSTRY
1987	6,892	10,012	3,325	5,135
1988	7,101	10,825	3,416	5,353
1989	7,409	11,850	3,232	5,960
1990	7,853	13,315	4,304	6,704
1991	7,987	14,396	5,260	7,183
1992	8,459	15,271	5,869	8,121

Source: Petroleum Report, INDONESIA, August 1993
Embassy of United States of America,
Jakarta, Indonesia.

5. EFFORTS IN REDUCING POLLUTANTS

There are 2 (two) main efforts can be taken, i.e.;

a. reducing pollutant fuels;
b. the use of Gas Fuel as an alternative energy.

5.1 REDUCING POLLUTANT FUELS

The effort consists of reducing pollutant substances in fuel and using additive substances in fuel in order to reach a perfect ignition to create cleaner exhaust emission.

By reducing Pb (Lead) in gasoline will produce better quality of the fuel.

The Decree of Director General for Oil and Gas No. 002/P/DM/MIGAS/1979 issued on May 25th, 1979 stated that specification of gasoline as follows:

- Premium gasoline with maximum TEL content of:
  2.5 cc/AG
  0.75 gram Pb/liter

- Super 98 gasoline with maximum TEL content of:
  3.0 cc/AG
  0.9 gram Pb/liter

Whereas, according to the Decree of Director General for Oil and Gas No.18K/72/DDJM/1990 issued on April 20th, 1990 and No.21K/72/DDJM/1990 issued on April 25th, 1990 stated that specification of gasoline, as follows;

- Premium gasoline with maximum TEL content of:
  1.5 cc/AG
  0.45 gram Pb/liter

- Premix gasoline with maximum TEL content of:
  1.5 cc/AG
  0.45 gram Pb/liter

From the decrees mentioned above, indicates that Pb (lead) content in Premium gasoline reduced by 40%, and Premix (Premium Mixture) reduced by 50% from Super 98 gasoline.

For the next future, the use of TEL tend to be reduced gradually, and eventually no more TEL content in gasoline fuel, likewise implemented in many ceveloped countries.

The use of additive substances in gasoline fuel will give some advantages, as follows;

- conserve energy;
- improve driveability of motor vehicle;
- reduce pollution;
- etc.

5.2 THE USE OF GAS FUEL AS AN ALTERNATIVE ENERGY

There are 3 (three) different alternatives of gas fuel for motor vehicles, i.e.;

- Liquid Natural Gas (LNG);
- Liquid Petroleum Gas (LPG);
- Compressed Natural Gas (CNG).

The use of LNG for motor vehicle fuel is more expensive in price than LPG and CNG. This is, therefore, many countries choosing LPG and CNG as an alternative energy, whereas in Indonesia prefer the use of CNG which is usually called BBG (Bahan Bakar Gas). Such fuel (Gas) normally does not content of Sulphur and Pb (Lead), so that ignition will not produce SO_2 and PbO. The content of CO, HC, and NO_x from exhaust emission are also smaller, and this is resulting the adverse effect on the environment could also be reduced.

Characteristics of CNG:

- Metana is the main component of CNG;
- Ignition temperature is about 630 ^oC (higher than ignition temperature of gasoline fuel). CNG, therefore, is safer than gasoline;
- Octane Number relatively high;
- Less Pollutant than gasoline fuel;
- There is no Carbon deposit in motor engine, so efficient use of plug, piston ring, etc. Therefore, the total masintenance cost for motor vehicle will be less expensive.

Exhaust emission from CNG motor vehicle:
- The use of CNG for gasoline motor engine can reduce pollutant content of:

  * Carbon Monoxide (CO);
  * Unburned Hydro Carbon (UHC);
  * Hydro Carbon (HC);
  * Nitrogen Oxide (NO_x);
  * Pb (Lead).

- The use of CNG for diesel motor engine can reduce pollutant component of:

  * Carbon Monoxide (CO);
  * Unburned Hydro Carbon (UHC);
  * Nitrogen Oxide (NO_x);
  * Sulphur Oxide (SO_x);
  * Particulate;
  * Smoke;
  * Odour;
  * Noise.

6. STRATEGY AND POLICY

Based on the brief description previously, clearly that it is necessary to set-up concrete strategy and policy related to the issue of quality improvement of fuel for motor vehicles.

In general, some actions as a strategy and policy on the issue might be taken as follows:

- Reducing Tetra Ethyl Lead (TEL), so that Pb (Lead) content decrease from 0.45 becomes 0.15 gram/liter gasoline.

- Introducing and encouraging the use of Methyl Tertiary Buthyl Ether (MTBE).

- Encouraging the use of Bahan Bakar Gas (BBG) or Compressed Natural Gas (CNG) for motor vehicles.

7. CONCLUSION

a. Quality level of fuel for motor vehicle is closed related to some aspects of development of motor vehicle engine and the need of clean air and environment.

b. Since 1987 transportation sector consume more than 10 billion liter per year, and there is an evidence that this sector contributes the highest percentage on air pollution, particularly in big cities.

c. In order to reduce adverse effect on air/environment (atmospheric pollution, noise, etc.) due to fuel for motor vehicles, there are 2 (two) efforts might be taken, i.e.: reducing pollutant in fuels, and the use of gas fuel as an alternative energy.

d. This is realized that the effort on protection the environment not only related to the quality of fuel and the use of CNG as an alternative energy, but also other aspects which correspond to its motor vehicle, such as motor vehicle inspection and standard procedure.

TABLE : PRICES OF FUELS (INCLUDING TAXES AND INSENTIVE)

NO.	TYPE OF FUELS	RUPIAHS
1.	PREMIUM MIXTURE GASOLINE	840
2.	PREMIUM GASOLINE	700
3.	DIESEL FUEL	300
4.	2-STROKE ENGINE FUEL	850

NOTE : BANK INDONESIA RATE

1 US $ = RP. 2,151.00

TABLE : AIR POLLUTION CONTRIBUTION BY SECTOR IN DKI JAKARTA, 1991/1992.

POLLUTANT	TRANSPORTATION TONNES/YEAR	INDUSTRY TONNES/YEAR	RESIDENTIAL TONNES/YEAR	GARBAGE TONNES/YEAR	T O T A L EMISSION TONNES/YEAR
CO	373,662.00	378.20	378.20	3,782.00	378,200.40
HC	13,717.00	185.16	339.46	1,188.11	15,429.73
NOx	15,388.00	3,333.44	2,012.64	230.62	20,964.70
TSP	3,252.00	1,076.75	2,433.75	619.50	7382.00
SOx	7,476.00	17,687.67	3,018.47	56.42	28,238.56
TOTAL	413,495.00	22,661.22	8,182.52	5,257.15	449,595.89

SOURCE : RESULT OF SURVEY CONDUCTED BY BAPPEDAL IN COOPERATION WITH LPM-ITB, 1991/92 (PROCESSED)

NOTES :

FOR COMPARATION, BETWEEN JAKARTA AND MEXICO CITY :

TOTAL DAILY PRODUCTION OF POLLUTANT IN JAKARTA	=	1,230	TONNES POLLUTANT/DAY.
TOTAL DAILY PRODUCTION OF POLLUTANT IN MEXICO CITY	=	11,700	TONNES POLLUTANT/DAY
TOTAL ANNUALLY JAKARTA	=	449,596	TONNES/YEAR
TOTAL ANNUALLY MEXICO CITY	=	4,095,000	TONNES/YEAR

TABLE-B/KAD-RISAL

TABLE : AIR POLLUTION CONTRIBUTION BY SECTOR IN DKI JAKARTA, 1991/1992.

POLLUTANT	TOTAL EMISSION TONNES/YEAR	INDUSTRY (%)	HOUSEHOLD (RESIDENTIAL) (%)	GARBAGE (%)	TRANSPORTATION (%)
CO	378,662.00	0.10	0.10	1.00	98.80
HC	15,430.00	1.20	2.20	7.70	89.90
NOx	20,965.00	15.90	9.60	1.10	73.40
TSP	7,302.00	14.60	33.00	8.40	47.90
SOx	28,239.00	62.70	10.70	0.20	26.50
TOTAL	449,596.00	10.9	11.12	3.88	67.10

SOURCE : RESULT OF SURVEY CONDUCTED BY BAPPEDAL IN COOPERATION WITH LPM-ITB, 1991/92

NOTES :
FOR COMPARATION, BETWEEN JAKARTA AND MEXICO CITY :

TOTAL DAILY PRODUCTION OF POLLUTANT IN JAKARTA	=	1,230 TONNES POLLUTANT/DAY.
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TOTAL ANNUALLY JAKARTA	=	449,596 TONNES/YEAR
TOTAL ANNUALLY MEXICO CITY	=	4,095,000 TONNES/YEAR

TABLE-A/MAD-RISAL

TABLE : TRAFFIC DENSITY IN JAKARTA CITY

SURVEY I

NO.	LOCATION (STREET)	FOUR WHEEL (PER HOUR)	MOTOR CYCLE (PER HOUR)	TOTAL (PER HOUR)	NORMAL STANDARD	PERCENT (%)
1.	SUDIRMAN ST.	7,820	1,804	9,624	1,200	800
2.	GATOT SUBROTO	13,770	1,915	15,749	1,500	1,000
3.	S. PARMAN	12,440	1,454	13,894	900	1,400
4.	KRAMAT RAYA	5,881	3,321	9,202	900	1,000
5.	CASABLANCA	960	335	1,316	600	200

SURVEY II

NO.	LOCATION (STREET)	FOUR WHEEL (PER HOUR)	MOTOR CYCLE (PER HOUR)	TOTAL (PER HOUR)	NORMAL STANDARD	PERCENT (%)
1.	SUDIRMAN ST.	10,751	1,845	12,956	1,200	1,000
2.	GATOT SUBROTO	13,495	1,986	15,687	1,500	1,000
3.	S. PARMAN	11,540	1,170	11,540	900	1,100
4.	KRAMAT RAYA	5,471	3,597	9,014	900	1,000
5.	CASABLANCA	983	497	1,480	600	220

SOURCE : RESULT OF SURVEY CONDUCTED BY BAPEDAL IN COOPERATION WITH KP2L JAKARTA (DECEMBER 1991-FEBRUARY 1992).

TABLE : REALIZATION OF COMPRESSED NATURAL GAS CONSUMPTION (BBG)

YEAR	1989/90 - 1993/94 (PELITA V)		
	ESTIMATION	REALIZATION	RISE IN CONSUMPTION (FROM PREVIOUS YEAR)
1989/90	8,000	300	-
1990/91	13,600	1,170	290 %
1991/92	7,500	4,150	255 %
1992/93	5,000	4,483	8 %
1993/94*	7,500	7,991	78 %

SOURCE : PERTAMINA
DIRECTORATE OF PPDN, 1994

NOTE : *) REALIZATION IN APRIL 1993 - FEBRUARI 1994

Annex 7

In The Name of God

ISLAMIC REPUBLIC OF IRAN

Country Paper

To be presented at the

Expert Group Meeting on Consideration of Automotive Fuel Quality Standards and their effect on Motor Vehicle Emissions in the Asia-Pacific Region

Beijing - China

29 to 31 March 1994

Air Quality Control Co

(A Subsidiary of Tehran Municipality)

List of Contents

1. INTRODUCTION

Iran is one of the major oil producing countries in the world with more than 70 years of experience in petroleum production and refining. It is also the second largest producer of natural gas. Therefore most petroleum products have been easily available at very low prices, except for certain imported products such as gas oil which due to the past war, limitation on refining processes, population growth, and increase in consumption, the domestic production is not sufficient for the demand.

For this reason and due to pricing policies the energy conservation and emission control of motor vehicle have not received enough attention until recently. However, the Government of the Islamic Republic of Iran is highly concerned with environmntal issues related to automotive emissions as well as energy conservation and is planning to pose these problems in the near future. There exists the infrastructure necessary to adopt new fuel policies , although the implementation time depends on the economical situation.

All major automotive fuels including regular gasoline, super gasoline , some unleaded fuel, diesel fuel, LPG, and compressed natural gas (CNG) are produced in Iran. And due to the varying temperatures and geographical conditions (the temperature, differences as high as 50°C are possible and climatological conditions of hot and humid type in the Persian Gulf area to mountainous and cold weather in the northern states, and desert climate in the midland), the fuel specifications for various regions and different seasons vary significantly.

In this paper, a brief description of fuels standards, quality control procedures, consumptions, pricing, legislation, and an estimate of the number of motor vehicles is presented.

2. AUTOMOTIVE FUELS AND 2-STROKE OILS STANDARDS

a. FUELS

Currently five major fuels including regular gasoline, unleaded gasoline (only limited distribution and in certain areas) , super gasoline (also limited), gas oil (diesel fuel) , and LPG (limited distribution in Tehran and few major cities only) are available. Of these regular gasoline and gas oil have the majority of consumption (more than 95%) for automotive fuels. CNG is also available in very limited areas, but is being considered for wider applications in larger vehicles. LPG application is being increased in passenger cars as well as in trucks and other vehicles.

Tables 1 , 2 and 3 (see appendix) show respectively the standard specifications for regular gasoline , super gasoline, and gas oil which are currently applied along with the annual overall average specifications which are obtained from six refineries in 1993. Table 4 (see appendix) shows the standard specification for LPG. The standard specifications for unleaded gasoline are more or less similar to the regular gasoline except for the lead content and the appearance which is clear and bright.

b. 2-STROKE OILS

The 2-stroke oils are formulated and produced locally from refinery feedstocks by two lubricating oil producers.

Imported additives are used to improve the quality of oil for reduction of smoke and deposits. Table 5 (see appendix) shows the standard specifications of the 2-stroke oils along with the typical specifications measured for one of the products.

3. FUEL AND 2-STROKE OIL CONSUMPTIONS

The daily consumption of automotive fuels in the country are approximately as follows:

a. Regular gasoline	~ 28,000,000	lit/day
b. Super gasoline	~ 870,000	lit/day
c. Unleaded gasoline	~ 145,000	lit/day
d. Gas oil	~ 20,000,000	lit/day
e. LPG	~ 13,000	lit/day
f. CNG	not available	

And the daily consumption of the 2-stroke oil is estimated to be 100,000 lit/day.

4. FUEL AND 2-STROKE OIL PRICES AND INCENTIVES

The price of the automotive fuels in local currency (Rials; 1 USD ~2000 Rials) which are mainly subsidized by the government are as follows:

Fuel	Price/liter* (Rials)**
a. Regular gasoline	50
b. Super gasoline	70
c. Unleaded gasoline	50
d. Gas oil	10
e. LPG (Rials/lit)	5
f. CNG (Rials/m^3)	8

* except for CNG which is for 1 m^3.

** one USD is equivalent to approximately 2000 Rials

It can be seen that, as compared to international prices of all fuels, the fuel prices in Iran are much lower, since the government subsidizes the prices for economic reasons. In addition, fuel taxes are also low which result in little incentive for the public to conserve energy and protect the environment. Recently taxis which run on LPG in certain cities including Tehran have the advantage of very low prices for fuel as an incentive for lower emissions. Of course the government is highly concerned with this matter and the local fuel prices may eventually be raised to international levels.

The 2-Stroke oil prices are in the range of 800 to 1500 Rials per liter depending on grade. These prices are not subsidized and are close to international prices.

5. AUTOMOTIVE FUELS QUALITY CONTROL PROCEDURES

The petroleum products are distributed by the National Oil Products Distribution Company which is owned by the Ministry of Petroleum and thus quality control on fuels and other products is administered by that company. It should be noted that the quality control on products is performed at the refineries based on the standard specifications described in the previous sections. The procedures presented here are for distribution systems only. Different procedures exist when delivered by pipelines or tankers.

When delivered by pipelines, after settling in the storage tank, samples are taken by standard procedures and are sent to the laboratories for the following tests:

For regular and super gasoline:

Test	Method
Sp. Gr. at 60/60 °F	ASTM D-1298
Distillation	ASTM D-86
Colour	---
Water	---
Appearance	---
Research Octane No.	ASTM D-2699

For gas oil :

Test	Method
Sp. Gr. at 60/60 °F	ASTM D-1298
Colour	ASTM D-1500
Pour Point (if necessary)	ASTM D-97
Water and Sediment (Vol%)	ASTM D-2709
Flash Point (PY - MS)	ASTM D-93

When delivered by tankers, samples are taken from the discharge valves (after draining some of the product to assure the sediments not to enter the sample) and the same tests are performed on the products except for octane number for gasoline and pour point for gas oil (these tests are performed at the distribution centers near refineries).

6. VEHICLE PARC BY ENGINE TYPE; SIZE, AND EMISSION CONTROL SYSTEMS

The total registered motor vehicles in Iran until March 1993 are approximately as follows:

Type	Number
1. Various passenger cars	~ 2,210,000
2. Various vans	~ 588,000
3. Various buses and minibuses	~ 126,000
4. Various trucks of different sizes	~ 302,000
5. Motocycles* (2 and 4-stroke)	~ 1,180,000

* This is the registered and official number; the real number for motocycles is much higher.

Although the majority of passenger cars are produced locally namely Paykan (Hillman) and Renault 5 , many imported cars of different made are also in use. They are mostly German, Japanese, Italian, and most recently Korean. The average life of cars is high (more than 10 years) and they are of older technologies which are also poorly maintained. As a result these cars are severely polluting the ambient air.

Regarding diesel engines, most buses which are produced locally, are equipped with OM360 Mercedes-Benz engines, although some of them are also made by Volvo and other manufacturers.

Recently there have been some research and development activities with pilot demonstration in order to convert diesel fueled buses to LPG and CNG, especially for city buses. There are virtually no emission control systems installed on the engines although there have been some studies to use catalytic converters, carbon canisters, fuel treatment devices, etc. None have been implemented until now.

7. LEGISLATION

1. Section 59 of the Constitution concerns environmental protection including air pollution conrol.
2. Act of 1973 on environmental protection.
3. Act of 1974 on air pollution in 5 sections and 38 articles.
4. Resolutions of the High Council for Environmental Protection (No. 104 dated 1974 on standards for exhaust emissions from gasoline powered motor vehicles).

APPENDIX

FUELS SPECIFICATIONS

Table 1. Standard and typical annual average (1993) specifications of regular gasoline

Property	limiting Values	Typical Values	Test* Method ASTM
Appearance	Clear and bright		
Colour (1 kg/1000 m^3)	Light red		
Specific gravity at 60/60°F	To be reported	0.722	D.1298
Distillation:			D.86
10% evaporated at (°C)	65 max.	54	
50% evaporated at (°C)	115 max.	81	
90% evaporated at (°C)	180 max.	134.6	
Final boiling point at (°C)	205 max.	165.1	
Residue (% vol)	2 max.	0.9	
Loss (% vol)	To be reported	0.9	
Sulphur, total (wt %)	0.1 max.	0.0211	D.1266
Copper strip corrosion (3 hr at 50°C) Class	No.1	No.1	D.130
Reid Vapor Pressure Seasonal (psi):			D.323
Mid Nov. - Mid March	10 max.	7.9	
Mid March - Mid May	9 max.	7.9	
Mid May - Mid Sept.	8 max.	7.9	
Mid Sept - Mid Nov.	9 max.	7.9	
Gum Existent (mg/100 ml)	4 max.	1.3	D.381
Oxidation resistance at 100°C (Induction Period)	480 min.	> 700	D.525
Lead (gm/ U.S. Gallons)	2.11 max.	1.13	D.526
Research Octane number	87 min.	87.1	D.2699
Mercaptan Content (ppm)	5 max.	< 5	D.1219

* The latest issues of the relevant test methods shall be used.

Table 2. Standard and typical annual average (1993) specifications of super gasoline

Property	limiting Values	Typical Values	Test* Method ASTM
Appearance	Clear and bright		
Colour (1 kg/1000 m^3)	Light blue		D.2392
Specific gravity at 60/60°F	To be reported	0.7495	D1298
Distillation:			D.86
10% evaporated at (°C)	45 max.	58.5	
50% evaporated at (°C)	115 max.	92.2	
90% evaporated at (°C)	180 max.	141.3	
Final boiling point at (°C)	205 max.	169.6	
Residue (% vol)	3 max.	0.8	
Loss (% vol)	To be reported	0.6	
Sulphur, total (wt %)	0.1 max.	0.0219	D.1266
Copper strip corrosion (3 hr at 50°C) Class	No.1	No.1	D.130
Reid Vapor Pressure Seasonal (Psi):			D.323
Mid Nov. - Mid March	10 max.	7	
Mid March - Mid May	9 max.	7	
Mid May - Mid Sept.	8 max.	7	
Mid Sept - Mid Nov.	9 max.	7	
Gum Existent (mg/100 ml)	4 max.	2	D.381
Oxidation resistance at 100°C (Induction Period)	480 min.	- - -	D.525
Lead (gm/ U.S. Gallons)	2.11 max.	1.55	D.526
Research Octane number	95 min.	95.1	D.2699
Mercaptan Content (ppm)	5 max.	3	D.1219

* The latest issues of the relevant test methods shall be used.

Table 3. Standard and typical annual average (1993) specifications for gas oil (diesel fuel)

Property	limiting Values	Typical Values	Test* Method ASTM
Appearance	Clear and bright		
Specific gravity at 60/60 °F	0.820-0.860	0.844	D.1298
Distillation:			D.86
Vol.% evaporated at 150 (°C)	to be reported	Nil	
Vol.% evaporated at 300 (°C)	to be reported	52.3	
Vol.% evaporated at 357 (°C)	90 min	90.9	
Final boiling point (°C)	385 max.	382.6	
Colour	3 max.	0.7	D.1500
Flash Point (°F)	125 min.	149.6	D.93
Sulphur, total (wt%)	1 max.	0.82	D.129
Corrosion, 3hr at 100 °C	No. 1	No. 1	D.130
Kinematic Viscosity at 100 °F	2.0-5.5	3.5	D.445
Cloud Point (°F) Seasonal:		D.2504	
Mid March - Mid Aug.	40 max.	23	
Pour Point (°F) Seasonal:			D.97
Mid March - Mid Aug	30 max.	24	
Carbon Residue (wt%)	0.1 max.	Nil	D.189
Ash (wt%)	0.01 max.	Nil	D.482
Water and sediment (Vol.%)	0.05 max.	Nil	D.2709
Diesel index	55 min	57.9	IP 21
Cetane index	50 min	56.4	D.976

Table 4. Standard Specifications for LPG

Property	Specification	Test method(ASTM)
C_2 hydrocarbon (Vol.%)	Nil	D 2163
C_3 hydrocarbon (Vol.%) Seasonal (Tehran refinery):		D 2163
Mid May - Mid Sept.	15-25	
Mid Sept. - Mid Nov.	30-40	
Mid Nov. - Mid Jan	50-60	
Mid Jan. - Mid May	30-40	
C_4 hydrocarbons (Vol.%) Seasonal (Tehran refinery):		D.2163
Mid May - Mid Sept.	85-75	
Mid Sept. - Mid Nov.	70-60	
Mid Nov. - Mid Jan.	50-40	
Mid Jan. - Mid May	70-60	
C_5 hydrocarbons (Vol.%)	2 max.	D.2163
Hydrogen Sulphide	Negative	D.2420
Mercaptan Sulphur, grain/100 Cu.ft	10 max*	IP.104(A)
Odorizing Agent gram/m^3	12	

* The limit applies to the product before addition of odorizing agent(Ethyl mercaptan)

Table 5. Standard and typical specifications for 2-storke oils (Only limited data were available as shown below)

Property	limiting Values	Typical Values	Test* Method ASTM
Specific gravity at 60/60 °F	-	0.879	D.1298
Viscosity at 100 °F (cst.)	9-10.5	---	D.445
Viscosity index	100 min.	---	D.2270
Flash Point (°C)		205	D.92
Pour Point (°C)	-15 max.	---	D.97
Sulfated ash (wt%)	Report	0,15	D.874
Water (mg/kg)	---	---	---
Sulphur (wt%)	---	---	---
Distilation (Vol%) rec : at 320 °C	---	---	---
Total base number (TBN) mg KOH/g	---	0.7	---

Automotive Fuel Quality Standards and Their Effect on Motor Vehicle Emission in the Republic of KOREA

Representatives : Dr. K. H. Ahn
Dr. U. S. Choi
Dr. J. W. Choi

Republic of Korea

I. Introduction

As the Asia-Pacific region including Republic of KOREA has probably the most rapid automotive growth, fule consumption has increased continuously. As a result, countries of this region have encountered severe air pollution problems or are projecting that this will occur in the nearest future. Recently, in the view of Green Movement in the all of the world, it needs especially goverment policy in this region for pollution reduction. In addition, to solve this problem, it is essential to co-operate among countries of this region in the field of automotive emission control and to introduce common standar of fuels and lubricants. The goverment of Republic of KOREA has estabilished the projects of short and long terms for reduction of air pollution.

The projects are same as follows :

1st, The improvements of the quality levels of petroleum products including fuels, and supply of low pollution fuels and light spilits.

2nd, The construction and investment of facilities for hydrocracking of heavy spilits and desulfurizatior

3rd, The R&D plans of automotive industry for air pollution reduction.

II. Trends in the Quality Levels and Fuel Consumption in KOREA

II-1. Fuel Consumption

In KOREA, the fuel consumption has been increased every year with the most rapid automotive growth. (Table 1 and 2). Of these, diesel fuel consumption has increased, which caused by increasing of diesel automobiles compared with last year (Table 3). By the reasons, air pollution can be increased.

Ⅱ-2. Fuel Quality Standards

Korea goverment have enforced the supply of low pollution fuels, which is unleaded gasoline and supply rate of low sulfur diesel fuel and low sulfur Bunker-C oil : 85.6% ⇒ 87.3%, 73.3% ⇒ 73.6%, respectively from 1st Jan. 1993 (Table 4).The ministry of environment has registrated the conservation law of air environments separatly except KOREAN Standard and the Petroleum Business Law, and enforced after 1st Jan.'93(Table 5). The conservation law of air environments (NO.86 and NO.69) is shown by table 6 and 7. The korean goverment (the ministry of trade, industry, and resource,and the ministry of environments) has tried the reduction of air pollution by the improvements of quality levels of fuels.

Ⅲ. The Construction and Investment in the Hydrocracking of Heavy Fraction and Desulfurization Facility

Recently, the gasoline quality controls for the air pollution reduction has progressed continuously. The refinery companies have constructed the cracking facility of heavy fraction (FCC unit) after 1993, and as a result, it reduced the pollutions such as aromatic compounds and benzene. However the disel fuel has been greatly interested in the environmental policy and quality controls because of the low price and the lots of demand. Therefore, the goverments has enforced the reduction of sulfur content included in the automotive disel fuel and bunker-C oil. According to this policy, refinery companies will construct continuously the desulfurization facilities (Table 8 - 9).

Ⅳ. Investment Plan in the Automotive Field for the Pollution Reducing

In KOREA, the above mentioned, the quality controls of the automotive fuels for the pollution reduction in the automotive field is progressing. The investment plans are shown by Table 10.

V. Conclusions

·Because of the effect on the automotive emission, lightening of the heavy fractions and desulfurization of fuel oils will be progressed. Therefore the refinery companies have to invest for the construction of the facilities for the hydrocracking of heavy fractions and desulfurization of the high sulfur fuels. In the automotive industry, the R&D plans for the air pollution reduction have to be progressed. And also the goverment has to establish the policy for the quality controls of the automotive fuels, and the conservation of the air environments from automotive emission. Therfore, the goverment takes the strong and continuous policy for all pollution redution.

Table 1 Petroleum Consumption Distribution ('92)

(unit : thousand BBL)

Classi-fication	Industry	Transportation	Home & Commercial	Etc	Power Generation	Gas Producing	Total	Proportion(%)
Gasoline	885.0 (31.4)	33,418.8 (24.2)	344.0 (48.8)	586.6 (2.6)	1.0	12.5	35,247.9 (24.1)	6.9
Kerosene	5,100.3 (7.3)	236.4	28,363.2 (40.7)	540.0 (1.9)	5.4	4.3	34,249.4 (33.8)	6.7
Dieself-uel	24,822.9 (4.1)	65,136.6 (9.3)	28,547.1 (23.1)	4,873.1 (-2.0)	4,005.8 (101.7)	48.0	127,433.6 (12.2)	24.8
B-A oil	1,718.5 (-1.3)	744.6 (23.5)	129.2 (20.2)	29.0	0.6 (-30.9)	---	2,622.0 (6.1)	0.5
B-B oil	1,191.6 (-3.8)	238.2 (-2.7)	277.6 (-6.8)	47.5	5.6 (-43.8)	---	1,760.4 (-3.6)	0.3
B-C oil	67,560.6 (10.6)	11,108.2 (21.8)	11,630.6 (6.6)	1,995.6 (-1.0)	47,809.15 (21.3)	0.1	140,104.3 (14.3)	27.2
JA-1	---	8,479.1 (24.8)	---	6.8	---	---	8,486.0 (24.7)	1.7
JP-4	---	2.8 (59.8)	---	2,919.7 (-13.0)	---	---	2,922.4 (-13.0)	0.6
Naphtha	97,157.8 (47.9)	---	---	---	---	---	97,157.8 (47.9)	18.9
Solvents	349.4 (-3.3)	---	---	---	---	---	349.4 (-3.3)	0.1
Propane	3.761.2 (66.1)	107.7 (17.6)	24.927.9 (11.1)	31.8	---	6.462.3 (41.4)	35.291.0 (20.0)	6.9
Butane	5,853.1 (190.2)	12,723.5 (9.4)	17.4 (-6.1)	9.4	---	23.0 (4.5)	18,626.4 (35.7)	3.6
Asphalt	9,971.7 (42.1)	---	---	---	---		9,971.7 (42.1)	1.9
Total	218,372 (28.0)	132,197 (14.8)	94,237.1 (21.8)	11,039.6 (-4.7)	51,827.5 (25.1)	6,650.2 (41.6)	514,224.0 (22.2)	100.0
Proport-ion (%)	42.5	25.7	18.3	2.1	10.1	1.3	100.0	

Table 2 Petroleum Consumption Distribution during Jan.- Nov. 1993

(unit : thous.BBL)

Classi-fication	Industry	Transportation	Home & Commercial	Etc	Power Generation	Gas Producing	Total	Proportion(%)
Gasoline	894 (9.9)	36,342 (19.8)	365 (16.0)	511 (-4.8)	---	7	38,119 (19.1)	7.6
Kerosene	4,528 (3.1)	234 (51.4)	29,002 (26.2)	671 (56.4)	6	---	34,443 (23.2)	6.9
Dieself-uel	21,534 (-3.1)	66,348 (12.7)	26,735 (9.3)	4,525 (6.4)	1,930 (-47.1)	27 (-36.4)	121,100 (6.7)	24.3
B-A oil	1,468 (-5.6)	809 (21.7)	118 (6.1)	65 (173)	---	---	2,458 (4.4)	0.5
B-B oil	1,017 (-4.7)	217 (2.6)	224 (-6.0)	89 (116.1)	3	---	1,550 (-0.9)	0.3
B-C oil	62,958 (4.0)	12,796 (29.6)	10,062 (1.2)	2,506 (47.9)	42,100 (-2.7)	---	130,412 (4.1)	26.1
JA-1	---	9,336 (21.0)	---	4 (-35.7)	---	---	9,340 (20.9)	1.9
JP-4	---	3	---	2,442 (-8.5)	---	---	2,444 (-8.5)	0.5
Naphtha	97,914 (11.3)	5	---	---	---	---	97,918 (11.3)	19.6
Solvents	370 (15.0)	---	---	---	---	---	370 (15.0)	0.1
Propane	3,474 (3.4)	231 (128)	23,429 (6.9)	28 (8.0)	---	---	34,472 (11.8)	6.9
Butane	5,394 (1.8)	12,739 (9.4)	16 (0.6)	---	---	7,331 (34.8)	18,165 (6.9)	3.6
Asphalt	8,323 (-7.9)	---	---	---	---	---	8,323 (-7.9)	1.7
Total	207,870 (5.7)	139,064 (16.3)	89,942 (12.5)	10,842 (11.9)	44,040 (-6.2)	7,361 (33.8)	499,119 (8.9)	100.0
Proportion (%)	41.6	27.9	18.0	2.2	8.8	1.5	100.0	

Table 3 Automotive Distribution

(unit : thousands)

classification	1988	1989	1990	1991	1992	89 - 92 increasing rate (%)
Passenger Car	1,118	1,559	2,075	2,728	3,461	32.6
Bus	250	323	384	428	484	16.8
Truck and Specialty Car	658	778	936	1,092	1,286	18.2
Total	2,035	2,660	3,395	4,248	5,231	26.6

Tabel 4 Recent Trends in the Supply of Low Pollution fuels

Classification	1992	Jan-Nov, 1992	Jan-Nov, 1993
Diesl fuel (MBBL)	127.4	113.5	121.1
Low Sulfur 0.4 %	109.3	97.1	0.3
Low Sulfur 0.2 %	-	-	105.4
Low Sulfur oil Proportion (%)	85.7	85.6	87.3
B - C Oil (MBBL)	140.1	125.3	130.4
Low Sulfur 1.6 %	90.0	80.8	77.8
Low Sulfur 1.0 %	-	-	5.9
Low Sulfur 0.3 %	12.7	11.0	12.3
Low Sulfur oil Proportion (%)	73.3	73.3	73.6
Gasoilne (MBBL)	35.2	32.0	38.1
Unleaded	29.8	26.7	37.8
Unleaded proportion (%)	84.6	83.4	99.2

Table 5 Automotive fuel Standards

Fuel oil's	Standard Item	before '92.12.31.	'93.1.1-'95.12.31	'96.1.1 -
Gasoline	Aromatic Compound Content (vol. %), Max.	-	55	50
	Benzene Content(vol. %), Max.	-	6	5
	Lead Content(g/l), Max.	0.3	0.013	0.013
	Phosphorus Content(g/l), Max.	0.0013	0.0013	0.0013
	Oxygen Content(wt.%), Min.	-	0.5	1.0
Diesel Fuel	Sulfur Content(wt.%), Max.	0.4	0.2	0.1
	10% Carbon Residue(wt.%),Max.	0.20	0.15	0.15

Table 6 The Conservation Law of Air Environments, No.69

Used fuels	Kind of cars	Exhaust Emission Classification	Carbon monoxide (CO), max	Emission hydrocarbon, max	Smoke, max
Gasoline Gas Alcohol	Passenger Car	Manufactured Cars befor 31.Dec.1989	4.5 %	1,200 ppm	-
		Manufactured Cars after 1.Jan.1988	1.2 %	220 ppm (gasoline, and alcohol automotive) 400 ppm (gas automotive)	-
	Light Automo-tive, Light and Heavy Trucks	Total	4.5 %	1,200 ppm	-
Diesel Fuel	Passenger Car, Light and Heavy Trucks	Manufactured Cars befor 31.Dec.1995	-	-	40 %
		Manufactured Cars after 1. Jan.1996	-	-	35 %

Table 7 The Regulation Emission of the Diesel Automotive in KOREA

Classification of Automotive	Term	CO	HC	NO_x	PM	Test Std.
Passenger	'96.1.1- '99.12.31	2.11 g/km	0.25 g/km	0.62 g/km	0.08 g/km	FTP - 75
	2000.1.1-	↑	↑	↑	0.05 g/km	
Small Cars	'96.1.1- '99.12.31	6.21 g/km	0.50 g/km	1.43 g/km	0.16 g/km	
	2000.1.1-	2.11 g/km	0.25 g/km	0.75 g/km	0.12 g/km	
Heavy	'96.1.1- '99.12.31	4.9 g/kwh	1.2 g/kwh	11.0 g/kwh	0.9 g/kwh	D - 13
	2000.1.1	↑	↑	6.0 g/kwh	0.1 g/kwh	

Table 8 Construction and Investment Plans for Cracking and Desulfurizing Facilities of Petroleum Heavy Fraction

Classification	Refine Company	Refining Facilities (thousand BPSD)			Enlargement Plan		
		Present Facilities	Enlargement Plan	Total	Invest Amounts billion US $	Permission date	Completion date
Cracking and Desulfurization Facilities of Heavy Fraction	Yukong	Cracking : 30 Desulfurization : 30	Cracking : 40 Desulfurization : 20	Cracking : 70 Desulfurization : 50	9.3	'92.12.7	'96.12
	Honam	-	Cracking : 70 Desulfurization : 50	Cracking : 70 Desulfurization : 50	13	'89. 8.5	'95.1 '96.10
	Kyungin	-	Cracking : 40 Desulfurization : 30	Cracking : 40 Desulfurization : 30	11.2	'87.6.12	'96.12 '97.12
	Ssang young	-	Cracking : 60 Desulfurization : 25	Cracking : 60 Desulfurization : 25	11.5	89.12.11	'95. 6
	Hyundai	- Cracking : 34	-	- Cracking : 34	-	-	-
	Total	Total : 94 Cracking : 64 Desulfurization : 30	Total : 335 Cracking: 190 Desulfurization: 125	Total : 429 Cracking: 254 Desulfurization: 155	45.0		

Table 9 Trends in The Supply of The Low Sulfur fuel oils

(Unit : Thousand B/D)

Classification		'83	'85	'86	'89	'90	'91	'92
Low Sulfur Diesel Fuel	Total Production	42.7	92.1	134.4	186.4	218.4	250.6	299.3
	Supply (%)	34.8	62.8	75.0	81.8	81.8	83.1	85.7
Low Sulfur B-C Oil	Total Production	79.0	93.3	96.7	154.3	190.4	228.9	280.4
	Supply (%)	32.7	47.3	59.3	64.6	66.5	68.1	73.0
Unleaded Gasoline	Total Production	-	-	* 0.8	22.9	41.1	59.2	81.7
	Supply (%)	-	-	* 3.0	45.7	63.3	75.2	84.6

Remark : * During '87.7 - '87.12

Table 10 Investment Plans in the Automotive Industry for Pollution Reduction

R&D Plan for Next Generation Automotive (1st year : Oct. 1992 - Sep. 1993)

	R & D Item	Institute	Budget	Joint Company
Low Pollution	CNG Engine Super Small Engine Basic Technology	Daewoo Moters co Hyundai Moters co Kia Moters co K I M M	2,200(Mil. ₩) (Government: 950(Mil. ₩)	Changwon machinery & chemical co Daewoo & 2
Electrical Car	Battery Moter, Control system	Korea Electrical Institute Korea Spare Parts of Automotive Institute	2,390(Mil. ₩) (Goverment: 140(Mil. ₩)	Hyundai & 7 Mando Mech. & 5 Daewoo & 3

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Ⅵ-1. Price of Fuel Oils

Ⅵ-2. Special Tax for Fuel Oils

Ⅶ. Flow Diagram of Quality Control and Inspection System of Automotive Fuels

I. Petroleum Consumption Distribution

I-1 Index of Petroleum Consumption vs. GNP (1985' - 1992')

Year / Index	'85	'86	'87	'88	'89	'90	'91	'92
Petroleum Consumption / GNP	2.42 (100)	2.27 (94)	2.11 (87)	2.24 (93)	2.40 (99)	2.73 (113)	3.00 (124)	3.55 (147)

Remark : (100) basis of 1985'

I-2 Petroleum Consumption with Use Distribution (1992' - 1993')

● Petroleum Consumption with Use Distribution during 1992'

(Unit : thousand BBL)

Classification	Industry	Transpo-rtation	Home and Commerical	E T C	Power Generation	Gas Manu-facturing	Total	Proportion(%)
Gasoline	885.0 (31.4)	33,418.8 (24.2)	344.0 (48.8)	586.6 (2.6)	1.0	12.5	35,247.9 (24.1)	6.9
Kerosene	5,100.3 (7.3)	236.4	28,363.2 (40.7)	540.0 (1.9)	5.4	4.3	34,249.4 (33.8)	6.7
Diesel	24,822.9 (4.1)	65,136.6 (9.3)	28,547.1 (23.1)	4,873.1 (-2.0)	4,005.3 (101.7)	48.0	127433.6 (12.2)	24.8
B - A Oil	1,718.5 (-1.3)	744.6 (23.5)	129.2 (20.2)	29.0	0.6 (-30.9)	-	2,622.0 (6.1)	0.5
B - B Oil	1,191.6 (-3.8)	238.2 (-2.7)	277.6 (-6.8)	47.5	5.6 (-43.8)	-	1,760.4 (-3.6)	0.3
B - C Oil	67,560.6 (10.6)	11,108.2 (21.8)	11,630.6 (6.6)	1,995.6 (-1.0)	47809.15 (-30.9)	0.1	140104.3 (14.3)	27.2
J A - 1	-	8,479.1 (24.8)	-	6.8	-	-	8,486.0 (24.7)	1.7
J P - 4	-	11,108.2 (21.8)	-	2,919.7 (-13.0)	-	-	2,922.4 (-13.0)	0.6
Naphtha	97,157.8 (47.9)	-	-	-	-	-	97157.8 (47.9)	18.9
Solvent	349.4 (-3.3)	-	-	-	-	-	349.4 (-3.3)	0.1
Propane	3,761.2 (66.1)	107.7 (17.6)	24,927.9 (11.1)	31.8	-	6,462.3 (41.4)	35,291.0 (20.0)	6.9
Butan	5,853.1 (190.2)	12,723.5 (9.4)	17.4 (-6.1)	9.4	-	23.0 (4.5)	13,626.4 (35.7)	3.6
Asphalt	9,971.7 (42.1)	-	-	-	-	-	9,971.7 (42.1)	1.9
Total	218,372 (28.0)	132,197 (14.8)	94,237.1 (21.8)	11,039.6 (-4.7)	51,827.5 (25.1)	6,650.2 (41.6)	514,224 (22.2)	100.0
Proportion (%)	42.5	25.7	18.3	2.1	10.1	1.3	100.0	

Remark : ( ) Consumption increasing ratio against last year

● Petroleum Consumption with Use Distribution during 1993' (Jan. - Nov.)

(Unit : thousand BBL)

Classification	Industry	Transpo-rtation	Home and Commerical	E T C	Power Generation	Gas Manu-facturing	Total	Proportion (%)
Gasoline	894 (9.9)	36,342 (19.8)	365 (16.0)	511 (-4.8)	-	7	38,119 (19.1)	7.6
Kerosene	4,528 (3.1)	234	29,002 (26.2)	671 (56.4)	6	-	34,443 (23.2)	6.9
Diesel	21,534 (-3.1)	66,348 (12.7)	26,735 (9.3)	4,525 (6.4)	1,930 (-47.1)	27.0 (-36.4)	121,100 (6.7)	24.3
B - A Oil	1,466 (-5.6)	809 (21.7)	118 (6.1)	65 (173)	-	-	2,458 (4.4)	0.5
B - B Oil	1,017 (-4.7)	217 (2.6)	224 (-6.0)	89 (116.1)	3	-	1,550 (-0.9)	0.3
B - C Oil	62,958 (4.0)	12,796 (29.6)	10,062 (1.2)	2,506 (47.9)	42,100 (-2.7)	-	130,412 (4.1)	26.1
J A - 1	-	3,336 (21.0)	-	4 (-35.7)	-	-	9,340 (20.9)	1.9
J P - 4	-	3	-	2,442 (-8.5)	-	-	2,444 (-8.5)	0.5
Naphtha	97,914 (11.3)	5	-	-	-	-	97,918 (11.3)	19.6
Solvent	370 (15.0)	-	-	-	-	-	370 (15.0)	0.1
Propane	3,474 (3.4)	231 (12.8)	23,429 (6.9)	28 (8.0)	-	7,311 (34.8)	34,472 (11.8)	6.9
Butan	5,394 (1.8)	12,739 (9.4)	16 (0.6)	-	-	15 (-33.8)	18,165 (6.9)	3.6
Asphalt	8,323 (-7.9)	-	-	-	-	-	8,323 (-7.9)	1.7
Total	207,870 (5.7)	139,064 (16.3)	89,942 (12.5)	10,842 (11.9)	44,040 (-6.2)	7,361 (33.8)	499,119 (8.9)	100.0
Proportion (%)	41.6	27.9	18.0	2.2	8.8	1.5	100.0	

I-3 Petroleum Consumption Distribution (1992' - 1993')

Petroleum	'92			'93 (Jan. - Nov.)		Causes for consumption increasing rate
	Products (MBBL)	Consumption increasing rate for year (%)	Consumption increasing rate (%) (Jan-Nov)	Products (MBBL)	Consumption increasing rate (%)	
Total	514.2	22.2	21.0	499.1	8.9	
Gasoline	35.2	24.1	22.7	36.1	19.1	Increasing of automotive
Kerosene	34.3	33.8	34.3	34.4	23.2	Replacement of coal
Diesel	127.4	12.2	11.3	121.1	6.7	Reduction of power gener-ationand slack market
B - C Oil	140.1	14.3	13.2	130.4	4.1	Reduction of power gener ation and slack market
J A - 1	8.5	24.7	24.6	9.3	20.9	Increasing of airlines running times
Naphtha	97.2	47.9	49.0	97.9	11.3	
L P G	53.9	25.0	25.5	53.6	12.2	
Asphalt	10.0	42.1	45.7	8.3	- 7.9	
Etc	7.6	- 52	-27.9	6.8	- 1.3	

I-4 Use Distribution of Petroleum Consumption ('1992 - '1993)

(Unit : M BBL)

Classification	'92 Products	(%)	Jan ~ Nov '92 Products	(%)	Jan ~ Nov '93 Products	(%)
Total	514.2	22.2	458.3	21.0	499.1	8.9
Industry	218.4	28.0	196.6	28.9	207.9	5.7
Transportation	132.2	14.8	119.6	14.4	139.1	16.3
Home and Commericial	94.2	21.8	80.0	21.5	89.9	12.5
etc.	11.0	-4.7	9.7	-28.6	10.8	11.9
Power Generation	51.8	25.1	47.0	22.4	44.0	-6.2
Gas Manufacturing	6.6	41.6	5.5	40.6	7.4	33.8

I-5 Transportation Distribution of Petroleum Consumption (1992' - 1993')

<Consumption increasing rate (%)>

	Total	On-highway Off-highway	Airlines	Ships	Railroads
'1992	14.8	14.0	24.4	17.2	1.7
Jan.-Nov. 1992	14.4	13.9	24.3	14.7	0.3
Jan.-Nov. 1993	16.3	14.1	20.8	30.7	6.0

Ⅱ. Specifications for Automotive Fuels

Ⅱ-1 Specification for Automotive Gasoline (KS)

Items \ Grades		1	2	3	4
Octane Number	Research method, min	95	91	88	91
	Motor method, min	87	83	80	83
Distillation Temperature (℃)	10% Evaporated, max	70	70	70	70
	50% Evaporated, max	125	125	125	125
	90% Evaporated, max	190	190	190	190
	End Point, max	225	225	225	225
	Residue(vol %), max	2.0	2.0	2.0	2.0
Water and Sediment(vol %), max		0.01	0.01	0.01	0.01
Copper Corrosion, max		1	1	1	1
Vapor Pressure		0.45 - 0.85	0.45 - 0.85	0.45 - 0.85	0.45 - 0.85
Oxidation Stability (min), min		480	480	480	480
Gum Existent(mg/100ml), max		5.0	5.0	5.0	5.0
Sulfur (wt %), max		0.10	0.10	0.10	0.10
Colour		Colouring	Colouring	Colouring	Yellow
Lead Content(g/l), max		0.3	0.3	0.3	0.0013
Phosphorus content(g/l), max		-	-	-	0.0013

Remarks : 1. Octane number is tested by either research method or motor method.
2. Max of vapor pressure in the cold regions is defined as 0.98.

II-2 Current Qualities for Domestic Automotive Galsoline (Aug. 1992')

Clssification		
Octane Number		91 - 95
Distillation Temperature(℃)	10 % Evaporated	53 - 60
	50 % Evaporated	77 - 110
	90 % Evaporated	140 - 158
	End Point	167 - 209
	Residue (vol %)	1.0
Tetra Ethyl Lead Content (ml/l)		0.10 - 0.20
Lead Content (g/l)		0.001
Phosphorus Content (g/l)		0.0001 - 0.0002
Composition Analysis	Aromatic Compds	24.5 - 47.2
	Benzene	2.2 - 5.8

Ⅱ-3. Specification for Diesel Fuel Oil (KS)

Classification (1) / Items	Automotive					Boiler	
	NO. 1	NO. 2		NO. 3			
		S	W	S	W	S	W
Flash Point (℃), min	40	40		40		40	
Pour Point (℃), max	- 25	0	- 10	0	- 10	0	- 10
10 % Carbon Residue(%), max	0.15	0.20		0.20		0.35	
Ash(%), max	0.01	0.02		0.02		0.05	
Distillation Tamp (℃) 90% Evaporated, max	330	360		360		388	
Kinematic Viscosity (cSt, 37.8 ℃)	1.4 - 1.5	2.0 - 5.8		2.0 - 5.8		2.0 - 10.0	
Sulfur Content (wt%), max (2)	0.2	0.2		1.0		0.2	
Copper Corrosion (100℃, 3h), max	1	1		1		1	
Cetane Coefficient, min(3)	45	45		45		-	
Colour	-	-		-		Color	

Remarks : 1. Kind (1) S: Summer Using, W: Winter Using.
2. Sulfur Content (2): Diesel fuel contained low sulfur content is determined by the Conservation law of Air Environments
3. Cetane Coefficient (3): Cetane Coefficient is same as the Cetane Number
4. Kind (1): Disel fuel for boiler can not use for automotive.

Ⅲ. Trends of the Legal Regulation for the Automotive Fuels in KOREA

Ⅲ-1. Recent Trends in the Supply of Low Pollution Fuels

0 The over all supply of unleaded gasolines for automotive from Jan. '93

0 The sulfur contents of diesel fuel and B - C oil are 0.2% and 1.0% from Jan. '93

Classification	1992	Jan.-Nov. 1992	Jan.-Nov. 1993
Diesel Fuel (M BBL)	127.4	113.5	121.1
Low Sulfur – 0.4 %	109.3	97.1	0.3
Low Sulfur – 0.2 %	-	-	105.4
Low Sulfur Proportion (%)	85.7	85.6	87.3
B - C Oil (M BBL)	140.1	125.3	130.4
Low Sulfur – 1.6 %	90.0	80.8	77.8
Low Sulfur – 1.0 %	-	-	5.9
Low Sulfur – 0.3 %	12.7	11.0	12.3
Low Sulfur Proportion (%)	73.3	73.3	73.6
Gasoilne (M BBL)	35.2	32.0	38.1
Unleaded	29.8	26.7	37.8
Unleaded Proportion (%)	84.6	83.4	99.2

Ⅲ-2. Production Standards of Automotive Gasoline

(The conservation law of air environments, No.86 / The ministry of environment)

Application Terms / Standard Items	2. Feb. 1991 - 31. Dec. 1992	1. Jan. 1993 - 31. Dec. 1995	From 1. Jan. 1996
Aromatic Compound Content (Vol. %), max	-	55	55
Benzene Content (Vol. %), max	-	6	5
Lead Content (g/l), max	-	0.013	0.013
Phosphorus Content (g/l), max	0.0013	0.0013	0.0013
Oxygen Content (wt. %), min	-	0.5	0.5

Ⅱ-3. Permissible Exhaust Emission Standards of Running Automotives

(The conservation law of air environments, No.69)

Used fuels	Kind of cars	Exhaust Emission Classification	Carbon monoxide (CO), max	Emission hydrocarbon, max	Smoke, max
Gasoline Gas Alcohol	Passenger Car	Manufactured Cars befor 31.Dec.1989	4.5 %	1,200 ppm	-
		Manufactured Cars after 1.Jan.1988	1.2 %	220 ppm (gasoline, and alcohol automotive) 400 ppm (gas automotive)	-
	Light Automo-tive, Light and Heavy Trucks	Total	4.5 %	1,200 ppm	-
Diesel Fuel	Passenger Car, Light and Heavy Trucks	Manufactured Cars befor 31.Dec.1995	-	-	40 %
		Manufactured Cars after 1. Jan.1996	-	-	35 %

Ⅳ. Construction and Investment Plans for Cracking and Desulfurizing Facilities of Petroleum Heavy Fraction

Classification	Refine Company	Refining Facilities (thousand BPSD)			Enlargement Plan		
		Present Facilities	Enlargement Plan	Total	Invest Amounts	Permission date	Completion date
Cracking and Desulfurization Facilities of Heavy Fraction	Yukong	Cracking : 30 Desulfurization : 30	Cracking : 40 Desulfurization : 20	Cracking : 70 Desulfurization : 50	7,500	'92.12.7	'96.12
	Honam	-	Cracking : 70 Desulfurization : 50	Cracking : 70 Desulfurization : 50	10,400	'89. 8.5	'95.1 '96.10
	Kyungin	-	Cracking : 40 Desulfurization : 30	Cracking : 40 Desulfurization : 30	9,000	'87.6.12	'96.12 '97.12
	Ssangyoung	-	Cracking : 60 Desulfurization : 25	Cracking : 60 Desulfurization : 25	9,280	89.12.11	'95. 6
	Hyundai	- Cracking : 34	-	- Cracking : 34	-	-	-
	Total	Total : 94 Cracking : 64 Desulfurization : 30	Total : 335 Cracking: 190 Desulfurization: 125	Total : 429 Cracking: 254 Desulfurization: 155	36,180		

⟨Supply Proportion of Light Fraction and Low Sulfur B - C oils⟩

Years	Light fraction proportion (%)	Low sulfur B - C oil proportion (%)
'89	67.1	64.6
'90	68.1	66.5
'91	68.5	63.1
'92	70.0	73.3
'93	69.9	74.8
'94	71.2	77.7

Automotive Possession Trends per Thousand of persons

(Unit : Car/ thousand Persons)

Years / Item	KOREA 1988	1989	1990	1991	1992
Automotive	48.5	62.8	79.3	97.8	119.8
Passenger cars	26.6	36.8	48.5	62.8	79.3

Fuel Consumption per Automotive

(Unit : thousand B/D, thousand cars, l/day)

Classification		'91 Average	'92 Average	Increasing rate (%)
Gasoline Car	Consumption per day	73.7	91.5	24.2
	Numbers of Running Cars	2,192.2	2,890.5	31.9
	Consumption per Car	5.347	5.033	-5.8
Diesel Fuel Car	Consumption per day	149.8	164.7	9.9
	Numbers of Running Cars	1,423.2	1,653.8	16.2
	Consumption per Car	16.734	15.835	-5.4
Business use Car (LPG)	Consumption per day	32.1	35.2	9.7
	Numbers of Running Cars	163.3	177.6	8.8
	Consumption per Car	31.316	31.510	0.6

V-2 Investment Plan in the Automotive Industry for Pollution Reduction

R&D Plan for Next Generation Automotive (1st year : Oct. 1992 - Sep. 1993)

	R & D Item	Institute	Budget	Joint Company
Low Pollution	CNG Engine Super Small Engine Basic Technology	Daewoo Moters co Hyundai Moters co Kia Moters co K I M M	2,200(Mil.₩) (Goverment: 950(Mil.₩)	Changwon machinery & chemical co Daewoo & 2
Electrical Car	Battery Moter, Control system	Korea Electrical Institute Korea Spare Parts of Automotive Institute	2,390(Mil.₩) (Goverment: 140(Mil.₩)	Hyundai & 7 Mando Mach. & 5 Daewoo & 3

Ⅵ. Price Trends of Petroleum (Fuel Oils)

Ⅵ-1. Price of Fuel Oils

● Consumer price (Including tax)

(Unit : US$ / Gal)

Price std. date	Unleaded gasoline	Leaded Premium gasoline	Diesel Fuel	Kerosene	Bunker - C (BBL)	L P G (LBS)
'93. 8	2.86	3.74	1.00	1.19	20.10	0.26

US$: ₩ = 1 : 808.10 ('93. Nov)

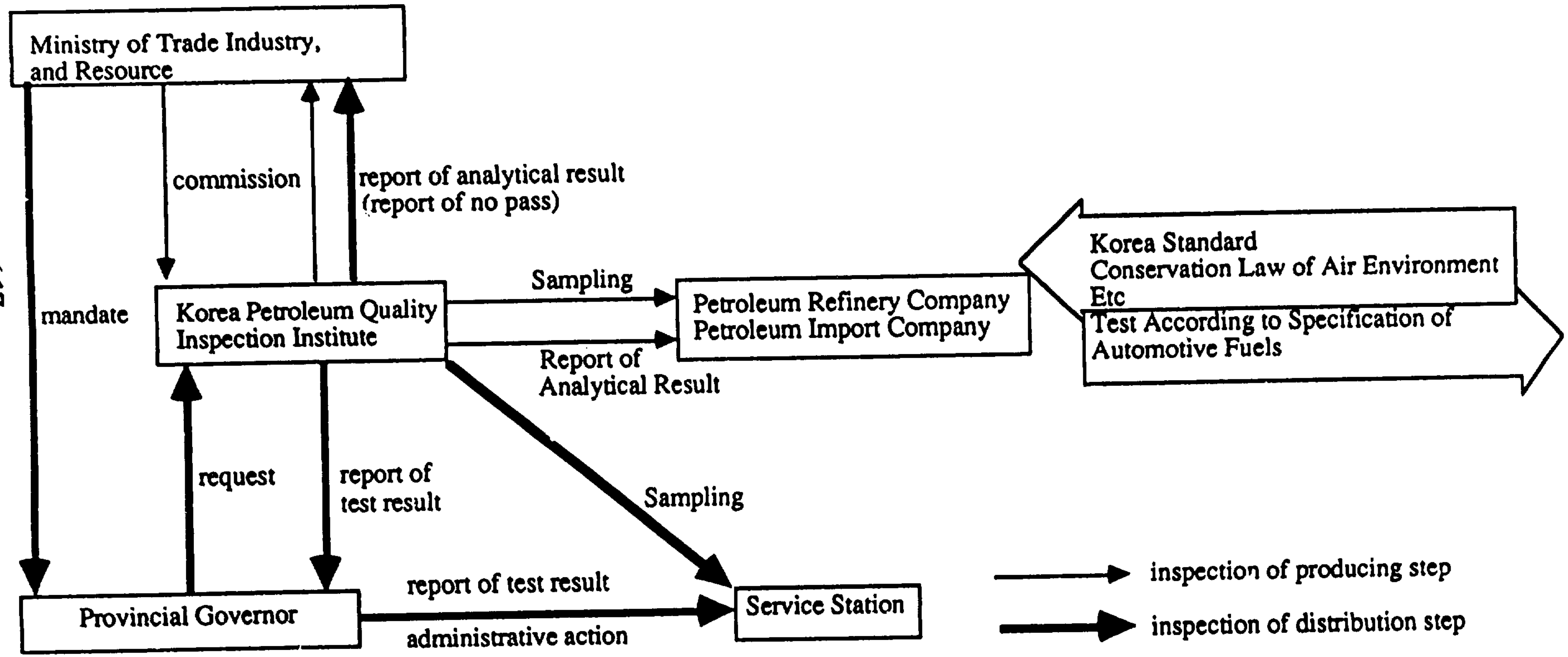
The Korea governments has enforced the Price Linkage System for the Price of fuel oils.
The price of fuel oils changes per month according to the exchange rate and the international oil price.

Ⅵ-2. Special Tax for Fuel Oils

(Unit : %)

Years	Gasoline			Diesel Fuel		L P G	
	Basic Tax Rate	Elastic Tax		Basic Tax Rate	Elastic Rate	Basic Tax Rate	Elastic Rate
		Reguler	Unleaded				
Aug. 80	160	160	-	10	7	-	-
Nov. 80	160	130	-	10	7	-	-
Feb. 83	100	100	-	10	9	10	-
Jul. 87	100	100	85	10	9	10	8
Mar. 89	100	85	70	10	9	10	8
Jul. 91	100	120	100	10	9	10	8
Jan. 92 - Dec. 93	100	130	109	10	9	10	8

VII. Flow Diagram of Quality Control and Inspection System of Automotive Fuels



COUNTRY PAPER
ON
IMPACT OF FUEL QUALITY ON VEHICULAR POLLUTION IN INDIA

N. BAGCHI, T. CHANDINI & B. SENGUPTA

PRESENTED AT
EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS & THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION, BEIJING,
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IMPACT OF FUEL QUALITY ON VEHICULAR EMISSION IN INDIA

1.0 Introduction

The State of environment in India continues to deteriorate as far as air pollution is concered. Irrespective of the State of economic development, the ultimate goal is to achieve air quality standards that would not impact adversely on the health of the people and environment. The primary contributors to the anthropogenic air pollution are the transport, industrial and power sectors. Combustion of fuels to release energy required to either provide motive power or thermal energy result in formation of gases that contain besides water vapour and carbon dioxide, CO, NOx, SO2, HC, lead and inhalable particulate matter. The concentration of the different pollutants in exhaust and flue gases will depend on the characteristics of the fuel and efficiency of combustion. The quality of pollutants released will depend on the quality and quality of fuel consumed. It is therefore, proper to take actions on improvement of fuel quality to reduce air pollution levels.

2.0 Air pollution due to fuel burning in India

About 60-70 % of air pollution in metropolitan cities in India is contributed by automobile sector. The increase in CO emission trend in ambient air of Calcutta and Bombay from 1920 to 2000 are given in figures 7,8 & 9 while increased NOx emission trend in ambient air of Delhi Calcutta & Bombay from 1970 to 2000 are given in figures 10,11 & 12. The effects of lead and CO on the health of children and adults, interaction of nitrogen dioxide and hydro carbons in the presence of sun light to form ozone at the ground level and depletion of ozones in the stratosphere and global warming from emission of green house gases are also concerned to us. In the pursuit of cleaner air, clean fuels play an important role and in India. It is realised that quality of fuel has to be improved to reduce the overall air pollution levels.

3.0 Specifications of liquid fuels in India

The present Indian specifications of fuels namely petrol fuel oil, diesel oil, kerosene oil etc are provided at Annexure I to IV. From pollution control point of view we are more concerned about sulphur, tetraethyl lead, reid vapour pressure, aromatic contents etc of fuel. Sulphur contents in various Indian fuels are given below:

Fuel	Sulphur content
Kerosene	0.25
Fuel oil	3.5 - 4.5
Gasoline	0.25
Diesel-HSD	1.0
Diesel-LDO	1.8

4.0 Ambient air quality status in India

In India, Central Pollution Control Board is operating ambient air quality monitoring network comprising of 250 monitoring stations. About 90% of the monitoring stations are manually operated stations and rest are fully automatic where continuous air quality monitoring is done. The ambient air quality levels of some of the metropolitan cities and towns are given in Annexure V . The ambient air quality data reveals that in metropolitan cities the major problem of air pollution are due to emission from motor vehicles and the pollutants which are above the prescribed norms are oxide of nitrogen, carbon monoxide, polyaromatic hydrocarbon (Benzopyrene) and lead.

5.0 International trends towards fuel quality improvement

Automotive vehicles had been recognised as a major source of air pollution about 25 years back. In USA legislative means had been adopted to control the vehicle emissions in early seventies. Prior to 1975, control was achieved primarily with engine modifications. Since then, catalytic convertors, improved fuel metering, improved combustion chamber design, exhaust gas recirculation (EGR) and serval other engine design changes have been incorporated to reduce exhaust emissions (1) Fig.1. Charcoal canisters and positive crankcase ventilation have been used to control evaporative and blowby emissions. It may appear that there is not much room for further reductions in developed countries. However, that is not stopping legislators from imposing more stringent vehicle emission standards because the air quality continues to deteriorate.

Efforts must therefore be made to control emissions in entire inuse fleet which includes large number of older vehicles with limited or no control devices. The improvements in fuel quality would reduce emissions on all vehicles. The environment protection agency (EPA) of USA expects that the emphasis for emission control in 1990's would be on the fuel as compared to the automobile in the past . The US clean air Act for 1990 (2) has included the setting up of limited " clean fuel" demonstration fleets and introduction of " reformulated gasoline". From 1995. fuels in USA will have to be certified for emission reduction targets and must contain oxygenates. a maximum of 1% benzene but no heavy metals. The move towards unleaded gasoline continues worldwide (3). In Europe. Germany already has 70% unleaded. and Austria has banned leaded gasoline from 1993. Canada has banned leaded fuel from 1990. and the US will do so from 1995 (currently only less than 10% leaded). Japan is already 100% unleaded. In France, a labelling scheme has been developed by the National Transport Ministry Technical Advisory Committee (UTAC) whereby fuel suppliers can certify that their fuel meets the requirements of the French motor industry. In case of diesel fuels. the main thrust has been on reduction of sulphur.

This paper describes the international trends of fuel quality related to emissions. The implications of future emission standards in India for required fuel quality improvements have been discussed. The efforts being made by oil industry to improve fuel quality have also been described.

Changes in fuel quality related to emissions have mostly been on content of lead in gasoline. composition and volatility of gasoline. In case of diesel fuels. sulphur in diesel. aromatic content and cetane number are important. Trends of fuel quality changes worldover are given below:

4

5.1 Lead in Gasloine

Unleaded regular gasoline was introduced in USA in 1975 to cater for cars equipped with catalysts. Currently about 90% of gasoline sold in US is unleaded. The EPA imposed limits of 0.5 g/US gal (0.13 g/ltr) from 1.7.85 and 0.1 g/US gal (0.026 g/ltr) from 1.1.86 in leaded gasoline. This is considered to be the lowest level of lead which will allow continued operation in order engines (4). Sale of leaded gasoline however will be banned in US from 1.1.95.

From January 1993. all new cars sold in Europe will be fitted with three way catalysts and would require unleaded gasoline. The maximum authorised lead level in leaded grades remain 0.4 g/ltr. but EC member states have been advised to mandate maximum limit of 0.15 g/ltr. Member states are also being encouraged to provide tax incentives for unleaded gasoline.

In Japan. unleaded regular gasoline was introduced in 1974. followed by unleaded premium in 1983. All gasoline is now unleaded and both premium and regular grades are now widely available.

The maximum permitted lead content in g/ltr. for leaded and availability of unleaded gasoline in various countries are shown in Table-1.

The unleaded gasoline has been introduced mostly without compromises for octance quality and changes have been brought about by modifications in refineries and also the use of oxygenates (5).

5.2 Gasoline Composition

The replacement of leaded fuels with unleaded fuel of the same octance quality would result in major changes in fuel composition which may effect the vehicular emissions.

The smog forming tendency of gasoline is related to the amount and type of hydrocarbons evaporated from the vehicle fuel system and emitted in the exhaust. Dishart in a study of wide range of gasoline observed that as the aromatic content of gasoline increased . the amount of aromatic compounds in the exhaust also increased (6). The aromatics and olefins which are the two high octane components have high reactivity in the smog reaction whereby hydrocarbons and oxides of nitrogen react under the influence of sunlight to form irritant products (7.8). The higher aromatic content can also increased the plynuclear aromatic hydrocarbons (PNA) in exhaust. The PNA is known to be carcinogenic and is a major health hazard.

Most of the fuel quality legislations restrict Benzene in gasoline upto 5%. EC directive has suggested this limit for member states. However. some states have reduced benzene to 3%. The US clean Air Act 1990 require benzene in gasoline to be restricted to 1% vol from 1995 . California has proposed limit of 0.8 % vol from 1993.

Oxygenates are being recommended not only to regain lost octances due to reduced aromatics but also due to reduced emissions of carbon monoxide. Oxygenates especially ethers. MTBE and ETBE are becoming more popular as compared to primary alcoholds (9). The ethers. in addition to their excellent octance quality. do not increased gasoline volatility. have good fuel system compatibility. are hygroscopic and can be blended at the refinery.

EPA has ruled that aliphatic alcohols and glycols. ethers and polyethers may be added to the gasoline provided amount of oxygen in finished fuel does not exceed 2.7% wt. Upto 15% MTBE is now allowed in gasoline. Ethanol upto 10% can also be blended in gasoline containing 2% MTBE. Mixture of TBA and methanol upto max. of 3.7 oxygen is also allowed. Methanol upto 5% vol plus atleast 2.5% vol. cosolvent (ethanol. propanols or butanols) plus corrosion inhibitor with max. oxygen content of 3.7 % wt. is also allowed.

Under the new Clean Air Act in USA. the use of oxygenates will be mandatory from November 1992 for fuels sold during winter months in 41 major cities with high carbon monoxide.

EC regulation permits use of oxygenates as shown in Table 2. Use of methanol upto 3% and ethanol upto 5% is permitted in European countries.

5.3 Additives

Additives which reduce fuel system and engine deposits are now being extensively used in motor gasoline worldover. Use of such multifunctional additives have been found to be quite effective in maintaining lower carbon monoxide emission due to reduced carburettor deposits (10).

5.4 **Reformulated Gasoline**

"Reformulated Gasoline" will have to be sold in 9 worst US cities from 1995 as per the clean air Act of 1990. Such gasoline will have minimum of 2 percent oxygen year round. If EPA determines that this interferes with national standard of ozone and increase NOx emissions. this level may be modified. Benzene content must not exceed 1% on pool average basis. The reformulated fuel must contain additives to prevent engine deposits. Such fuel must not contain any heavy metals. The aromatic content of this gasoline will be capped at 25% on a pool basis.

All gasoline sold as reformulated must be certified to achieve reduction of 15% by 1995 in total volatile organic compounds (exhaust and evaporative) and total air toxics. By 2000. the level of the reduction in VOC and air toxic required will be 25%.

5.5 **Gasoline Volatility**

Reduced summer gasoline vapour pressure (RVP) can reduce evaporative. refuelling and running losses. The impact of 3 VP reduction on various types of losses based on EPA model are shown in Fig 2 (1). These results show that reducing gasoline RVP from 11.7 psi to 9.0 psi would reduce total vehicle HC emissions by about 75 % at a 95 F ambient temperature and by about 60% at 75 F.

In US. the EPA has prescribed limits for gasoline volatility during summer months May to September. Tables -3 & 4 show the RVP limits as per ASTM classification of gasoline for different seasons and geographical regions and the EPA limits applicable from May 1992. It can be seen that RVP has been lowered substantially with a view to control emissions.

In Europe. volatility limits have been incorporated in the new CEN specification for motor gasoline (Table 5). The limits in CEN specs. have been set for performance reasons rather than environmental controls. A number of countries. including Austria. Sweden and Switzerland are considering further limitations on RVP.

5.6 **Diesel Fuels**

Diesel fuel quality has become the subject of discussion worldover in view of the more and more stringent emission regulations. Diesel fuel characteristics such as distillation characteristics. viscosity, density. cetane number and sulphur content etc. varies due to various factors such as different crudes processed. refinery design. required product mix and low temperature performance requirements. They are interdependent. it is therefore. more difficult and expensive to control these characteristics within the narrow ranges.

5.7 **Diesel fuel - Sulphur content**

In case of diesel fuels. the issue most talked about is the sulphur content. 98% of sulphur in fuel is converted to SO2 and balance is coverted to sulphates which are discharged with unburnt carbon as particulates (11). Although sulphur content has several deleterious effects on engine. environmental reasons have lead to very low levels of sulphur in international market. Increasing use of catalysts to achieve low emissions from diesel engines may further increase pressure for reduction of sulphur. Table 6 gives average sulphur content of diesel fuel in 1991 in world market.

In US. sulphur limit of 0.05% wt. has been imposed with effect from 1.10.1993 against the earlier limit of 0.5% wt. It is necessary to have such low levels of sulphur to meet the particulate emission standard of US for 1994 (0.18 / HP-hr) Fugure 3 (12).

The maximum permitted sulphur content of diesel fuel is given in Table 7. In Europe. the limit of sulphur varies from State to State and EC propose to have uniform limit of sulphur i.e.. 0.2% immediately and 0.05% wt. in due course.

5.8 **Aromatic Content**

The aromatic compounds which are inherent part of diesel fuels are the most undesirable hydrocarbon chain present in diesel fuels. They are not only low cetance components but also reported to lead to increased particulate emissions(13). However. the present levels of aromatics present in commercial fuels in Europe are considered only as a secondary parameter in influencing emissions.

8

5.9 Cetane Number

Cetance number of diesel fuel is related to the ignition delay in the combustion process. Cetane number effects fuel economy. engine noise. engine emissions. cold starting and durability of the engine. A study carried out by concawe (14) on the effects of cetane number on emissions indicate that the emissions of CO. HC and particulate increase upto 35. 25 and 20 percent respectively when the cetance number of diesel fuel is lowered from 50 to 44. However. there is only a marginal effect on NOx emissions.

Cetane number of diesel fuel can be improved by additives like cyclohexylnitrate and ethylexylnitrate. However. cetane number achieved with additives is not as good as natural cetane number of the fuel.

The trends of cetane number worldover are shwn in fig-4.

6.0 Indian scenario

In India. the beginning for emissions control was made only in 1988 when emission regulations were formulated (15) . In view of the fact that present Indian Standards have been quite liberal as confirmed bythe test results obtained under type approval tests at ARAI and also due to the deteriorating air quality particularly in metropolitan cities. stringent emission standards have been proposed by CPCB which may be effective from the year 1995 and 2000 AD (16). The proposed future standards for 2000 AD would require considerable efforts in terms of technology upgradation and use of emission control devices.

The automotive industry has stated that while stringent emission standards are being imposed upon them. the petroleum companies should also be advised to upgrate the fuel quality in line with European norms. They have also said that the standards in case of petrol driven passenger cars. scooters and motorcycles for the year 2000 AD cannot be met without use of catalytic converter which may require lead free petrol.

Besides stringent exhaust emission standards. evaporative emission standard of 2 g / test as in US and EC in also proposed. There may be demand to control fuel volatility as in US and EC countries.

In case of diesel engines. the particulate emissions limit has also been recommended with effect from 2000 AD. The sulphur content in diesel which effect the particulate emissions may have to be reduced to meet such standards. Since the lubricants can play major role in total particulate matter. superior quality lubricants for this purpose would also be required.

In the following paragraphs of this paper we have tried to describe the efforts being made in India to improve the fuel quality. Centre for High Technology set up by Government of India also looking into the areas where quality upgradation will be required. IIP. CPCB and BIS also working on this issue given recommendation to MOEF and Ministry of Petroleum and natural gas about specifications of fuel quality. In case of new refineries. it is felt fuel quality as per international Standards should be achieved from the beginning itself. The design of these refineries must take care of these aspects.

6.1 Lead content in gasoline

Although the limit of lead in gasoline in India is 0.56 gms/ ltr. as per Indian standards. the actual lead in petrol has been mostly in the range of 0 to 0.25 gms/ltr. except in case of few eastern sector refineries where it is higher (Table 8) (17).

Changes in refinning processes would be required to produce unleaded fuel from the existing refineries. Use of processes like FCC to product high octane components may merely increase research octane number (RON) while motor octane number (MON) may be lower . The changes in gasoline composition also should not lead to the discharge of more reactive or carcinogenic emissions.

The programme for lead phase down in India is given in Table-9.

Since it is proposed to set up some new refineries in India in near future, they must be designed to produce lead free gasoline.

6.2 Gasoline Stability

With increase in secondary conversion processes in the refineries the amount of cracked stock in gasoline has increased the worldover. Similarly in India, with the operation of FCC units in the refineries and increaseed use of virgin naphtha as petrochemical and fertiliser feed stocks, the amount of cracked stocks in gasoline has drastically increased. Such gasoline has a tendency to form gum as a result of oxidation and polymerisation processes. This gum formation depends on the storage conditions and period. The gum tends to deposit on the carburettor and the valves in the carburetted engine system. This can shift the air fuel ratio away from the optimum and as a consequence the fuel consumption and emissions would increase (Fig. 5).

IIP, Dehradun & IOC, R & D Centre have carried out extensive work (19) including engine test development for evaluation of certain additives which when added in gasoline can keep the valves and carburettor clean. Field trials had also been conducted by IOC, R & D Centre jointly with a reputed vehicle manufacturer. The use of multifunctional additives was found to result in better fuel economy and reduced emissions (fig. 6) . Based on this work, recommendations have been made for addition of multifunctional additives in gasoline. It is expected that very soon gasoline in India will contain such multifunctional additives. This will lead to fuel savings as well as reduced emissions.

6.3 Reformulated Gasoline

Although limited use of oxygenates like alcohols in motor gasoline is being experimented at present at IIP and other Labs, we have no immediate plans in India to go in for reformulated fuels. Considering the large population of 2 stroke engine powered scooters and motorcycles and the extent of emissions from such vehicles, we feel that there is a need to consider reformulated fuel separately for this category of vehicles. However, this will require elaborate studies before any concrete recommendations can be given.

6.4 Gasoline Volatility

Since reduced gasoline vapour pressure can reduce evaporative emissions, there is need to look into the volatility specifications of motor gasoline. Currently, IOC, R & D Centre and IIP are conducting joint experimental work on passenger cars of all Indian makes to assess their fuel requirements from volatility point of view. Based on this work being done in the all weather chassis Dynamometer Laboratory of IOC, R & D, suitable recommendations would be given in near future for revisions of fuel specifications. Although the major objective is to set the limits for performance reasons but environmental aspect will also be taken care of.

6.5 Diesel Fuel

In India, the automotive transport sector is so much dependent on diesel fuel that our refineries have to stretch the yield of middle distillates to the maximum from crude oil. Inspite of concerted efforts by our refineries, we have to import large quantities of diesel fuel in addition to crude oil. The quality of the diesel fuel available to the consumers in India varies from place to place largely depending on the type of crude processed by the refinery, design of refinery and the product mix as well as the required low temperature properties. As already discussed earlier it is much more difficult to control the diesel fuel characteristics as they are quite interdpendent. For example, the crude oil from Bombay High is quite good from the point of view of sulphur i.e. very low sulphur but has very high wax content which makes winter operability very poor with diesel produced from it. The diesel fuel quality aspects in which improvements are contemplated in India are briefly described below:

6.5.1 Sulphur in Diesel Fuel

The current Indian specifications permit sulphur upto 1% wt. in diesel fuel. However, actual amount of sulphur in diesel is much less i.e. in the range of 0.2 to 0.5 % wt. from most of the refineries (Table 10) with a few exceptions. The sulphur content in diesel fuel also depends on the type of crude processed. The sulphur in crudes from Basrah and Iran is very high while in most of indigenous crudes the sulphur content is much lower (Table 11). However, it is very difficult to control the source of crude due to financial as well as availability point of view.

In order to meet Indian standards of particulates as suggested by CPCB for 2000 AD. it may be required to control sulphur in diesel to a maximum of around 0.5 % wt. This may be possible to meet by 2000 AD. The target in our opinion should be more for new refineries so as to control sulphur to a maximum of 0.2% wt. in order to reduce lube oil degradation and wear of engine components also. In case of new refineries. it should be taken care of form the design stage itself. Also. Bureau of Indian Standard based upon IIP study suggested the following sulphur reduction

April 1996 - 0.5% wt max
By 2000 - 0.25% wt max

6.5.2 **Cetane Number**

While the cetane number specification in India is 42 minimum. the actual cetane number of the fuel from various refineries except in case of a few is mostly found to be around 50. In case of a few eastern refineries. they cetane number is around 42. It is suggested that it should be raised to 45. Higher cetane number fuel is expected to lead to lower HC. CO and particulates emissions.

6.5.3 **Aromatic content**

Since aromatics represent undesirable hydrocarbon chain present in any fuel. the total content may have to be restricted in line with European trends.

6.5.4 **Diesel fuel stability**

In the past. automotive diesel fuel was blend of straight run products only. However. presently cracked stocks from various secondary conversions processes are incorporated in diesel fuel. Some of these stocks lead to poorer fuel stability which increases gum and sediments. This may lead to fouling of fuel intake system and coking of fuel injectors. Coked injectors will deteriorate the engine performance as a result of distoration of desirable spray pattern and increase emissions. If proper antioxidant. detergent and dispersant additives are added. this can improve the performance by keeping the system clean. IOC. R & D has developed a suitable engine test for screening of additives and are also engaged at present in a collaborative R & D programme with a leading vehicle manufacturer. Suitable recommendations shall be given to the refineries on conclusion of this work.

7.0 Recommendations

7.1 Motor Gasoline

Lead content

In case of existing refineries. the lead in gasoline is to be phased down to 0.15 gm/lt for all motor gasoline supplied in metropolitan cities by end of 1994. By the year 1996-97. the lead in gasoline in the entire country should be maximum of 0.15 gm/ltr. From Ninth Plan. unleaded gasoline may be supplied atleast in metropolitan cities like Bombay and Delhi . The octane level may be maintained atleast at the present level. The motor octance number may also be taken care of.

In case of new refineries. they should be designed to produce unleaded gasoline from the beginning itself. The possibility of increasing the octane values to RON - 91 and MON - 83 should also be explored in case of new refineries.

Gasoline stability

For the stability requirements. it is necessary to control the potential gum to 5 mg/100 ml. and gasoline maybe doped with suitable multifunctional additive to control the intake system deposits.

For the new refineries. the above recommendations may be adhered to while also exploring the possibility of suitable refinery techniques which may reduce the total crack stocks in gasoline.

Reformulated Gasoline

In India. it may be possible to consider reformulated gasoline for 2 stroke vehicles. When the new refineries come up. it may also be possible to control the aromatics and benzene to a maximum of 25% and 1% respectively. The use of oxygenates may require eleborate study in collaboration with vehicle manufacturers' before suitable recommendations can be given on the lines of US clean Air Act.

Gasoline Volatility

Based on the studies being carried out at present by IOC. R & D Centre and IIP. Dehradun. suitable recommendatins will be made with respect to-the control gasoline volatility specification.

7.2 Diesel Fuels

Sulphur Content

The sulphur content in diesel may be reduced to 0.25% wt. by 2000 AD from the existing refineries. For the new refineries. the limit may be 0.2% wt. maximum.

Cetane number

The Cetane Number of Diesel fuel in India should be minimum of 45. A time frame needs to be established for this purpose. However. this should not be later than 2000 AD . For the new refineries. this level of 45 cetane number should be taken care of at the design stage itself.

Diesel Stability

The oxidation stability of the diesel should be controlled by UOP 413 or modified DEF 2000-16T Test. Based on the current studies being carried out by IOC. R & D Centre. suitable recommendations may be given for doping of multifunctional additives which may keep the fuel injection system clean.

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TABLE - 1

MAXIMUM PERMITTED LEAD CONTENT IN GASOLINE. (gm/ltr.)

COUNTRY	LEADED	UNLEADED
AUSTRALIA	0.4	W
AUSTRIA	0:15	W
CANADA	0.026	W
HONGKONG	0.15	W
INDIA	0.56	N
NEW ZEALAND	0.45	W
SINGAPORE	0.15	W
SWEDEN	0.15	W
UNITED KINGDOM	0.15	W
USA	0.026	W
USSR	0.4	L

N = NOT AVAILABLE
L = LIMITED AVAILABILITY
W = WIDELY AVAILABLE

OXYGENATES LIMITS AS PER EC REGULATION

	A* (% VOL)	B** (% VOL)
METHANOL, SUITABLE STABILIZING AGENTS MUST BE ADDED	3%	3%
ETHANOL, STABILIZING AGENTS MAY BE NECESSARY	5%	5%
ISO-PROPYL ALCOHOL	5%	10%
TBA	7%	7%
ISO-BUTYL ALCOHOL	7%	10%
ETHERS CONTAINING 5 OR MORE CARBON ATOMS PER MOLECULE	10%	15%
OTHER ORGANIC OXYGENATES	7%	10%
MIXTURE OF ANY ORGANIC OXYGENATES	2.5% OXYGEN WT. NOT EXCEEDING THE INDIVIDUAL LIMITS FIXED ABOVE FOR EACH COMPONENT	3.7% OXYGEN WT. NOT EXCEEDING THE INDIVIDUAL LIMITS FIXED ABOVE FOR EACH COMPONENT

A* ALL MEMBER STATES MUST PERMIT THESE LEVELS.

B** IF LEVELS EXCEED THESE VALUES, PUMPS WHICH DISPENSE FUEL MUST BE CLEARLY MARKED.

EARLIER EPA MAXIMUM VOLATILITY(RVP) STANDARDS FOR GASOLINE, psi

STATE	MAY	JUNE	JULY	AUG	SEPT
ARIZONA, NEW MEXICO W.TEXAS	9.5	9.0	9.0	9.0	9.5
CALIFORNIA (EXCEPT N.COAST), S.NEVADA	9.5	9.5	9.5	9.5	9.5
CALIFORNIA (N.COAST) COLORADO,N.NEVADA, OKLAHOMA,E.TEXAS, UTAH	10.5	9.5	9.5	9.5	9.5
ALABAMA,ARKANSAS, GEORGIA,ILLINOIS(S) KANSAS,LOUISIANA MISSISSIPPI, MISSOURI, N/S CAROLINA,TENNESSE	10.5	10.5	9.5	9.5	10.5
ALL OTHER STATES	10.5	10.5	10.5	10.5	10.5

TABLE - 4

REVISED EPA MAXIMUM VOLATILITY(RVP) STANDARDS FOR GASOLINE w.e.f.MAY'92

STATE	MAY	JUNE	JULY	AUG	SEPT
ALABAMA, ARIZONA ARKANSAS,CALIFORNIA COLORADO,DIST.COLUMBIA FLORIDA,GEORGIA,KANSAS LOUISIANA,MARYLAND, MISSISSIPPI,MISSOURI, NEVADA, NEW MEXICO, NORTH CAROLINA,OKLAHOMA, OREGON, SOUTH CAROLINA, TENNESSEE,TEXAS, UTAH, VIRGINIA	9.0	7.8	7.8	7.8	7.8
ALL OTHER STATES	9.0	9.0	9.0	9.0	9.0

DRAFT UPDATE CEN UNLEADED GASOLINE SPECIFICATION

		PREMIUM	REGULAR (a)	TEST METHOD
RON	min	95.0	*	ISO 5164
MON	min	85.0	*	ISO 5163
LEAD, g/l	max	0.013	0.013	ASTM D3237
BENZENE,% vol. max		5.0	5.0	ASTM D2267
SULPHUR,% wt. max		0.10(b)	*	EN 41
GUM, mg/100ml. max		5	1	ISO 2160
APPEARANCE		CLEAR AND BRIGHT		VISUAL
OXIDATION STABILITY,mins. min.		360		
DENSITY, kg/cu.m.		725 – 780		
OXYGENATES		AS PER DIRECTIVE 85/536/EEC		
WATER TOLERANCE		TO BE DEFINED		

VOLATILITY	CLASS 1	2	3	4	5
RVP hPa	350–700	450–800	550–900	600–950	700–1050
E70 % vol.	10–45	10–45	15–47	15–57	20–50
VLI max (RVP+7E70)	900	1000	1100	1200	1300
E100 % vol.	38–65	38–65	43–70	43–70	43–70
E180 % vol. min	85	85	85	85	85
FBP deg C max.	215	215	215	215	215

(a) PROPERTIES MARKED * MUST BE SPECIFIED IN NATIONAL STANDARD.

(b) SULPHUR REDUCED TO 0.05 % wt. FROM 1995

AVERAGE SULPHUR CONTENT OF DIESEL FUEL IN 1991, % MASS

WORLDWIDE	0.22
EUROPE	0.15
U.S.	0.20

MAXIMUM PERMITTED SULPHUR CONTENT IN AUTOMOTIVE DIESEL FUEL

EC COUNTRIES	% MASS
U.K.	0.3
FRANCE	0.3
GERMANY	0.2
ITALY	0.3
OTHERS	
CANADA	0.5
JAPAN	0.5
SWITZERLAND	0.2
SOUTH KOREA	1.0
U.S.A.	0.5
INDIA	1.0

TABLE -8

LEAD LEVELS IN GASOLINE FROM INDIAN REFINERIES 1990-91

S.NO.	REFINERY	AVERAGE LEAD gms/ltr.
1.	IOC, GUWAHATI	0.434
2.	IOC, BARAUNI	0.560
3.	IOC, HALDIA	0.412
4.	IOC, GUJARAT	0.138
5.	IOC, MATHURA	0.218
6.	BPC, BOMBAY	0.020
7.	HPC, BOMBAY	0.250
8.	HPC, VIZAG	0.120
9.	CRL, COCHIN	0.13
10.	MRL, MADRAS	0.15
11.	BRPL	0.0

PROGRAM FOR LEAD REDUCTION IN MOTOR GASOLINE IN INDIA

CURRENT	0.56 GMS/LTR.
DEC. 1993	0.15 GMS/LTR. (BOMBAY, DELHI, CALCUTTA, MADRAS)
1996–97	0.15 GMS/LTR. (ENTIRE COUNTRY)
NINTH PLAN	UNLEADED (BOMBAY, DELHI)

SULPHUR CONTENT IN DIESEL FROM INDIAN REFINERIES*, % WT.

S.NO.	REFINERY	SULPHUR CONTENT
1.	BPC, BOMBAY	0.3
2.	IOC, HALDIA	1.0
3.	IOC, GUWAHATI	0.1
4.	IOC, BARODA	0.3
5.	IOC, MATHURA	0.7
6.	IOC, BARAUNI	0.2
7.	MADRAS REFINERY	0.8
8.	HPLC, BOMBAY	0.5
9.	HPLC, VIZAG	0.6
10.	COCHIN REFINERY	0.4

* TYPICAL VALUES

SULPHUR CONTENT IN CRUDE OIL,% WT.

S.NO.	SOURCE OF CRUDE OIL	SULPHUR,% WT.
1.	BOMBAY HIGH	0.18
2.	HEERA	0.24
3.	RATNA	0.26
4.	ANKLESHWAR	0.12
5.	ASSAM (MIX)	0.28
6.	GUJARAT (MIX)	0.17
7.	BASRAH	1.95
8.	LIGHT IRANIAN	1.35

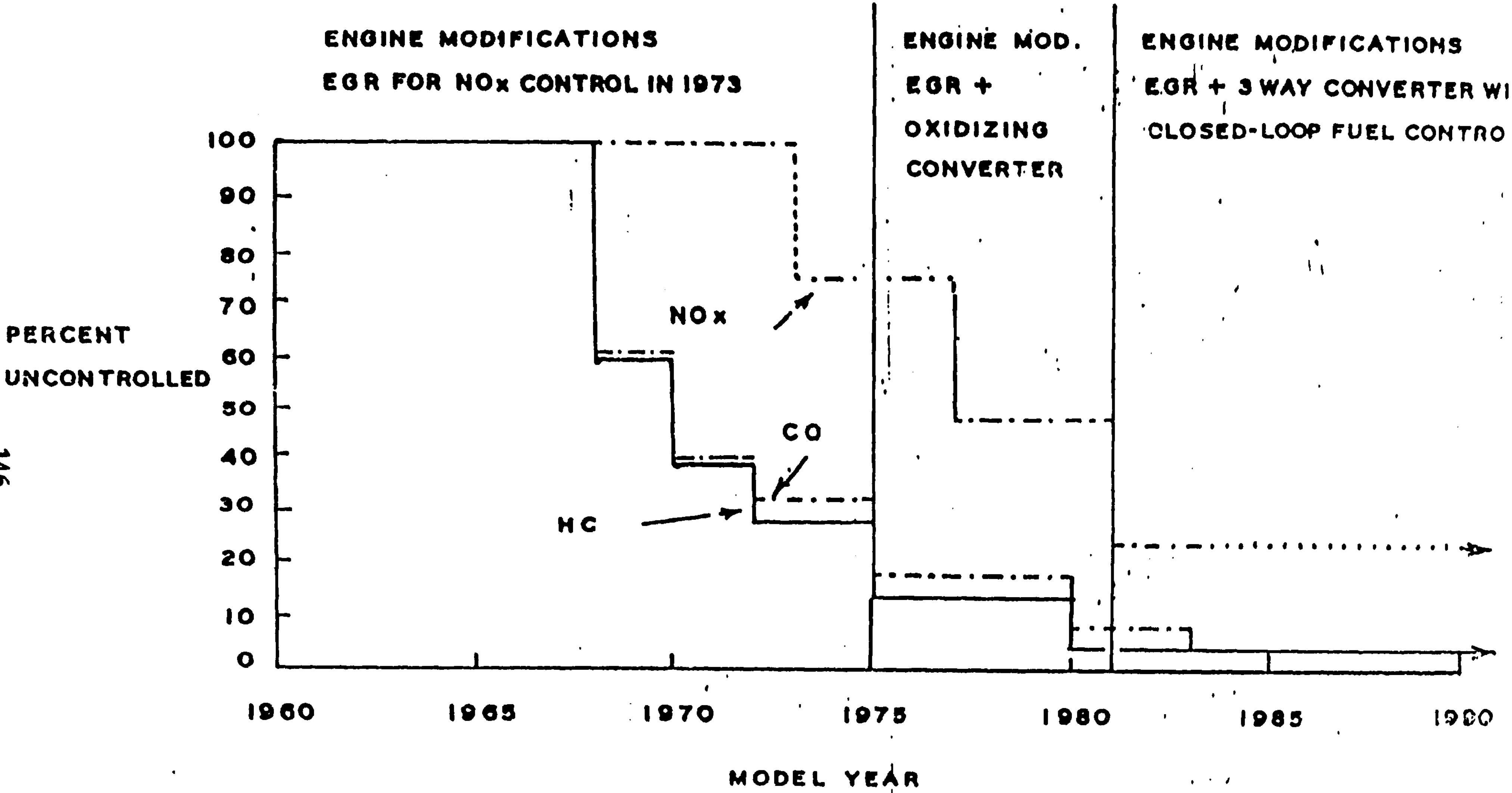


FIG.-1 PASSENGER CAR EXHAUST EMISSION CONTROL IN USA (

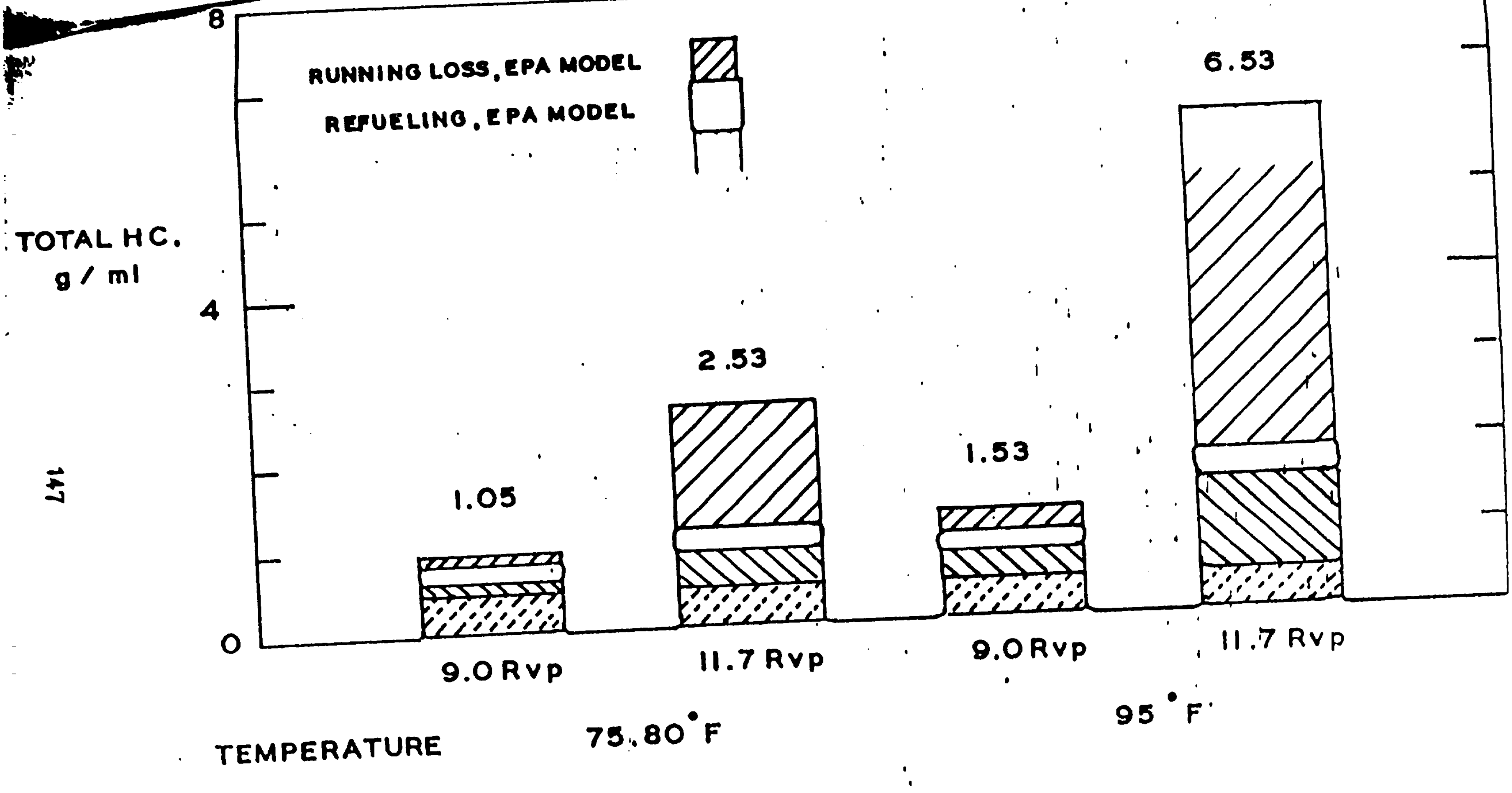


FIG. - 2 PASSENGER CAR HC EMISSIONS (1981 & NEARER MODELS) (1)

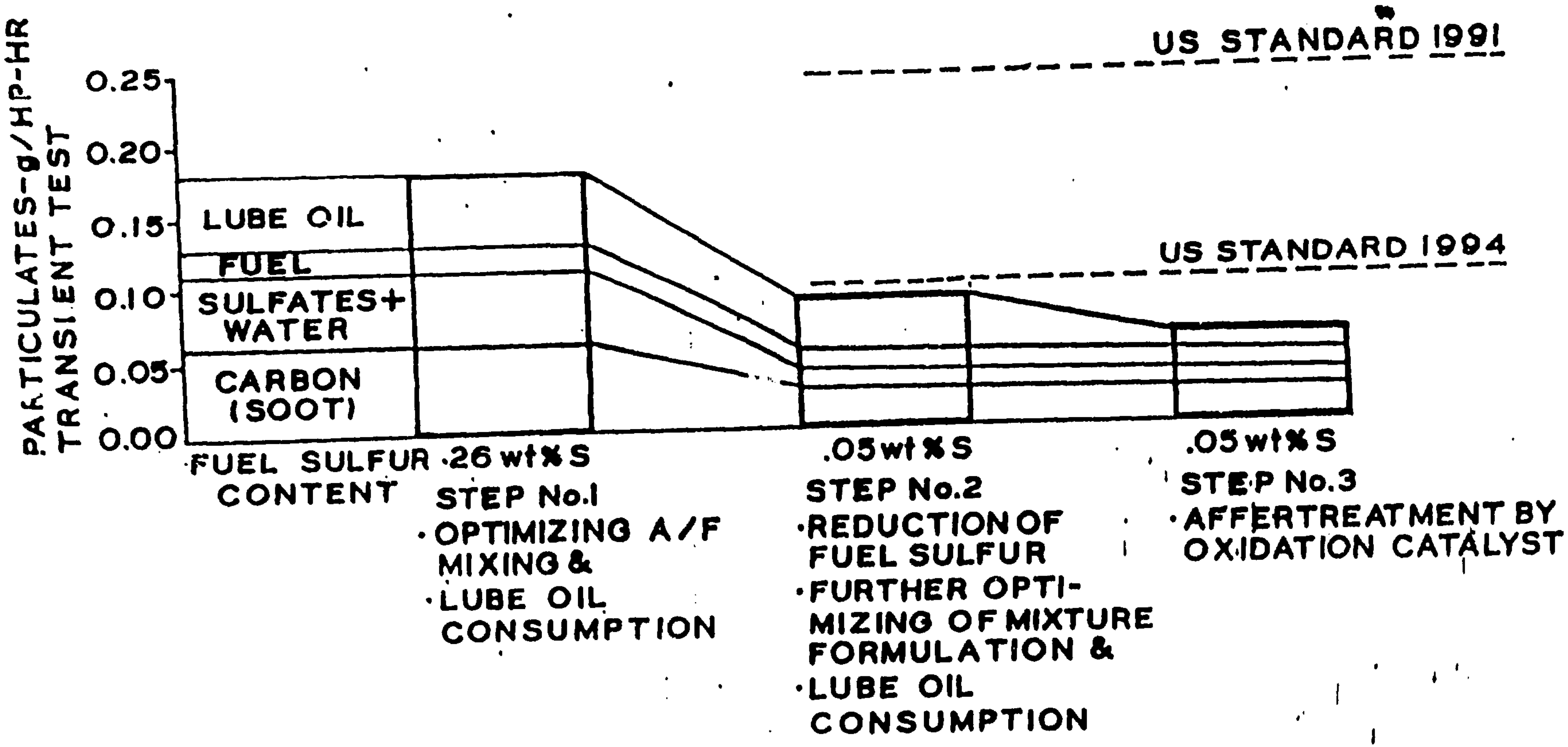


FIGURE-3 PARTICULATE EMISSION STANDARDS (12)

CETANE NUMBERS OF DIESEL FUEL

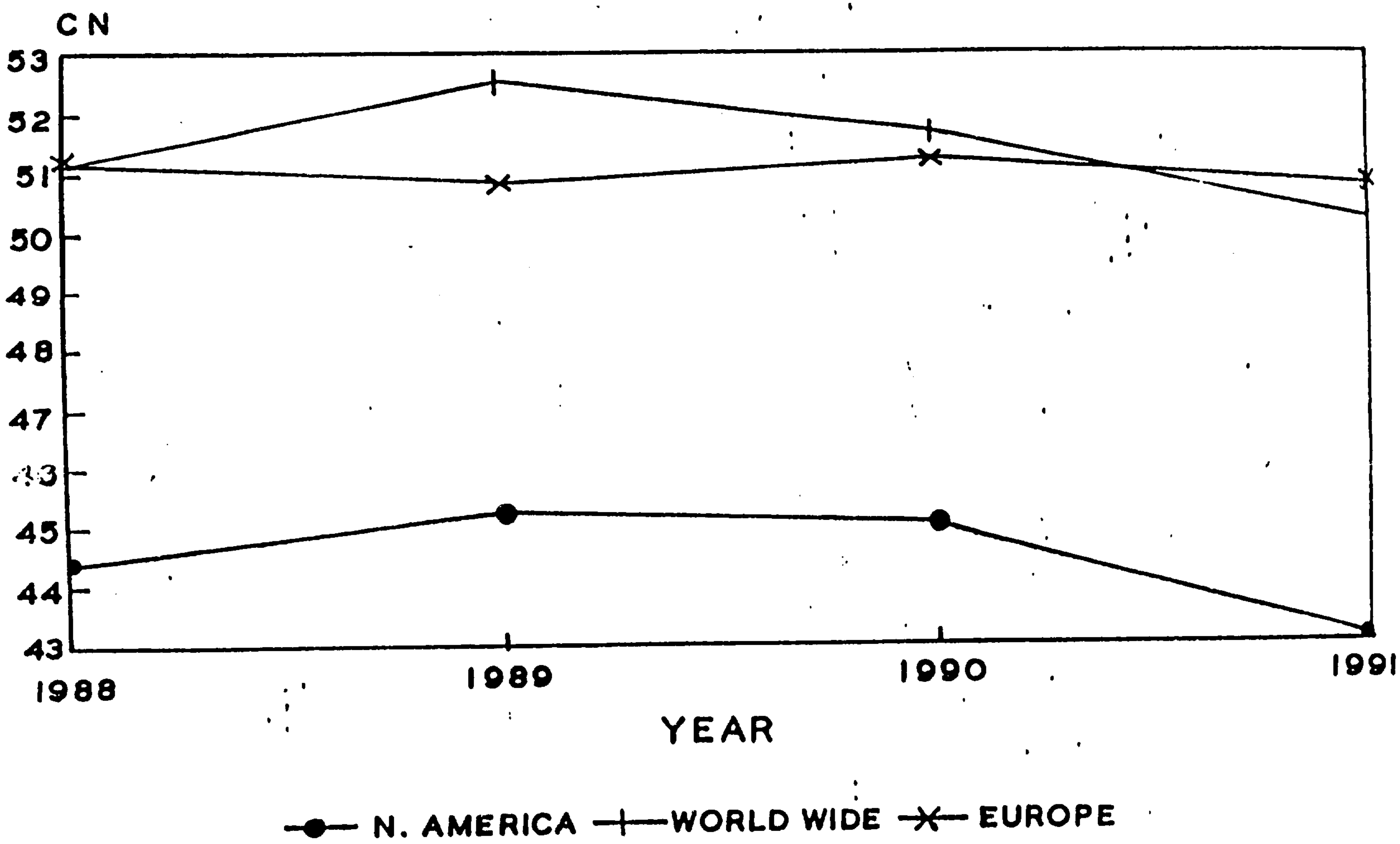
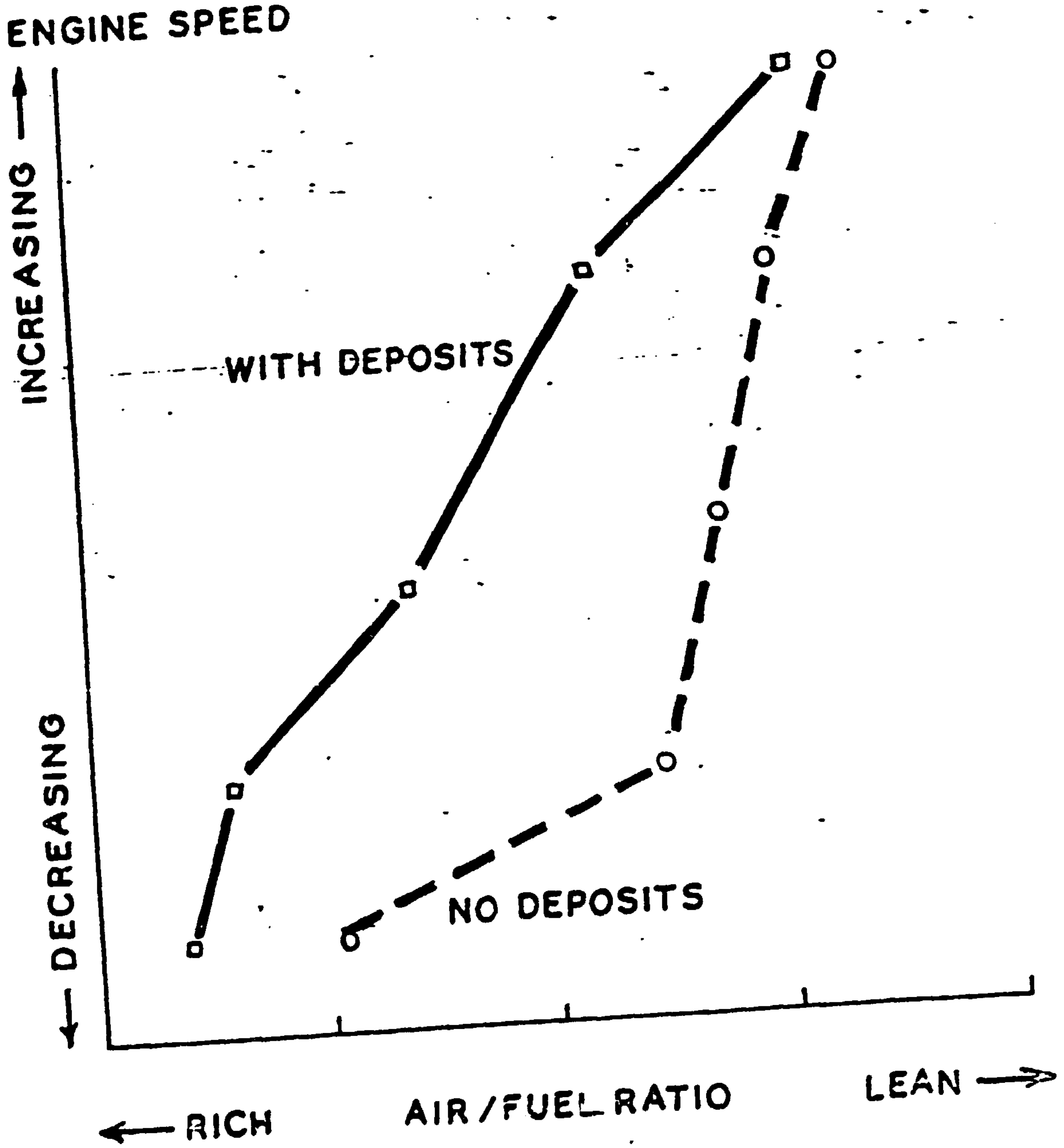


FIG. 4 VARIATION IN CETANE NUMBER OF DIESEL FUEL

FIGURE-5 EFFECT OF DEPOSITS ON AIR / FUEL RATIO



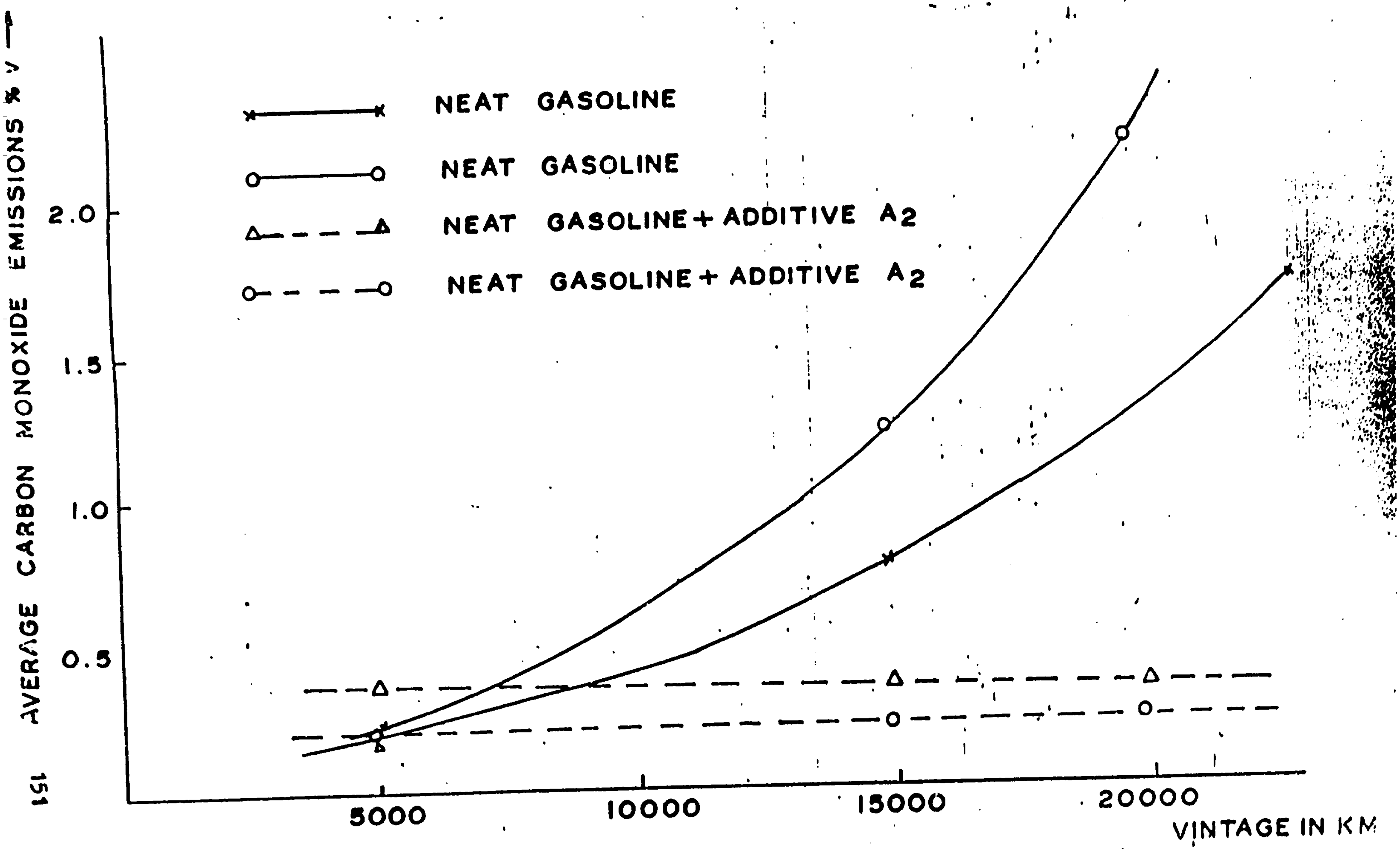


FIGURE - 6 VINTAGE Vs CARBON MONOXIDE EMISSIONS

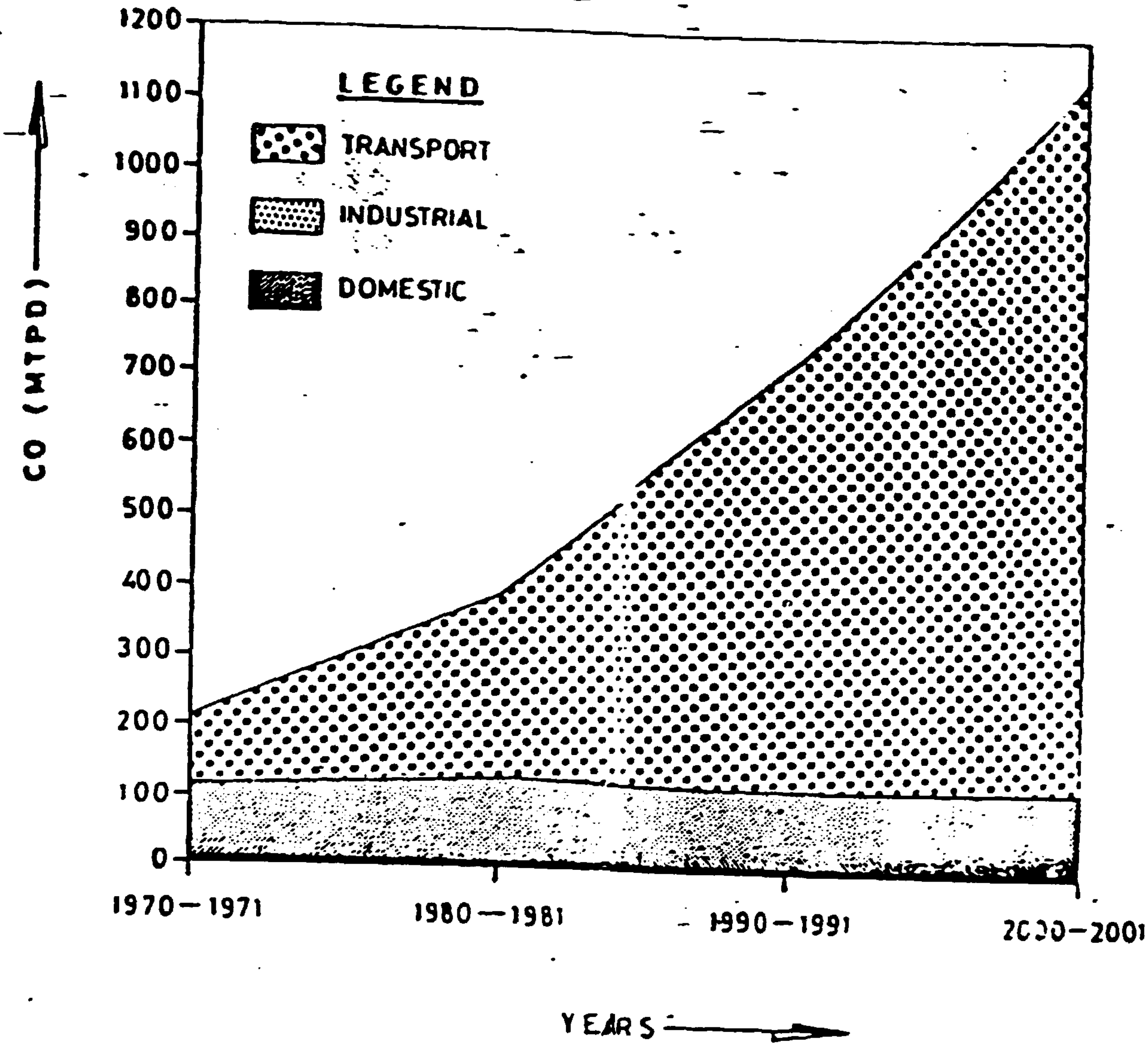


FIG. 7 CO EMISSIONS IN DELHI 1971-2001

CO emissions in Calcutta 1971-2001

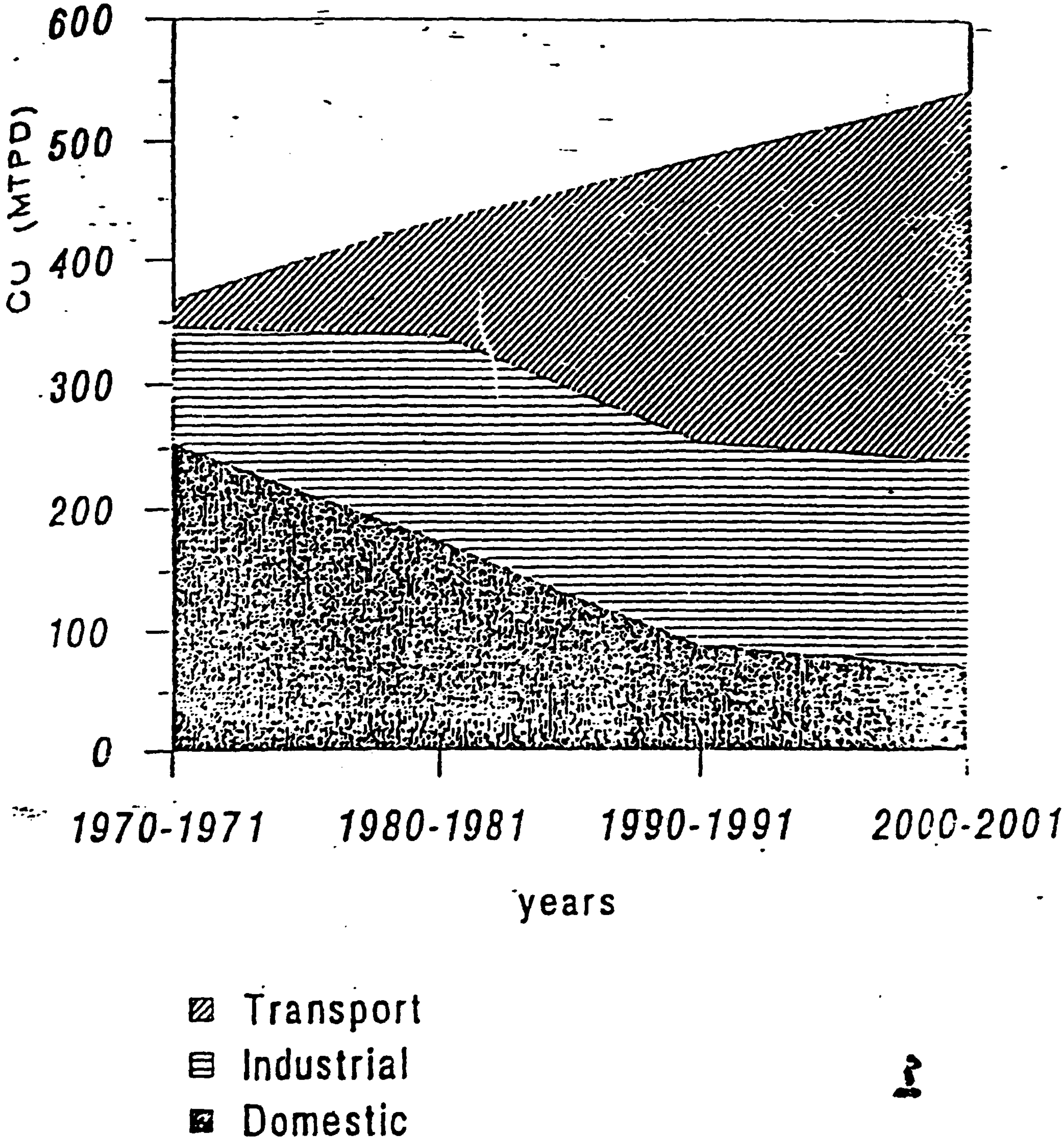


Fig 8 Estimated CO emission in Calcutta (1971-2001)

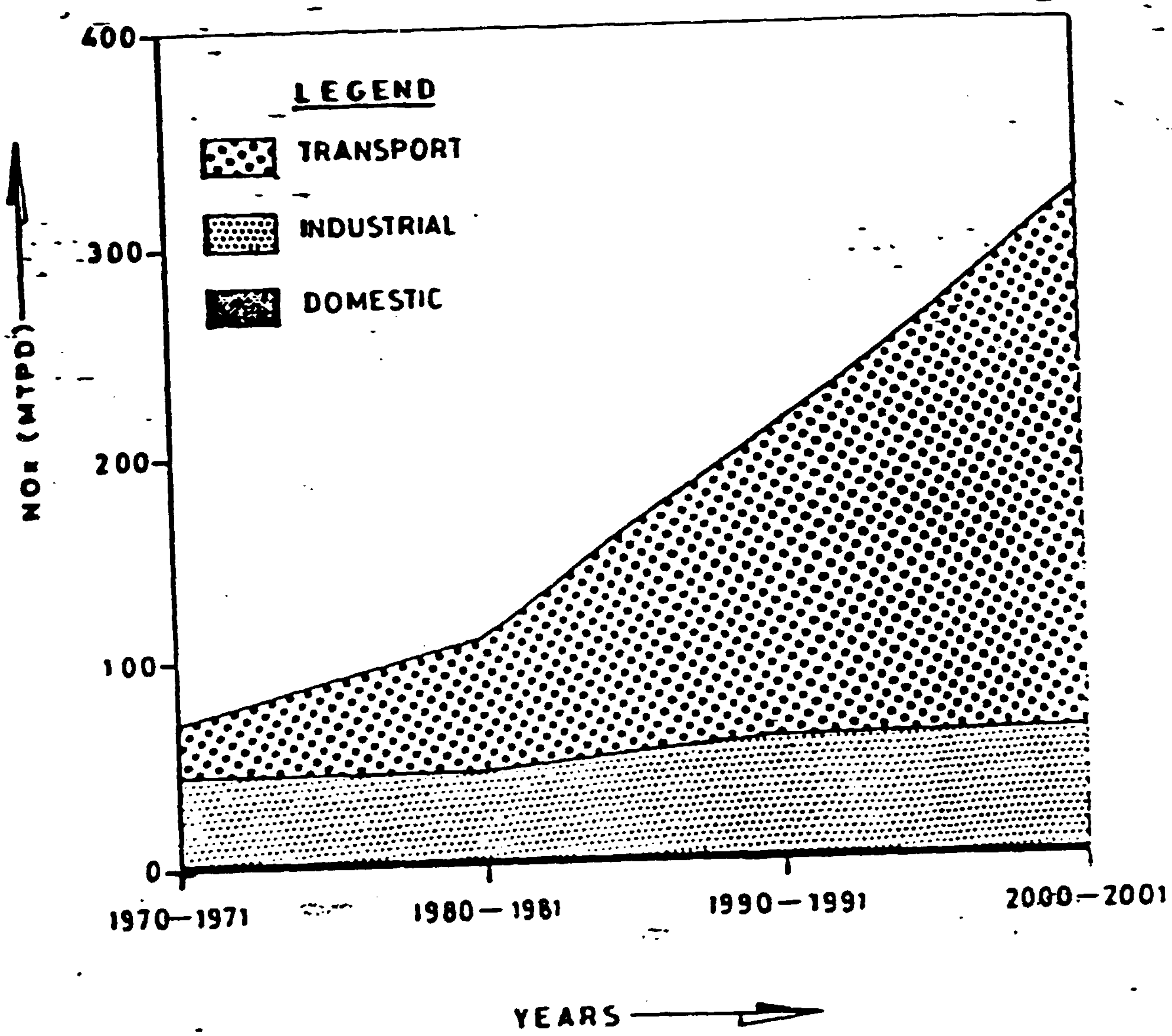


FIG. 9 NOx EMISSIONS IN DELHI 1971-2001

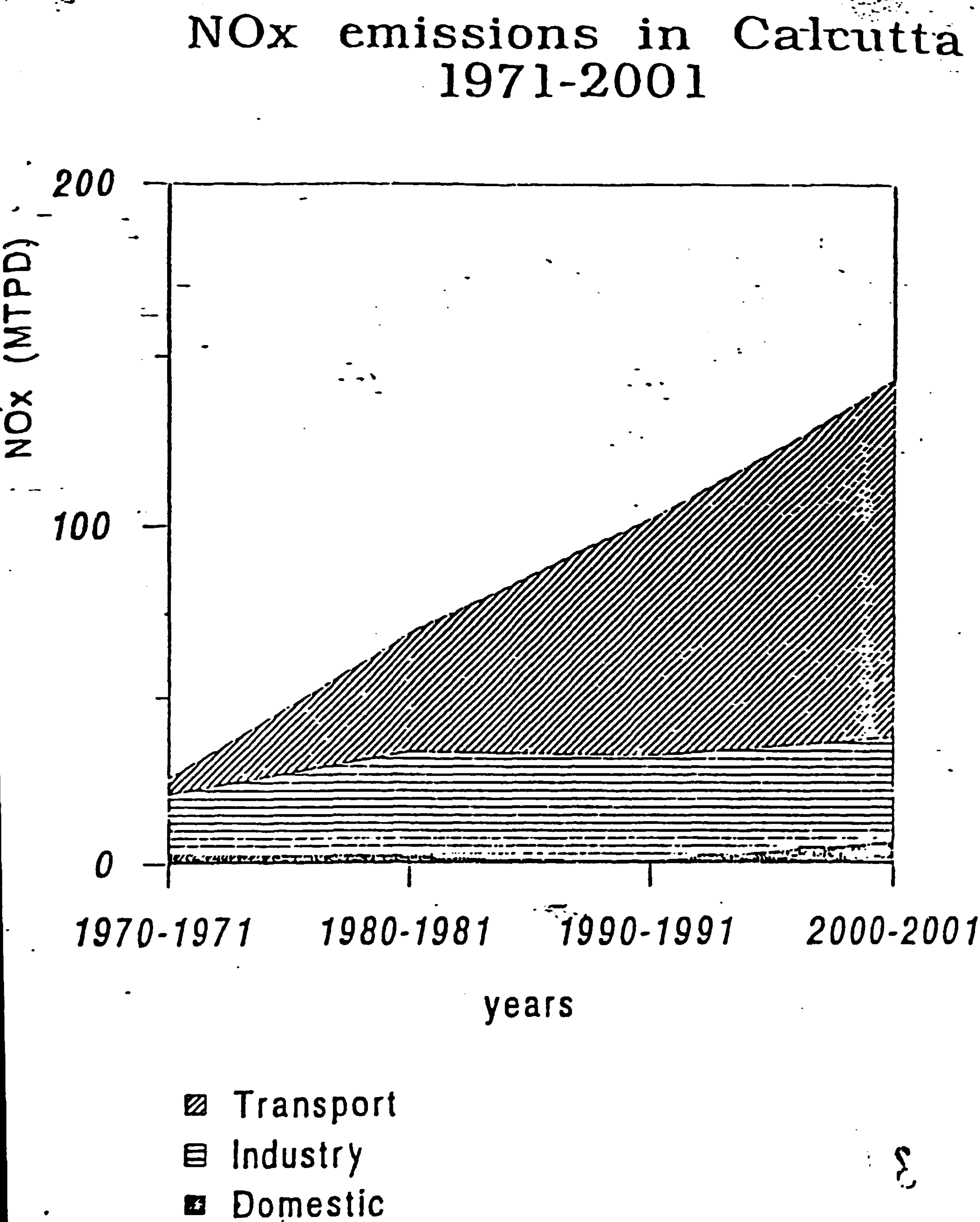


Fig. 10 Estimated NO_x emission in Calcutta (1971-2001)

Bombay emissions and annual average concentrations

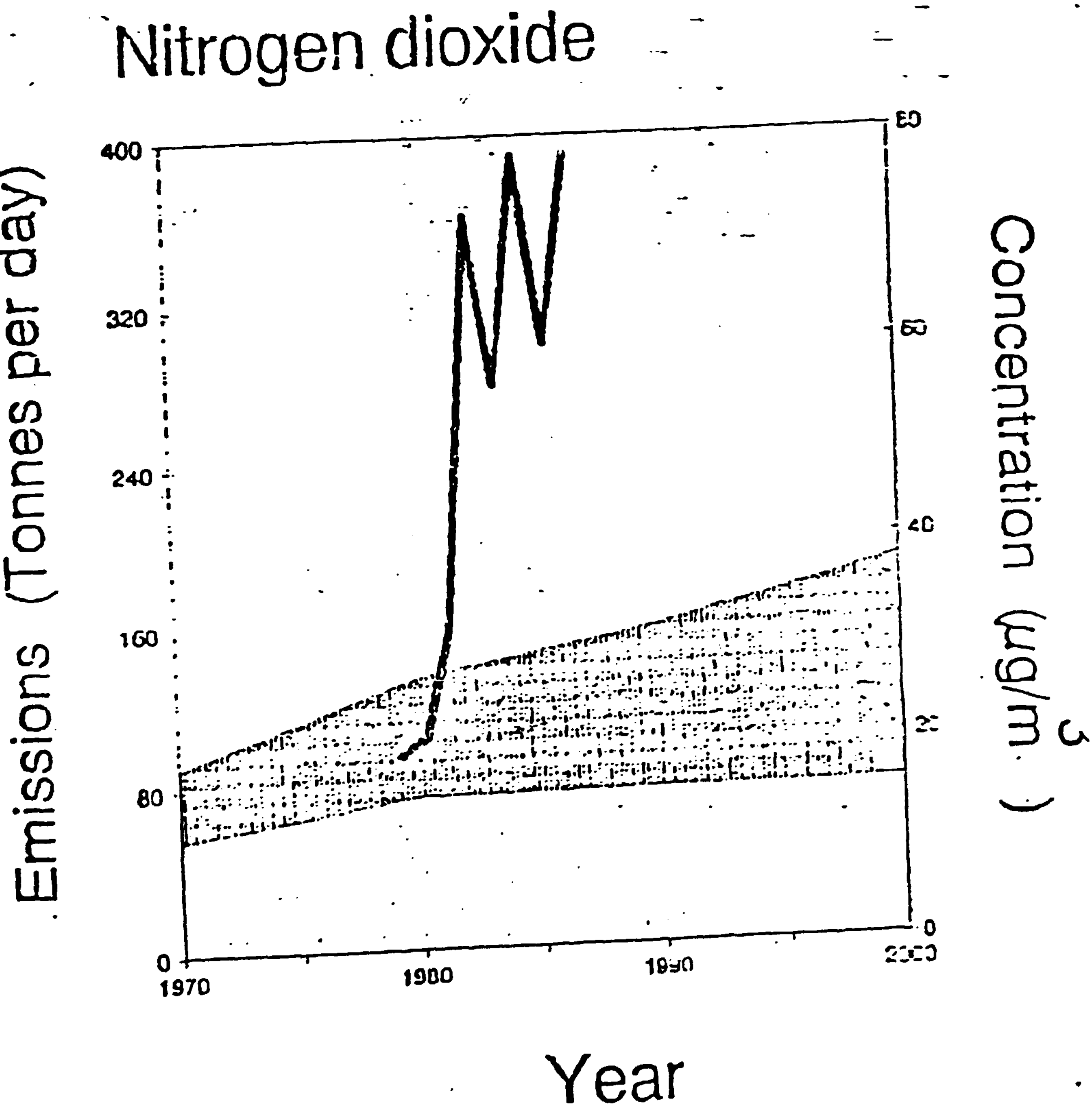


Fig 4 Estimated NO_x emission in Bombay (1971-2001)

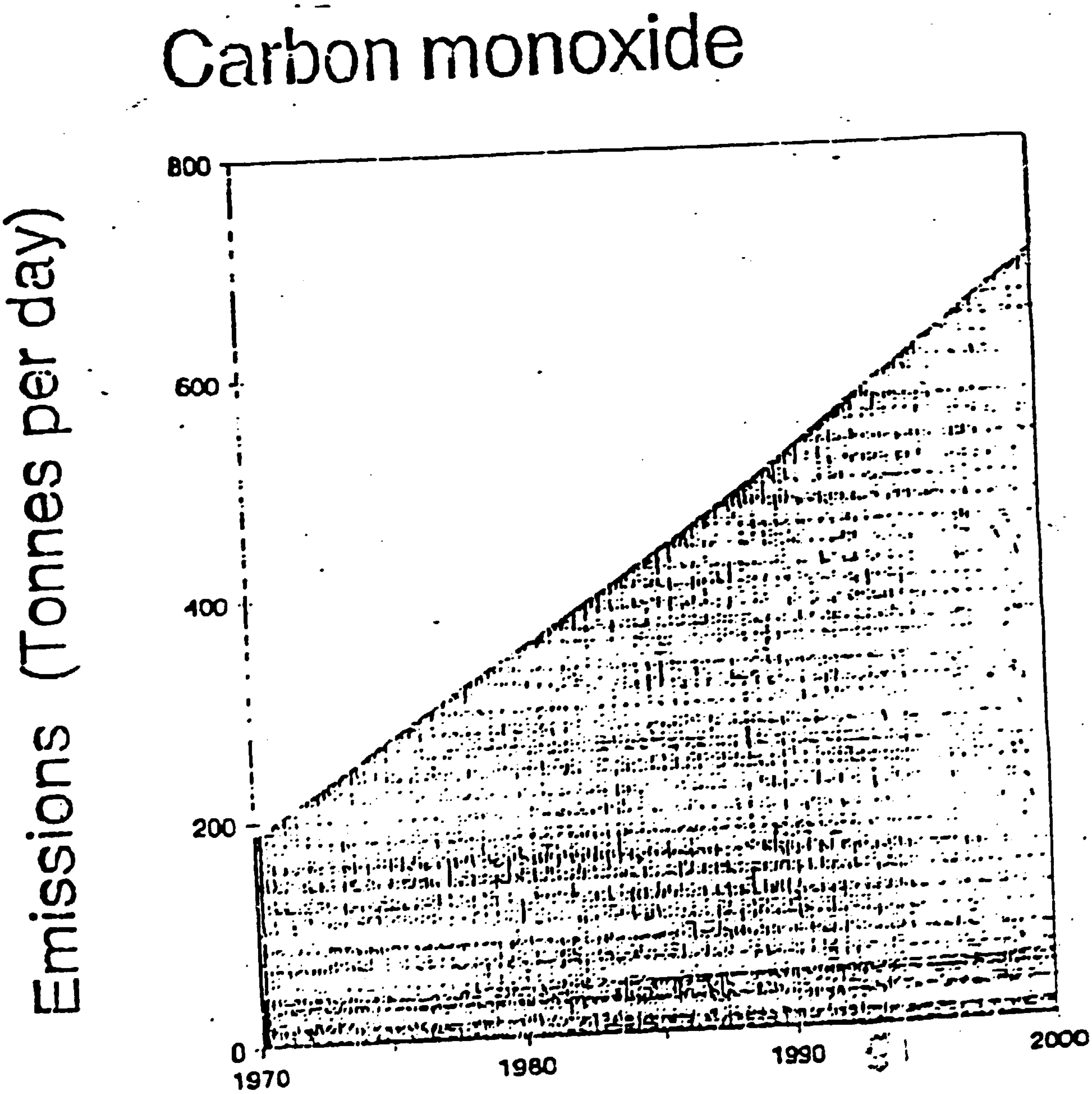


Fig. 12 :Estimated CO Emission in Bombay (1991-2001)

TABLE 1 REQUIREMENTS FOR MOTOR GASOLINES

(*Clauses* 2.1.1.1, 2.1.1.3 *and* 2.2)

Sl. No.	Characteristic	Requirements		Method of Test (Ref to P: of IS: 1448*)
		83 Octane	93 Octane	
(1)	(2)	(3)	(4)	(5)
i)	Colour, visual	Orange	Red	—
ii)	Copper-strip corrosion for 3 hours at 50°C	Not worse than No. 1		P : 15 (1968)
iii)	Density at 15°C	Not limited but to be reported		P : 16 (1967)
v)	Distillation:			P : 18 (1967)
	a) Initial boiling point	Not limited but to be reported		
	b) Recovery up to 70°C, percent by volume, *Min*	10	10	
	c) Recovery up to 125°C, percent by volume, *Min*	50	50	
	d) Recovery up to 180°C, percent by volume, *Min*	90	90	
	e) Final boiling point, *Max*	215°C	215°C	
	f) Residue, percent by volume, *Max*	2	2	
v)	Octane number (Research method), *Min*	83	93	P : 27 (1960)
vi)	Oxidation stability, in minutes, *Min*	300	360	P : 28 (1966)
vii)	Residue on evaporation, mg/100 ml, *Max*	4·0	4·0	P : 29 (1960) (Air-jet, solvent washed)
viii)	Sulphur, total, percent by weight, *Max*	0·25	0·20	P : 34 (1966)
ix)	Lead content (as Pb), g/l, *Max*	0·56	0·80	P : 37 (1967) or P : 38 (1967)
x)	Reid vapour pressure at 38°C, kgf/cm², *Max*	0·70	0·70	P : 39 (1967)

*Methods of test for petroleum and its products.

TABLE 1 REQUIREMENTS FOR DIESEL FUELS

Characteristic	Requirement		Method of Test, Ref to	
	HSD	LDO	Appendix	(P :) of IS : 1448*
(2)	(3)	(4)	(5)	(6)
i) Acidity, inorganic	Nil	Nil	—	P : 2
ii) Acidity, total, mg of KOH/g, *Max*	0·50	—	—	P : 2
iii) Ash, percent by mass, *Max*	0·01	0·02	—	P : 4
iv) Carbon residue (Ramsbottom), percent by mass, *Max*	0·20	1·50	—	P : 8
v) †Cetane number, *Min*	42	—	—	P : 9
vi) ‡Pour point, *Max*	6°C	12°C for winter§ 18°C for summer§	—	P : 10
vii) Copper strip corrosion for 3 hours at 100°C	Not worse than No. 1	Not worse than No. 2	—	P : 15
viii) Distillation percent recovery at 366°C, *Min*	90	—	—	P : 18
ix) ‖ Flash point:				
a) Abel, °C, *Min*	32	—	—	P : 20
b) Pensky-Martens (closed), °C, *Min*	—	66	—	P : 21
x) Kinematic viscosity, cS, at 38°C	2·0 to 7·5	2·5 to 15·7	—	P : 25
xi) Sediment, percent by mass, *Max*	0·05	0·10	—	P : 30
xii) Total sulphur, percent by mass, *Max*	1·0	1·8	—	P : 33¶ or P : 35
xiii) Water content, percent by volume, *Max*	0·05	0·25	—	P : 40
xiv) **Total sediments, mg per 100 ml, *Max*	1·0	—	A	—
xv) Cold filter plugging point, CFPP, °C, *Max*	To be reported	-	-	P: ++

*Methods of test for petroleum and its products.

†Diesel fuel for Naval applications shall have a cetane number of 45, *Min*. When an engine for the determination of cetane number is not available, diesel index determined by IS : 1448 [P : 17]-1960 Methods of test for petroleum and its products, P:17 Diesel index may be used as a rough indication of ignition quality. A diesel index of 45 is normally considered sufficient to ensure a minimum cetane number of 42. This approximate correlation holds good only in case of fuels which are of petroleum origin and contain no additives. For arbitration purposes, the direct determination of cetane number by means of the standardized engine test shall be used unless the buyer and the seller agree otherwise.

‡Subject to agreement between the purchaser and the supplier, a lower or higher maximum pour point may be accepted.

§Winter shall be the period from November to February (both months inclusive) and rest of the months of the year shall be called as summer.

‖Diesel fuel for Naval applications including Merchant Navy shall have a flash point of 66°C, *Min*, when tested by the method prescribed in IS : 1448 [P : 21]-1970 Methods of test for petroleum and its products, P:21 Flash point (closed) by Pensky-Martens apparatus (*first revision*).

¶In case of any dispute IS : 1448 [P : 33]-1967 Methods of test for petroleum and its products, P: 33 Sulphur by bomb method shall be considered as referee method.

**This test shall be carried out only at the refinery or manufacturer's end.

"††Under preparation. Till such time the standards under preparation are published, method IP 309/76 'Cold filter plugging point of distillate fuels' issued by the Institute of Petroleum, U.K. may be followed."

TABLE 1 REQUIREMENTS FOR FUEL OILS
(Clause 3.3)

SL No.	CHARACTERISTIC	REQUIREMENT FOR				METHOD OF TEST [REF TO (P:) OF IS : 1448*]
		Grade LV	Grade MV1	Grade MV2	Grade HV	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Acidity, inorganic	Nil	Nil	Nil	Nil	P : 2
ii)	Ash, percent by mass, *Max*	0·1	0·1	0·1	0·1	P : 4 (Method A)
iii)	Gross, calorific value	Not limited, but to be reported (*See* Note 1)				P : 6 (for reference) and P : 7 (for routine)
iv)	Relative density at 15/15°C	Not limited, but to be reported (*See* Note 2)				P : 32
v)	Flash point, [Pensky martens (closed)], *Min*	66°C	66°C	66°C	66°C	P : 21
vi)	Kinematic viscosity in centistokes at 50°C, *Max*	80	125	180	370	P : 25
vii)	Sediment, percent by mass, *Max*	0·25	0·25	0·25	0·25	P : 30
viii)	Sulphur, total, percent by mass, *Max* (*See* Note 3)	(3·5)	(4·0)	(4·0)	(4·5)	P : 33 (for reference) and P : 35 (for routine)
ix)	Water content, percent by volume, *Max*	1·0	1·0	1·0	1·0	P : 40

NOTE 1 — Normally the gross calorific value is of the order of 10 000 cal/g.

NOTE 2 — Fuel oil for marine uses in diesel engines shall not exceed a limit of 0.99.

NOTE 3 — Recognizing the necessity for low-sulphur fuel oils in some specialized uses, a lower limit may be specified by mutual agreement between the purchaser and the supplier.

*Methods of test for petroleum and its products.

5.2 Marking

5.2.1 The material shall be supplied in accordance with the marking and delivery instructions given by the purchaser.

5.2.2 Each container shall be marked with the following information:

a) Name and grade of the material;

b) Manufacturers' name, initials or trade-mark;

c) Volume of the contents in litres; and

d) Year of manufacture or packing.

2.2 The material shall also comply with the requirements given in Table 1, when tested according to the appropriate methods prescribed under 'P' series of IS : 1448*, reference to which is given in col 4 of the table.

TABLE 1 REQUIREMENTS FOR KEROSINE

Sl. No.	Characteristic	Requirement	Method of Test, Ref to 'P' of IS : 1448*
(1)	(2)	(3)	(4)
i)	Acidity, inorganic	Nil	P : 2
ii)	Burning quality:		P : 5
	a) Char value, mg/kg of oil consumed, *Max*	20	
	b) Bloom on glass chimney	Not darker than grey	
iii)	Colour (Saybolt)†, *Min*	†10	P : 14
iv)	Copper strip corrosion for 3 h at 50°C	Not worse than No. 1	P : 15
v)	Distillation:		P : 18
	a) Percent recovered below 200°C, *Min*	20	
	b) Final boiling point, °C, *Max*	300	
vi)	Flash point (Abel), °C, *Min*	35	P : 20
vii)	Smoke point, mm, *Min*	18‡	P : 31
viii)	Total, sulphur, percent by mass, *Max*	0·25§	P : 34

*Methods of test for petroleum and its products.

†Where Saybolt chromometer is not available, Lovibond colour of the sample kept in an 18-in cell may be measured according to IS : 1448 [P : 13]-1960 'Methods of test for petroleum and its products, P : 13 Colour by Lovibond tintometer' in which case, the colour shall not be deeper than Standard White (IP 4·0).

‡For supplies to Defence, the smoke point of the product shall be 21 mm, *Min* and for Railways it shall be 20 mm, *Min*.

§For supplies to Defence, total sulphur content, percent by mass, of the product shall be 0·20, *Max*.

*Methods of test for petroleum and its products.

AMBIENT AIR QUALITY AT MAJOR TRAFFIC INTERSECTIONS IN DELHI

There are ten major traffic intersections in Delhi.

Mixed Use Area	Sensitive Area
- Azadpur	- A.I.I.M.S.
- Ashram Crossing	- L.N.J.P. Hospital
- Connaught Place	
- Dhaula Kuan	*Residential Area*
- Old Delhi Railway Station	- Laxmi Nagar
- Raja Garden Crossing	- I.A.R.I., Pusa
- Shyam Lal College	

Ambient Air Quality at traffic intersections compared to relatively pollution free sitle at I.A.R.I., Pusa.

Parameters	Average Concentration Ranges		Prescribed Standards (Area wise)		
	At IARI Campus (pollution free reference site)	At Traffic Intersections	Sensitive	Residential	Mixed used
CO	572 - 1374	5725 - 1145[illegible]	100[illegible]	[illegible]	5000
SO_2	1.83 - 5.24	13.10 - 39.30	30	[illegible]	[illegible]
NO_x ($NO + NO_2$)	33 - 75.20	52.[illegible] - 84[illegible]	[illegible]		[illegible]

Ambient Air Quality

The status of ambient air quality in past three years (1990-93) is presented below.

Parameters	Range of value eight hour observations	Air Quality Standards Industrial/Mixed Use Area
Suspended Particulate Matter (SPM)	200-1400 $\mu g/m^3$	500 $\mu g/m^3$
Sulphur Dioxide (SO_2)	10-70 $\mu g/m^3$	120 $\mu g/m^3$
Oxide of Nitrogen as NO_x	30-200 $\mu g/m^3$	120 $\mu g/m^3$
Carbon Mono oxide (CO)	0.17-15.43 ppm	4.37 ppm
Polyaromatic hydrocarbon (PAH) - Benzopyrene	36-722 ng/m^3	10 ng/m^3
Lead	0.8-8.3 $\mu g/m^3$	1 $\mu g/m^3$

$$1 \mu g/m^3 = 10^{-6} g/m^3$$
$$1 ng/m^3 = 10^{-9} g/m^3$$

On the basis of Monitoring data the annual period may be classified into three seasonal category considering air pollutants level in ambient environment of National Capital Territory of Delhi-

Period	Feature
April through June	Critical period [illegible] particulate matter because of low humidity [illegible] rbulance due to winds in the environment
July to mid- October	Cl[illegible]er period [illegible] to high humidity and monsoon season.
Mid-October to March	Critical period due to pollutants trapp[illegible] and also because of inversion and unfavourable meteorological conditions.

Annexure V.
(Page 3 of 7 Pages)

Table 4 : List of NAAQM Locations in Desending Order of Concentrations (ug/cub.m) based on 1990 Data for 16 or more Hours Monitored Days

S No	Area Class Industrial: Sulphur Dioxide	Area Class Industrial: Nitrogen Dioxide	Area Class Industrial: SPM	Area Class Commercial: Sulphur Dioxide	Area Class Commercial: Nitrogen Dioxide	Area Class Commercial: SPM	Area Class Residential: Sulphur Dioxide	Area Class Residential: Nitrogen Dioxide	Area Class Residential: SPM
1	Naskarpara Pump House Howrah (81 8)	Naskarpara Pump House Howrah (90 8)	Raipur Road, Dehradun (837)	Eye Hospital, Jamshedpur (55 9)	Town Hall, Delhi (51 5)	Hamida Road, Bhopal (594)	Jugshali, Jamshedpur (78 2)	Veternary Hospital, Kota (101 2)	Deputy Ka Parao Kanpur (566)
2	Municipal Corp. Howrah (70 0)	Municipal Corp Howrah (75 7)	Municipal Corp Howrah (560)	LalBazar Calcutta (38 5)	Bank More, Bihar (44 4)	Town Hall, Delhi (568)	India Chowk, Gajroula (48 4)	Raipura, Kota (87 2)	Jaipur House Agra (502)
3	Parel Bombay ([illegible])	Bandhaghat, Howrah ([illegible])	Najafgarh, Delhi (527)	Bank More, Bihar (31 8)	LalBazar, Calcutta (42 0)	Clock Tower, Dehradun (506)	Visak Hostel, Bihar (37 7)	Akelgarh Kota (85 3)	ESI Hospital Agra (445)
4	Raunaq Ltd., Gajroula (56 2)	Super Market Haldia (58 2)	Rita Sewing Mach., Ludhiana (516)	Town Hall, Delhi (30 6)	Vehicular, Traffic, Pune (42 2)	Tripolia Bazar, Jaipur (502)	Civil Lines, Satna (33 0)	Anantpura, Kota (70 4)	Air India Bldg., Surat (416)
5	Golmuri Jamshedpur (52 7)	Bator Howrah (52-8)	Agra Univ Agra (478)	Kalbadevi Bombay (27 2)	Hamida Road, Bhopal (31 7)	Kotwali, Kanpur (382)	Cadila Narol, Ahmedabad (33 4)	Barkhera, Kota (68 1)	Netaji Nagar, P.O., Delhi (383)
6	Manali P S Madras (54 1)	Raunaq Ltd Gajraula (50 4)	Indus Area Satna (449)	Clock Tower, Dehradun (26 0)	Kalbadevi, Bombay (30 7)	Kothan Mkt., Indore (358)	(Sec -9, Faridabad (30 7)	India Chowk, Gajroula (53 4)	Cadila Narol, Ahmedabad (357)
7	Adityapur R O Jamshedpur (46 1)	Milk Plant Ludiana (46 4)	Shahzada Bagh, Delhi (447)	Hamida Road Bhopal (24 7)	MRD Bank, G Path, Nagpur (28 9)	Kotwali, Kanpur (328)	R O., Dhanbad, (29 5)	SVR Engg., College, Surat (40 9)	Nyaya Mandir, Baroda (357)
8	Industrial Area, Satna (43 7)	Alandi Road Pune (46 3)	Hero Cycle, G T., Road, Ludiana (428)	RCH School, Ahmedabad (20 3)	Eye Hospital, Jamshedpur (28 2)	Bank-More, Bihar (291)	Bandra, Bombay (28 2)	R/O, Dhanbad, (39 8)	PHED Gandhi, Nagar, Jaipur (357)
9	Dhundhera Vill, Bhilai (41 5)	Rita Sewing Mach., Ludhiana (43 6)	RSP College, Jharia (415)	Anand Rao, Cir., Bangalore (17 9)	Clock Tower, Dehradun (23 2)	Lal Bazar, Calcutta (274)	Air India, Bldg., Surat (21 1)	Air India, Bldg., Surat (37 7)	Bapod, Baroda (339)
10	Anpara Colony Anpara (36 4)	Shardaben Hosp. Ahmedabad (42 8)	Raunaq Ltd., Gajraula (378)	Vehicular Traf., Traffic Pune (13 6)	Parry's Corpn., Madras (20 6)	Vehicular Traf., Pune (273)	CESE M G., Calcutta (19 5)	Cadila Narol, Ahmedabad (36 6)	Visak Hostel, Bhilai (329)

Note: SPM - Suspended Particulate Matter

Source : *Central Pollution Control Board - Annual Report - 1991-92*

Annex 10

COUNTRY REPORT OF MALAYSIA

CONTROL AND REGULATORY MEASURES CONCERNING MOTOR VEHICLES EMISSIONS IN ASIA PACIFIC REGION

AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS

by

MARZUKI MOKHTAR
ENVIRONMENTAL CONTROL OFFICER
MOBILE SOURCES UNIT
DEPARTMENT OF ENVIRONMENT
MALAYSIA

and

YAAKOB SIDIKIN
SECTION HEAD OF FUEL & SPECIAL PRODUCT
PETRONAS, MALAYSIA

BEIJING 29-31 MARCH 1994

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

AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS

Marzuki Mokhtar
&
Yaakob Sidikin

INTRODUCTION

1. Malaysia as a developing country has embarked on the programme of industrialisation since the 1970's. The country has a vision to be an industrialised country by the year 2020. As a result, transportaticn has become more essential and important for daily activities especially in urban areas.

2. Based on studies and prediction by Department of Environment (DOE), more than 70 percent of the air pollution load is contributed by motor vehicle emission.

3. The main pollutant emitted by petrol powered vehicle are Carbon Monoxide (CO), Hydrocarbon (HC), Oxides of Nitrogen (NOx) and lead particulates. Particulate matters (black smoke) and Oxide of Sulphur (SOx) are the type of pollutants normally associated from diesel powered vehicle.

MOTOR VEHICLE STATISTICS

4. Until October 31st, 1993 there are about 6 million registered vehicles in Peninsular Malaysia, of which 92.5 per cent were petrol driven vehicles while the remaining 7.5 per cent were diesel-powered vehicles. (Table 1). Breakdown of motor vehicles according to vehicle types and engine power for 1992 are as shown in Table 2.

5. Motorcycles (including mopede and tricycle) are petrol driven and they constitute the biggest share amounting to 57.9 per cent of the total vehicle population.

6. The number of vehicles on the roads has been increasing steadily at a rate of 12 per cent per annum in the 80's and in 1992 the growth rate was recorded at 7 per cent.

FUEL QUALITY

7. Presently, there are four refineries in operation in Malaysia. The refining capacities range from 30,000 barrels per day up to 90,000 barrels per day. The products produced are as follows.

i) light naptha

ii) heavy naptha

iii) reformate

iv) kerosene/jet fuel

v) diesel

vi) bitumen

The type of crudes refined by these refineries are Local Sweet Crude (Tapis blend) or Middle East Sour Crude.

Types of Fuel

8. The four types of fuel produced by these refineries are gasoline, diesel, kerosene/jet fuel and fuel oils. The fuel consumption and breakdown by grade are as in Table 3.

9. The gasoline marketed are classified based on the Research Octane Number (RON) and the maximum lead content. The grades are as follows.

Grade	RON	Max lead content
Premium (leaded)	97.0	0.15 gm/l
Premium (unleaded)	97.0	0.013 gm/l
Regular (leaded)	92.0	0.15 mg/l
Regular (leaded)	85.0	0.15 gm/l

Detail properties of the gasoline are as shown in Table 4.

10. To control the lead concentration in gasoline, the DOE has introduced the Environmental Quality (Control of Lead Concentration in Motor Gasoline) Regulations, 1985. Under these Regulations, all petroleum refiners and importers are required to reduce the lead level in stages as follows.

Year	Max lead content (gm/l)
Initial	0.84
1985-1990	0.4
1990	0.15

11. The lead free gasoline (ULG) was introduced into Malaysian market on July 1990. The retail sale of ULG for 1993 is 31.3% of the total sale of gasoline in Malaysia. Three cents price different between unleaded and leaded gasoline was introduce on the January 1, 1994 to encourage motorists to use unleaded gasoline. It is anticipated that the use of ULG will be increased tremendously in 1994.

12. In future, the oil companies has made proposals to the Government to introduce two grades of gasoline, i.e RON 97.0 (ULG) and RON 92.0

(leaded). The existing RON 85 (leaded) gasoline will be upgraded to RON 92.0 (leaded) gasoline by July 1, 1994.

13. For ULG, the oil companies plan to introduce two grades of gasoline, RON 97.0 and RON 92.0 by 1996.

14. Presently, oil companies are using detergent additive in the premium grade ULG sold in Malaysian market.

Diesel

15. The demand of diesel fuel for 1992 was 6200 million liters, out of which 42% is for the transportation sector.

16. The critical parameters of diesel quality are cetane index, sulphur content, distillation and flash point. The minimum cetane index is 47 while the typical value is 50.

17. Sulphur in diesel has been the focus of attention with regards to black smoke emission. The Government had revised the Malaysian Standard for Diesel MS 123 (1993) and reduce the sulphur content from 1% to 0.5% wt by 1992. Table 5. It will be further reduce to 0.3% by the year 1996.

18. The flash point is related to the storage of the product. The reduction of flash point from 66^{o}C to 60^{o}C does not affect the quality of the product.

TWO STROKE ENGINE OIL

19. Currently, there are 3.4 millions registered motorcycles in Peninsular Malaysia, out of which 70% are two stroke motorcyles.

20. The 2T oil is manufactured in compliance with API (American Petroleum Institute) The different grades of 2T engine oils are :

    i) API-TA,TB,TC for air cooled engine

    ii) API-TD for water cooled engine

21. Low smoke 2T was introduced by oil companies since 1991. However the price of the low smoke 2T is twice the price of the conventional 2T oil. The pricing structure of 2T oil are as follow :

Grade	Price
Conventional (TA, TB, TC)	RM 2.40 - 3.80 / lit
Low Smoke (TC)	RM 9.00 - 12.00/ lit
Taxes	
Duty	RM 0.22 / lit
Sales tax	5 %

* Exchange rate: US $1.00 = RM 2.70

CONCLUSION

22. The air pollution problems in Malaysia are mainly due to the rapid development of manufacturing activities and urbanization. Emission from motor vehicles is the major contributor to the deterioration of air quality especially in urban areas.

23. To reduce vehicle emission, the Government has taken several steps such as introducing stringent standard to control emission from motor vehicles, control of lead concentration in gasoline, encourage the use of ULG and upgrading transportation system. Lately, the use of natural gas for vehicles has been introduced as alternative fuel. The response has been very encouraging especially from fleet owners in particular taxis.

Table 1

Peninsular Malaysia: Number of Motor Vehicles
Until October, 1993

TYPE OF VEHICLES	NUMBER OF VEHICLES			PERCENTAGE
	PETROL-POWERED	DIESEL-POWERED	TOTAL	
Motorcycle	3429210	-	3429210	57.9
Taxi	11503	18823	30326	0.5
Private Car	1863076	48701	1911777	32.3
Van, Lorry and Trailer	160227	230547	390774	6.6
Bus	1496	25009	26505	0.4
Others	13011	123245	136256	2.3
Total	5478523	446325	5924848	100.0
Percentage	92.5	7.5	-	-

Source: Road Transport Department, Malaysia

1/(ROAD.WP)/MM-ar/230394

Table 2

REGISTERED MOTOR VEHICLE ACCORDING TO VEHICLE TYPE AND ENGINE POWER
(PENINSULAR MALAYSIA)

MONTH : JANUARY - DECEMBER 1992

VEHICLE	< 1000		1001 - 1500		1501 - 2000		2001 - 2500		2501 - 3000		3001 - 3500		3501 - 4000		4001 - 4500		4501 - 5000		5000		Total		Grand
TYPE	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	Total
MOTORCAR	2764	154	72745	10	20997	20	3389	274	1882	157	212	22	66	8	23	23	12	1	18	4	102108	673	102781
TAXI/HIRED CAR	0	0	604	15	128	525	77	594	22	24	0	0	3	0	0	0	0	0	0	0	874	1158	1992
HIRE AND DRIVE	3	4	297	1	161	8	25	10	6	36	0	0	0	0	0	1	0	0	0	1	492	41	533
VAN	814	27	7143	107	2568	186	318	1133	96	276	6	41	5	45	1	11	0	0	0	124	10951	2450	13401
LORRY	88	1876	838	183	1052	270	78	3347	146	4665	36	676	21	247	7	23	0	16	2	3220	2268	14523	16791
TANKER	3	165	0	1	0	3	0	0	0	0	0	33	0	0	0	1	0	1	0	854	3	1048	1051
SPECIALISED	53	3465	58	89	64	341	162	942	49	542	57	958	53	572	9	236	3	86	5	2750	513	9781	10294
OTHERS NON SALOON	93	19	37	7	106	10	113	535	113	467	1	22	9	9	14	73	0	1	0	6	486	1149	1635
BUS	0	0	0	1	5	8	2	33	3	36	0	128	3	275	1	46	0	61	6	1262	20	1840	1860
TOTAL	3818	5700	81722	414	25081	1171	4164	6868	2317	6683	312	1880	160	1156	55	414	15	156	31	8221	117675	32663	150338

* Source : Road Transport Department, Malaysia

Table 3

FUEL COMSUMPTION FOR VEHICLE IN MALAYSIA
1993

NO	TYPE OF GASOLINE	RON	OVERALL TOTAL (MILLION LIT.)
1.	PREMIUM-UNLEADED	97	1330
2.	PREMIUM-LEADED	97	3100
3.	INTERMEDIATE-LG	92	130
4.	REGULAR-LG	85	100
5.	DIESEL	-	2540
			7200

Note:

Total no. of vehicles is only indicative as of 1993 and will not reflect the actual no. on the road

I:(FUEL.WK1)/MM-er/230394

Table 4

PREMIUM MOGAS Date: 1 February 1993

NO.	PROPERTIES	UNIT	MIN.	MAX.	METHOD
1.	Density @ 15°C	Kg/L	Report		ASTM D 1298
2.	Colour		Orange		Visual
3.	Vapour Pressure (Reid)	kPa		70	ASTM D 323
4.	Distillation				ASTM D 86
	Initial boiling point	°C		40	
	10% evaporated	°C	75	74	
	50% evaporated	°C		115	
	90% evaporated	°C		180	
	Final boiling point	°C		215	
	Residue	Vol.%		2.0	
5.	Lead	g/L		0.15	ASTM D 3341
6.	Total Sulphur	wt%		0.15	ASTM D 3120
7.	RON		97.0		ASTM D 2699
8.	Copper Corrosion (3 hours, 50°C)			1	ASTM D 130
9.	Existent Gum	mg/100ml		4	ASTM D 381

1/(MOGAS)/MM-ar/230394

Table 5

HIGH SPEED DIESEL Date: 01 February 1993

No.1	PROPERTIES	UNIT	MIN.	MAX.	METHOD
1.	Density @ 15°C	kg/L	Report		ASTM D1298
2.	Pour Point	°C		+ 15	ASTM D97
3.	Flash Point	°C	60		ASTM D93
4.	Distillation @ 90% recovered	°C		370	ASTM D86
5.	Kinematic Viscosity @ 40°C	cSt	1.6	5.8	ASTM D445
6.	Ash	Wt.%		0.01	ASTM D482
7.	Total Sulphur	Wt.%		0.50	ASTM D4294
8.	Water by Distillation	Wt.%		0.05	ASTM D95
9.	Sediment by Extraction	Wt.%		0.01	ASTM D473
10.	Conradson Carbon (10% residue) or Micro Carbon (10% residue)	Wt.%		0.10 0.10	ASTM D189 ASTM D4530
11.	Colour			2.5	ASTM D1500
12.	Cetane Index		47		ASTM D976
13.	Strong Acid Number	mg koH/g	Nil		ASTM D974
14.	Total Acid Number	mg koH/g		0.25	ASTM D974

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A

COUNTRY PAPER
PREPARED FOR EXPERT GROUP MEETING ON
CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS
AND
THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION

ORGANIZED BY

United Nations Industrial Development Organization (UNIDO)
in co-operation with Ministry of Communications
Beijing, China, P. R.
(29th - 31st March, 1994)

TITLE:

AN
INTRODUCTION TO MOTOR VEHICLE AIR POLLUTION AND FUEL QUALITY AND STANDARDS IN NEPAL.

MARCH, 1994

ABSTRACT

Automobile contributes to a great extent to air pollution. Two types of automobiles namely SI engine operated by petrol fuel and CI engine operated by diesel fuel in the country are responsible for pollutant emissions from their exhaust pipes. The degree of contribution to air pollution depends on the composition of the existing vehicle park, traffic flow, fuel quality and management activities to control it.

The paper reviews the vehicle population, present vehicle air pollution situation, studies done and findings made by some projects in Nepal with reference to the Kathmandu Valley, where most of the studies so far have been done and where lies 55% of the whole vehicle park of the country.

The initiation of setting standards for Automotive fuels in the country, the exhaust emission level standard on Nepal in comparison with some other countries have also been discussed in brief.

The standards, traffic and transport management act - 1992, policies on legislation, economic incentives also have been reviewed.

AN INTRODUCTION TO MOTOR VEHICLE AIR POLLUTION AND FUEL QUALITY AND STANDARDS IN NEPAL

BACKGROUND

Automobile became a basic necessity in today's world. It will be wrong to look upon them as a luxury item. In recent years production of cars, commercial vehicles, two wheelers and three wheelers have shown a significant upward trend. Nepal lags behind many of developing as well as developed countries yet. On the basis of number of vehicles in percentage-wise of our population, only one out of 638 persons in Nepal has a car and one out of 332 persons has a two wheeler. That means a large part of population depends on public transport such as buses, minibuses, taxi and auto ricksha. we have 12304 trucks and 6497 buses and minibuses which are inadequate for a population of our size.

If we compare the vehicle population growth in Nepal from April ,1993 to March 1994 a 1235 vehicles per months upward trend is observed. Thus in one decade in 2004, the nos will be 2,69,843 vehicles.

Table no. 1.
MOTOR VEHICLE POPULATION IN NEPAL TILL FEBRUARY, 1994.

S. NO	TYPE	NUMBERS	REMARKS
1	BUS	4445	
2	MINIBUS	2052	
3	TRUCK	12304	
4	CAR/JEEP	29902	
5	TEMPO	4527	
6	MOTORBIKE	57431	
7	TRACTOR	8203	
8	OTHERS	2806	
	TOTAL	121670	

Source: Department of Transport Management HMG/Nepal

Table no. 2.
VEHICLE TYPES BY FUEL (For reference only)

S. NO	TYPE	NUMBERS	%
1	Diesel Vehicles	3484800	29
2	Petrol Vehicles	8682200	71

The automobile related pollution in fast growing area turns into a problem of serious dimensions in the city like Kathmandu where more than 55% of the whole vehicles of the country ply in the streets, and where the road lengths are 820 km only to give the motor density of 88 vehicles per kilometer in average.

This is caused not only due to rapid rise in automobile population, but also due to the narrow roads. slow moving traffic, unfavorable driving modes, poor enforcement of traffic laws, poor emission control measure and low quality fuel used in them.

Though the country is in very initial and crucial phase to address national environmental problems, a few studies have been started with an objective to minimise the pollutants from vehicles. It was found that gaseous pollutants in all the cases are within WHO standard besides CO and TSP and PM10. Lead concentration was also found to lie within the WHO standard.

The exceeded values of suspended particulates and CO can be reduced to a great extent by proper inspection and maintenance as shown by another field test study done at Thapathali Engineering Campus, under the Kathmandu Valley Vehicular Emission Control Project (KVVECP).

Setting national standards should be a long term plan and it needs a quite good deal of works of continuous monitoring of vehicular emission, fuel quality and ambient air quality. Right now 65 HSU is declared by Environment Protection Council Steering Committee, the smoke opacity emission limit standard for diesel operated vehicles and 3% by volume of CO for Petrol operated vehicles.

Table no. 3.

EMISSION LIMIT IN SOME COUNTRIES (For reference sake)

S. NO	COUNTRY	DIESEL ENGINE SMOKE OPACITY IN HSU	PETROL ENGINE CO% BY VOLUME
1	NEPAL	65	3
2	INDIA	65 - urban 70 - Rural	a) 5-two wheeler & three wheeler of 50cc b) 4.5 > 50 cc c) 4- four wheeler
3	CHINA	68	a) 6 now (1994) b) 4.5 (1995)
4	INDONESIA	68	4.5
5	MALAYSIA	50	4.5
6	THAILAND	68	NA
7	HONGKONG	60	NA
8	PHILIPINES	NA	6
9	SIGAPORE	50	NA

PETROLEUM FUEL SUPPLY SITUATION IN NEPAL

Petroleum Fuel Demand Pattern

Petroleum fuels in Nepal are supplied by Nepal Oil Corporation (NOC) Ltd. which imports these fuels from different fuel depots of Indian Oil Corporation located near by Nepal-India border.

Most of petroleum fuels are of Indian Origin and are products of Indian Refineries. Most of the petroleum fuels which come to Kathmandu valley are products of Barauni Refinery of India. Petroleum fuels are marketed under the various names as given below :

- Petrol or MS (motor spirit)
- Diesel or HSD (high speed diesel)
- Kerosene or SKO (superior kerosene oil)
- Jet fuel or ATF (Aviation turbine fuel)
- LDO or light diesel oil
- LPG or liquified petroleum gas
- FO or fuel oil or furnace oil

Petroleum fuel consumption in Nepal over the period of 18 years has been increased by nearly five times. Given below is the table of historical consumptions and its growth.

Table no. 4
UTILISATION OF PETROLEUM PRODUCTS IN NEPAL AND KATHMANDU VALLEY

Fiscal year	MS Motor spirit (KL)	HSD Diesel (KL)	SKO Kerosene	LDO KL	AV. fuel KL	FO KL	LPG KL	Total KL	Remarks Lube KL
1974/75	10231	27111	33240	9434	9238	500	396	90160	1333
1979/80	12625	47146	37156	8344	16398	3137	657	125463	347
1984/85	18410	75922	53489	7980	24247	9263	2035	191346	771
1989/90	17934	98907	86281	-	9169	-	-	212291	-
1992/93	28335	156885	131145	300	28105	20260	-	-	-

Source : NOC

Table no. 5.
DEMAND/SALES AT VARIOUS DEPOTS

Product	Kathmandu	Amlekhgunj	Biratnagar	Bhairahawa	Nepalgunj	Dhangadhi	Total in %
Gasoline	79.04	11.54	5.93	1.85	1.16	0.45	100
Diesel	27.07	35.66	14.00	12.23	5.48	5.56	100
kerosene	48.74	21.12	16.23	9.93	2.05	1.93	100
Av. fuel	86.18	-	2.94	0.30	6.47	1.01	100

From the table no 4. of sales figure of 18 years as given above it can be seen that an average annual demand of MS, HSD, SKD, AVF and FO are increased by the growth rate of 7%, 12%, 14%, 7% and 5% respectively.

Note: fuel distributed by NOC and used in vehicles are with 87 octane rating for petrol and 42 cetane rating for diesel are in practice according to the corporation.

FUEL QUALITY CONTROL PROCEDURE

Standards for automotive fuels such as petroleum oil and diesel oil have already been fixed but Nepal Standards for 2 stroke oils has not yet been fixed. It shall be fixed during the year 1994. The copy of the available standards are attached herewith . (Appendix I, II and III)

Since Nepal is a land locked country and does not have her own refinery, petroleum products are being supplied through India. As according to the agreement made between India and Nepal, the latter is to buy the raw oil from other countries and is processed in India and India is to supply the product from any refinery which, is nearest to Nepal-India border. A semi-government organization called Nepal Oil Corporation (NOC) is an authorised agency to supply the oil in Nepal. Regarding the fuel quality control procedure, right now, NOC is practicing the Indian standards as the basic parameters required to check the quality of the fuel. Since the quality of the fuel depends upon the base material and the different parameters may vary as according to the basic raw material, the quality control is done according to the quality at the primary supplier i.e. Indian Oil Corporation which is taken as the basis of the whole procedure. The tank lorries, which are the carriers of the petroleum products throughout Nepal, are calibrated first and the fuel is transfered from the storage tank. The quality parameters of the fuel is recorded and a sealed sample of the fuel is sent along with the tank lorry to the destination in Nepal. The station or the storage station in Nepal while receiving the tank lorries shall perform the testing of the fuel and shall make confirmation with the reference sample. Similarly, the same procedure is applied by the vendors or the dispensing pumps when it is felt necessary.

Now, Nepal bureau of Standards and Metrology in good collaboration with Nepal Oil Corporation is going to undertake the programme of monitoring the fuel quality control job. However the procedure may not deviate to higher degree. The quality of the fuel being provided by the dispensing pumps shall be checked with respect to different parameters being fixed in Nepal standard. The product dispatched by IOC and NOC shall be taken as the basic reference material.

CURRENT FUEL PRICES

1.	Petroleum	-	us$	0.59	(Rs	29/lt)
2.	Diesel	-	us$	0.24	(Rs	12/lt)
3.	Two stroke oil-		us$	2.42	(Rs	120/lt)
4.	Kerosene	-	us$	0.19	(Rs	9.75/lt

LEGISLATION AND INCENTIVES

Regarding legislation and economic incentives some plan and policies and action plan have been prepared and started already in the country.

Nepal currently faces a number of serous environmental challenges. The Nepal Environmental Policy and Action Plan (NEPAP)has been prepared to address these challenges. It represents HMG's firm commitment to continuing efforts to integrate environmental concerns with development objectives. and to address environmental problems.

A number of important measures have already been taken to tackle some of these problems. The endorsement of the National Conservation Strategy in 1988 and the follow -up NPC/UNC, NCS

Implementation Project have provided a basis for much of the NEPAP work. More recently the establishment of the Environment Protection Council in October 1992 was an important step towards integrating environmental concerns into the development process. At the local level,the process of decentralisation is giving greater responsibility to village and district-level agencies and the private sector, including non-governmental organisation, to manage resources.

The NEPAP builds on these initiatives: identification of major environmental problems review of the causes and consequences of these problems and recommendation of practical policy guidelines and actions to address them. The Nepal Environmental Policy and Action Plan (NEPAP) has been prepared as part of His Majesty's Government of Nepal's continuing efforts to incorporate environmental concern into the country's development process.

A number of reports produced over the last five years on the stage of Nepal's environment have suggested methods of addressing environmental problems. HMG regards the NEPAP as a significant step forward in further defining its environmental strategy. It builds on the issues raised and actions proposed in earlier reports and aims to develop a coherent strategy to deal with Nepal's environmental problems. The NEPAP analyses the country's environmental issues in a multi-sectoral framework and sets forth a strategy for maintaining the country's natural environment, the health and safety of its population and its cultural heritage as economic development occurs.

A thirteen member multisectoral and multidisciplinary Task Force was constituted for the preparation of NEPAP. A National Steering Committee consisting HMG Secretaries from related Ministries and NGO representative members was set up under the chairmanship of the member of the National Planning Commission for Environment. The Steering committee has guided the Task Force in the preparation of NEPAP.

An earlier draft of this document was extensively discussed at a national workshop held in April 1993. The workshop was participated by members of Environment Protection Council,senior official of relevant HMG Ministries,individual experts,NGOs and representatives of various donor agencies. Revised drafts were then circulated among the above agencies and individuals for further comments and suggestions. Attempts have been made to incorporate all relevant suggestions that were received.

The NEPAP Task Force wishes to acknowledge the helpful comments received from government ministries and department,NGOs, and the donor community. Financial support for preparation of the NEPAP has been provided by the world Bank and The Ford Foundation. Coordination and management support during the preparation of this document as well as publishing costs were provided by NPC/IUCN National Conservation Strategy Implementation Project.

Fuel adulteration appears to be an issue, though to date no comprehensive studies have dealt with this. Kerosene and diesel are both subsidised, while petrol is heavily taxed. The large price differential has encouraged individuals to adulterate petrol with kerosene, leading to higher emissions and reduced engine life. The widespread use of less polluting petrol-powered vehicles has also been deterred due to the relatively high cost of fuel. Some reduction in the price differential has recently taken place, and HMG will continue to review its pricing policies in this area.

Some doubt has also been raised regarding the quality of imported petroleum products. Possible sources of contamination include poor refining,improper storage, dirty tankers that are not properly cleaned after each use and poor petrol -station storage. With a monopoly on the purchase and distribution of petroleum products, the Nepal Oil Corporation is responsible for checking its products for possible contamination and for taking steps to improve fuel quality, however, at present, there appears to be no consistent mechanism to check the quality of petroleum products. One possibility would be to assess the findings of a recent paper (USAID 1992) that recommended privatisation of the purchase and distribution of petroleum products.

In short, though HMG Nepal intends to enact a comprehensive environmental protection legislation that will place a high priority on sustainability, intergenerational equity and "polluter pays" principle, legislation with regard to automotive fuels and infrastructure have to be developed in practicable and implementable form.

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6. Automotive Hand book - 2nd edition, Bosch.s

7. Nepal Environmental Policy and Action Plan Integrating environment and development, HMG of Nepal Environment Protection Council August 1993.

This country paper has been jointly prepared by following teams

Team members :

1.	Mr. Poorna Prasad Manandhar :	Director General, Nepal Bureau of Standards & Metrology, Ministry of Industry.
2.	Mr. Hari Lal Rajbahak :	Director General, Department of Transport Management, Ministry of transport
3.	Mr. Om Bahadur Shrestha :	An Automobile Engineer and lecturer in Thapathali Engineering Campus, Tribhuvan University.

Appendix I

Nepalese National Standards for Kerosene

S. no.	Characteristics	Requirements	Method of test ref. to part of NS: 237
1	Acidity, inorganic	nil	part
2	Burning quality :		
a)	Char value, mg/kg of oil consumed, Max	20	Part: Ist
b)	Bloom on glass chimney	Not darker than grey	
3	Colour (saybolt), Min	10	Part: 9
4	Copper strip corrosion for 3 hrs. at 50°C	Not worse than No. 1	Part:
5	Distillation		
a)	Percent recovered below 200°C, Min	20	Part: 4th
b)	Final boiling point, °C Max.	300	
6	Flash point (Abel), °C, Min	35	Part: 7
7	Smoke point, mm, Min.	20	Part:
8	Total, sulphur, percent, by mass, max	0.25	Part: 10

Appendix II

Nepalese National Standards for Diesel Fuels

S. no.	Characteristics	Requirements		Method of test ref. to part of NS: 237
		HSD	LDO	
1	Acidity, inorganic	Nil	Nil	part:
2	Acidity, mg of KOH/g, Max	0.50	-	part:
3	Ash, percent by mass, Max	0.01	0.02	Part:
4	Carbon residue (Ramsbottom), % by mass Max	0.20	1.50	part:
5	Cetane number, Min	42	-	part:
6	Pour point, Max.	6°C	12°C for winter 18°C for sumer	Part:
7	Copper strip corrosion for 3 hrs. at 100°C	Not worse than No.1	Not worse than No. 2	part:
8	Distillation % recovery at 366°C, Min.	90	-	Part: 4
9	Flash point :			
a)	Abel, °C Min	38	-	Part: 7
b)	Pensky - Martens (closed) °C, Min	-	66	Part :
10	Kinematic viscosity, cs, at 38°C	2 to 7.5	2.5 to 15.7	part: 8
11	Sediment, % by mass, Max	0.05	0.10	part:
12	Total sulphur, % by mass, Max.	1.0	1.8	part:
13	Water content, % by volume, Max.	0.05	0.25	part:
14	Total sediments, mg per 100ml, Max.	1.0	-	part:

Appendix III

Nepalese National Standards for Motor gasoline (petrol)

S. no.	Characteristics	Requirements		Method of test ref. to part of NS: 237
		83 Octane	93 Octane	
1	Colour, visual	Orange	red	-
2	Copper strip corrosion for 3 hrs at 50°C	Not worse than No. 1	Not worse than No. 1	part:
3	Density at 15°C	Not limited but to be reported	Not limited but to be reported	Part: 3
4	Distillation			
a)	Iniatial boiling point	Not limited but to be reported	Not limited but to be reported	part: 4
b)	Recovary up to 70°C percent by volume, Min.	10	10	part: 4
c)	Recovary up to 125°C percent by volume, Min.	50	50	part: 4
d)	Recovary up to 180°C percent by volume, Min.	90	90	part: 4
e)	Final boiling point, Max.	215°C	215°C	part: 4
f)	Residue, percent by volumn, Max.	2	2	part: 4
5	Octane number (research method) Min.	83	93	part: ...
6	Oxidation stability in minutes, Min	360	360	part: ...
7	Residue on evaporation, mg/100ml, max	4.0	4.0	part: ...
8	Sulphur, total, % by weight, Max	0.25	0.2	part: ...
9	Lead content (as Pb), gm/l, Max	0.56	0.80	part: ...
10	Reid vapour pressure at 38°C, Kgf/cm^2, Max	0.70	0.70	part: ...

Annex 12

EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECTS ON MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION

29-31 March, 1994
Beijing, China

PAKISTAN COUNTRY REPORT

Prepared by:

ASIF S. KHAN
Director General
Pakistan Environmental
Protection Agency
Government of Pakistan

INTRODUCTION

Pakistan is a country of 120 million people. Its 90% population is concentrated on 30% area. The ambient air quality is detoriorating particularly in the urban areas due to tremendous increase of vehicles on roads. The population of vehicles, which was only 0.85 million in 1982, has increased tc 2.5 million in 1993 showing an overall increase of 194%. In the last year, under the Prime Ministers Scheme for revamping public transport, about 50,000 vehicles were imported at a concessional rate of duty in a period of 9 months. It is envisaged that with the current average growth rate, the number of vehicles will exceed to 4.5 million by the year 2000. Due to substantial price difference between gasoline and diesel oil, the diesel vehicle is a first choice of our people. Even owners of old cars get their gasoline engines replaced by second hand diesel engines which are readily available at Afghan border at a very attractive price. The vehicles fitted with such engines are one of the major sources of pollution in the urban areas. Another trend has been seen that the people in Pakistan prefer to buy reconditioned cars mostly imported from Japan and Dubai. The reconditioned car runs only for a year in better condition thereafter its emission exceeds.

STATE OF AIR QUALITY

Pakistan does not have continuous air monitoring stations as yet. However, analysis on mobile laboratories and various studies concluded by the experts revealed that in the southern part of the Country, concentration of NO_2, dust and benzo(a) pyrene exceeded acceptable values in very serious way. The measured concentrations of dust and also the carcinogenic benzo(a) pyrene approximately reached ten times the limit value. NO_2 concentrations exceeds the maximum allowable concentrations of about 3 times. Short time concentration of about 10 times the acceptable value was absorbed. CO and O_3 concentrations were also on the high side.
SO_2 level, however, was low (Attachement I). The test results of some Southern - areas showed that hydrocarbon concentrations were as much as double and NO_2 concentrations were 3 times the acceptable standards. SO_2 concentrations were found within limit. The lead concentrations in some areas were approximately 3 to 7 fold higher than the permissible limit.
The situation in central part is almost same as that of northern and southern parts of the country (Attachement II). The studies have proved that the effect of vehicular emission is 60% in degrading urban air quality.

LEGISLATION

The following legislation applies to vehicle emissions in Pakistan:

i) The Pakistan Environmental Protection Ordinance;
ii) The Pakistan Motor Vehicle Act; and

iii) The Pakistan Criminal Procedure Act.

Under the Pakistan Motor Vehicle Act, public transport vehicles are periodically examined after every six month. The Pakistan Environmental Protection Ordinance and the Pakistan Criminal Procedure Act impose penalty on polluting vehicles. Since the above legislation is quite old, the Government is now reviewing laws with a view to make it more conversant with the prevailing environmental situation.

ACTIONS TAKEN TO CONTROL VEHICLE EMISSIONS

The government of Pakistan is very much aware of the environmental issues prevailing in the country and has taken a number of steps for abating pollution including the vehicular pollution. The National Environmental Quality Standards on vehicle exhaust and noise have recently been notified by the Ministry of Environment and Urban Affairs. These standards allow smoke opacity not exceeding 40% or 2 on Ringlemann Scale. Permissible limit for CO for new car is 4.5%, while for old car it is 6%. In the last month a national campaign was launched against highly polluting vehicles. The polluters were not only charged penalty but in some of the cases their vehicles were locked up.

In Pakistan plenty of natural gas is available. A couple of years ago, the Ministry of Petroleum and Natural Resources, as a pilot project, introduced CNG in gasoline cars. The CNG operated car became so popular that the Government has now involved private sector to enhance the scope and introduce it in all the metropolitan cities at larger scale. In the second phase CNG will be used in diesel vehicles. The Government is also planning to introduce exhaust recirculation system in old vehicles. A locally made device has been tested successively in an old car. The device is quite effective for recovery of hydrocarbons from vehicle exhaust. After confirmation of further test results, the device will be made available in the market.

FUEL QUALITY

Pakistan has not established fuel quality standards as yet, but it intends to develop such standards on priority basis. For this purpose, services of a foreign consultant are being hired to carry out an in-depth study of the existing capability of domestic refineries and on that basis the consultant will recommend National Quality Standards on fuel oil. The Guidelines on fuel quality standards being prepared by the experts Group of UNIDO/UNDP would be very helpful for Pakistan in establishing its own standards.

The lead contents in gasoline were ranging from 1.5 to 2 g/litre. In compliance to the directive of the Government the refineries reduced lead content in supreme gasoline. Efforts are being made to improve octane and cut down lead contents.

CONCLUSION

The vehicles population is growing at an alarming rate, the effect of which is degradation of urban air quality. Cleaning of fuel before combustion is an excellent idea to control vehicle emission. The Guidelines for fuel quality standards, as being developed by the Expert Group of UNIDO/UNDP, would be very helpful in establishing consistent fuel quality standards in the countries of the Asia - Pacific region. Where the fuel quality standards would help keep the environment clean there apprehension exists that any price escalation of vehicle fuel will result in serious socio-economic implications. The developing countries like Pakistan whose import bill of fuel oil is already on the high side, cannot afford further price escalation.

Concentrations of polluting components in ambient air in $\mu g/m^3$

Location	Meteo	Pollutant	Average	Maximum	Minimum
Peshawar	sun/overcast	SO_2	1	72	0
	wind NW	CO	834	9280	0
	4-6 m/s	O_3	30	103	12
		NO	19	235	0
	temp	NO_2	53	363	0
	23-26°C	NO_x	80	401	17
		dust	1290	1890	789
Kohat	sunny	SO_2	3	48	0
	calm wind	CO	975	7192	0
		O_3	31	110	13
	temp	NO	10	153	1
	30-35°C	NO_2	156	659	29
		NO_x	167	684	31
		dust	1640	2670	1150
Mingora Swat	sunny	SO_2	5	226	0
	calm wind	CO	3340	5800	0
		O_3	15	100	3
	temp	NO	10	199	0
	26-30°C	NO_2	38	392	4
		NO_x	66	401	15
		dust	1630	2720	1020

Concentration of the sum of PAH (16 EPA priority pollutants) and benzo(a)pyrene in ambient air in ng/m_3.

Date	Place	Time	16 EPA PP	BaP
18-05-1993	Peshawar	08:30-10:30 am	43,9	5,4
18-05-1993	Peshawar	00:05-01:05 pm	23,5	2,0
19-05-1993	Peshawar	03:30-06:30 pm	18,2	2,5
20-05-1993	Peshawar	04:30-07:30 pm	64,8	11,3

MONTHLY REPORT : 05/93 STATION N 1 EPA-P8 ATTACHEMENT-II

INSTALLATION REFERENCE: PAKISTAN Lahore VALIDITY CRITERION 75%

Param	1	2	3	4	5	6	7	8	9	10	11	12	13	14
NAME	OZONE	SO_2	CO	NO	NO_x	DUST	METH	NMETH	W.Speed	W.dir	Hum	Temp	Baro	Solar
UNII	ppb	ppb	ppm	ppb	ppb	$\mu g/m^3$	ppm	ppm	ms^{-1}	Deg	%	$^{\circ}C$	mBars	Wm^{-2}
LO THRS	500	500	10	500	500	2500	80	80	100	360	100	100	1100	1000
HI THRS	700	700	10	800	800	3800	90	90	100	360	100	100	1100	1000
DAY														
1														
2														
3														
4														
5														
6														
7														
8	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10	...	...	0.6	1.5	12.6	353.4	...	...	0.9	169.3	28.6	30.7	981.1	408.3
11	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	29.3	4.0	1.0	2.7	22.7	200.8	3.8	0.3	0.6	27.0	14.9	30.6	986.2	680.9
13	...	...	...	...	...	...	...	...	...	...	...	...	...	...
14	29.5	3.5	2.1	30.3	55.2	396.8	6.6	0.8	0.4	93.7	17.8	33.0	986.3	759.5
15	22.8	6.8	1.7	5.4	26.5	392.8	6.5	0.6	0.8	70.7	22.4	33.1	985.3	756.5
16	29.9	6.7	1.6	5.7	23.2	292.8	6.2	0.4	0.7	85.5	25.4	32.8	982.3	755.7
17	29.3	1.4	0.9	2.8	11.6	189.1	4.8	0.2	1.6	85.9	39.4	29.0	983.6	760.2
18	37.5	4.4	1.4	2.8	17.3	155.2	5.9	0.4	1.0	93.4	37.1	28.5	986.8	760.0
19	30.5	4.8	1.6	6.7	26.6	310.7	7.9	0.5	0.6	113.0	28.2	31.5	985.6	764.5
20	36.2	8.6	2.2	10.3	32.0	299.5	8.7	0.7	0.5	108.5	25.4	32.5	985.5	760.6
21	33.0	2.2	1.0	2.9	15.7	368.1	6.2	0.3	0.4	162.8	27.2	33.8	985.8	757.7
22	20.7	5.4	1.4	5.9	22.3	587.1	7.1	0.4	0.5	176.6	25.1	35.3	986.2	753.9
23	26.8	8.8	1.6	8.9	29.1	450.1	8.2	0.6	0.3	141.0	22.8	36.4	984.1	756.2
24	27.8	8.1	1.2	4.4	20.9	387.7	6.9	0.4	0.4	169.4	21.5	36.8	980.4	753.9
25	32.9	8.4	1.2	4.1	17.9	367.0	5.7	0.3	0.5	178.7	21.8	37.9	977.7	753.0
26	29.6	7.7	1.6	8.8	23.0	536.1	6.2	0.4	0.9	128.9	22.6	36.8	980.7	755.7
27	30.7	8.1	1.7	4.4	24.3	406.3	8.4	0.6	0.3	116.1	24.1	37.2	979.4	754.3
28	25.8	3.6	1.2	7.9	20.0	408.0	7.0	0.5	0.1	4.6	33.5	35.3	976.4	752.9
29	29.5	0.4	0.8	2.3	7.5	592.6	4.8	0.2	0.1	4.5	41.2	33.1	975.5	755.5
30	24.7	...	...	2.5	11.1	469.9	3.2	0.1	0.5	12.4	49.3	29.0	978.8	759.1
31	26.2	1.4	0.7	3.1	10.5	124.9	0.4	0.0	1.3	163.0	53.8	27.8	982.0	759.6
MINIMUM	20.7	0.4	0.6	1.5	7.5	124.9	0.4	0.0	0.1	4.5	14.9	27.8	975.5	408.3
MAXIMUM	37.5	8.8	2.2	30.3	55.2	592.6	8.7	0.8	1.6	178.7	53.8	37.9	986.8	764.5
AVERAGE	29.1	5.2	1.3	6.2	21.5	364.4	6.0	0.4	0.6	111.0	29.1	33.1	982.5	735.9

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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
LAND TRANSPORTATION OFFICE
East Avenue, Quezon City

SPEECH DELIVERED

During The

EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA PACIFIC REGION

Held In

Beijing, People's Republic of China

On

March 29–31, 1994

By

JUAN A. MAGARRO, JR.
Executive Director
CESO Rank III

The quality of air that every plant, animal and human being breathe may determine the very survival of Mother Earth, our planet. During the past decade, scientists have raised the specter of global annihilation no longer from the threat of nuclear war but from the effects of industrialization. We who inhabit the Asia Pacific Rim although we belong to the Third World countries with developing or newly industrialized economies, are equally threatened as the fully industrialized nations of Europe and the Americas. Our disadvantage lies in the fact that we are less prepared to counter these effects of global industrialization than our more affluent neighbors in the North. We cannot abandon industrialization or lessen our dependence on motorization and the use of fossil fuel. We are left with limited choices.

Today, Ladies and Gentlemen, we sit down to consider our options, and the steps we have to avert this impending gloom. The Philippines, an archepelagic nation of 7,000 islands in the bossom of the Pacific Ocean and the China Sea, the problem is mainly centered in Metro Manila – a metropolis of 3 cities and 14 municipalities comprising a land area 636 sq. kilometer with a population of about 8,000,000. The density of population per square kilometer is 12,579/sq.km., its total road network is 160,560 kms. with a vehicle population of 2,102,946 and vehicle per kilometer of road density of 13.10/km. The ratio of diesel to gasoline fed motor vehicle is 6:14. An estimated 250,000 new vehicles are added every year with an annual growth rate of 15%.

Motor vehicle emissions have become great concern to the government especially in urban areas of Metro Manila. A recent study commissioned by the Asian Development Bank shows that particulate matter and lead in the air are above international acceptable levels. Such emissions come from automotive fuels gasolines and diesel, as well as from blends of gasoline and two-stroke cycle engine oils used in motorcyles.

Gasoline-fed vehicles, mostly cars and light vehicles, numbering 1,448,634 consume 37.6 thousand barrels a day of fuels in 1993 while diesel-fed vehicles, including jeepneys, AUV's, trucks, buses (mostly for public utility). cars and vans, numbering 654,312 consume 67.2 barrels a day.

This UNDP/UNIDO project "Regional Network on Control and Regulatory Measures concerning Motor Vehicle Emissions" is indeed very relevant and timely. As no man is an island, no country is fully independent of the other. NAFTA & AFTA are proofs of this reality --- the interdependence among nations, considering regional specific conditions.

The Quality of the fuels used in motor vehicles has been identified as one of the contributing factors to air pollution. Standards for such fuels have been considered lax by most environmentalists just to say the least. The demand for better better quality and cleaner fuels have mounted dramatically not only in highly industrialized countries, but also in Third World nations such as we represent in this forum.. The draft guidelines for this expert group meeting actually reflects most of our thrusts and considerations. Yes, our government and people want cleaner and better quality fuels from multinational oil companies but we have to face the cold realities of such constraints, as:

1. **SUPPLY** - The configuration and capabilities of the oil refineries as well as the accessibility to other alternative sources for supply of the better fuels,

2. **CAPACITY TO PAY** - The economics of international market prices, foreign currency fluctuations and domestic pricing regulations.

3. **COMPATIBILITY** - To user vehicles and existing infrastructure for storage, handling and distribution.

Presently, there are three oil companies in the country - PETRON, SHELL and CALTEX. The oil industry in the Philippines is heavily regulated and a sensitive sector linked to political and economic stability. Adjustments in prices of petroleum do not adjust according to current market fluctuations, and can only be done after lengthy public hearing and decision by a quasi-judicial body, the Energy Regulatory Board. Invariably, these public hearings are scenes of furious opposition from consumer groups and militant transport organizations, especially the provision for the Oil Price Stabilization Fund, which for a time served its purpose, but has now outlived its usefulness and has been the subject of mounting public criticism and scrutiny by lawmakers in Congress. Deregulation in the fuel industry is fast gaining a foothold especially with the initial privatization of the government owned refinery PETRON with the sale of 40% equity to ARAMCO last February.

As early as 1988, the Bureau of Philippine Standards and the Departments of Energy, Environment and Natural Resources, Science & Technology, and the Department of Education, Culture and Sports with the prodding of non-governmental organizations with ecological and environmental issues, have embarked on lead and sulfur phasedown program for petroleum products. Last year, the leaders of the petroleum industry representing Petron, Shell, and Caltex, sharing the government's environmental objectives of reducing the effects of exposure to lead, which existing technology utilizes as additive to upgrade the octane in gasoline, signed a Memorandum of Agreement with PRESIDENT FIDEL V. RAMOS witnessing the ceremonies, agreeing to pursue a comprehensive program of reducing the lead content of gasoline and reducing pollutants in diesel fuel. With active support from all sectors for cleaner fuel, the lead phasedown prgoram was accelerated and unleaded gasoline was made available in Metro Manila last month. Sulfur reduction in diesel fuel and oil are next in the agenda. The high sulfur content in diesel fuel is complicated by the fact that the Philippines source 80% of its crude oil requirement from the Middle East. The high demand for diesel fuel requires existing desulfurizing capabilities of the oil refineries supported by higher importations of low sulfur crude to meet present standards. Even with the on-going refinery upgrading to install desulfurizing units, the desired level may not be met soon.

A Philippine National Standards (PNS) for automotive fuel is being discussed in the technical committee of the Bureau of Philippine Standards. The Department of Energy will enforce and monitor compliance by the industry. Quality control procedures include site inspection, sampling and testing at the refineries, bulk storage points, retail outlets, and even import shipments prior to discharge. At this stage, the government has no testing laboratory of its own relying mainly on the testing laboratories of the oil companies or abroad. With the samples being tested by several laboratories and results confirmed piece meal basis, the results could indeed be subject to error.

We are actively participating in the ASEAN Conferences on uniform conventions for motor vehicle type approval which will impose strict compliance with emission standards for imported engines and reduced dependence on used engine importations to re-power the existing motor vehicle fleet. Within a year's time, the government agency engaged in regulating the registration of motor vehicles - the Land Transportation Office which yours truly represent in this meeting, with the entry of private entrepreneurs will operate a nationwide network of smoke emission testing stations in 200 locations all over the country. At this point in time. we are looking forward to cooperative assistance from our Pacific Rim neighbors for the establishment of a petroleum testing laboratory with facilities capable of testing properties required in the standards which may be set or agreed upon as a result of this meeting.

Finally, I wish to express my personal and that of my fellow delegates' appreciation for the host country - the People's Republic of China and the eternal City of Beijing for a warm welcome and pleasant stay. Good day, Ladies and Gentlemen!

JUAN A. MAGARRO, JR.
Executive Director
CESO Rank II

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

Republic of the Philippines

COUNTRY REPORT

Presented to the

EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION

Beijing, China
28-31 March 1994

by:

JUAN A. MAGARRO, JR.
Executive Director
Department of Transportation and Communications
Land Transportation Office

ZENAIDA Y. MONSADA
Chief, Energy Resources Supply Division
Department of Energy
Energy Industry Administration Bureau

HERIBERTA C. DOMINGO
Senior Transportation Development Officer
Department of Transportation and Communications
Land Transportation Office

Paper for the "EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS IN THE ASIA-PACIFIC REGION", (Beijing, China, 3/29-31/94)

INTRODUCTION

The Philippines, with the assistance of various international agencies, has been trying to address the increasing concern on the environment, identifying as many, if not all, of the causes of pollution, their interrelationships, and possible solutions, both in the short term and long term. The Department of Environment and Natural Resources (DENR), in cooperation with international agencies, is conducting meetings and workshops in connection with the Metropolitan Environment Improvement Program. With the various government agencies participating in said program, much of the contents of this report considers the output and thrusts of said program.

1.0 FUEL STANDARDS

1.1. STANDARDS FORMULATION/REVIEW

1.1.1. In General

In the Philippines, the Bureau of Product Standards (BPS) of the Department of Trade and Industry is mandated to formulate and enforce standards as well as coordinate all standardization activities in the country. Standards are drawn up by the BPS through its Technical Committees (TC's) comprising representatives from all sectors of society which will be affected by the standards.

When a TC has come up with a proposed standard or revision, reflecting a balance of various interests, such proposal is circulated to the public for comments prior to approval and promulgation by proper authorities.

1.1.2. For Petroleum Products and Lubricants

Enforcement of standards is through the Department of Energy (DOE).

The BPS TC (#12) is co-chaired by a representative of the oil manufacturers. The members are representatives from each of the oil manufacturers (Petron, Caltex and Shell), the academe, and from government - the Department of Energy (DOE), and Industrial Technology Development Institute (ITDI) of the Department of Science and Technology. Invitees to this TC include the car manufacturers, oil recyclers and very recently, oil/engine research laboratories, oil researchers/ producers. The Environmental Management Bureau (EMB) of the Department of Environment and

Natural Resources (DENR), which used to be just an invitee, has been made a permanent member.

Reviews of existing standards are undertaken every two (2) years or earlier as deemed necessary.

1.1.3. Considerations in Formulations/Reviews of Petroleum Products

When the BPS conducted its review of the standards for gasoline in 1988, and diesel and fuel oil in 1989, a lead and sulfur phasedown was programmed.

Sharing the national environmental objective that reflects the growing global awareness of the effects of exposure to lead, which existing technology utilizes, among other things, as an additive to upgrade the octane of gasoline, the leaders of the petroleum industry (Petron, Caltex and Shell) and government agencies (DENR, DOE and the Department of Education, Culture and Sports - DECS) signed a Memorandum of Agreement, in the presence of the President. The parties bound themselves to pursue a comprehensive program of reducing the lead content of gasoline with end in view of eventually totally eradicating the use of lead and introducing unleaded gasoline and substantially reducing other pollutants in the gasoline and diesel fuel production - refining process. Said MOA was attested by the Senate Committee on Environment and witnessed by the Department of Health (DOH), Department of Social Welfare and Development (DSWD), Metro Manila Authority (MMA), and the Rotary International, Philippine Jaycees, Pinagkaisahang Samahan ng Tsuper at Operators Nationwude, Inter-city Bus Operators, Soroptimist International Philippines Region, Catholic Bishops Conference of the Philippines, Philippine Medical Association, and ZONTA Club Philippines. As a result, the lead phasedown program was accelerated, and even modified to include early introduction of unleaded gasoline.

As earlier mentioned, the standards should reflect a balance of various interests. For petroleum, the standards formulation/review considers:

a.) government policies and thrusts, especially as regards the environment;

b.) product supply, e.g., the configuration of the oil refineries, the accessibility to other alternative sources of supply, and the practicability and accessibility of alternative fuels, among others;

c.) capacity to pay (economics) and the present regulations and pricing mechanism;

d.) logistics and infrastructure, i.e., compatibility to user vehicles and infrastructure for storage, handling, marketing and distribution, both existing and programmed.

1.2. PREVAILING STANDARDS

There are at present Philippine National Standard (PNS) for three grades of fuel for spark ignition engines, namely: regular, premium and unleaded premium gasolines, and for the single grade diesel fuel for combustion ignition engines. Meanwhile, the PNS for 2-stroke cycle engine oil is only for air-cooled gasoline engines.

1.2.1 Fuels for SI Engines

The prevailing standard for both the regular and premium grades of low leaded gasolines is contained in PNS 1119:1993 while that for the unleaded gasoline is PNS 1131:1994 (Annexes 1 & 2). These are actually very recent revisions or formulations to reflect the Memo of Agreement mentioned earlier.

It is noteworthy to mention that the country's gasolines have a maximum lead content of 0.15 g/l, a proposal in the guidelines. The low lead gasolines were introduced nationwide in June 1993, way ahead of the lead phasedown program. The unleaded premium gasoline (ULG) was introduced last February 14, 1994 through 30 stations in the Metro Manila area to test the market.

Lead (in g/l)

	Programmed in 1988		Actual	
	Premium	Regular	Premium	Regular
1989	.86	.60	.86	.60
1992	.6	.4	.6	.4
1993			.15	.15
1994	.4	.2	.15/.013	.15
1996	.2	.15		

A full swing nationwide introduction though, at this early, is not possible because of logistics constraints, especially considering the many islands and varying demand mix and patterns throughout the country. The benzene content of our ULG is controlled at a maximum of 5% (V/V), also consistent with the guidelines.

1.2.2. Fuel for CI Engines

In 1989, the diesel and fuel oil standards were reviewed, particularly on the sulfur levels. Because of desulfurization constraints, the sulfur level was only reduced to 0.8% from 0.9% maximum. PNS 20:1992, the prevailing standard for diesel fuel (Annex 3), also applies to diesel for industrial use, including power generators, except for gas turbines intended for electricity generation by utility firms.

1.2.3. Two-Stroke Cycle Engine Oils

PNS 236:1992 (Annex 4) sets the standard for two stroke cycle engine oil, or what is commonly called 2-T oil. This standard was developed to properly classify the minimum quality levels of motor oils for two-stroke cycle air-cooled gasoline engines. This also serves as a guide to the correct use of two-stroke cycle oils to increase margin of safety and to reduce maintenance cost. This standard does not include the specification for smokeless two-stroke cycle engine and large water-cooled two-stroke cycle outboard engine oils.

1.3. PLANNED CHANGES

1.3.1. On Fuels for SI Engines

Discussions are on-going on the possibility of mandating the phaseout of leaded gasoline by year 2000 at the latest. Some quarters would even want total phaseout by 1997, unmindful of the capabilities of the existing oil refineries to supply the product.

There are executive orders and bills being drafted to mandate the lead phasedown and phaseout. Because the current lead level for both gasoline grades is 0.15 g/l, the technical people recommend the phaseout approach rather than a phasedown, pointing out that for both technical and economic reasons, the present lead level is the optimum.

The ULG formulation, (considering the fact that the lead substitutes may be as harmful or even worse) is being seriously looked into. Of particular concern on the quality of the ULG is the level of aromatics in general and benzene in particular. Besides, as mentioned earlier, the logistics and infrastructure to support the program, the fleet mix, as well as the economics have to be taken into account, in addition to the supply availability aspect.

The country has embarked on an alcogas project in the 80's, using ethanol from sugar. This was implemented on a pilot project basis in two sugar-producing provinces. Its full implementation was not carried out because of the higher cost of the fuel blend, with alcohol or sugar commanding prices higher than gasoline. However, should the need arise, this may be resorted to.

Pilipinas Shell's new refinery is expected to be completed late this year. This is a relatively modern refinery, capable of producing unleaded gasoline, but not the later technology reformulated gasolines.

1.3.2. On Fuels for CI Engines

1.3.2.1. Diesel Fuel

DENR's Administrative Order No. 14 sets SO_2 emission levels of motor vehicles which would require diesel fuel with lower sulfur level. An executive order is being worked out to mandate the reduction of sulfur to 0.5% by weight before December 1995 and 0.05% by December 2000.

The local oil companies expressed concern. At present, the existing oil refineries are fully utilized, as far as diesel production is concerned, and while diesel demand is at 112 thousand barrels per day (MBCD), the present desulfurization capability is only 40 MBCD, although projected to increase to 84 MBCD with the commissioning of Shell's new refinery late this year. Petron has an on-going plant expansion project, including additional desulfurizing capacity, expected to be completed early 1997, with which they will be able to improve and maintain diesel quality of 0.4% by weight (max) up to year 2000. Caltex, meanwhile, noted experiences in developed countries that extraction of sulfur to the very low level of 0.05% causes removal of compounds that provide wear protection to diesel fuel injectors. Premature wear of injectors lead to poor fuel atomization which result to poor combustion and consequently smoke belching. Recent work suggesting that for many current production engines, a reduction in sulfur content from 0.3% to 0.05% has little effect on particulates.

Disposal of the huge amounts of sulfur that would build-up at the oil refineries should also be considered.

1.3.2.2. Other Fuels

The shortage in desulfurization capability is further aggravated by the high sulfur Middles East crudes which, besides being abundant and low-cost, are the optimum type of feed to produce the country's product demand slate (Annex 5).

Because of difficulties associated with the requirements for a cleaner diesel fuel, alternative fuels have been or are still being looked into.

The country had a project on cocodiesel and tested on Metro Manila buses, also in the 80's. Variations were made from the use of plain coconut oil to an esterified coco-oil at varying blends with diesel. Present studies include 100% esterified coconut oil fuel. The various blends are subjected to tests such as fuel effects on engine, durability (hours), and compression.

LPG has been recommended for use in public transport vice diesel fuel. This was not encouraged by government because of shortage of supply from local production, the difficulties in the logistics of this special petroleum product, as well as its high subsidy because of its current use as mainly household fuel. However, the Board of Investment has approved lately incentives for the importations of semi-knock down taxis fueled by LPG, for cooperatives. The resulting LPG consumption of these vehicles would replace what would have been an increase in diesel consumption.

1.3.3. On Two-Stroke Cycle Engine Oils

There has been no suggestion yet on the revision of the existing standard. The concern related to 2-T oil is the lack of knowledge of the users on quality against the perceived economy using oils from backyard recyclers. Further, most tricycle drivers regard more oil and smoke as an indication of good lubrication.

The quality improvement could result, therefore, not from the changing of the standard, but through information campaign on proper lubrication. This could even lead to the extinction of the backyard (illegal) recyclers, whose products do not meet the standards. The DOE is licensing recyclers and their products of recycling. There are existing standards for products of recycling, as encouraged by law.

2.0 MOTOR VEHICLE PARC/EMISSION CONTROL SYSTEM

2.1 COMPOSITION OF MOTOR VEHICLES BY TYPE:

In 1993, the Philippines has a total of 2,102,946 registered motorized vehicles, excluding tractors and trailers, itemized and categorized as follows:

- CARS - (Light, Medium, and Heavy) 531,240; of this total 94% is privately owned, 4% is for-hire, and only 2% accounts for government, diplomatic and exempt;

- UTILITY VEHICLES - 834,168; of this total 83% is privately owned, 14% is for-hire, and 3% is government;

- TRUCKS - 168,280; of this total 91% is privately owned, 6% is for-hire, and 3% is government;

- BUSES - 24,603; of this total 16% is privately owned, 83% is for-hire, and 1% is government; and

- MC/TC - 547,655; of this total 59% is privately owned, 39% is for-hire , and 2% is government.

As regards the classification, the greatest percentage of motorized vehicles in the country belong to the Private Sector which is 79% (or 1,665,631) of the total, followed by For-Hire which is 18% (or 385,429), and only 2.22% (47,020) for Government, .15% (3,141) for Diplomatic, and .13% (1,625) for Exempt.

2.2 MOTOR VEHICLES BY FUEL USED:

A majority of motor vehicles in the Philippines is fueled by gasoline which is 69% or 1,448,634 of the total registered, and only 31% or 654,312 motor vehicles are diesel fed, presented and itemized in Table below.

1993 MV REGISTERED BY FUEL USED

TYPE	GAS	DIESEL
CARS	500,908	30,332
UTILITY VEHS.	390,550	443,618
TRUCKS	13,930	151,350
BUSES	665	23,938
MC/TC	542,581	5,074
T O T A L	1,448,634	654,312

Details and breakdown of items 2.1 and 2.2 are shown in Annexes 6 to 15 of this report.

2.3 EMISSION CONTROL SYSTEM:

The control system for emissions from motor vehicles is specified in "Rules and Regulations for the Prevention, Control and Abatement of Air Pollution from Motor Vehicle (1979)" issued by the National Pollution Control Commission (now Environmental Management Bureau) pursuant to the provisions of Presidential Decree No. 1181.

The provisions of the "Rules and Regulations" for new vehicles have not been fully implemented. At present, new vehicles are registered without any problems.

On the other hand, the Philippines has a total of four (4) government-owned mechanized motor vehicle inspection stations (2 stations in Metro Manila and 2 stations in 2 different highly populated regions of the country), and has just purchased 25 portable smoke testing units for diesel fed motor vehicles distributed to all field district offices of the Land Transportation Office in Metro Manila.

Due to the limited number of government owned MVIS, implementation of the mechanized Motor Vehicle Inspection Stations is confined only to areas where these stations are located, to in-use motor vehicles, and to certain classes or type of motor vehicles:

a. all for-hire motor vehicles except tricycles;

b. all for-hire provincial buses whose authorized routes include Metro Manila.

c. all motor vehicles apprehended for smoke-belching by LTO law enforcers and deputized agents.

The abovementioned vehicles are required to comply with the standards before they are accepted for renewal registration.

Nondispersive infrared analyzer (NDIR) type tester is employed in the stations to measure the volumetric concentrations of CO and HC emissions at idling conditions. The standards are as follows:

CO : up to 6%

HC : up to 1200 ppm for vehicles with a 4-stroke engine; 7800 ppm for vehicles with a 2-stroke engine; and 3300 ppm for vehicles with a rotary and specialized engine.

All motor vehicles shall not emit excessive smoke, bad-smelling or harmful gases while running. It shall have an exhaust pipe which shall comply with the following requirements:

a. The exhaust pipe shall not have its opening towards the plate;

b. The exhaust pipe shall not be directed towards the passenger compartment; and

c. The exhaust pipe shall be so located that it may not cause fire to the motor vehicle itself or the cargo, or that it shall not obstruct the functions of the other systems of the vehicle, such as the breaking system or the electrical system.

With respect to the exhaust emission from the exhaust pipes of diesel-fueled motor vehicles, the black soot content shall not exceed 2.5 m-1 light absorption coeficient or 66% hartridge smoke limit or 48% in the Bosch type smoke meter. The diesel smoke shall be sampled while the accelerator is pressed and tested with diesel smoke tester.

The standard for diesel-fed vehicles under no load and fully accelerated conditions shall not be more than 48%.

3.0 FUEL CONSUMPTION

3.1 TRANSPORT SECTOR

3.1.1. Gasoline and Diesel for Land Transport

The consumption of gasolines and diesel in the land transport sector represents 30-40% of the total petroleum products consumption in the country, in the past five years. This sector is second only to the industrial/power generation sector insofar as oil consumption is concerned.

FUEL CONSUMPTION
(in thousand barrels per day)

	1989	1990	1991	1992	1993
PREMIUM GASOLINE					
- transport	24.0	25.8	22.0	24.8	28.2
- total	24.2	26.8	22.2	25.1	28.5
REGULAR GASOLINE					
- transport	9.4	9.4	8.0	8.8	9.4
- total	9.5	9.5	8.1	8.9	9.5
DIESEL					
- transport	34.8	44.9	55.4	65.5	67.2
- total	61.0	71.3	79.1	92.3	112.0
TOTAL OIL	219.2	226.9	221.7	250.4	277.9
- transport					
- volume	68.2	80.1	85.4	99.1	104.8
- % of total	31	35	38	40	38

Last year, diesel fuel accounted for 64% of the consumption within the land transport sector. Besides fuel efficiency, diesel has been attractive because it is considered as a product for the masses, and therefore, with the socialized pricing scheme adopted for petroleum products, the price of diesel, together with LPG and fuel oil, is subsidized by other products, e.g. gasoline.

3.1.2. Two-Stroke Cycle Oil

Two-stroke cycle oils (2-T oils) are commonly used for motorcycle units with no more than 250 cc engines. The oil is introduced in the engine either thru premixing with gasoline in the fuel tank or thru the automatic lube injection system.

The former national oil comapny has conducted a study on the market of this product and its characteristics. The study revealed that 90% of the two stroke engines are tricycles, a popular public transport in the residential villages and towns located far from the main roads. Potential market for 2-T oil is 2.0 to 3.0 million liters per month. The supply of 2-T oil is dominated by the oil recyclers.

Last year's reported sales for 2-T oil is about 2.0 million liters per month.

3.2. PETROLEUM PRODUCT DEMAND

There has been a supply (production) - demand imbalance in the country (Annex 16). The product mix required by the market is not the same mix coming from crude oil refining considering the types of crude available, the cost of crude and freight, and the configurations of the refineries, including storage. To optimize production over demand, the oil companies make use of linear programs to guide them in their crude slates, and whether they make or buy/sell certain products. The optimum Philippines' crude mix has been about 80% Middle East Crudes and the rest is composed of China, Australia and Far East Crudes, including the country's own indigenous production.

Thus, the country has been importing some products and exporting other products. Diesel, fuel oil and LPG are the frequently imported products, while naphtha and reformate are exported. With the accelerated low-lead program, reformates could no longer be exported, but even have to be imported, to conform with the lead requirement for the same octane rating. Low Sulfur Diesel (0.5% S) is being imported to be blended with the higher-sulfur diesels produced from the Middle East crudes. But there is an increasing demand to make available in Metro Manila only the Low Sulfur Diesel.

Because of the power crisis in the country as the supply increased faster than the demand, aggravated by the non- commisioning of the nuclear power plant and the delayed commissioning of other non-conventional energy projects due to environmental concerns, the demand for diesel substantially increased to 40% of the total oil demand. Diesel is used as fuel for the stand-by power barges and other fast track projects, as well as in generator sets.

4.0 FUELS AND LUBES PRICING

4.1. Government Regulations

Republic Act No. 6173 (RA 6173) created the Oil Industry Commission, a major function of which is to set the price of petroleum products. This function is now vested upon the Energy Regulatory Board (ERB) by virtue of Executive Order No. 172 (EO 172).

4.2. Lubricants Pricing

Because of the thousand and one ways of producing lubricants, as well as the significant number of market players, the government, through the ERB, opted not to regulate the price of lubricating oils and greases and basestocks. However, these products are still subject to the non-pricing regulations of the DOE.

4.3. Petroleum Fuels Pricing

RA 6173, the mother law on regulating the oil industry, provides that "no changes in prices may thereafter be made by the Commission without prior public notice and hearing at which any consumer of petroleum products and other parties who may be affected may appear and participate". The Commission, later replaced by the Board of Energy (BOE) and now the ERB, priced petroleum products based on cost recovery. However, to encourage the reduction of lead from 0.86 and 0.6 g/l level for premium and regular gasolines, respectively, to 0.15 g/l for both grades, the ERB calculated the oil company netback for the low lead gasolines based on the Singapore Import Parity (SIP) differential between the high lead and low lead gasolines. The same approach was adopted in setting the Unleaded Gasoline (ULG) netback in January of this year.

The present wholesale posted price of petroleum products is built up of the (1) oil company recovery (netback) which includes the landed cost of crude, duties and margin, (2) special duty, (3) specific tax, and (4) the Oil Price Stabilization Fund (OPSF). Retail prices would have the dealers' and haulers' margins added to the wholesale posted prices. Taxes, duties and OPSF affects socialized pricing. The OPSF, which is used to absorb fluctuations due to changes in the crude cost and foreign exchange rate, also varies, with cross-product subsidization. Prices of products consumed by the masses, e.g., diesel, fuel oil and LPG, are subsidized by products consumed by the more affluent members of the society, e.g., gasoline. Thus, the subsidized products may be withdrawing from the fund where the subsidizing products contribute to.

The oil industry in the Philippines is heavily regulated. Adjustments in prices of petroleum products can be made only after due notice and hearing. Price increases are usually met with strong oppositions such that the OPSF has been effectively abused, and for many, has outlived its purpose.

A Task Force on Oil Deregulation is studying the program for deregulation of the oil industry, the activities to be undertaken over what time frame, as well as the impacts of such activities, as oil affects transport, power, and all industries. Consultations with various sectors are now on- going. Many believe that deregulation of the oil industry will result in better competition, better quality fuels, better prices. However, the government is proceeding with caution because there are only three oil companies at present, such that there may not be real competition yet.

4.4. CURRENT PRICES & TAXES & DUTIES

In general, petroleum product importations are charged 20% ad valorem (CIF) tariff while crude oils are charged 10% ad val. to encourage domestic refining. An additional special duty of P1.00/liter is charged to petroleum product importations, including its crude oil equivalent. A socialized specific tax, which varies from product to product, is also collected as the finished product leaves the refinery. Total taxes and duties constitute 50 to 120% of the domestic wholesale posted price of petroleum products.

	Duty		Tax	Price	
	Ad Val.	Special	Specific	Wholesale	Pump
Premium-leaded	20	1.00	2.52	9.4296	10.00
Premium-unleaded	20	1.00	2.52	9.4296	10.00
Regular Gasoline	20	1.00	2.28	8.9466	9.50
Diesel	20	1.00	0.45	5.4266	7.00
Kerosene	20	1.00	0.50	6.4726	7.00
Avturbo	20	1.00	2.38	[illegible]	
LPG	10	1.00	0.00	5.2551	
Fuel Oil	10	1.00**	0.00	[illegible]	

4.4. INCENTIVES

Regulating the price of petroleum products have both critics and supporters. On one hand, the critics blame regulation as causing the oil companies' complacency as far as investing to upgrade or modernize their facilities are concerned. On the other hand, critics blame the government of assuring a reasonable rate of return to the regulated industry players. Whichever is true, the government is regulating to ensure a continuous and adequate supply of affordable energy. Deregulation studies are on-going, bearing in mind the impacts of the power crisis in the early 90's.

The OPSF has also provided the oil companies incentives to import diesel even at costs higher than the netbacks allowed them, by way of a recovery mechanism. However, should import costs be lower than their allowed netback, the oil companies have to contribute to the fund.

The Philippines considers the oil industry as a basic industry. Recognizing the need for expansion and modernization of the oil refining capabilities, as well as its other support facilities, new and expansion projects for petroleum products outside the National Capital Region are included in the Board of Investment's (BOI) Investment Priority Program. This entitles the project to be BOI-registered, and therefore be granted incentives, e.g., income tax holiday, additional labor deduction for labor expense, tax and duty exemptions, tax credits, employment of foreign nationals, and so on.

4.5. Government Thrusts on Pricing

The present pricing mechanism, which results in socialized pricing, has indeed caused distortions in the price of petroleum products. Before deregulation could be effected, the distortions have to be gradually corrected. As there is the OPSF to account for cross-product subsidization, its removal in a deregulated environment would have impacts on the resulting prices. A tax restructure is therefore deemed necessary. And such could even include the shift from duty on imports to a single tax on products. The tax restructure could also consider the environmental thrusts, e.g. taxing lead in gasoline, which would result in lower prices for unleaded gasoline, thus encourage its use.

5.0 QUALITY CONTROL

5.1 GOVERNMENT REGULATIONS

The oil industry in the Philippines., particularly the downstream sector, is currently heavily regulated. Prices of petroleum products with the exception of lubricants are set by the ERB. Non-pricing regulations exercised by the DOE cover registration and licensing of practically every activity in the oil business, from construction of oil refinery to sale of the product through gas stations. Moreover, clearances have to be secured prior to importations/ exportations of petroleum crudes and products, as well as for tanker chartering/ acquisition/disposition. Licenses to construct/operate facilities are renewable every year, while clearances for import, export, chartering and other activities are on a per shipment or transaction basis.

While the BPS-DTI sets/reviews petroleum products' standards, the DOE enforces same, even as these are not mandatory. With the increasing awareness of the importance of fuel quality vis-a-vis emissions/ pollution, the DENR is also closing in on the oil refiners/producers, who are also the marketers.

There are laws, rules and regulations, e.g. Batas Pambansa Bilang 33 (BP 33), as amended by Presidential Decree No. 1865 (PD 1865) that provide for penalties and charges against adulteration, shortselling, and such activities inconsistent with fair trade practices.

5.2 BPS CERTIFICATION PROCESS

The Bureau of Product Standards certifies companies that comply with national or internationally accepted standards. It affixes the "PS Quality Mark" on products manufactured by said companies, after passing rigid assessment and product testing requirements.

5.3 QUALITY CONTROL PRACTICES

The socialized pricing which results in a disparity between the prices of gasolines and kerosene/ diesel fuels encourages adulteration.

5.3.1. Tools

A "test kit" enables the government inspectors, and motorists, petroleum dealers/haulers or anybody to detect adulteration with only 25 ml of sample. Marker dyes, added to likely adulterants kerosene, diesel and regular gasoline (MR) can be detected by a few drops of extractants provided in the test kit. However, the extent of adulteration and its consequential impact on the octane rating have to be confirmed by full laboratory tests.

The use of hydrometers for spot checks is also another major practice.

Another common practice by government is the conduct of correlation studies among the oil companies and the various laboratories of government agencies as well as the accredited private laboratories.

The DOE, as part of its licensing procedure, requires a certification from the Bureau of Product Standards that the product proposed for registration/license conforms to the standards or its own guaranteed specification. For manufacturers and blenders of petroleum products, a quality control/assurance laboratory is a requirement.

5.3.2. Inspection Sites

The DOE conducts round-the-year spot inspections at refineries/ blending plants, terminals/ bulk plants/ warehouses, retail outlets/ gas stations, tankers, barges, pipelines, tank trucks and even import shipments to ensure compliance to government requirements as well as conformance to the standard, or in its absence, to guaranteed specifications of the producer/marketer.

For 1994, the DOE targets to inspect at least 1.3 times the 3,000 retail outlets nationwide. With the introduction of ULG, the source refineries or bulk plants in Metro Manila have been inspected by the DOE, and samples of the ULG were obtained and submitted for testing.

Last year, with the introduction of the low lead gasolines and the corresponding increase in oil company recovery for the low-lead gasoline (LLG) over the high-lead gasoline (HLG) a nationwide inspection and sampling was conducted by the DOE.

Besides the targeted inspection of all retail outlets, inspections are also conducted wherever there are complaints received. The inspections though may not only cover quality checks but also shortselling and overpricing.

5.3.3. Inspection and Testing Constraints

Inspection, sampling and testings are constrained by budget, and on the facilities available for testing. At present, only the oil companies have complete testing facilities for petroleum. There was a time when most of the samples were tested in the oil companies' laboratories, particularly at the National Oil Company. This practice raised the eyebrows of competitors, but there was no other recourse, because equipments and/or manpower of the government's laboratories, e.g. of ITDI (DOST), FATL (DOE), and the BPS (DTI) are inadequate. There are commercial testing laboratories, e.g. SGS, and research laboratories of universities, e.g. UP and Ateneo, but also incomplete for petroleum. So, samples obtained have to be brought to several laboratories for complete testing.

The then regulating body Energy Regulatory Board (ERB) has been approved the setting up of petroleum laboratory under the WB-ESL, however, the reorganization in the energy sector have complicated the implementation. It may even be possible that because of the reorganization, the allocation may be realigned to address other needs of the ERB. Should the laboratory project materialize, the facilities still would not be complete since the equipment requested for acquisition allocation did not include non-conventional facilities for unleaded gasoline, as ULG was not part of the program three years ago. Further, the government has not been keen on allowing new buildings to house the necessary equipment, hence, a full octane testing machine could not be acquired. The DOE is contemplating on an electronic, portable RON and MON octane analyzer.

The ULG specs requires non-conventional facilities even for the big oil companies. At the moment, we need to have our samples tested in several laboratories to have a full analysis.

6.0 LEGISLATIONS

6.1. ON THE OIL INDUSTRY

In addition to the general laws of the land, the oil industry is governed by RA 7638 and EO 172. Both laws have as the mother law RA 6173, as amended by PD 1206, PD 1573 and EO 193.

The BOI has included the oil refinery construction and tanker acquisition among its Investment Priorities Projects (IPP).

6.2. ON THE CAR MANUFACTURING INDUSTRY

Public utility buses are also listed in the BOI's IPP, but only limited to Visayas and Mindanao only.

This report was prepared and presented to the Expert Group meeting on Consideration of Automotive Fuel Quality Standards and their Effect on Motor Vehicle Emissions in the Asia-Pacific Region, held in Beijing, China, from 28-31 March 1994.

by:

JUAN A. MAGARRO, JR.
Executive Director
CESO Rank III
Department of Transportation and Communications
Land Transportation Office
Quezon City, Metro Manila
Philippines

ZENAIDA Y. MONSADA
Chief, Energy Resources Supply Division
Department of Energy
Energy Industry Administration Bureau
Makati, Metro Manila
Philippines

HERIBERTA C. DOMINGO
Senior Transportation Development Officer
Department of Transportation and Communications
Land Transportation Office
Quezon City, Metro Manila
Philippines

ANNEX 1

PNS 1119:1993
UDC

BPS

PHILIPPINE NATIONAL STANDARD

Petroleum Products - Low Lead Motor Gasoline - Specification

BUREAU OF PRODUCT STANDARDS

DEPARTMENT OF TRADE AND INDUSTRY

Foreword

This standard was prepared by the Bureau of Product Standards' Technical Committee on Petroleum Products and Lubricants (BPS/TC 12).

This standard was prepared in view of the Memorandum of Agreement (MOA) between the petroleum industry (Pilipinas Shell Petroleum Corporation, Petron Corporation, and Caltex Philippines, Inc.) and government agencies concerned (Department of Environment and Natural Resources, Department of Energy and Department of Education, Culture and Sports) signed in the presence of President Fidel V. Ramos. The MOA stipulates the urgent implementation of reduced lead content of premium gasoline from 0.6 gram per litre to 0.15 gram per litre and the lead content of regular gasoline also to the same level.

Petroleum Products - Low Lead Motor Gasoline - Specification

1 Scope

This standard specifies the requirements for low lead motor gasoline used in spark-ignition internal combustion engines. This standard does not include aviation gasoline and blends of gasoline with oxygenates, such as alcohols and ethers.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definition

For the purpose of this standard gasoline is defined as a volatile mixture of liquid hydrocarbons, generally containing small amounts of additives, suitable for use as a fuel in spark-ignition internal combustion engines.

4 Classification

Low lead motor gasoline shall be classified into two grades:

4.1 Regular - Gasoline with a minimum octane number of 81.

4.2 Premium - Gasoline with a minimum octane number of 93.

5 Requirements

Low lead motor gasoline shall conform to the requirements in Table 1.

6 Sampling

Low lead motor gasoline shall be sampled in accordance with PNS 389.

Table 1 - Chemical and Physical Requirements

Property	Limit: Regular	Limit: Premium	Method of Test
Color	Orange	Red	Visual
Copper Corrosion, 3 h at 50°C, maximum	1	1	PNS 379
Distillation:			PNS 380
Temperature, °C at:			
10 % recovered, maximum	70	70	
50 % recovered	75-121	77-121	
90 % recovered, maximum	185	185	
End point, maximum	221	221	
Residue, % volume, maximum	2.0	2.0	
Existent Gum, mg/100 mL, maximum	4	4	PNS 381
Lead Content, g/L, maximum	0.15	0.15	PNS 382 and/or PNS 383 PNS 384 PNS 385
Octane Number, Research, minimum	81	93	PNS 386
Reid Vapor Pressure, kPa at 37.8°C, maximum	85	85	PNS 387
Sulfur, % mass, maximum	0.2	0.2	PNS 614 or PNS 503 or PNS 505

References.

The following standards through reference in the text form part of this national standard. At the time of publication of this PNS, the editions indicated were valid:

PNS 379:1990. Petroleum Products - Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test - Test Method

PNS 380:1990. Petroleum Products - Method for Distillation

PNS 381:1990. Petroleum Products - Existent Gum in Fuels by Jet Evaporation - Test Method

PNS 382:1990. Petroleum Products - Lead in Gasoline, Volumetric Chromate Method - Test Method

PNS 383:1990. Petroleum Products - Lead in Gasoline(Iodine Monochloride Method) - Test Method

PNS 384:1990. Petroleum Products - Lead in Gasoline by X-ray Spectrometry - Test Method

PNS 385:1991. Petroleum Products - Total Lead in Gasoline by Non-Dispersive X-ray Fluorescence - Test Method

PNS 386:1991. Petroleum Products - Knock Character-istics of Motor Fuels by Research Method - Test Method

PNS 387:1991. Petroleum Products - Vapor Pressure of Petroleum Products (Reid Method) - Test Method

PNS 389:1989. Petroleum Products - Manual Sampling of Petroleum and Petroleum Products - Practice

PNS 505:1991. Petroleum Products - Sulfur in Petroleum Products by Non-dispersive X-Ray Fluorescence Spectroscopy - Test Method

PNS 614:1985. Petroleum Products - Sulfur in Petroleum Products (General Bomb Method) - Test Method

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PS Certification Mark

The use of the PS Certification Mark is governed by the provisions of Standards Administrative Order No. 20-3 series of 1982, Rules and Regulations Providing for the Marking of Goods by the Bureau of Product Standards and for Other Purposes. This mark on a product/container covered by a PS is an assurance by the manufacturer/producer that the product is in conformance to the requirements of the standard. Details of conditions under which a license to use the PS mark may be granted, are obtainable from the Bureau of Product Standards, Department of Trade and Industry, 361 Sen. Gil J. Puyat Avenue, Makati, Metro Manila

Bureau of Product Standard
Department of Trade and Industry

Technical Committee 12 - Petroleum Products and Lubricants

Co-Chairmen

Private Sector:

1 Whitman L. Uy Matiao
Caltex Phils., Inc.

Government:

2 Perla F. Baje
Bureau of Product Standards

Members

Academe:

3 Adelaida L. Bago
De La Salle Universit

Government Agencies:

4 Ma. Ariel S. Paraiso
Department of Energy - FATL

5 Zenaida Y. Monsada
Ricardo S. Infante*
Department of Energy - EIAB

6 Jean N. Rosete
Environmental Management Bureau

Manufacturers/Marketers:

7 Benjamin Bautista
Edgar O. Chua
Pilipinas Shell Petroleum
Corporation

8 Florello C. Galindo
Willy S. Toledo*
Petron Corporation

Technical Officer

9 Perla F. Baje
Bureau of Product Standards

* Alternate

ANNEX 2

PNS 1131:1984

BPS

PHILIPPINE NATIONAL STANDARD

Petroleum Products - Unleaded Motor Gasoline - Specification

BUREAU OF PRODUCT STANDARDS

DEPARTMENT OF TRADE AND INDUSTRY

Foreword

This Philippine National Standard Specification for Unleaded Motor Gasoline was prepared by the Bureau of Product Standards' Technical Committee on Petroleum Products and Lubricants (BPS/TC 12).

This standard was prepared in response to the government's environmental objective of eliminating pollutants to safeguard the health of our people.

In the preparation of the standard, American Society for Testing and Materials (ASTM) D-4814-91 b, Standard Specification for Automotive Spark-Ignition Engine Fuel, was considered.

Petroleum Products - Unleaded Motor Gasoline - Specification

1 Scope

This standard specifies the requirements for unleaded motor gasoline used in spark-ignition internal combustion engines. This standard does not include aviation gasoline.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definition

For the purpose of this standard, gasoline is defined as a volatile mixture of liquid hydrocarbons, generally containing small amounts of additives, suitable for use as a fuel in spark-ignition internal combustion engines.

4 Requirements

Unleaded motor gasoline shall conform to the chemical and physical requirements specified in Table 1.

5 Sampling

Unleaded motor gasoline shall be sampled in accordance with PNS 388.

Table 1 - Chemical and Physical Requirements

Property	Limit	Method of Test
Color	Green	Visual
Copper Corrosion, 3 h at 50°C, max.	1	PNS 379/ASTM D130
Distillation:		PNS 380/ASTM D86
Temperature, °C at:		
10% recovered, max.	70	
50% recovered	75-121	
90% recovered, max.	185	
End point, max.	221	
Residue, % volume, max.	2.0	
Existent gum, mg/100 mL, max.	4	PNS 381/ASTM D381
Hydrocarbons:[a]		
Alcohols (C_2 to C_4), % volume, max.[b]	10	PNS 1172/ASTM D4815
Aromatics, % volume, max.	55	PNS 1171/ASTM D4420
Benzene, % volume, max.	5	PNS 894/ASTM D3606 PNS 1171/ASTM D4420
Ethers (e.g. MTBE), % volume, max.[b]	10	PNS 1172/ASTM D4815
Lead content, g/L, max.	0.013	PNS 1173/ASTM D3116 PNS 1212/ASTM D3237 PNS 1213/ASTM D5059
Manganese (e.g. MMT) Content, mg/L, max.[b]	1.32	PNS 1208/ASTM D3831
Octane Number, Research, , min.	93	PNS 386/ASTM D2699
Sulfur, % mass, max.	0.10	PNS 502/ASTM D1266 PNS 504/ASTM D2622 PNS 505/ASTM D4294
Vapor Pressure at 37.8°C, kPa, max.	85	PNS 1209/ASTM D4953 PNS 1210/ASTM D5190 PNS 1211/ASTM D5191

a Based on certificate from production site.
The product should not contain methanol and should contain not more than 2.7% mass oxygen if it contains ether and/or alcohol.

b Required only if used as additive.

NOTES:

1 MMT is methylcyclopentadienyl manganese tricarbonyl
2 MTBE is methyl tertiary butyl ether

References:

The following standards contain provisions which, through reference in the text form part of this national standard. At the time of publication of this PNS, the editions indicated were valid:

PNS 379:1990, Petroleum Products - Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test - Test Method $\equiv$ ASTM D 130-88

PNS 380:1990, Petroleum Products - Distillation of Petroleum Products - Test Method $\equiv$ ASTM D 86-90

PNS 381:1990, Petroleum Products - Existent Gum in Fuels by Jet Evaporation - Test Method $\equiv$ ASTM D 381-86

PNS 386:1991, Petroleum Products - Knock Characteristics of Motor Fuels by the Research Method - Test Method $\equiv$ ASTM D 2699-88.

PNS 388:1989, Petroleum Products - Manual Sampling of Petroleum and Petroleum Products - Practice $\equiv$ ASTM D 4057-88

PNS 502:1989, Petroleum Products - Sulfur in Petroleum Products (Lamp Method) - Test Method $\equiv$ ASTM D 1266-91

PNS 504:1991, Petroleum Products - Sulfur in Petroleum Products by X-Ray Spectrometry - Test Method $\equiv$ ASTM D2622-87

PNS 505:1991, Petroleum Products - Sulfur in Petroleum Products by Energy Dispersive X-Ray Fluorescence Spectroscopy - Test Method $\equiv$ ASTM D 4294-90

PNS 894:1993, Petroleum Products - Benzene and Toluene in Finished Motor and Aviation Gasoline by Gas Chromatography -Test Method $\equiv$ ASTM D 3606-87

PNS 1171:1993, Petroleum Products - Aromatics in Finished Gasoline by Gas Chromatography - Test Method $\equiv$ ASTM D 4420-89

Bureau of Product Standard
Department of Trade and Industry

Technical Committee 12 - Petroleum Products and Lubricants

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Caltex Phils., Inc.

Government:

2 Perla F. Baje
Bureau of Product Standards

Members

Academe:

3 Adelaida L. Bago
De La Salle University

Government Agencies:

4 Corazon O. Villanueva
Industrial Technology Development Institute

5 Zenaida Y. Monsada
Ricardo S. Infante
Ma. Ariel S. Paraiso
Department of Energy

6 Jean N. Rosete
Environmental Management Bureau

Manufacturers/Marketers:

7 Benjamin Bautista
Allan Albino
Pilipinas Shell Petroleum Corporation

8 Willy S. Toledo
Susan Mojica
Petron Corporation

ANNEX 3

PNS 20:1992
UDC

BPS

PHILIPPINE NATIONAL STANDARD

Petroleum Products - Diesel Fuels - Specification

BUREAU OF PRODUCT STANDARDS

DEPARTMENT OF TRADE AND INDUSTRY

Foreword

This second revision of PNS 20 was prepared by the Technical Committee on Petroleum Products and Lubricants of the Bureau of Product Standards, BPS/TC 12.

This revision was undertaken to reduce the maximum sulfur content of diesel fuels from 0.9% by mass to 0.8% by mass for health and environmental reasons.

Gas turbines intended for electricity generation by utility firms are not covered by this standard.

Petroleum Products - Diesel Fuels - Specification

1 Scope

This standard specifies the requirements for diesel fuels suitable for various types of diesel engines and other similar types of engines except for gas turbines intended for electricity generation by utility firms.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purpose of this standard, diesel fuels shall be defined as refined petroleum distillates which may contain small amounts of hydrocarbon or non-hydrocarbon additives to improve ignition qualities or other characteristics, suitable for compression ignition engines and other suitable types of engines.

4 Requirements

4.1 Composition - Diesel fuels shall be hydrocarbon oils and may contain small amounts of hydrocarbons or non-hydrocarbon additives to improve ignition qualities or other characteristics.

4.2 Chemical and Physical Characteristics - Diesel fuels shall conform to the chemical and physical requirements specified in Table 1.

5 Sampling

Diesel fuels shall be sampled in accordance with PNS 388/ASTM D 4057.

6 Test Methods

Diesel fuels shall be tested in accordance with the methods specified in Table 1.

Table 1 - Chemical and Physical Requirements

Property	Limit	Test Method
Calculated Cetane Index,	45	PNS 705/ASTM D 976 or PNS 709/ASTM D 4737
or Cetane Number, min.	40	PNS 653/ASTM D 613
Carbon Residue on 10% distillation residue, %m, max.		
Conradson or	1.0	PNS 406/ASTM D 189
Ramsbottoms or	0.8	PNS 619/ASTM D 524
Micro	1.0	PNS 708/ASTM D 4530
Cloud point, or	20	PNS 706/ASTM D 2500
CFPP °C, max.	17	PNS 710/IP 309
Flash Point, Pensky-Martens, °C, min.	52	PNS 613/ASTM D 93
Sulfur, %m, max. 199[illegible] 199[illegible]	0.80 0.5	PNS 614/ASTM D 129 or PNS 505/ASTM D 4294 or PNS 503/ASTM D 1552
Viscosity, Kinematic, cst at 40°C	1.7 - 6.0	PNS 407/ASTM D 445
Water and Sediment %v, max.	0.10	PNS 618/ASTM D 1796 or PNS 707/ASTM D 2709

References

The following standards which, through reference in the text form part of this national standard. At the time of publication of this PNS, the editions indicated were valid:

PNS 388/ASTM D 4057-88, Standard Practice for Manual Sampling of Petroleum and Petroleum Products

PNS 406/ASTM D 189-88, Standard Method for Conradson Carbon Residue of Petroleum Products

PNS 407/ASTM D 445-88, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)

PNS 503/ASTM D 1552-90, Standard Test Method for Sulfur in Petroleum Products (High-Temperature Method)

PNS 505/ASTM D 4294-83, Standard Test Method for Sulfur in Petroleum Products by Non-dispersive X-ray Fluorescence Spectrometry

PNS 613/ASTM D 93-90, Standard Test Method for Flash Point by Pensky-Martens Closed Tester

PNS 614/ASTM D 129-78, Standard Test Method for Sulfur in Petroleum Products (General Bomb Method)

PNS 618/ASTM D 1796-83, Standard Test Method for Water and Sediment in Fuel Oils by the Centrifuge Method (Laboratory Procedure)

PNS 619/ASTM D 524-88, Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products

PNS 653/ASTM D 613-86, Standard Test Method for Ignition Quality of Diesel Fuels by the Cetane Method

PNS 705/ASTM D 976-80, Standard Test Method for Calculated Cetane Index of Distillate Fuels

PNS 706/ASTM D 2500-88, Standard Test Method for Cloud Point of Petroleum Oils

PNS 707/ASTM D 2709-88, Standard Test Method for Water and Sediment in Distillate Fuels by Centrifuge

PNS 708/ASTM D 4530-85, Standard Test Method for Micro Carbon Residue of Petroleum Products

PNS 709/ASTM D 4737-90, Standard Test Method for Calculated Cetane Index by Four Variables Equation

PNS 710/IP 309-83, Standard Test Method for Cold Filter Plugging Point of Distillate Fuels

Abbreviations

ASTM - American Society for Testing and Materials

IP - Institute of Petroleum

PNS - Philippine National Standard

PS Certification Mark

The use of the PS Certification Mark is governed by the provisions of Standards Administrative Order No. 20-3 series of 1982, Rules and Regulations Providing for the Marking of Goods by the Bureau of Product Standards and for Other Purposes. This mark on a product/container covered by a PS is an assurance by the manufacturer/producer that the product is in conformance to the requirements of the standard. Details of conditions under which a license to use the PS mark may be granted, are obtainable from the Bureau of Product Standards, Department of Trade and Industry, 361 Sen. Gil J. Puyat Avenue, Makati, Metro Manila

Bureau of Product Standard
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Technical Committee 12 - Petroleum Products and Lubricants

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1. Whitman L. Uy Matiao
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Government:

2. Perla F. Baje
   Bureau of Product Standards

Members:

Academe:

3. Adelaida L. Bago
   De La Salle University

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   Office of Energy Affairs

5. Zenaida Y. Monsada
   Ricardo S. Infante*
   Energy Regulatory Board

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   Industrial Technology
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7. Benjamin G. Bautista
   Pilipinas Shell Petroleum
   Corporation

8. Florello C. Galindo
   Susan A. Mojica*
   Petron Corporation

9. Job M. Marasigan
   Philippine Petroleum
   Corporation

10. Linda A. Gonzales
    Jean N. Rosete
    Environmental Management Bureau

Technical Officer:

11. Perla F. Baje
    Bureau of Product Standards

* Alternate

PNS 1172:1993, Petroleum Products - Determination of C_1 to C_4 Alcohols and MTBE in Gasoline by Gas Chromatography - Test Methods ≡ ASTM D 4815-89

PNS 1173:1993, Petroleum Products - Trace Amounts of Lead in Gasoline - Test Method ≡ ASTM D 3116-89

PNS 1208:1993, Petroleum Products - Manganese in Gasoline by Atomic Absorption Spectroscopy - Test Method ≡ ASTM D 3831-90

PNS 1209:1993, Petroleum Products - Vapor Pressure of Gasoline - Oxygenate Blends (Dry Method) - Test Method ≡ ASTM D 4953-91

PNS 1210:1993, Petroleum Products - Vapor Pressure of Petroleum Products (Automatic Method) - Test Method ≡ ASTM D 5190-91

PNS 1211:1993, Petroleum Products - Vapor Pressure of Petroleum Products (Mini Method) - Test Method ≡ ASTM D 5191-91

PNS 1212:1993, Petroleum Products - Lead in Gasoline by Atomic Absorption Spectroscopy - Test Method ≡ ASTM D 3237-90

PNS 1213:1993, Petroleum Product - Lead in Gasoline by X-ray Spectroscopy - Test Method ≡ ASTM D 5059-90

ANNEX 4

PNS 236:1992
UDC 665.7.03

BPS

PHILIPPINE NATIONAL STANDARD

Petroleum Products - Gasoline Engine Oil, Two-Stroke Cycle, Air-Cooled - Specification

BUREAU OF PRODUCT STANDARDS

DEPARTMENT OF TRADE AND INDUSTRY

Foreword

This Philippine National Standard Specification for Two-Stroke Cycle Air-Cooled Gasoline Engine Oil was prepared by the Bureau of Product Standards' Technical Committee on Petroleum Products and Lubricants, BPS/TC 12.

This standard was developed to properly classify the minimum quality levels of motor oils for two-stroke cycle air-cooled gasoline engines. This also serves as a guide to the correct use of two-stroke cycle oils to increase margin of safety and to reduce maintenance cost.

This standard does not include the specifications for smokeless two-stroke cycle engine and large water-cooled two-stroke cycle outboard engine oils.

Petroleum Products - Gasoline Engine Oil, Two-Stroke Cycle, Air-Cooled - Specification

Scope

This standard specifies the requirements for each of the three performance levels of 2T (two-stroke cycle) gasoline engine oil blended from virgin and/or re-refined basestocks conforming to PNS 104:Part 2:1992 for use in two-stroke cycle air-cooled engines.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purpose of this standard, the following definitions shall apply:

3.1 2T - A common term for two-stroke cycle.

3.2 two cycle - A conventional term for two-stroke cycle.

3.3 2T or two cycle engines - Small engines that are usually air-cooled and which are primarily used in equipment such as motorbikes, motorcycles, scooters, lawnmowers, garden tractors, portable generators, chainsaws and small outboard motors. This type of engine combines the four strokes of the Otto cycle in an internal combustion engine into only two movements - one upward and one downward. The upward movement combines the compression and intake strokes while the downward movement combines the power and exhaust strokes.

3.4 additives - Oil-soluble chemical compounds added to a lubricating oil to improve its performance characteristics.

3.5 virgin basestocks - Refined mineral oils from petroleum crudes used as raw materials for the blending of lubricating oils.

3.6 re-refined basestocks - Oils produced from any process or series of processes including but not limited to distillation, filtration, and chemical treatment that are applied to waste lubricating oil to remove physical and chemical contaminants and to restore the oil, with or without the use of additives to, more or less, the original condition.

3.7 TSC - An abbreviation for two-stroke cycle.

3.8 OEM - An abbreviation for original equipment manufacturers.

3.9 TCW - An abbreviation for Two-Cycle Water Cooled Engine.

.10 fuel-to-oil ratio - The volumetric ratio of gasoline to 2T il manually or automatically (by a lube injection system) mixed n the fuel tank of a two-cycle engine.

Classification

wo-stroke/air-cooled gasoline engine oils shall be classified as ollows:

esignation	Engine Operating	Parameters	Applications
SC - 1	No destructive pre-ignition due to deposits Prone to exhaust System blockage	Detergency Piston seizing	Mopeds Lawn Mowers Small Generators
C - 2	Prone to scuffing, pre-ignition and power loss (from combustion chamber) Moderately prone to ring sticking at high tempera-tures	Detergency Piston seizing	Motorscooters Motorcycles (operating at high power load factor) Chainsaws (up to 32:1 fuel to oil ratio)
C - 3	Moderately prone to deposit-in-duced pre-igni-tion damage Prone to high temperature ring sticking	Detergency Smoke reduct-ion, piston seizing, ring sticking, piston scuff-ing, plug fouling and port blocking	Chainsaws (>32:1 fuel to oil ratio) Motorcycles Water-cooled engines not requiring TCW quality oils

5 Requirements

5.1 The 2T engine oil shall be bright and clear in appearance. It shall not have a burnt obnoxious odor and shall conform to the requirements for two-cycle engine oils specified in Table 1.

5.2 A certification shall be provided by the additive manufacturers/suppliers stating the equivalent API TSC classification of the 2T oil. The additive supplier shall likewise indicate in the certification the limits of metallic and non-metallic additives and pertinent chemical properties that qualify the 2T oil.

6 Sampling

A representative sample of the 2T oil shall be obtained in accordance with PNS 389/ASTM D 4057.

Table 1 - Physical and Chemical Requirements

Property	Limit	Test Methods
Corrosion, Cu, 100°C 3 h, max.	1	PNS 379/ASTM D 130
Flash Point, °C, min.	200	PNS 404/ASTM D 92
Pentane Insolubles, %m, max.	0.03	PNS 409/ASTM D 893
Viscosity at 100°C, cst.		PNS 407/ASTM D 445
min.	9.3	
max.	12.4	
Viscosity Index	90 - 130	PNS 412/ASTM D 2270

NOTE - Metal content (if present) in mass percent, sulfated ash in mass percent and total base number in mg KOH/g value should be furnished by the additive supplier.

7 Test Methods

This engine oil shall be tested in accordance with the test methods specified in Table 1.

8 Marking and Labelling

The 2T engine oil shall be labelled according to the API Designation.

References

The following standards which, through reference in the text form part of this national standard. At the time of publication of this PNS, the editions indicated were valid:

PNS 104:Part 2:1992, Petroleum Products - Re-refined Oils Part 2 - Automotive Engine Oils Blended from Re-refined Basestocks - Specification

PNS 379/ASTM 130-83, Standard Test Method for Detection of Copper Corrosion form Petroleum products by Copper Strip Tarnish Test

PNS 388/ASTM D 4057-81, Standard Practice for Manual Sampling of Petroleum and Petroleum Products

PNS 404/ASTM D 92-85, Standard Test Method for Flash and Fire Points by Cleveland Open Cup

PNS 407/ASTM D 445-86, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquid (and the Calculation of Dynamic Viscosity)

PNS 409/ASTM D 893-85, Standard Test Method for Insolubles in Used Lubricating Oils

PNS 412/ASTM D 2270-86, Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C

Abbreviations

ASTM - American Society for Testing and Materials

PNS - Philippine National Standard

Bureau of Product Standards
Department of Trade and Industry

Technical Committee 12 - Petroleum Products and Lubricants

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    Union Refinery Corporation

13. Bernadette Raymundo
    Sea Oil

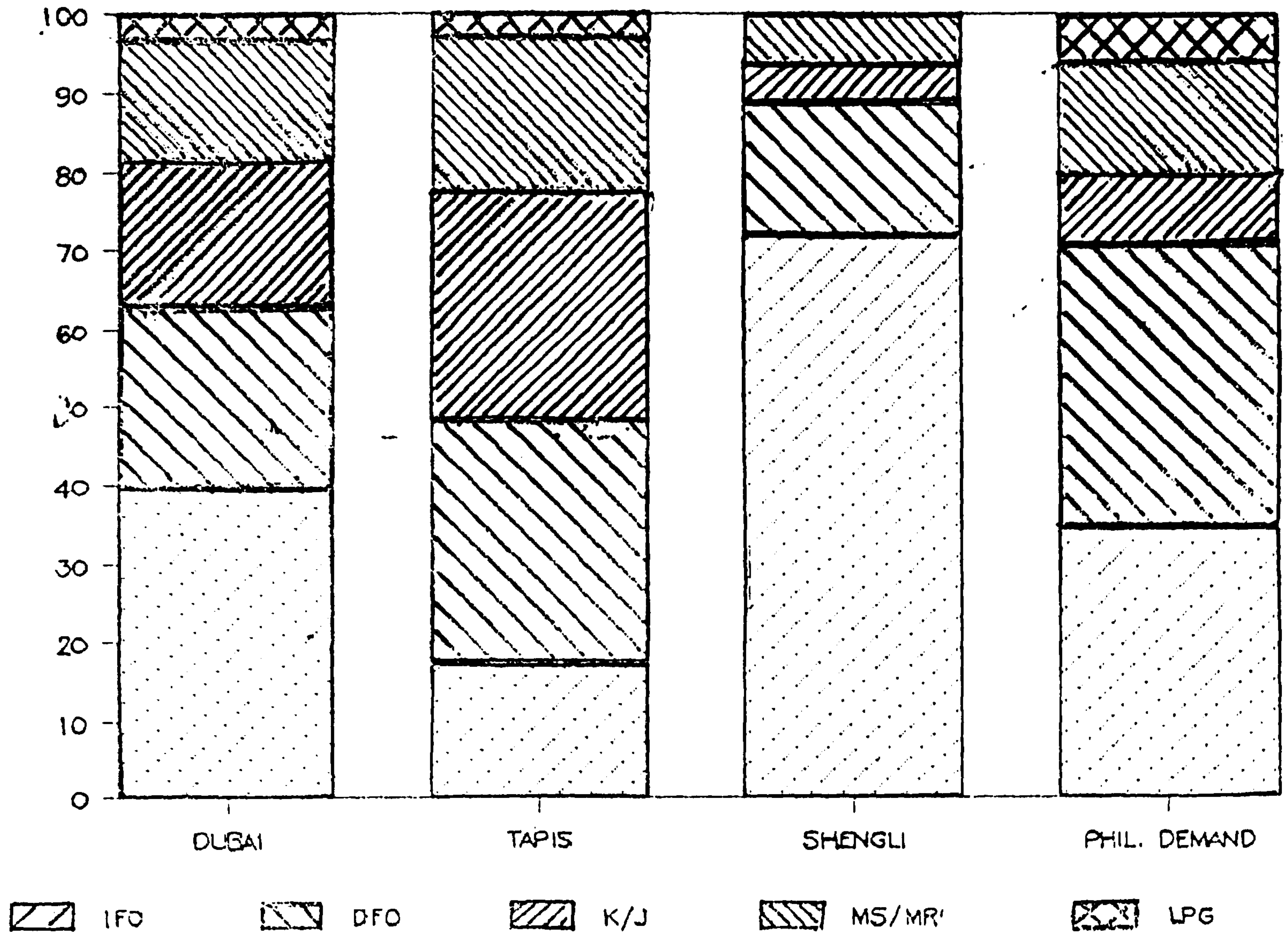
Technical Officer

14. Irene G. Cristobal
    Bureau of Product Standards

* Alternate

ANNEX 5

CRUDE COMBINATION vs. PHILIPPINE DEMAND



NUMBER OF MOTOR VEHICLES REGISTERED BY TYPE AND BY CLASSIFICATION
ANNUAL 1993

ANNEX 6

CLASSIFICATION	TYPE OF MOTOR VEHICLE						TOTAL	% SHARE
	CARS	UTILITY V	TRUCKS	BUSES	MC/TC	TRAILERS		
PRIVATE	498,126	689,406	151,207	3,948	322,944	19,449	1,685,080	79.29
GOVERNMENT	4,843	25,130	4,632	350	12,065	165	47,185	2.22
DIPLOMATIC	3,239	0	2	0	0	0	3,241	0.15
FOR HIRE	24,047	119,208	9,232	20,303	212,639	1,348	386,777	18.20
EXEMPT	985	424	207	2	7	1,207	2,832	0.13
TOTAL	531,240	834,168	165,280	24,603	547,655	22,169	2 125,115	100.00
% SHARE TO TOTAL	25.00	39.25	7.78	1.16	25.77	1.04	00.00	

NUMBER OF MOTOR VEHICLES REGISTERED BY CLASSIFICATION/BY REGION
ANNUAL 1993

ANNEX 7

REGION	PRIVATE	GOVERNMENT	DIPLOMATIC	FOR HIRE	EXEMPT	TOTAL	% SHARE
I	66,558	1,792	2	28,536	2	96,890	4.56
II	32,051	2,014	2	17,405	0	51,472	2.42
III	176,711	2,721	0	50,736	0	230,168	10.83
IV	184,643	2,693	0	54,272	0	241,608	11.37
V	30,195	2,030	4	15,763	0	47,992	2.26
VI	82,362	2,718	0	22,940	0	108,020	5.08
VII	118,476	3,185	0	27,264	0	148,925	7.01
VIII	23,629	1,816	2	7,545	0	32,992	1.55
IX	31,735	1,547	1	10,799	1	44,083	2.07
X	44,689	2,668	5	11,059	0	58,421	2.75
XI	80,847	3,182	0	20,879	0	104,908	4.94
XII	24,292	2,206	0	7,144	0	33,642	1.58
NCR	772,074	17,594	3,225	105,590	2,829	901,312	42.41
CAR	16,818	1,019	0	6,845	0	24,682	1.16
TOTAL	1,685,080	47,185	3,241	386,777	2,832	2,125,115	100.00
% SHARE	79.29	2.22	0.15	18.20	0.13	100.00	

ANNEX 5

NUMBER OF MOTOR VEHICLES REGISTERED, BY REGION, BY CLASSIFICATION AND MODE OF REGISTRATION
ANNUAL 1993

AREA	PRIVATE		GOVERNMENT		DIPLOMATIC		FOR HIRE		EXEMPT	
	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL
REGION 1	9,333	57,225	66	1,726	0	2	179	28,357	0	2
REGION II	4,071	27,980	201	1,813	0	2	3,093	14,312	0	0
REGION III	19,026	157,685	122	2,599	0	0	3,203	47,533	0	0
REGION IV	31,984	152,659	290	2,403	0	0	7,298	46,974	0	0
REGION V	3,545	26,650	103	1,927	0	4	694	15,069	0	0
N C R	118,744	653,330	2,430	15,164	768	2,457	8,797	96,793	348	2,481
C A R	567	16,251	118	901	0	0	91	6,754	0	0
LUZON(SUBTOTAL)	187,270	1,091,780	3,330	26,533	768	2,465	23,355	255,792	348	2,483
REGION VI	9,145	73,217	182	2,536	0	0	899	22,041	0	0
REGION VII	19,607	98,869	269	2,916	0	0	655	26,609	0	0
REGION VIII	2,890	20,739	56	1,760	0	2	400	7,145	0	0
VISAYAS(SUBTOTAL)	31,642	192,825	507	7,212	0	2	1,954	55,795	0	0
REGION IX	4,470	27,265	120	1,427	0	1	642	10,157	0	1
REGION X	4,475	40,214	128	2,540	0	5	317	10,742	0	0
REGION XI	9,054	71,793	427	2,755	0	0	741	20,138	0	0
REGION XII	1,792	22,500	193	2,013	0	0	35	7,109	0	0
MINDANAO(SUBTOTAL)	19,791	161,772	868	8,735	0	6	1,735	48,146	0	1
PHILIPPINES(TOTAL)	238,703	1,446,377	4,705	42,480	768	2,473	27,044	359,733	348	2,484

ANNEX 9

NUMBER OF MOTOR VEHICLES REGISTERED BY REGION BY CLASSIFICATION AND BY TYPE OF FUEL USED
ANNUAL 1993

REGION	PRIVATE		FOR-HIRE		GOVERNMENT		DIPLOMATIC		EXEMPT		T O T A L		TRAILERS	GRAND TOTAL
	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL		
I	47,590	18,360	21,124	7,391	1,330	459	2	0	2	0	70,048	26,210	632	96.890
II	17,280	14,033	14,314	3,038	1,337	671	1	1	0	0	32,932	17,743	797	51,472
III	111,293	62,354	37,774	12,828	1,879	836	0	0	0	0	150,946	76,018	3,204	230,168
IV	107,099	76,380	39,287	14,946	1,894	794	0	0	0	0	148,280	92,120	1,208	241,600
V	21,408	8,675	10,909	4,853	1,590	437	2	2	0	0	33,909	13,9[illegible]	116	47,992
VI	57,307	24,384	11,678	11,197	1,855	858	0	0	0	0	70,840	36,439	741	108,020
VII	95,068	22,088	19,570	7,592	2,430	750	0	0	0	0	117,068	30,430	1,427	148,925
VIII	18,160	5,313	4,733	2,782	1,288	525	2	0	0	0	24,183	8,620	189	32,992
IX	26,291	5,326	8,078	2,719	1,269	276	0	1	0	1	35,638	8,323	122	44,003
X	31,577	12,789	6,629	4,391	1,920	744	3	2	0	0	40,129	17,926	366	58,421
XI	58,001	22,073	12,680	7,953	2,225	913	0	0	0	0	72,906	30,939	1,063	104,908
XII	17,691	6,518	3,293	3,822	1,368	832	0	0	0	0	22,352	11,172	118	33,642
NCR	564,669	197,128	33,593	71,421	14,040	3,481	2,859	366	1,114	508	616,265	272,904	12,143	901,312
CAR	9,699	7,077	2,791	4,053	648	371	0	0	0	0	13,138	11,501	43	24,682
TOTAL	###,###	482,498	226,443	158,986	35,073	11,947	2,869	372	1,116	509	1,448,634	654,312	22,169	2,125,115

ANNEX 10

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION
ANNUAL 1993

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	TOTAL	% SHARE
PRIVATE																
L	7,300	2,482	26,999	25,309	3,300	12,488	20,333	1,468	1,943	5,118	11,962	3,103	268,687	3,733	394,225	23.40
M	1,776	665	7,361	5,736	621	2,647	3,850	241	232	774	1,425	258	72,780	831	99,197	5.89
H	79	13	688	221	16	102	145	15	0	22	37	4	3,[illegible]26	36	4,704	0.28
UV	25,444	13,087	95,977	114,433	10,499	28,377	33,509	7,331	9,704	14,887	24,356	7,546	295,[illegible]95	9,061	689,406	40.91
TB	332	166	414	462	234	397	179	90	163	347	527	39	[illegible]42	56	3,948	0.23
T	5,886	6,147	16,017	12,247	3,076	14,372	13,416	2,823	2,837	5,711	10,232	2,292	54,[illegible]69	1,682	151,207	8.97
MC/TC	25,133	8,753	26,191	25,071	12,337	23,308	45,724	11,505	16,738	17,507	31,535	10,967	66,[illegible]98	1,377	322,944	19.16
TRL	304	125	2,439	659	87	64	362	97	67	60	177	46	3,[illegible]20	16	8,023	0.48
TRM	9	16	11	8	7	448	43	4	0	4	36	4	[illegible]03	1	1,094	0.06
TRH	295	597	614	497	18	159	915	55	51	259	560	33	6,[illegible]34	25	10,332	0.61
TOTAL	66,558	32,051	176,711	184,643	30,195	82,362	118,476	23,629	31,735	44,689	80,847	24,292	772,[illegible]74	16,818	1,685,080	100.00
% SHARE	3.95	1.90	10.49	10.96	1.79	4.89	7.03	1.40	1.88	2.65	4.80	1.44	45.[illegible]2	1.00	100.00	

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION
ANNUAL 1993

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	TOTAL	% SHARE
FOR HIRE																
L	3	0	6	1	6	473	552	4	1	387	728	55	0	492	2,708	0.70
M	0	0	2	6	0	688	643	5	3	1	143	7	0	239	1,737	0.45
H	0	0	1	1	7	1	8	0	0	5	0	15	0	1	39	0.01
UV	5,446	2,080	9,615	10,641	3,665	10,244	7,225	1,956	2,449	3,633	6,532	3,376	48,561	3,785	119,208	30.82
TB	1,714	684	2,735	2,887	1,046	830	1,058	651	588	591	857	221	6,129	312	20,303	5.25
T	260	241	485	962	160	482	968	232	187	333	1,188	290	3,323	121	9,232	2.39
MC/TC	21,092	14,347	37,758	39,735	10,875	10,157	15,688	4,667	7,569	6,070	11,185	3,151	28,662	1,683	212,639	54.98
TRL	0	8	0	2	0	37	17	7	0	3	5	11	0	0	90	0.02
TRM	0	0	0	2	0	26	1	0	0	0	9	5	0	0	43	0.01
TRH	21	45	134	35	1	2	84	23	2	36	232	13	586	1	1,215	0.31
TX	0	0	0	0	3	0	1,020	0	0	0	0	0	18,329	211	19,563	5.06
TOTAL	28,536	17,405	50,736	54,272	15,763	22,940	27,264	7,545	10,799	11,059	20,879	7,144	105,590	6,845	386,777	100.00
% SHARE	7.38	4.50	13.12	14.03	4.08	5.93	7.05	1.95	2.79	2.86	5.40	1.85	27.30	1.77	100.00	

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION
ANNUAL 1993

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	TOTAL	% SHARE
GOVERNMENT																
L	115	66	162	219	92	142	191	39	60	113	148	69	2,358	55	3,829	8.11
M	20	19	52	67	16	3	58	3	1	5	5	12	672	9	942	2.00
H	0	3	1	5	30	0	4	1	0	0	0	0	28	0	72	0.15
UV	937	909	1,186	1,215	865	1,290	1,464	939	720	1,125	1,226	955	11,764	535	25,130	53.26
TB	23	23	15	14	8	14	60	16	13	8	6	18	128	4	350	0.74
T	200	250	336	310	176	430	368	183	183	314	403	354	1,016	109	4,632	9.82
MC/TC	494	738	963	858	840	834	1,035	632	568	1,099	1,350	792	1,555	307	12,065	25.57
TRL	2	1	2	4	3	0	1	3	1	0	0	4	1	0	22	0.05
TRM	0	0	0	0	0	0	0	0	0	0	1	0	3	0	4	0.01
TRH	1	5	4	1	0	5	4	0	1	4	43	2	69	0	139	0.29
TOTAL	1,792	2,014	2,721	2,693	2,030	2,718	3,185	1,816	1,547	2,668	3,182	2,206	17,594	1,019	47,185	100.00
% SHARE	3.80	4.27	5.77	5.71	4.30	5.76	6.75	3.85	3.28	5.65	6.74	4.68	37.29	2.16	100.00	

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MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION
ANNUAL 1993

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	TOTAL	% SHARE
DIPLOMATIC																
CM	0	1	0	0	0	0	0	0	0	0	0	0	28	0	29	0.89
DC	0	1	0	0	0	0	0	0	1	0	0	0	564	0	566	17.46
CC	0	0	0	0	0	0	0	0	0	0	0	0	30	0	30	0.93
DEV	1	0	0	0	4	0	0	1	0	5	0	0	2,603	0	2,614	80.65
USAF	1	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0.06
TOTAL	2	2	0	0	4	0	0	2	1	5	0	0	3,225	0	3,241	100.00
% SHARE	0.06	0.06	0.00	0.00	0.12	0.00	0.00	0.06	0.03	0.15	0.00	0.00	99.51	0.00	100.00	

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION
ANNUAL 1993

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	TOTAL	% SHARE
EXEMPT																
L	1	0	0	0	0	0	0	0	0	0	0	0	70	0	171	6.04
M	0	0	0	0	0	0	0	0	0	0	0	0	48	0	748	26.41
H	0	0	0	0	0	0	0	0	0	0	0	0	66	0	66	2.33
UV	1	0	0	0	0	0	0	0	1	0	0	0	22	0	424	14.97
TB	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0.07
T	0	0	0	0	0	0	0	0	0	0	0	0	207	0	207	7.31
MC/TC	0	0	0	0	0	0	0	0	0	0	0	0	7	0	7	0.25
TRH	0	0	0	0	0	0	0	0	0	0	0	0	1,207	0	1,207	42.62
TOTAL	2	0	0	0	0	0	0	0	1	0	0	0	2,829	0	2,832	100.00
% SHARE	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	99.89	0.00	100.00	
AND TOT	96,890	51,472	230,168	241,608	47,992	108,020	148,925	32,992	44,083	58,421	104,908	33,642	901,312	24,682	2,125,115	
% SHARE	4.56	2.42	10.83	11.37	2.26	5.08	7.01	1.55	2.07	2.75	4.94	1.58	42.41	1.16	100.00	

NUMBER OF MOTOR VEHICLES REGISTERED, BY REGION, BY TYPE OF MV AND TYPE OF FUEL USED
ANNUAL 1993

ANNEX 11

REGION	CARS		UV		TRUCKS		BUSES		MC/TC		TRAILERS	TOTAL		GRAND TOTAL
	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL	GAS	DIESEL		GAS	DIESEL	
I	9,205	90	13,958	17,870	345	6,002	15	2,054	46,525	194	632	70,048	26,210	96,890
II	3,169	81	5,873	10,2[illegible]3	225	6,413	16	857	23,649	189	797	32,932	17,743	51,472
III	34,668	604	50.976	55,802	787	16,051	81	3,083	64,434	478	3,204	150,946	76,018	230,168
IV	31,141	424	51,682	74,607	686	12,833	42	3,321	64,729	935	1,208	148,280	92,120	241,608
V	3,955	140	5,885	9,144	129	3,283	11	1,277	23,929	123	116	33,909	13,967	47,992
VI	15,660	884	18,511	21,400	2,593	12,691	15	1,226	34,061	238	741	70,840	36,439	108,020
VII	25,875	929	27,516	14,682	1,242	13,510	197	1,100	62,238	209	1,427	117,068	30,430	148,925
VIII	1,736	41	5,317	4,909	328	2,911	5	752	16,797	7	189	24,183	8,620	32,992
IX	2,226	15	8,158	4,716	390	2,867	39	725	24,875	0	122	35,638	8,323	44,083
X	6,405	25	8,929	10,716	228	6,130	26	920	24,541	135	366	40,129	17,926	58,421
XI	14,049	399	14,120	17,994	1,058	10,765	49	1,341	43,630	440	1,063	72,906	30,939	104,908
XII	3,394	129	5,445	6,432	239	2,697	10	268	13,264	1,646	118	22,352	11,172	33,642
NCR	344,191	26,198	169,675	186,267	5,675	53,340	148	6,653	96,576	446	12,143	616,265	272,904	901,312
CAR	5,234	373	4,505	8,876	55	1,857	11	361	3,333	34	43	13,138	11,501	24,682
TOTAL	500,908	30,332	390,550	443,618	13,930	151,350	665	23,938	542,581	5,074	22,169	1,448,634	654,312	2,125,115

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION AND BY TYPE OF FUEL USED
ANNUAL 1993

ANNEX 12

DENOM		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	SUB TOTAL	TOTAL
PRIVATE																	
L	G	7,296	2,460	26,948	25,283	3,258	12,477	20,326	1,462	1,940	5,109	11,950	3,063	268,637	3,733	393,942	
	D	4	22	51	26	42	11	7	6	3	9	12	40	50	0	283	394,225
	G	1,708	612	6,832	5,371	547	2,400	3,562	214	224	763	1,217	224	61,644	772	86,150	
	D	68	53	529	365	74	187	288	27	8	11	208	34	11,136	59	13,047	99,197
N	G	73	11	669	196	13	93	136	14	0	21	32	3	2,495	34	3,790	
	D	6	2	19	25	3	9	9	1	0	1	5	1	831	2	914	4,704
UV	G	13,261	5,236	50,032	50,906	5,173	16,557	24,153	4,651	7,056	8,056	12,318	4,135	159,986	3,766	365,286	
	D	12,183	[illegible]	[illegible]5,945	63,527	5,326	11,820	9,356	2,680	2,648	6,831	12,038	3,411	135,209	5,295	324,120	689,406
TB	G	4	6	67	11	7	9	27	1	27	25	19	1	92	4	300	
	D	328	[illegible]	[illegible]	451	227	388	152	89	136	322	508	38	450	52	3,648	3,948
T	G	309	202	[illegible]55	457	82	2,545	1,140	314	306	214	980	222	5,463	40	13,029	
	D	5,577	5,945	[illegible],262	11,790	2,994	11,827	12,276	2,509	2,531	5,497	9,252	2,070	49,006	1,642	138,178	151,207
MC/	G	24,939	8,753	25,990	24,875	12,328	23,166	45,724	11,504	16,738	17,389	31,485	10,043	66,352	1,350	320,636	
	D	194	0	201	196	9	142	0	1	0	118	50	924	446	27	2,308	322,944
TRL		304	125	2,439	659	87	64	362	97	67	60	177	46	3,520	16	8,023	8,023
TRM		9	16	11	8	7	448	43	4	0	4	36	4	5[illegible]3	1	1,094	1,094
TRN		295	597	614	497	18	159	915	55	51	259	560	33	6,2[illegible]4	25	10,332	10,332
TOTAL		66,558	32,051	176,711	184,643	30,195	82,362	118,476	[illegible]	31,735	44,689	80,847	24,292	772,0[illegible]4	16,818		1,685,080

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION AND BY TYPE OF FUEL USED
ANNUAL 1993

DENOM		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	SUB TOTAL	TOTAL
FOR HIRE																	
L	G	3	0	6	1	1	464	540	2	1	387	636	22	0	489	2,552	
	D	0	0	0	0	5	9	12	2	0	0	92	33	0	3	156	2,708
	G	0	0	1	6	0	28	39	1	0	1	61	1	0	13	151	
	D	0	0	1	0	0	660	604	4	3	0	82	6	0	226	1,586	1,737
H	G	0	0	1	1	5	1	4	0	0	5	0	1	0	1	19	
	D	0	0	0	0	2	0	4	0	0	0	0	14	0	0	20	39
UV	G	29	138	273	87	101	1,112	2,254	66	499	175	1,084	708	137	464	7,177	
	D	5,417	1,942	9,342	10,554	3,564	9,132	4,971	1,890	1,950	3,458	5,448	2,668	48,374	3,321	112,031	119,208
TB	G	0	2	8	26	3	2	170	2	4	1	27	1	48	7	301	
	D	1,714	682	2,727	2,861	1,043	828	888	649	584	590	830	220	6,081	305	20,002	20,303
T	G	0	11	4	170	29	6	67	1	5	7	50	10	7	6	373	
	D	260	230	481	792	131	476	901	231	182	326	1,138	280	3,316	115	8,859	9,232
MC/	G	21,092	14,163	37,481	38,996	10,768	10,065	15,479	4,661	7,569	6,053	10,822	2,550	28,662	1,683	210,044	
	D	0	184	277	739	107	92	209	6	0	17	363	601	0	0	2,595	212,639
TRL		0	8	0	2	0	37	17	7	0	3	5	11	0	0	90	90
TRM		0	0	0	2	0	26	1	0	0	0	9	5	0	0	43	43
TRH		21	45	134	35	1	2	84	23	2	36	232	13	586	1	1,215	1,215
TX	G	0	0	0	0	2	0	1,017	0	0	0	0	0	4,679	128	5,826	
	D	0	0	0	0	1	0	3	0	0	0	0	0	13,650	83	13,737	19,563
TOTAL		28,536	17,405	50,736	54,272	15,763	22,940	27,264	7,545	10,799	11,059	20,879	7,144	105,590	6,845		386,777

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION AND BY TYPE OF FUEL USED
ANNUAL 1993

DENOM		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	SUB TOTAL	TOTAL
GOVERNMENT																	
L	G	105	65	161	214	92	134	190	38	60	111	148	69	2,318	55	3,760	
	D	10	1	1	5	0	8	1	1	0	2	0	0	40	0	69	3,829
	G	18	18	49	64	14	3	58	3	1	5	5	11	642	9	900	
	D	2	1	3	3	2	0	0	0	0	0	0	1	30	0	42	942
N	G	0	2	1	5	21	0	3	1	0	0	0	0	16	0	49	
	D	0	1	0	0	9	0	1	0	0	0	0	0	12	0	23	72
UV	G	667	499	671	689	611	842	1,109	600	603	698	718	602	9,315	275	17,899	
	D	270	410	515	526	254	448	355	339	117	427	508	353	2,449	260	7,231	25,130
TB	G	11	8	6	5	1	4	0	2	8	0	3	8	8	0	64	
	D	12	15	9	9	7	10	60	14	5	8	3	10	120	4	286	350
T	G	35	12	28	59	18	42	35	12	29	7	28	7	186	9	507	
	D	165	238	308	251	[illegible]	388	333	171	154	307	[illegible]	347	830	100	4,125	4,632
MC/	G	494	733	963	858	833	830	1,035	632	568	1,099	1,323	671	1,555	300	11,894	
	D	0	5	0	0	7	4	0	0	0	0	27	121	0	7	171	12,065
TRL		2	1	2	4	3	0	1	3	1	0	0	4	1	0	22	22
TRM		0	0	0	0	0	0	0	0	0	0	1	0	3	0	4	4
TRH		1	5	4	1	0	5	4	0	1	4	43	2	69	0	139	139
TOTAL		1,792	2,014	2,721	2,693	2,030	2,718	3,185	1,816	1,547	2,668	3,182	2,206	17,594	1,019		47,185

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION AND BY TYPE OF FUEL USED
ANNUAL 1993

DENOM	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	SUB TOTAL	TOTAL
DIPLOMATIC																
CM G D	0 0	0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	27 1	0 0	27 2	29
G D	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	0 0	0 0	0 0	542 22	0 0	543 23	566
CC G D	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	28 2	0 0	28 2	30
DEV G D	1 0	0 0	0 0	0 0	2 2	0 0	0 0	1 0	0 0	3 2	0 0	0 0	2,262 341	0 0	2,269 345	2,614
USAF G D	1 0	0 0	0 0	0 0	0 0	0 0	0 0	1 0	0 0	0 0	0 0	0 0	0 0	0 0	2 0	2
TOTAL	2	2	0	0	4	0	0	2	1	5	0	0	3,225	0		3,241

MOTOR VEHICLES REGISTERED BY DENOMINATION, BY REGION AND BY TYPE OF FUEL USED
ANNUAL 1993

DENOM		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	NCR	CAR	SUB TOTAL	TOTAL
EXEMPT																	
L	G	1	0	0	0	0	0	0	0	0	0	0	0	170	0	171	
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	171
	G	0	0	0	0	0	0	0	0	0	0	0	0	701	0	701	
	D	0	0	0	0	0	0	0	0	0	0	0	0	47	0	47	748
M	G	0	0	0	0	0	0	0	0	0	0	0	0	30	0	30	
	D	0	0	0	0	0	0	0	0	0	0	0	0	36	0	36	66
UV	G	1	0	0	0	0	0	0	0	0	0	0	0	187	0	188	
	D	0	0	0	0	0	0	0	0	1	0	0	0	235	0	236	424
TB	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	D	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2
T	G	0	0	0	0	0	0	0	0	0	0	0	0	19	0	19	
	D	0	0	0	0	0	0	0	0	0	0	0	0	188	0	188	207
MC/	G	0	0	0	0	0	0	0	0	0	0	0	0	7	0	7	
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
TRN		0	0	0	0	0	0	0	0	0	0	0	0	1,207	0	1,207	1,207
TOTAL		2	0	0	0	0	0	0	0	1	0	0	0	2,829	0		2,832
GRAND TOT		96,890	51,472	230,168	241,608	47,992	108,020	148,925	32,992	44,083	58,421	104,908	33,642	901,312	24,682		2,125,115

NUMBER OF MOTOR VEHICLES REGISTERED AND REGISTRATION CASES HANDLED BY REGION
COMPARATIVE 1992 - 1993
ANNUAL 1993

ANNEX 13

REGION	MOTOR VEHICLES REGISTERED			REGISTRATION CASES HANDLED		
	1992	1993	% INC (DEC)	1992	1993	% INC (DEC)
I	86,644	96,890	11.83	109,033	130,918	20.07
II	44,493	51,472	15.69	66,987	77,975	16.40
III	208,985	230,168	10.14	256,887	292,101	13.71
IV	206,619	241,608	16.93	257,655	305,116	18.42
V	43,147	47,992	11.23	92,309	102,220	10.74
VI	97,176	108,020	11.16	167,025	243,711	45.91
VII	126,793	148,925	17.46	161,198	196,821	22.10
VIII	29,313	32,992	12.55	33,517	38,289	14.24
IX	39,891	44,083	10.51	93,844	106,566	13.56
X	54,062	58,421	8.06	67,836	69,371	2.26
XI	89,245	104,908	17.55	178,005	233,155	30.98
XII	31,470	33,642	6.90	45,149	45,527	0.84
NCR	799,754	901,312	12.70	989,591	1,115,857	12.76
CAR	21,971	24,682	12.34	26,310	29,987	13.98
TOTAL	1,879,563	2,125,115	13.06	2,545,346	2,987,614	17.38

NUMBER OF MOTOR VEHICLES REGISTERED BY CLASSIFICATION AND MODE OF REGISTRATION
ANNUAL 1993

ANNEX 14

CLASSIFICATION	MODE OF REGISTRATION	1992	1993	% INCREASE (DECREASE)
PRIVATE	NEW	204,842	238,703	16.53
	RENEWAL	1,313,925	1,446,377	10.08
GOVERNMENT	NEW	4,406	4,705	6.79
	RENEWAL	38,957	42,480	9.04
DIPLOMATIC	NEW	941	768	(18.38)
	RENEWAL	2,286	2,473	8.18
FOR HIRE	NEW	19,319	27,044	39.99
	RENEWAL	288,568	359,733	24.66
EXEMPT	NEW	768	348	(54.69)
	RENEWAL	5,551	2,484	(55.25)
TOTAL	NEW	230,276	271,568	17.93
	RENEWAL	1,649,287	1,853,547	12.38
GRAND TOTAL		1,879,563	2,125,115	13.06

ANNEX 15

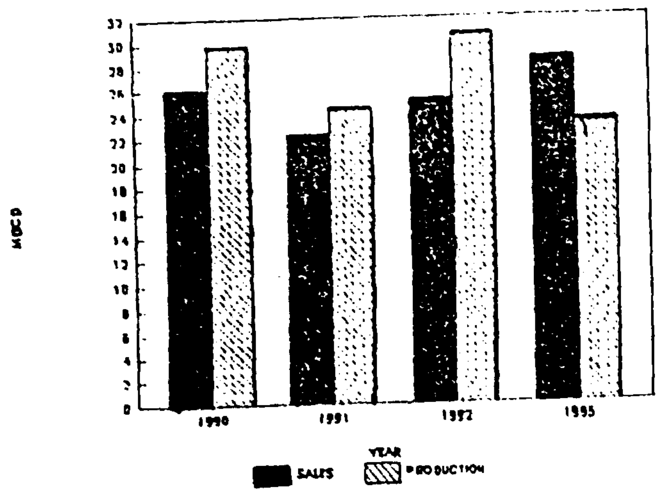
NUMBER OF MOTOR VEHICLES REGISTERED, NEW-RENEWAL, BY REGION, BY TYPE OF MV
ANNUAL, 1993

REG	CARS		UV		TRUCKS		BUSES		MC/TC		TRAILERS		T O T A L		GRAND TOTAL
	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	NEW	RENEWAL	
I	383	8,912	1,712	30,116	34	6,313	120	1,941	7,312	39,407	9	623	9,578	87,312	96,890
II	22	3,228	1,110	14,966	175	6,463	88	785	5,913	17,925	57	740	7,365	44,107	51,472
III	1,328	33,944	10,136	95,642	301	16,537	185	2,979	10,175	54,737	226	2,978	22,351	207,817	230,168
IV	1,125	30,440	23,909	102,380	336	13,183	479	2,884	13,614	52,050	109	1,099	39,572	202,036	241,608
V	71	4,024	649	14,380	83	3,329	92	1,196	3,442	20,610	5	111	4,342	43,650	47,992
VI	593	15,951	3,011	36,900	404	14,880	272	969	5,926	28,373	20	721	10,226	97,794	108,020
VII	2,408	24,396	4,691	37,507	4,058	10,694	111	1,186	8,954	53,493	309	1,118	20,531	128,394	148,925
VIII	3	1,774	388	9,838	65	3,174	96	661	2,790	14,014	4	185	3,346	29,646	32,992
IX	41	2,200	1,185	11,689	179	3,028	96	668	3,712	21,163	19	103	5,232	38,851	44,083
X	96	6,334	861	18,784	110	6,248	200	746	3,645	21,031	8	358	4,920	53,501	58,421
XI	1,076	13,372	2,357	29,757	223	11,600	118	1,272	6,392	37,678	56	1,007	10,222	94,686	104,908
XII	17	3,506	434	11,443	132	2,804	41	237	1,373	13,537	23	95	2,020	31,622	33,642
NCR	41,367	329,022	43,538	312,404	13,741	45,274	1,047	5,754	29,467	67,555	1,927	10,216	131,087	770,225	901,312
CAR	21	5,586	522	12,859	7	1,905	26	346	200	3,167	0	43	776	23,906	24,682
TOTAL	48,551	482,689	94,503	739,665	19,848	145,432	2,979	21,624	102,915	444,740	2,772	19,397	274,568	1,853,547	2,125,115

ANNEX 16

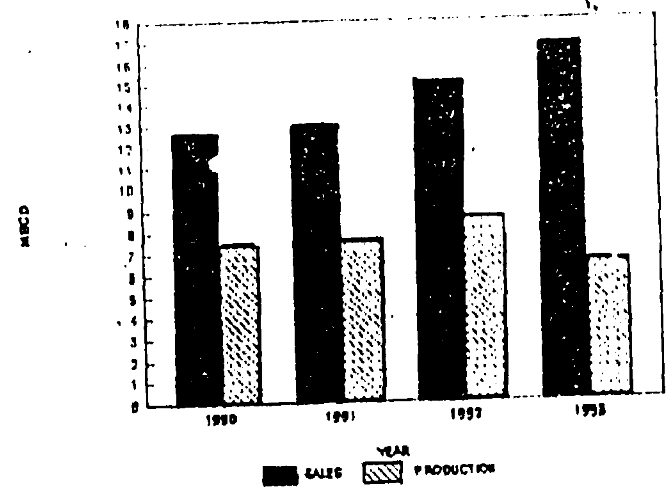
SALES VS. PRODUCTION

PREMIUM GASOLINE



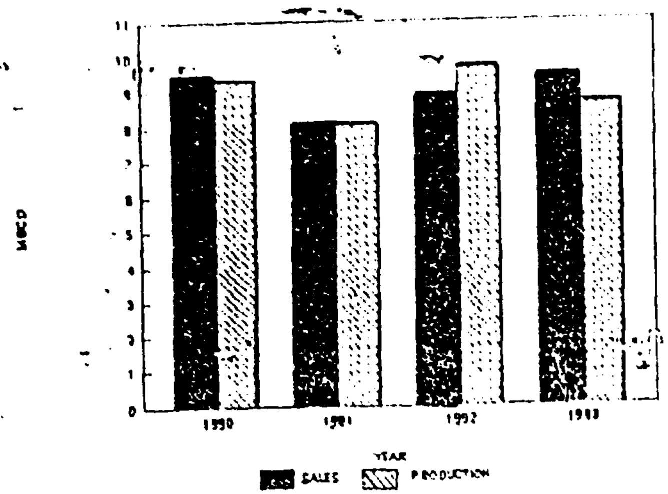
SALES VS. PRODUCTION

LPG



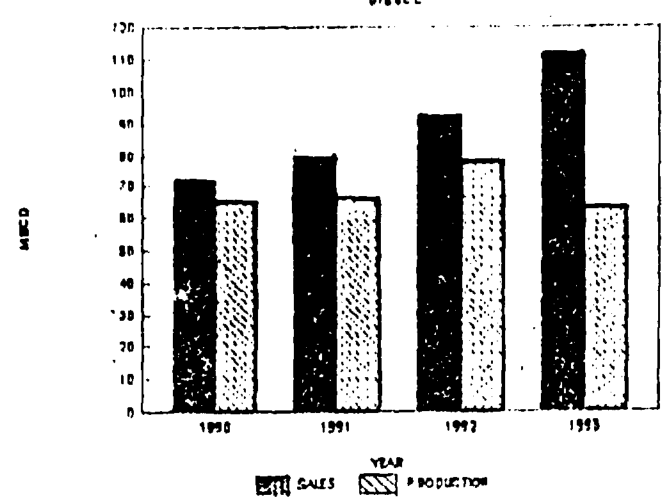
SALES VS. PRODUCTION

REGULAR GASOLINE



SALES VS. PRODUCTION

DIESEL



EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS

29 - 31 March 1994
Beijing, China

SINGAPORE COUNTRY REPORT

PREPARED BY :

Lee Kheng Seng
Executive Engineer
Strategic Planning and Research Department
Ministry of the Environment

Ng Yook Koong
Head
Vehicle Engineering Division
Registry of Vehicles

EXPERT GROUP MEETING ON CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMISSIONS
29 - 31 Mar 94, Beijing

Singapore Country Report

INTRODUCTION

1.1 Singapore consists of the main island of Singapore and some 58 islets within its territorial waters. It is approximately 140 km north of the equator and has a total land area of about 640 sq km. The population of Singapore is about 2.8 million as at end of 1992.

1.2 As a result of economic growth, Singapore's vehicle population has increased correspondingly. The vehicle population as at Dec 92 is 557,584, an increase of about 17% over the last decade. The vehicle population growth from 1983 to 1992 is shown in *Annex 1*. More roads were added annually to cope with the demand from more motor vehicles. As at 1992, there are 2,883 km of public roads comprising expressways and major arterial roads.

1.3 The vehicle population would probably have been greater had the government not discouraged the use of private motor vehicles through the various measures introduced under the Land Transport Policy. The Mass Rapid Transit rail system was one of the important infrastructure introduced in 1987 to enhance public transportation in Singapore.

1.4 Singaporeans have a relatively wide range of makes and models of vehicles for their transport needs There is no import restriction and the vehicles in Singapore are mainly imported from Europe, Japan, Korea and Malaysia. All vehicles must be registered with the Registry of Vehicles (ROV) before they can be used on the roads. For this purpose, they must comply with certain rules and regulations and meet technical requirements which are set out and administered by the ROV.

1.5 The main purpose of the rules and regulations is to ensure that all vehicles are built to acceptable international standards and are safe for use on the roads. In addition, it also requires vehicles be designed to comply with exhaust emission standards to maintain the good air quality.

PRESENT STATE OF AIR QUALITY IN SINGAPORE

2 In Singapore, as in any highly urbanised city, motor vehicle emission is a significant source of air pollution. Despite the growth in vehicle population and industrialisation, levels of pollutants in the air are generally low and well within the long-term goals of the World Health Organisation (WHO) and the primary air quality standards of the United States Environmental Protection Agency (USEPA). These standards are used as guidelines to assess the ambient air quality in Singapore.

MEASURES TO CONTROL VEHICLE EXHAUST EMISSION

3 The Ministry of the Environment (ENV) and the ROV work closely to control vehicle exhaust emissions in Singapore. The measures adopted are as follows :-

(a) Improving fuel quality;

(b) Setting of emission standards for type-approval to ensure that only low-emission vehicles can be registered for use;

(c) On the road enforcement on smoky vehicles; and

(d) Mandatory periodic inspection for in-use vehicles.

TYPES AND QUALITIES OF AUTOMOTIVE FUEL

4.1 At present, there are five oil refineries in Singapore. Their combined output has made Singapore one of the biggest oil refining centre in the world. Due to the limited size of the domestic market, the bulk of the products are exported to the region. The refining process and distribution logistics are therefore heavily dependent on the fuel qualities set by the different countries in the region.

4.2 There are only two types of automotive fuel used in Singapore, namely petrol and diesel. About 82% of the vehicle population (excluding motorcycles and scooters) run on petrol while the remaining 18% are diesel-driven vehicles. The sale of automotive fuel, however, are about 50% (by volume) for each type of fuel. All taxis in Singapore are diesel-driven whilst almost all passenger cars are petrol-driven. The distribution of vehicles by type of fuel is given in <u>Annex 2</u>.

4.3 The fuel specifications differ marginally from one oil company to another. All the specifications meet international guidelines on fuel qualities. The oil companies have to keep ENV informed of any proposed changes in the fuel specification and additives to be used.

UNLEADED PETROL

5.1 Singapore chose to reduce ambient lead concentrations by a gradual reduction of lead in petrol with the long-term goal that all petrol be unleaded. Between 1980 and 1987, the government gradually reduced the lead content in petrol from 0.84 grams per litre to 0.15 grams per litre.

5.2 The government then took steps to encourage the use of unleaded petrol in Feb 91. Unleaded petrol was promoted both through an intensive public education campaign and by restructuring the taxes on leaded and unleaded petrol that made unleaded petrol 10 cents per litre cheaper than leaded petrol. Legislation was made to require all petrol vehicles registered from 1 Jul 91 to be able to use unleaded petrol. By the end of 1993, unleaded petrol's share of the total petrol sales was 58.3%, compared to 42% when it was first launched. See Annex 3. As a result of the increasing use of unleaded petrol, ambient lead levels recorded between 1991 and 1993 were lower than those registered in 1990. The ambient lead levels monitored from 1981 to 1993 are given in Annex 4.

5.3 Two grades of unleaded petrol were made available, namely 97/98 Research Octane Number (RON) and 92 RON. The maximum lead content permissible is 0.013 grams per litre. Only one grade, i.e. 97/98 RON, was available for leaded petrol. The availability of the 97/98 RON grade of unleaded petrol had allowed all vehicles which can run on unleaded petrol to do so.

5.4 With the availability of unleaded petrol, the government then introduced stricter emission standards for petrol-driven vehicles which requires the use of catalytic converters. From 1 Jul 92, all petrol-driven vehicles (except motorcycles and scooters) imported must comply with either the United Nations Economic Commission for Europe Regulation No. 83 (UN/ECE R 83) or the Japanese emission standards (Article 31 of Safety Regulations for Road Vehicles) before they can be registered. The only way many of the new petrol-driven vehicles can comply with these standards is through the use of catalytic converters. From 1 Jul 94, Singapore will replace the UN/ECE R 83 with the Consolidated Emissions Directive (CED) currently adopted in the EC countries. The CED is more stringent than the UN/ECE R 83. The Japanese standard will remain since it is as stringent as the CED. With these standards, all petrol vehicles will have to use 3-way closed-loop catalytic converters in order to comply with the lower emission limits given the present level of technology.

5.5 In addition, from 1 Jul 92, vehicles equipped with catalytic converters are required to be fitted with fuel tanks that only accept unleaded petrol dispensers which have smaller nozzles than leaded petrol dispensers to prevent misfuelling.

OTHER CHARACTERISTICS OF PETROL

6 Aside from controlling the lead content, ENV also required that the benzene level be capped at 5.0% by volume. Other characteristics are as follows :-

Description	Typical Limits
Sulphur, % mass	0.1 max
Distillation, 90% evaporated, °C	180
Density @ 15°C, kg/l	0.75

CHARACTERISTICS OF AUTOMOTIVE DIESEL

7.1 The government has required the permissible sulphur level in diesel to be reduced from the current 0.5% to 0.3% by weight from 1 Jul 96. The move to lower sulphur level in diesel would reduce particulate emissions from diesel vehicles and also pave the way for the introduction of stricter emission standards for diesel vehicles in future. The current emission standard for diesel vehicles is the United Nations Economic Commissions for Europe Regulation Number (UN/ECE) R24.03 which essentially is a smoke emission standard. Singapore had adopted this emission standard since 1991.

7.2 Other important characteristics of automotive diesel used in Singapore are as follows :-

Description	Typical Limits
Cetane Index	48 - 52 min
Viscosity, cst @ 40°C	1.9 - 5.5
Density @ 15°C, kg/l	0.82 - 0.87
Ash content, % mass	0.01 max

USE OF 2-STROKE MOTORCYCLE ENGINE OIL

8.1 The emission of white smoke from motorcycles/scooters is of great concern to the government. Two-stroke engine motorcycles/scooters are the main culprits because of the excessive addition of engine oil to the fuel. The registration of new 2-stroke engine motorcycles/scooters have been reduced significantly when the government required all newly-imported motorcycles and scooters to comply with the U.S. Code of Federal Regulation 86.410-80 emission standard before they can be registered and used in Singapore from 1 Oct 91.

8.2 Both standard and low-smoke 2-stroke motorcycle engine oil were available in the market. There was no regulation to require the use of low-smoke engine oil. However, enforcement was carried out on motorcycles/scooters which emit excessive white smoke. The onus therefore lies with the motorcyclists to maintain their engines and to use the suitable type of engine oil.

CONCLUSION

9 Although Singapore already possesses a sound mobile source pollution control and traffic management programme, the government continues to look ahead at ways to improve. The present strategies will be reviewed periodically to keep abreast with world developments and the changing local scenario. With more vehicles on the road, fuel quality as well as engine technology would need to be improved in tandem to pre-empt any deterioration in the air quality.

Annex 1

MOTOR VEHICLE POPULATION 1983 - 1992

Item	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1 CARS										
i) Private cars & station wagons	182,120	195,873	200,032	200,163	201,651	215,928	234,438	247,808	261,050	268,435
ii) Company cars & station wagons	16,992	18,248	18,105	17,558	17,868	18,959	20,010	20,361	19,679	14,451
iii) Tuition cars & station wagons	1,090	1,085	1,104	910	856	957	954	963	904	847
iv) Private hire cars & station wagons	4,168	4,159	4,030	3,314	3,081	3,140	3,135	3,343	3,665	3,879
Sub-Total	204,370	219,365	223,271	221,945	223,456	238,984	258,537	272,475	285,298	287,612
2 MOTORCYCLES										
i) Motorcycles and scooters	140,267	133,492	126,337	119,241	115,476	116,476	119,897	121,338	121,164	115,339
Sub-Total	140,267	133,492	126,337	119,241	115,476	116,476	119,897	121,338	121,164	115,339
3 BUSES										
i) Omnibuses	3,287	3,354	3,597	3,530	3,482	3,410	3,304	3,220	3,145	3,211
ii) School buses	2,733	2,645	2,573	2,427	2,345	2,207	2,047	2,011	1,959	1,922
iii) Private buses	866	1,062	1,232	1,271	1,354	1,475	1,615	1,796	1,916	1,985
iv) Private hire buses	616	687	779	862	944	1,039	1,174	1,208	1,234	1,259
v) Excursion buses	338	356	356	383	458	657	855	1,063	1,088	1,127
Sub-Total	7,840	8,104	8,537	8,473	8,583	8,788	8,995	9,298	9,342	9,504
4 TAXIS										
i) Public taxis	10,668	11,058	10,938	10,677	10,552	10,473	10,652	12,239	12,705	13,445
ii) School taxis	5	4	3	0	0	0	0	0	0	0
Sub-Total	10,673	11,062	10,941	10,677	10,552	10,473	10,652	12,239	12,705	13,445
5 GOODS AND OTHER VEHICLES										
i) Goods-cum-passenger Vehicles	8,757	8,959	8,781	8,634	8,562	8,525	8,468	8,344	8,202	7,780
ii) Light Goods Vehicles	59,208	59,940	57,915	55,442	54,211	53,933	53,8[illegible]5	53,065	52,272	50,959
iii) Heavy Goods Vehicles	33,198	38,436	39,298	38,241	38,756	43,183	48,491	52,941	56,573	59,410
iv) Others	4,061	4,042	3,711	3,445	3,519	2,940	2,989	3,294	3,755	3,860
Sub-Total	105,224	111,377	109,705	105,762	105,048	108,581	113,773	117,644	120,802	122,009
6 TAX EXEMPTED VEHICLES										
i) Cars and station wagons	1,890	1,913	2,038	1,935	2,112	1,957	1,969	2,042	2,113	1,767
ii) Motorcycles and scooters	1,302	1,201	1,227	1,146	1,068	1,094	1,099	1,187	1,246	1,193
iii) Buses	164	179	180	165	150	136	131	150	136	154
iv) Goods Vehicles	1,370	1,296	1,152	1,112	1,114	1,202	1,156	1,186	1,162	1,186
vi) Others	3,188	3,333	3,372	3,203	3,565	4,117	4,328	4,793	5,336	5,375
Sub-Total	7,914	7,922	7,969	7,561	8,009	8,506	8,683	9,358	9,993	9,675
ALL MOTOR VEHICLES (TOTAL)	**476,288**	**491,322**	**486,760**	**473,659**	**471,124**	**491,808**	**520,537**	**542,352**	**559,304**	**557,584**

Source : ROV Annual Report 1992

MOTOR VEHICLES BY TYPE OF FUEL USED 1983 - 1992

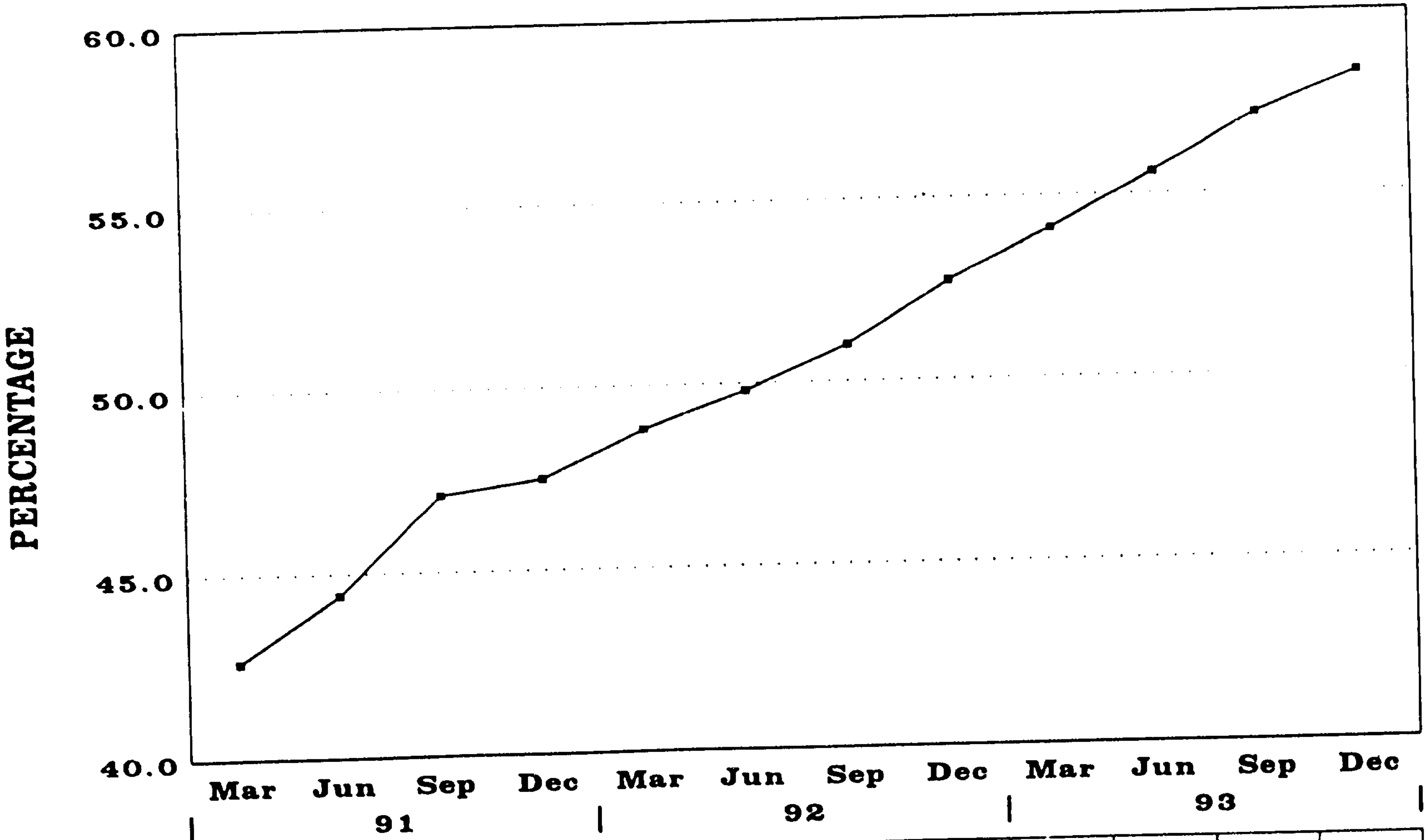
YEAR	CARS PETROL	CARS DIESEL	BUSES PETROL	BUSES DIESEL	GOODS & OTHER VEHICLES PETROL	GOODS & OTHER VEHICLES DIESEL
1983	204,365	5	671	7,169	67,260	37,964
1984	219,362	3	819	7,285	70,117	41,260
1985	223,269	2	948	7,589	68,552	41,153
1986	221,943	2	996	7,477	66,222	39,540
1987	223,454	2	1,060	7,523	65,447	39,601
1988	238,980	4	1,159	7,629	66,346	42,235
1989	258,535	2	1,252	7,743	67,549	46,224
1990	272,474	1	1,350	7,948	67,872	49,772
1991	285,294	4	1,398	7,944	67,952	52,850
1992	287,608	4	1,419	8,085	66,440	55,569

Note : Exclude motorcycles, taxis and tax exempted vehicles

Source : ROV Annual Report 1992

SALE OF UNLEADED PETROL
(1991-1993)

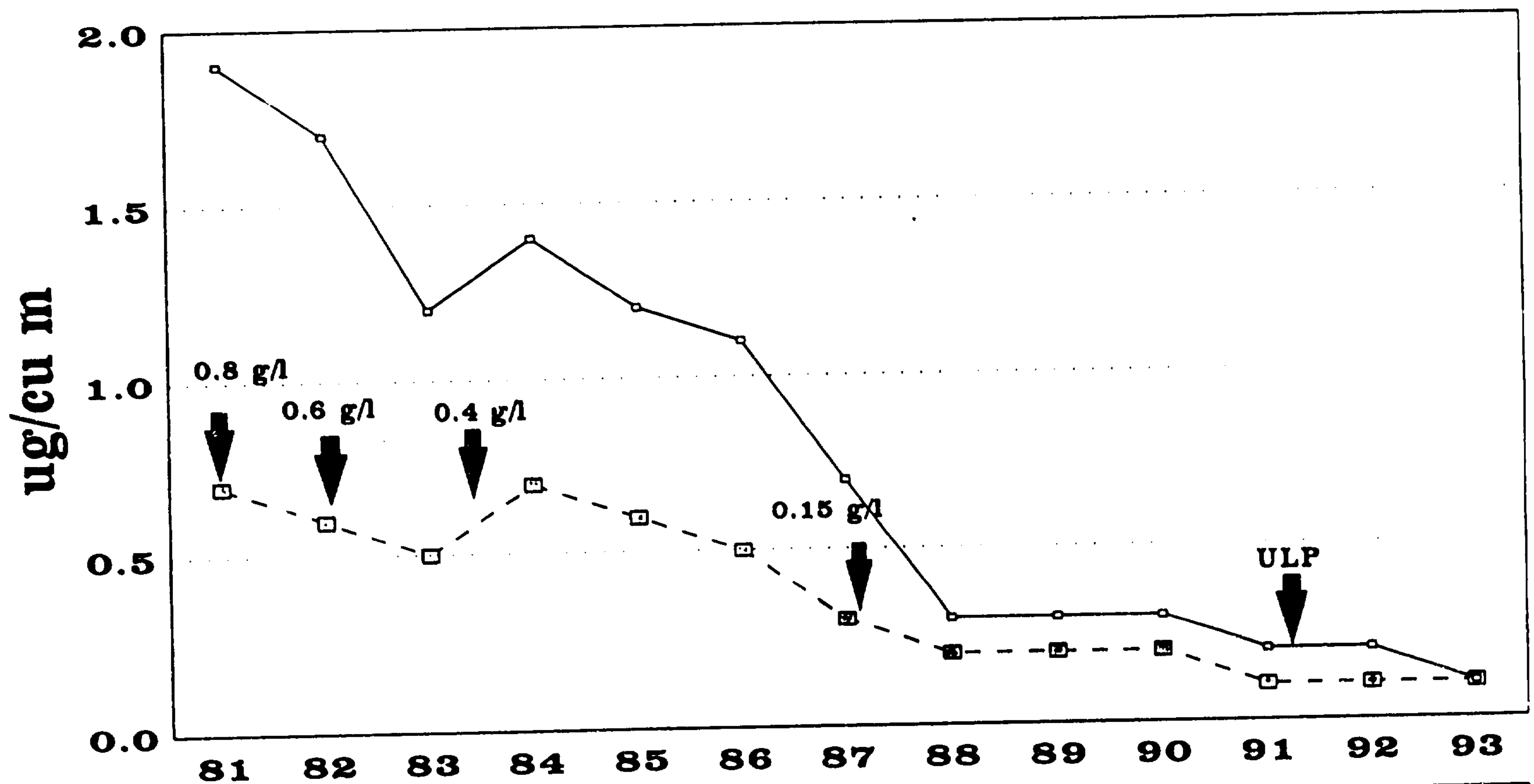
Annex 3



	Mar 91	Jun 91	Sep 91	Dec 91	Mar 92	Jun 92	Sep 92	Dec 92	Mar 93	Jun 93	Sep 93	Dec 93
Percentage	42.6	44.4	47.1	47.5	48.8	49.8	51.0	52.7	54.1	55.6	57.2	58.3

LEAD LEVEL
(81 TO 93)

Annex 4



	81	82	83	84	85	86	87	88	89	90	91	92	93
ROADSIDE	1.9	1.7	1.2	1.4	1.2	1.1	0.7	0.3	0.3	0.3	0.2	0.2	0.1
AMBIENT	0.7	0.6	0.5	0.7	0.6	0.5	0.3	0.2	0.2	0.2	0.1	0.1	0.1

YEAR

EXPERT GROUP MEETING

ON

AUTOMOTIVE FUEL QUALITY STANDARDS AND THEIR EFFECT ON MOTOR VEHICLE EMMISSIONS

29TH TO 31ST MARCH 1994

Prepared by:

T.L.PEIRIS AND M.R. PIYADASA
Assistant Commissioners of Motor Traffic

Department of Motor Traffic

Sri Lanka

(1) Sri Lanka has progressed to a great extent during the last two years with regard to the control and regulatory measures concerning Motor Vehicle emmissions. The vehicle emmission control compaign is promoted by the following ministries and organisations.

Ministry of Transport and Highways
Metropolitian Environmental Improvement programme.
Ceylon Institute of scientific and Industrial Research
Ministry of Environmental and parlimentary affairs.
Central Environmental Authority
Department of Motor Traffic
Police Department
Ceylon Petrolium Corporation

The vehicle population has increased three fold during the last twelve years. The present statistics indicate that there are more than one million of Motor Vehicles registered in Sri Lanka. Out of this more than half are Motor Cycles. All the registrations of Motor Vehicles are done in the Department of Motor Traffic Colombo. Most of the vehicles running on the highways are re-conditioned ones. The reconditioned Motor cars imported to the country are under three years and commercial vehicles under five years. The annexure indicate the statistics of the vehicle population in Sri Lanka

The fuel quality is a very important factor in the control of Vehicle emmissions. The type of fuel in Sri Lanka are the following:-

Super Petrol
Ordinary Petrol
Auto Diesel

Sapugaskanda refinery is the only refinery in Sri Lanka. Crude oil is refined at this place. The sulfur level is maintained below 0.1 percent. Tetracthyl lead is added on to this in order to increase the octane count of 83 and 90 respectively. The Motor cycles used in Sri Lanka are mainly Japanese Motor Cycles brought down as used vehicles. The Motor tricycles used in Sri Lanka are mainly of Indian, make and they are brought as brand new vehicles. These vehicles are mainly with two stroke engines. The S.I. engines in gasoline vehicles are without catalytic convertors. The subject of importing vehicles with catalytic covertors have been discussed and action has been taken to have a clean air programme for the year 2000. The feasibility of producing non leaded petrol had been studied and action has been taken to implement this programme in the future. It is a multi million project and the refinery has to be converted to produce non leaded petrol. By the year 1997 Sri Lanka would be able to produce non leaded petrol and the new vehicles imported could be with catalytic convertors. However the used vehicles in Sri Lanka would have no allternative but to use leaded petrol. The refinery at Sapugaskanda would be able to produce part of the required petrol when the lead content is reduced.

The fuel used in C I enginers is the normal diesel supplied by the only refinery at Sapugaskanda. The properties that influence emmission control is the viscocity of oil used in the vehicle. The particulates and smoke have to be controlled. The diesel fuel could be with less sulfur. The type of engine also contribute greatly for the control of emmission. The direct injection diesel engine is better than other types of diesel engines. The two stroke engine in Motor Cycles and Motor tricycles should be discouraged. The two stroke petrol engine emits smoke from the unburnt two stroke oil on normal engine oil mixed with the petrol. This emits CO, HC, smoke and particulates than the four stroke engine. The only way to control this emmission is by introducing a better quality oil additive to be mixed with perol.

The key properties with S I engine are

Lead Content
Benzene Content
Density
Volability

Vehicles equipped with C I engines are
Ignition quality
Density
back end volability
Viscolity
Sulfur Content

At the last Expert Group Meeting held in Indonesia on type Approval procedures for New Vehicles it was decided to have desicive action irrespective of differencess to the vehicle population in the participating countries in the Region. Priority should given to the control and Regulatory Measures with regards to emmission from the two main categories equipped with spark Ignation vehicles and diesel Vehicles. Type Approval procedures alone is insufficent to ensure that Motor vehicle enimissions would be contolled It was also discussed that it is necessary to develop the Technical Services by way of setting up Vehicle testing centeres to minimise pollution due to Motor Vehicles operated on the roads. there are many actions that could be taken which need participations from all concerned with regards to Motor Vehicles.

It was realised that inspection of Motor Vehicles certainly play an important role as one of the measures to cope with the problems related to Air pollution. Therefore all Motor Vehicles should be tested for road worthiness which include emmission related checks for carbon monoxide and Hydrocarbons in S I engines and smoke in diesel vehicles. Guidelines for New Motor Vehicles emmission control should be very desireable for all participating countries. It was felt that it is not an easy thing to implement therefore to harmonize the control systemof new vehicles in the Asia Pacefic Region. Local conditions should be considered when decisions are arrived at.

Sri Lanka is presently concerned about the Vehicle emmissions. The Govenment of Sri Lanka provided sixty five smoke meters brought down from Sweden. Arrangements are being made to train the personnel to opperate these meters. The standards are now being studied by a Technical Committee in order to lay down the limits of the new instrument. Our country is more concerned about controlling the diesel emmissions, rather than prosecuting the owners of Motor Vehicles in Court.

Action is being taken by the Government of Sri Lanka to establish a fully automatic Vehicle testing centre in the vicinity of the Capital City, Colombo, and to have such centres in all the Major cities susequently for the purpose of inspecting Vehicles, with moderr equipment including smoke testing equipment. Acording to present regulations a vehicle should be free of grit and smoke. Regid regulations would be laid down after the installation of the testing centres. Annexure of the draft regulations for smoke meters given.

SUGGESTED AMENDMENTS TO THE MOTOR TRAFFIC ACT.

It is suggested that the amendments to the Motor Traffic Act should include the following in order to mitigate the pollution caused by vehicle exhaust fumes.

1. STANDARDS FOR EXHAUST EMISSIONS FOR EXISTING DIESEL DRIVEN VEHICLES.

   Exhaust emissions from all diesel driven motor vehicles should conform to specified standards.
   These standards could be made by regulation/by order, etc. under the Motor Traffic Act.
   The standards may be made effective from a specified date or upon publication.

2. STANDARDS FOR EXHAUST EMISSIONS FOR EXISTING PETROL DRIVEN VEHICLES.

   Exhaust emissions from all petrol driven motor vehicles should conform to specific standards.
   These standards could be made by regulation/by order, etc. under the Motor Traffic Act.
   The standards may be made effective from a specified date or upon publication.

3. STANDARDS FOR EXHAUST EMISSIONS FOR EXISTING MOTOR CYCLES SCOOTERS AND THREE-WHEELERS.

   Exhaust emissions from every motor cycle, scooter or three-wheeler should conform to specific standards.
   These standards could be made by regulation/by order, etc. under the Motor Traffic Act.
   The standards may be made effective from a specified date or upon publication.

4. FINES FOR NON-COMPLIANCE WITH EXHAUST EMISSION STANDARDS.

   The appropriate authority/Department of Motor Traffic, Traffic Police/Central Envionmmental Authority should be empowered to specify and impose fines for non-compliance with the standards for exhaust emissions by motor vehicles as indicated under 1, 2, and 3 above.

5. STANDARDS FOR EXHAUST EMISSION FOR PETROL DRIVEN VEHICLES TO BE REGISTERED FOR THE FIRST TIME IN SRI LANKA.

   a) All petrol driven motor vehicles to be registered for the first time in Sri Lanka should be made to comply with relevant standards for exhaust emissions specified under the Motor Traffic Act.
   The standards could be made by regulation/by order,etc. and may be made effective from a specified date or upon publication.

2/

5. b) Applications for registration of petrol driven vehicles should be approved only after the Department of Motor Traffic has been satisfied that the petrol driven motor vehicle has been tested for compliance with the specified standards.
A certificate issued by the Manufacturer of the vehicle or by a registered Garage in Sri Lanka should be made acceptable for this purpose.

6. STANDARDS FOR EXHAUST EMISSION FOR DIESEL DRIVEN MOTOR VEHICLES TO BE REGISTERED FOR THE FIRST IN SRI LANKA.

a) All diesel driven motor vehicles to be registered for the first time in Sri Lanka should be made to comply with relevant standards for exhaust emissions specified under the Motor Traffic Act.
The standards could be made by regulation/by order, etc. and may be made effective from a specified date or upon publication.

b) Applications for registration of diesel driven vehicles should be approved only after the Department of Motor Traffic has been satisfied that the diesel driven motor vehicle has been tested for compliance with the specified standards.
A certificate issued by the Manufacturer of the vehicle or by a registered Garage in Sri Lanka should be made acceptable for this purpose.

7. STANDARDS FOR EXHAUST EMISSION FOR MOTOR CYCLES AND SCOOTERS TO BE REGISTERED FOR THE FIRST TIME IN SRI LANKA.

a) All motor cycles, scooters and three-wheelers to be registered for the first time in Sri Lanka should be made to comply with relevant standards for exhaust emissions specified under the Motor Traffic Act.
The standards could be made by regulation/by order, etc. and may be made effective from a specified date or upon publication.

b) Applications for registration of all motor cycles, scooters and three-wheelers should be approved only after the Department of Motor Traffic has been satisfied that the petrol driven motor vehicle has tested for compliance with the specified standards.
A certificate issued by the Manufacturer of the vehicle or by a registered Garage in Sri Lanka should be made acceptable for this purpose.

8. UNLEADED PETROL.

a) All petrol driven motor vehicles to be registered for the first time in Sri Lanka should be capable of running on unleaded petrol with effect from a specified date.

REGULATIONS

Since smoke-meters for the measurement of smoke emissions from diesel vehicles are already in the process of being purchased we may also Gazette the Regulations under the Motor Traffic Act for this purpose. A draft is given below :

REGULATIONS UNDER THE MOTOR TRAFFIC ACT FOR SMOKE EMISSIONS FROM DIESEL VEHICLES.

1. Any officer not below the rank of Sub-Inspector of Police, who has reason to believe that a vehicle is emitting excessive or other pollutants which are likely to cause environmental pollution, endangering the health or safety of any other user of the road or the public, may direct the driver of any other person in charge of the vehicle, to submit the vehicle for undergoing a test to measure the standard of black smoke or the standard of any of the other pollutants specified by these regulations.

2. The moke level measurements from diesel vehicles shall be carried out by a .... * by means of a smoke meter approved for that purpose by the Department of Motor Traffic and the Central Environmental Authority.

3. The driver or any person in charge of the vehicle shall upon demand by any officer referred to in (1) above, submit the vehicle for testing for the purpose of measuring the standard of smoke or the levels of other pollutants or both.

4. Smoke density for all diesel driven vehicles shall be as follows :

Method of Test	Maximum Smoke Density Hardridge Unit
Running with free acceleration method from idle speed to 60 per cent of the maximum rotating speed.	60

* To be specified in consultation with the Commissioner of Motor Traffic and Director/Traffic, Police Headquarters.

Annex 16a

AUTOMOTIVE FUEL QUALITY STANDARD
IN THAILAND

PRESENTED BY

MRS.PREEYAPORN VIVEKAPHIRAT

HEAD OF QUALITY CONTROL

FUEL OIL DIVISION

DEPARTMENT OF COMMERCIAL REGISTRATION

AT

THE EXPERT GROUP MEETING

ON

CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS

AND

THEIR EFFECT ON MOTOR VEHICLE EMISSIONS

IN THE ASIA-PACIFIC REGION

ORGANIZED BY

UNITED NATION INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

BEIJING, CHINA, P.R.

29 - 31 MARCH 1994

AUTOMOTIVE FUEL QUALITY STANDARD IN THAILAND

INTRODUCTION

The problem of air pollution in Thailand has been gradually deteriorating, especially in Bangkok and the major cities, due mainly to both automotive and industrial fuel combustion. The Thai government has made every effort to continuously improve the air quality in the country, both by upgrading the quality of fuels and setting emission standards for new vehicles. Significant measures have been introduced by the government including the reduction of lead content in gasoline, the introduction of unleaded gasoline, the reduction of 90% distillation temperature, the reduction of sulphur in diesel fuel and the introduction of low-smoke, two-stroke engine oil for motorcycles, etc. The major objectives are to reduce and eventually eliminate toxic elements such as lead content in gasoline as well as gaseous pollutants, most significant of which are CO (Carbonmonoxide), HC (Hydrocarbon), NO_x (Nitrogenoxide) as well as particulates.

LEADED AND UNLEADED GASOLINE

Measures already enforced include:

1. Establishment of the specification of unleaded gasoline, another type of gasoline, for use in cars equipped with catalytic converters, which have been marketed in Thailand since May 1, 1991.

2. Reduction in the level of lead content in gasoline from 0.40 grams/litre to 0.15 grams/litre from January 1, 1992.

3. Upgrading in the quality of unleaded gasoline to solve the problem of acceleration and engine knocking by making the following requirements on the traders:

   3.1 Increase the front end octane number to 87 RON

   3.2 Limit the increase in aromatic content to not more than 50% by volume

   3.3 Meet the required Motor Octane Number (MON) of 84 RON. (This measure is introduced on a voluntary basis in the initial phase).

4. Adjustment of the maximum distillation profile to make the fuel lighter, thereby reducing the emission of toxic elements and hydrocarbons from January 1, 1993

5. Establishment of a limit in the level of oxygenates in gasoline, especially MTBE, at 5.5 - 10.0% by volume in order to reduce CO (Carbonmonoxide) from January 1, 1993.

6. Reduction in the level of Benzene form 5.0% to 3.5% by volume in order reduce carcinogenic elements from January 1, 1993.

7. Requirement for the blending of PFI/IVDC detergent in gasoline fuel to clean the engine and reduce tailpipe emissions

8. Promotion of unleaded gasoline marketing by:

   8.1 Imposing less excise tax on unleaded gasoline than leaded gasoline by 0.70 - 1.00 Baht/Litre from May 1, 1991.

   8.2 Providing 0.20 Baht/Litre government subsidy for gasoline blended with MTBE.

Further measures to be implemented are as follows:

1. Limitation of the aromatic content in premium leaded and premium unleaded gasoline at a maximum of 50% by volume from January 1, 1994 and 35% from January 1, 2000 in order to reduce toxic elements

2. Shortening of the time frame for the switch from regular, leaded gasoline to regular, unleaded gasoline from the original schedule of January 1, 1995, to June 1, 1994 in order to solve the present problem of finding unleaded gasoline for cars equipped with catalytic converters in certain areas

3. Complete phase out of premium gasoline by the end of the 7th National Economic and Social Development Plan, before January 1, 1997 in order to reduce environmental problems caused by lead pollution

   The Department of Commercial Registration is presently studying the effect of complete phase out of premium leaded gasoline and the problem of cars with soft valve seats

HIGH-SPEED DIESEL

Measures already enforced include:

1. Upgrading in the quality of High-Speed Diesel to make it lighter in order to reduce the problem of black smoke and lower the level of sulphur for use in diesel vehicles equipped with catalytic converters in the future

2. Establishment of the specification of a new type of High-Speed Diesel (Type II) with the 90% distillation temperature by volume at 357° C and sulphur content at 0.5% by weight in order to reduce black smoke and SO_2 (Sulphurdioxide) from March 11, 1992. Traders are allowed to mix this new type of High-Speed Diesel (Type II) with the original High-Speed Diesel (Type I) which has the distillation temperature of 370° C and sulphur content of 1.0% by weight in the same tank.

3. Identification of the areas in Bangkok, Nonthaburi, Pathumthani and Samutprakarn where the use of High Speed Diesel (Type II), as specified under Item 2 above, is compulsory.

4. Reduction of the 90% distillation temperature, by volume, of the High-Speed Diesel with 1.0% sulphur content by weight, from 370° C to 357° C in order to reduce black smoke and polyaromatic Hydrocarbon from September 1, 1992

5. Expansion of the areas where the use of High-Speed Diesel (Type II) is compulsory to Samutsakorn, Samutsongkram, Phuket, Cholburi, Nakornpathom and Chacheongsao from January 1, 1993 as these are large cities with heavy traffic congestion

6. Reduction in the level of specific gravity from 0.82 - 0.90 to 0.81 - 0.87 and reduction in the level of viscosity from 1.8 - 5.0 cSt to 1.8 - 4.1 cSt in order to reduce black smoke and Polyaromatic Hydrocarbon from January 1, 1993

7. Requirement for detergent additive to be blended in the diesel fuel for more complete combustion which helps to keep the engine clean, reduce exhaust gas and black smoke from January 1, 1993

8. Complete phase out of High-Speed Diesel (Type I) (reduction of sulphur content from 1.0% by weight to 0.5% by weight in order to reduce the level of SO_2 (Sulphurdioxide) and particulates from September 1, 1993

9. Compulsory use of High-Speed Diesel, 90% distillation temperature at 338° C, provided by the Petroleum Authority of Thailand (PTT), in BMTA (Bangkok Mass Transit Authority) buses. This measure has been enforced since January 1, 1993 due to the poor maintenance of buses in Bangkok which is partly responsible for the environmental pollution caused by the emission of black smoke

Further measures to be implemented are as follows:

1. The reduction of sulphur from 0.5% by weight to 0.25% by weight from January 1, 1996 and a further reduction to 0.05% from January 1, 2000 in order to reduce SO_2 (Sulphurdioxide) and particulates

MEASURES TO SOLVE AIR POLLUTION PROBLEM FROM FUELS

GASOLINE

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
1. Launch premium unleaded gasoline prior to the effective date of the Ministry's announcement on July 8 1991.	1 May 1991	To promote nationwide utilization as soon as possible and to make premium unleaded gasoline available for new cars equipped with catalytic converters
2. Reduction of lead content in gasoline from 0.40 grams/litre to 0.15 grams/litre	1 January 1992	To reduce air pollution caused by lead which is used for boosting the octane number of gasoline
3. Reduction of the distillation temperature: • At 10% distillation temperature: From 75° C to 70° C • At 50% distllation temperature: From 125° C to 110° C	1 January 1993	To reduce hydrocarbon emissions

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
• At 90% distillation temperature: From 190° C to 170° C		
• At end point: From 215° C to 200° C		
4. Increase in oxidation stability from 240 minutes to 360 minutes	1 January 1993	To maintain its quality and stability
5. Reduction of gum from 0.005 gms/100 ml to 0.004 gms./ 100 ml	1 January 1993	To maintain its quality and stability
6. Voluntary use of oxygenates at 5.5 - 10.0 by volume	1 January 1993	To reduce carbonmonoxide from engine combustion
7. Specify the Motor Octane Number	1 January 1993	MON also has an important effect on the engine. RON is not the only factor to determine the octane number
8. Compulsory use of PFE/IVDC additive for engine cleanliness	1 January 1993	To reduce emissions from old cars unequipped with catalytic converters

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
9. Reduction in the level level of Benzene from 5.0% to 3.5% by volume	1 January 1993	Benzene is carcinogenic
10. Expedite the replacement of regular, leaded gasoline with regular unleaded gasoline	From original schedule of 1 January 1995 to 1 June 1994	To reduce air pollution from lead content and to make unleaded gasoline available nationwide. It is also a solution to the problem of finding premium, unleaded gasoline for cars equipped with catalytic converters in some areas due to the unavailability at the service stations.
11. Limit the aromatic content in gasoline:		Aromatic is carcinogenic If the level of aromatic can be reduced, benzene will also be lower
• Not higher than 50% By volume and gradually decreasing	1 January 1994	
• not higher than 35% by volume	1 January 2000	

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
12. Specify Front-End Octane Number (FEON) at not less than 87 RON	Inspect all oil traders	If the Front - End Octane Number (FEON) of premium unleaded gasoline is too low, it may cause start-up or acceleration problems
13. Complete lead phase out in premium gasoline by the end of th 7th National Economic and Social Development Plan	Prior to 1 January 1997	To reduce air pollution from lead content, study the effect of lead phase out in premium unleaded gasoline and provide solutions for cars with soft valve seats

MEASURES TO SUPPORT OIL TRADERS IN PRODUCING OR IMPORTING UNLEADED, PREMIUM GASOLINE

1. Impose less excise tax on unleaded gasoline than leaded gasoline by 0.70 - 1.00 Bath/Litre (January 1, 1992)

2. Reduce tax on MTBE which is used in the production of unleaded gasoline from 30% down to 1% (September 25, 1991)

3. Reduce the contribution to oil Fund for the Unleaded Gasoline from 0.12 Baht/Litre to 0.10 Baht/Litre which is the same as the contribution to Leaded Gasoline in accordance with the resolution of the Sub-Committee on Petroleum Policy. This measure became effective on October 31, 1991.

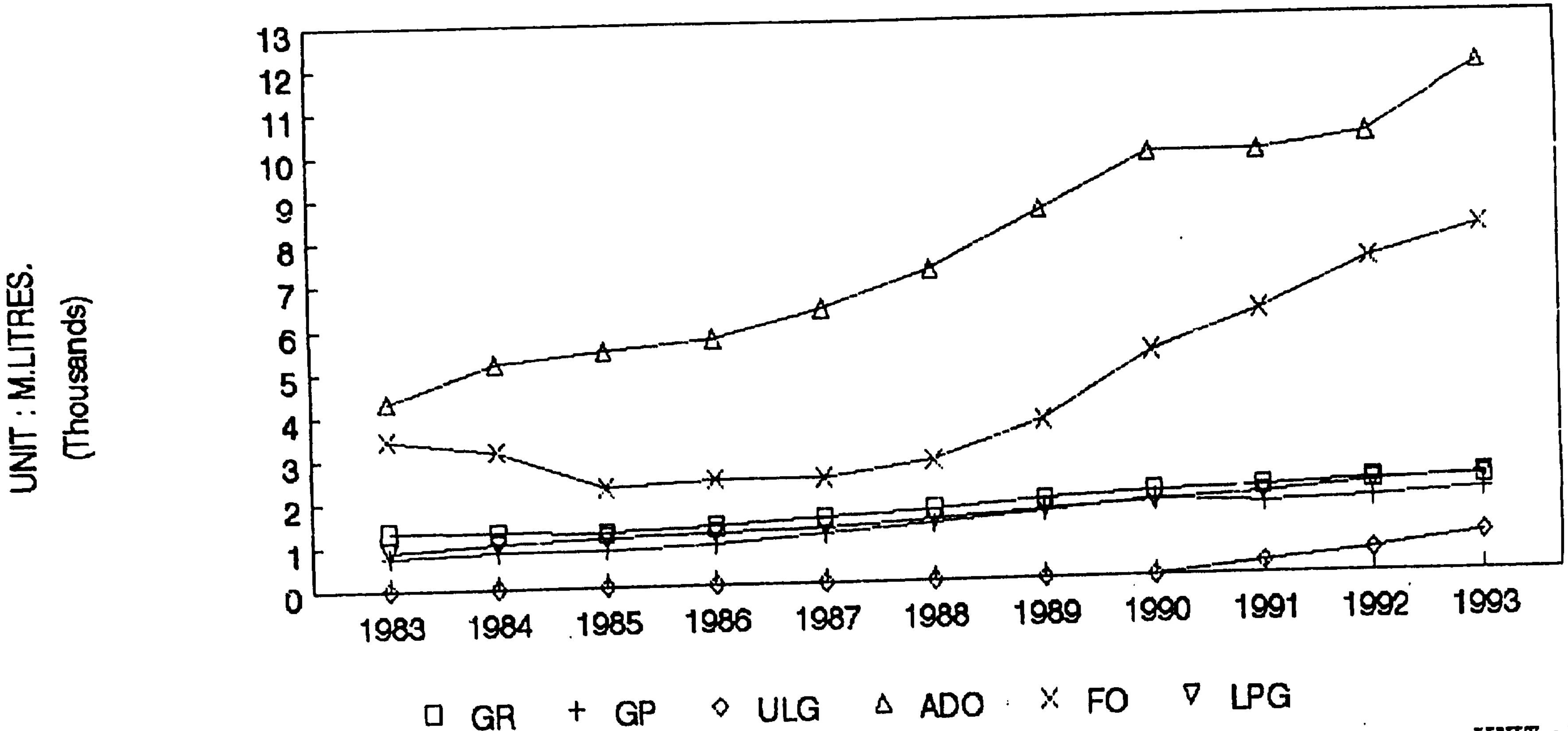
HIGH-SPEED DIESEL

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
1. Specify the quality of the new type of High-Speed Diesel (Type 2) with 0.5% sulphur by weight and 90% distillation temperature at 357° C	11 March 1992	To promote the utilization of the new type of High-Speed Diesel which can reduce black smoke and SO_2 and can also be put in the same tank as the other type of High-Speed Diesel
2. Compulsory use of High-Speed Diesel as specified in Item 1 only in Bangkok, Nontaburi, Pathumthani and Samutprakarn	3 April 1992	The problem of air pollution from SO_2 and black smoke is deteriorating
3. Reduction in the 90% distillation temperature by volume of the High-Speed Diesel - Type 1 (Sulphur 1.0% by weight) from 370° C to 357° C	1 September 1992	To reduce black smoke and polyaromatic hydrocarbon

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
4. Increase in the total number of areas where the compulsory use of High-Speed Diesel (Type 2) is enforced to 6 areas Samutsakorn, Samutsongkram, Phuket, Cholburi, Nakornpathom and Chacheongsao	1 January 1993	These provinces are experiencing rapid and high economic growt.. following Bangkok and the peripheral areas
5. Reduction of specific gravity from 0.82 - 0.90 to 0.81 - 0.87	1 January 1993	To reduce black smoke and Polyaromatic Hydrocarbon
6. Reduction in the viscosity from 1.8 - 5.0 cSt to 1.8 - 4.1 cSt	1 January 1993	To reduce black smoke and Polyaromatic Hydrocarbon
7. Compulsory use of detergent additive	1 January 1993	To reduce SO_2 and particulates To reduce gaseous pollutants (CO, HC and NO_x) and black smoke

ITEM	IMPLEMENTATION SCHEDULE	JUSTIFICATION
8. Reduction in the level of sulphur (% by weight)	1 September 1993	To reduce SO_2 and particulates
8.1 From 1.0 to 0.5 Hight-Speed Diesel (Type 1) becomes obsolete and use of High-Speed diesel (Type 2) is made compulsory		
8.2 From 0.5 to 0.25	1 ~~September~~ January 1996	To reduce SO_2 and particulates
8.3 From 0.25 to 0.05	1 January 2000	
9. Requirement for BMTA buses to use High-Speed Diesel with 90% distillation temperature at 338° C provided by the Petroleum Authority of Thailand (PTT)	1 January 1993	Poor maintenance of BMTA buses is the major cause of the problem of black smoke and particulates from the exhaust pipe

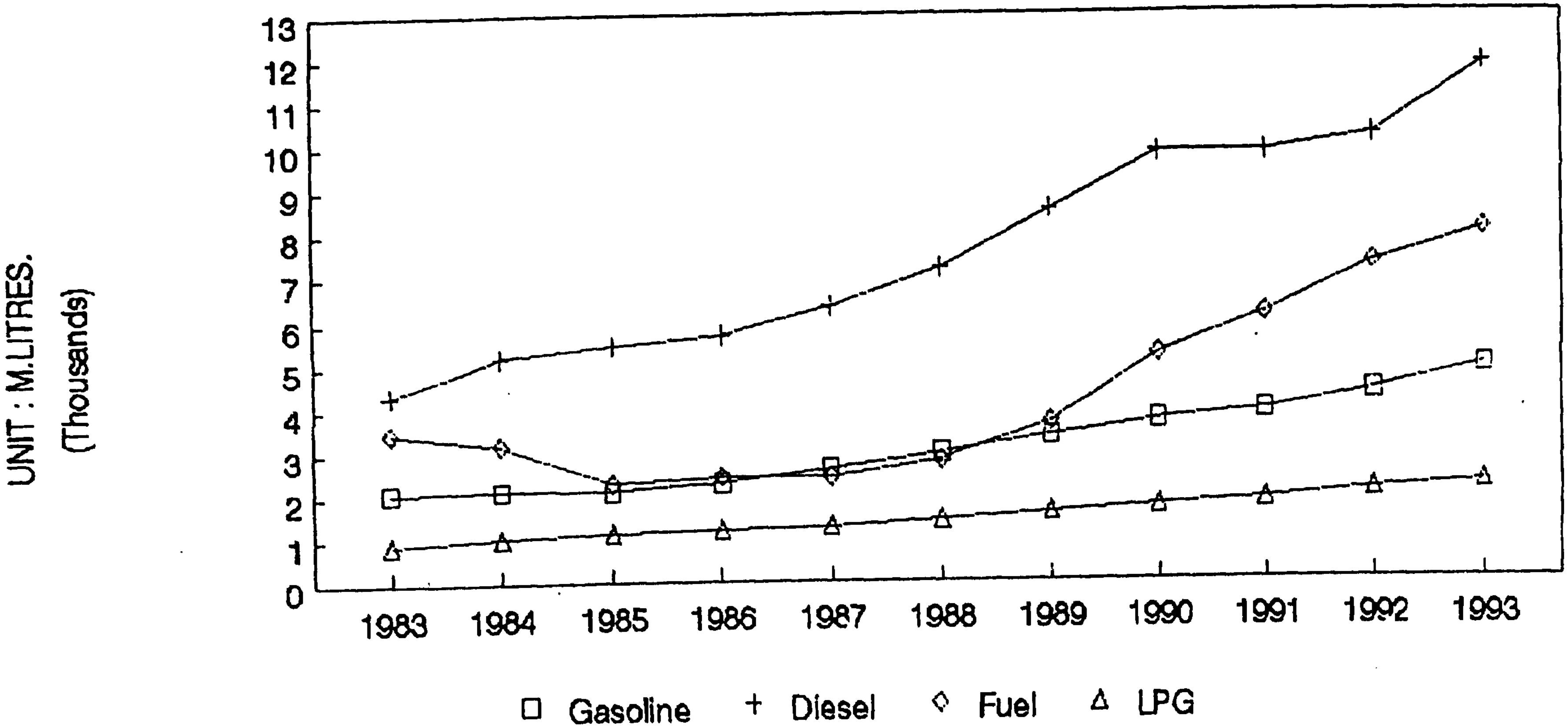
PRODUCTS SALES
Yr. 1983 – 1993



UNIT : M.LITRES.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
GR	1,322.2	1,271.0	1,237.6	1,336.2	1,483.8	1,623.4	1,795.8	1,940.6	2,005.0	2,116.3	2,163.9
GP	747.0	838.2	851.8	932.8	1,112.9	1,299.5	1,525.9	1,746.3	1,611.5	1,701.6	1,867.4
ULG	—	—	—	—	—	—	—	—	273.7	514.9	880.5
ADO	4,317.0	5,175.3	5,441.1	5,666.7	6,335.5	7,187.4	8,520.2	9,810.0	9,808.7	10,190.7	11,833.7
FO	3,447.3	3,162.6	2,280.8	2,410.2	2,395.7	2,761.4	3,635.3	5,210.4	6,106.5	7,271.0	8,026.8
LPG	876.7	1,016.6	1,126.2	1,179.1	1,258.7	1,400.7	1,568.0	1,716.3	1,844.8	2,058.5	2,223.9

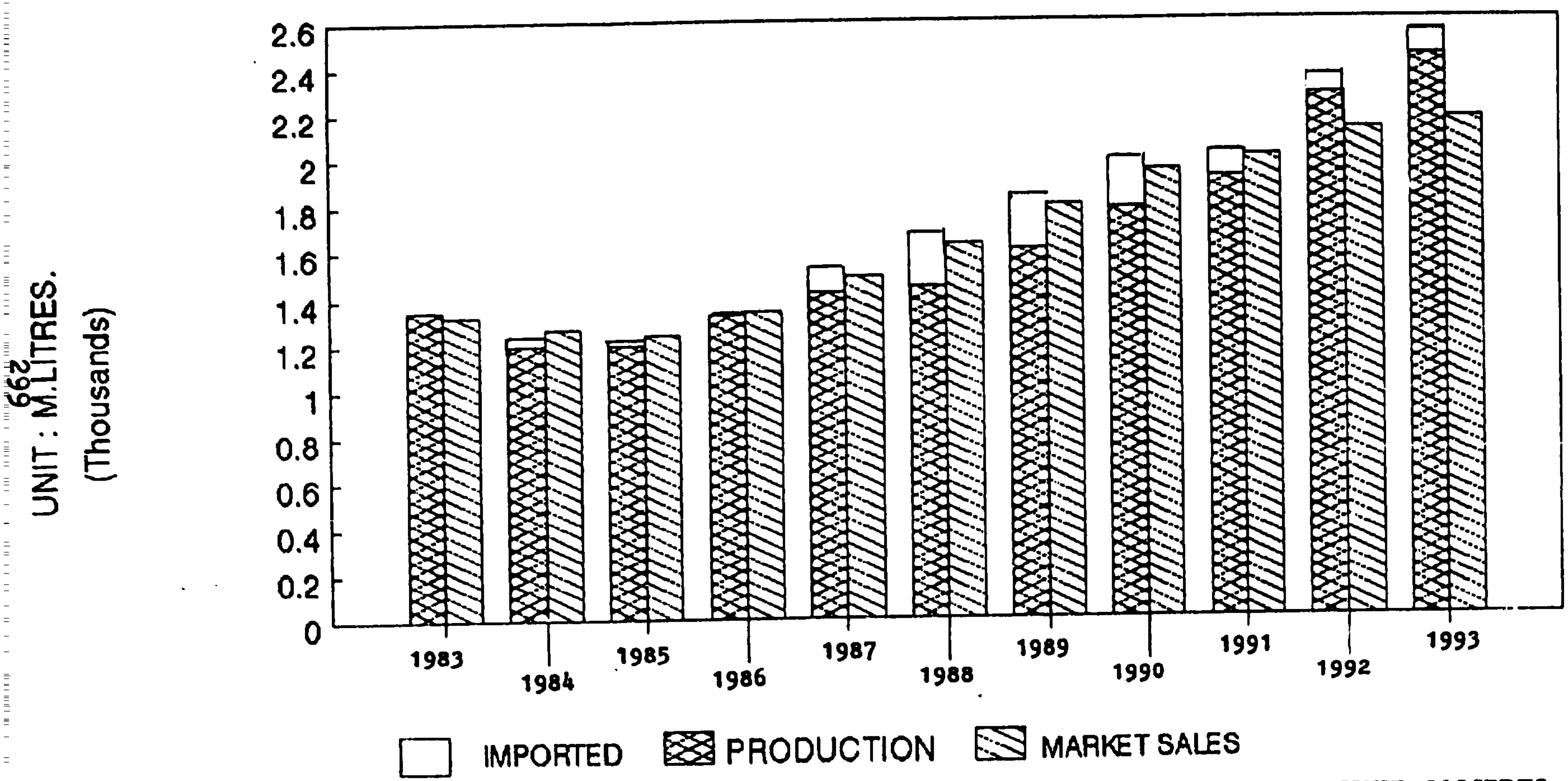
PRODUCTS SALES
Yr. 1983 – 1993



UNIT : M.LITRES.

Products	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Gasoline	2,069.3	2,109.2	2,089.4	2,268.9	2,596.7	2,922.9	3,321.7	3,686.9	3,890.2	4,332.9	4,911.8
Diesel	4,317.0	5,175.3	5,441.1	5,666.7	6,335.5	7,187.4	8,520.2	9,810.0	9,808.7	10,190.7	11,833.7
Fuel	3,447.3	3,162.6	2,280.8	2,410.2	2,395.7	2,761.4	3,635.3	5,210.4	6,106.5	7,271.0	8,026.8
LPG	876.7	1,016.6	1,126.2	1,179.1	1,258.7	1,400.7	1,568.0	1,716.3	1,844.8	2,058.5	2,223.9

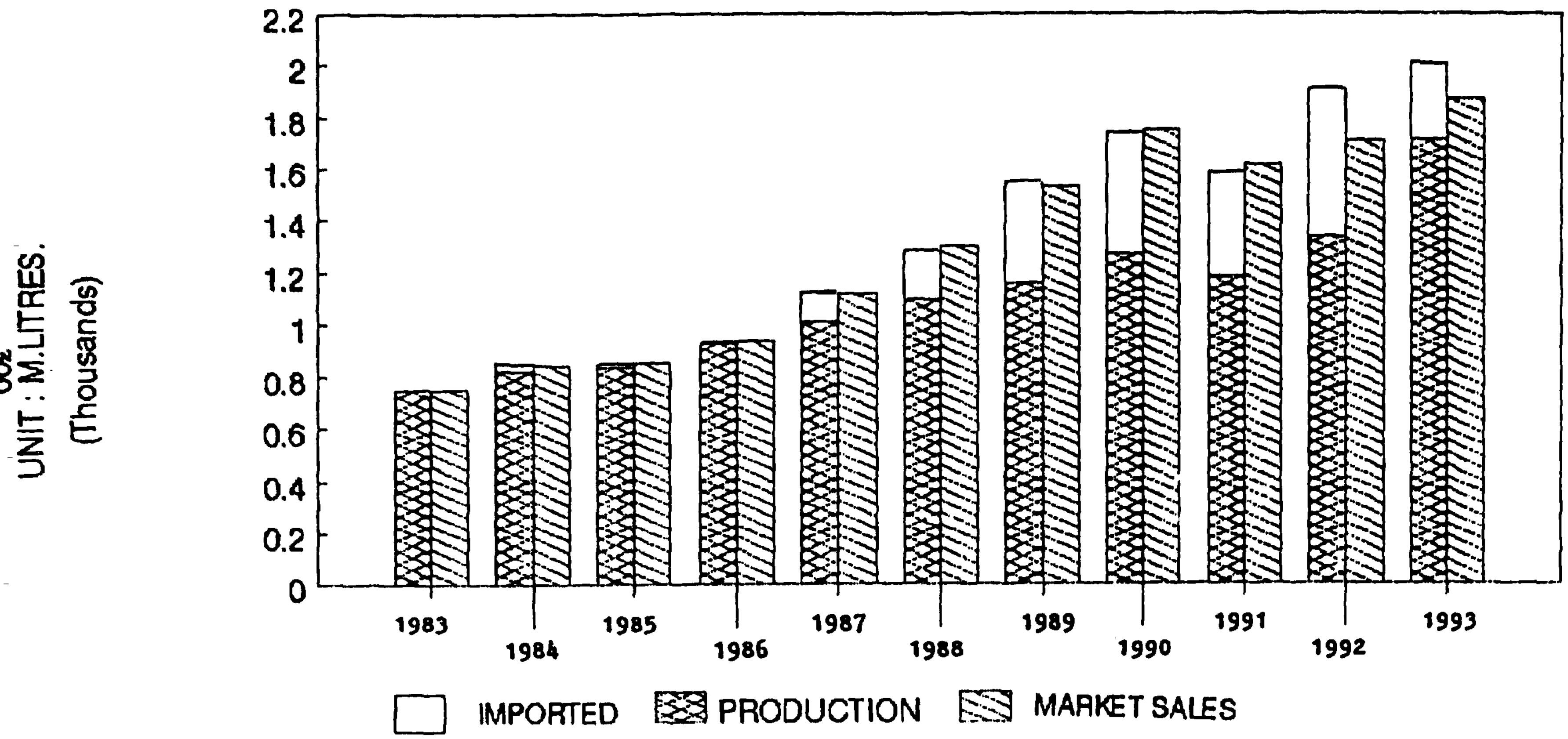
PRODUCTION IMPORTED AND MARKET SALES
REGULAR MOTOR GASOLINE



UNIT : M.LITRES.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCTION	1,346.7	1,189.9	1,193.4	1,320.0	1,418.3	1,443.9	1,601.1	1,777.2	1,911.0	2,270.6	2,442.2
IMPORTED	–	39.1	35.2	4.7	101.6	195.4	206.9	180.3	105.2	71.2	109.3
MARKET SALES	1,322.2	1,271.0	1,237.6	1,336.2	1,483.8	1,623.4	1,795.8	1,940.6	2,005.0	2,116.3	2,163.9

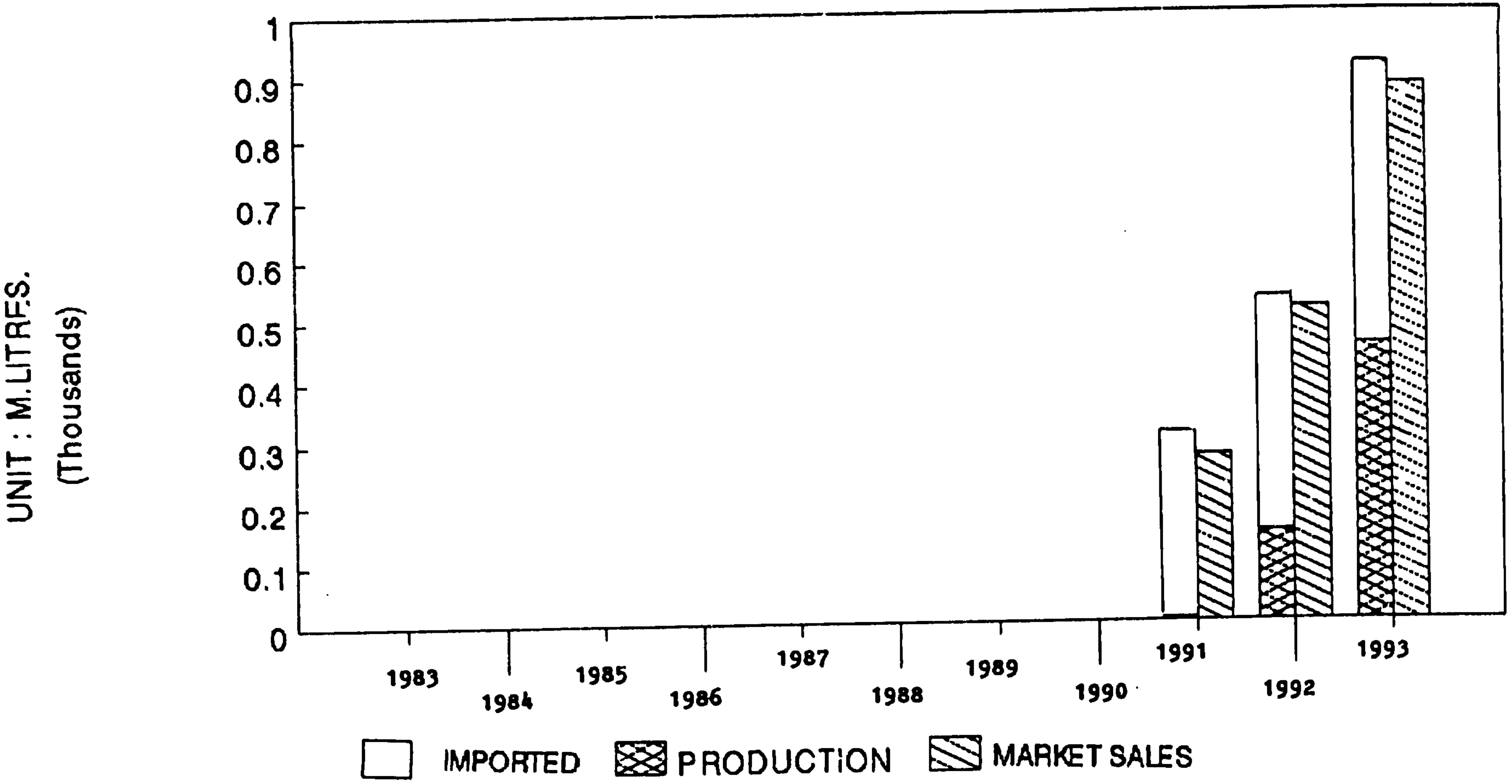
PRODUCTION IMPORTED AND MARKET SALES
PREMIUM MOTOR GASOLINE



UNIT : M.LITRES.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCTION	747.4	818.9	834.9	925.4	1,006.9	1,089.6	1,155.8	1,267.7	1,180.8	1,331.9	1,707.7
IMPORTED	–	27.1	3.7	3.1	121.6	179.8	406.7	472.4	396.7	607.3	370.0
MARKET SALES	747.0	838.2	851.8	932.8	1,112.9	1,299.5	1,525.9	1,746.3	1,611.5	1,701.6	1,867.4

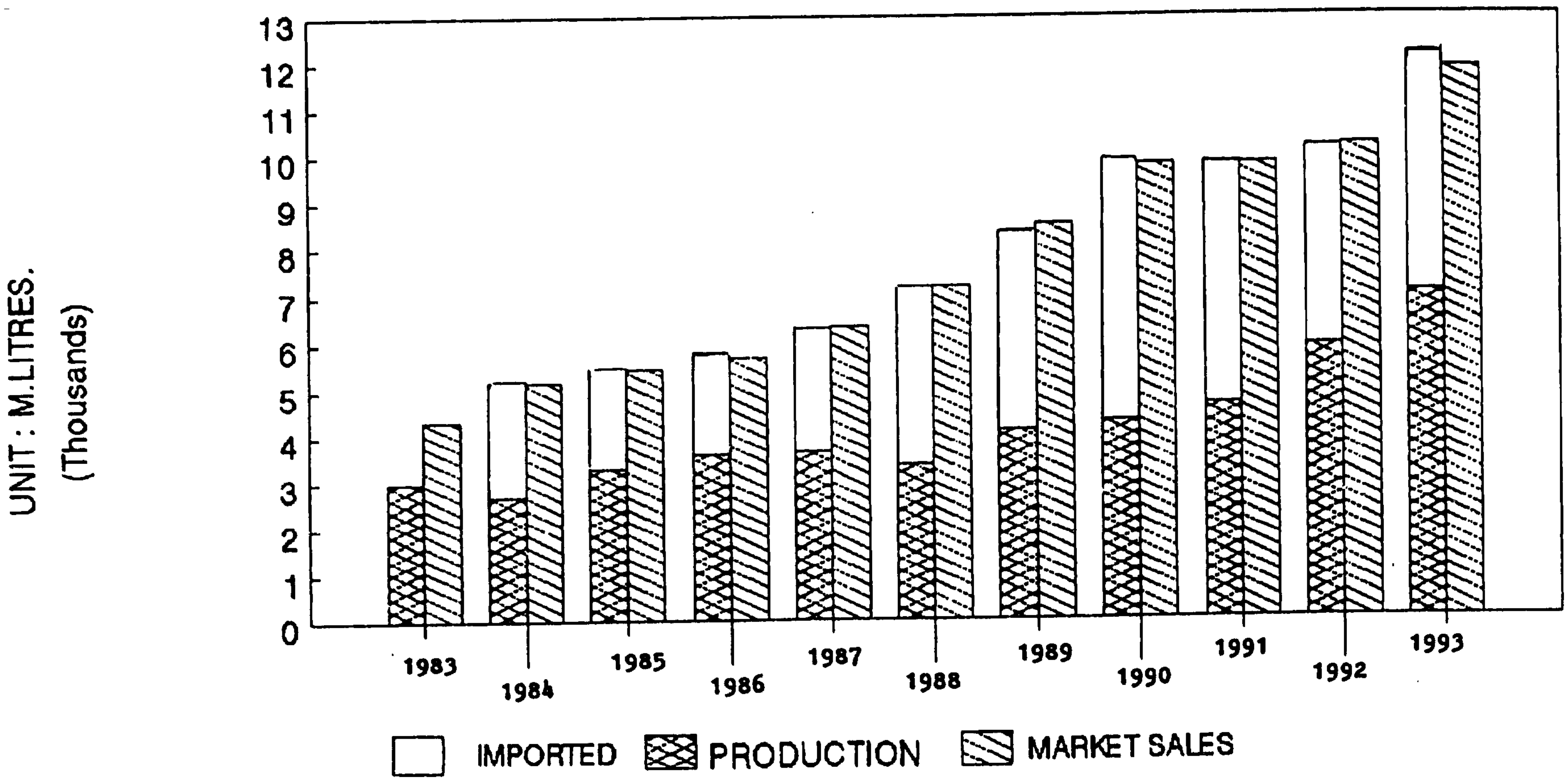
PRODUCTION IMPORTED AND MARKET SALES
ULG



UNIT : M.LITRES.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCTION	–	–	–	–	–	–	–	–	3.9	148.7	452.8
IMPORTED	–	–	–	–	–	–	–	–	300.5	380.3	459.6
MARKET SALES	–	–	–	–	–	–	–	–	273.7	514.9	880.5

PRODUCTION IMPORTED AND MARKET SALES
AUTOMOTIVE DIESEL OIL



UNIT : M.LITRES.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
PRODUCTION	2,968.1	2,681.0	3,289.4	3,588.1	3,642.1	3,366.6	4,075.0	4,303.6	4,651.3	5,861.1	7,023.8
IMPORTED	1,189.9	2,544.9	2,127.4	2,150.4	2,678.5	3,763.4	4,309.6	5,589.0	5,167.5	4,294.7	5,382.6
MARKET SALES	4,317.0	5,175.3	5,441.1	5,666.7	6,335.5	7,187.4	8,520.2	9,810.0	9,811.1	10,190.7	11,833.7

DEC 27, 1993

PRODUCT	EX-REFIN (AVG)	TAX B/LITRE	OIL FUND B/LITRE	CONS. FUND B/LITRE	WHOLESALE PRICE(AVG)	VAT	WS&VAT	MARKETING MARGIN	SUBSIDY FOR LPG	VAT	RETAIL PRICE
GP 98 R; 0.15 gl.	3.4654	3.3550	0.0300	0.0700	6.9204	0.4844	7.4048	0.7662	-	0.0537	8.22
GP 97 R; 0.15 gl.	3.2445	3.3550	0.0300	0.0700	6.6995	0.4690	7.1685	0.9871	-	0.0691	8.22
GP 95 R; 0.15 gl.	3.1243	3.3550	0.0300	0.0700	6.5793	0.4604	7.0399	1.1073	-	0.0775	8.22
ULG 97 R; UNL	3.6528	2.5850	0.0300	0.0700	6.3378	0.4436	6.7814	1.0641	-	0.0745	7.92
ULG 92 R; UNL	3.1111	2.5850	0.0300	0.0700	5.7961	0.4057	6.2018	1.4189	-	0.0993	7.72
REG-GAS; 87 RON	2.7451	3.3550	0.0300	0.0700	6.2011	0.4340	6.6341	1.0149	-	0.0710	7.72
KEROSENE	3.7572	3.3000	0.0300	0.0700	7.1572	0.5010	7.6582	1.0764	-	0.0754	8.81
H-DIESEL; 1%S	3.6064	2.3100	0.0300	0.0700	6.0164	0.4211	6.4375	0.9556	-	0.0669	7.46
H-DIESEL; 0.5%S	3.6764	2.2000	0.0700	0.0700	6.0164	0.4211	6.4375	0.9556	-	0.0669	7.46
L-DIESEL	3.3777	2.3100	0.0300	0.0700	5.7877	0.4051	6.1928	1.2590	-	0.0882	7.54
FUEL 600 (1)	1.9897	0.4305	0.0300	0.0700	2.5202	0.1764	2.6966	0.4518	-	0.0316	3.18
FUEL 1500 (2)	1.7907	0.3616	0.0300	0.0700	2.2523	0.1577	2.4100	0.4673	-	0.0327	2.91
FUEL 2800 (3)	1.6872	0.3655	0.0300	0.0700	2.1527	0.1507	2.3034	-	-	-	-
FUEL 2500 (4)	1.5496	0.3131	0.0300	0.0700	1.9627	0.1374	2.1001	0.[illegible]420	-	0.0379	2.68
FUEL (5)	1.8338	0.3279	0.0300	0.0700	2.2617	0.1583	2.4200	0.2430	-	0.0170	2.68
LPG-LARGE(B/KG)	6.7149	2.3870	- 1.4118	0.0000	7.6901	0.5383	8.2284	2.3566	0.0000	0.1650	10.75
LPG-SMALL(B/KG)	6.7149	2.3870	- 1.4118	0.0000	7.6901	0.5383	8.2284	2.3566	0.0000	0.1650	10.75
LPG-CARS(B/KG)	6.7149	2.3870	- 1.4118	0.0000	7.6901	0.5383	8.2284	1.3843	-	0.0969	9.71
BITUMEN(B/TON)	2157.2314	0.0000	0.0000	0.0000	2157.2314	151.0062	2308.2376	1959.5914	-	137.1714	4405.00

SOURCE : NATIONAL ENERGY POLICY OFFICE (NEPO)

PRODUCT	IMPORT PRICE	TAX B/LITRE	OIL FUND B/LITRE	CONS. FUND B/LITRE	WHOLESALE PRICE(AVG)	VAT	WS&VAT	MARKETING MARGIN	SUBSIDY FOR LPG	VAT	RETAIL PRICE
GP 98 R; 0.15 gl.	3.3385	3.4200	0.0300	0.0700	6.8912	0.4824	7.3736	0.7954	-	0.0557	8.22
GP 97 R; 0.15 gl.	3.1179	3.4200	0.0300	0.0700	6.6706	0.4669	7.1376	1.0160	-	0.0711	8.22
GP 95 R; 0.15 gl.	2.9553	3.4200	0.0300	0.0700	6,5080	0.4556	6.9636	1.1786	-	0.0825	8.22
ULG 97 R; UNL	3.5037	2.6500	0.0300	0.0700	6.2864	0.4400	6.7265	1.1155	-	0.0781	7.92
ULG 92 R; UNL	2.8161	2.6500	0.0300	0.0700	5.5989	0.3919	5.9907	1.6161	-	0.1131	7.72
REG-GAS; 87 RON	2.5195	3.4200	0.0300	0.0700	6.0722	0.4251	6.4973	1.1427	-	0.0800	7.72
KEROSENE	3.5817	3.3550	0.0300	0.0700	7.0789	0.4955	7.5744	1.1547	-	0.0503	8.81
H-DIESEL ; 1%S	3.4956	2.3750	0.0300	0.0700	6.0033	0.4202	6.4235	0.9687	-	0.0673	7.46
H-DIESEL ; 0.5%S	3.5404	2.2650	0.0700	0.0700	6.0033	0.4202	6.4235	0.9687	-	0.0673	7.46
L-DIESEL	3.2459	2.3750	0.0300	0.0700	5.7536	0.4028	6.1564	1.2931	-	0.0905	7.54
FUEL 600 (1)	1.7602	0.4405	0.0300	0.0700	2.3334	0.1633	2.4968	0.6385	-	0.0447	3.18
FUEL 1500 (2)	1.5359	0.3716	0.0300	0.0700	2.0403	0.1428	2.1831	0.6794	-	0.0476	2.91
FUEL 2000 (3)	1.4792	0.3755	0.0300	0.0700	1.9874	0.1391	2.1265	0.0000	-	-	-
FUEL 2500 (4)	1.4218	0.3231	0.0300	0.0700	1.8777	0.1314	2.0091	0.6270	-	0.0439	2.68
FUEL (5)	1.4218	0.3379	0.0300	0.0700	1.8924	0.1325	2.0249	0.6122	-	0.0429	2.68
LPG-LARGE(B/KG)	4.8378	2.3880	0.4643	0.0000	7.6901	0.5383	8.2284	2.3566	0.0000	0.1650	10.7500
LPG-SMALL(B/KG)	4.8378	2.3880	0.4643	0.0000	7.6901	0.5383	8.2284	2.3566	0.0000	0.1650	10.7500
LPG-CARS(B/KG)	4.8378	2.3880	0.4643	0.0000	7.6901	0.5383	8.2284	1.3848	-	0.0969	9.7100
BITUMEN(B/TON)	2157.2341	10.0000	0.0000	0.0000	2167.2314	151.7062	2318.9376	1959.5914	-	136.4714	4405.0000

SOURCE : NATIONAL ENERGY POLICY OFFICE (NEPO)

SPECIFICATION FOR AUTOMOTIVE GASOLINE

TEST ITEMS	LIMITS	REGULAR GASOLINE	PREMIUM GASOLINE LEADED TYPE I	PREMIUM GASOLINE LEADED TYPE II	PREMIUM GASOLINE UNLEADED TYPE I	PREMIUM GASOLINE UNLEADED TYPE II	TEST METHOD ASTM
1.OCTANE NUMBER							
RESEARCH OCTANE NUMBER							D 2699
PRODUCER	MIN	87.0	95.0	95.0	95.0	95.0	
RETAILER	MIN	86.6	94.6	94.6	94.6	94.6	
MOTOR OCTANE NUMBER							D 2700
PRODUCER	MIN	76.0	84.0	84.0	84.0	84.0	
RETAILER	MIN	75.6	83.6	83.6	83.6	83.6	
2.LEAD CONTENT, g/l							D 3341
BEFORE 1 JAN. 1995	MAX	0.15	0.15	0.15	0.013 1/	0.013 1/	D 3116 1/
SINCE 1 JAN. 1995	MAX	0.013 1/	0.15	0.15	0.013 1/	0.013 1/	
3.SULPHUR CONTENT, %wt.	MAX	0.15	0.15	0.15	0.10	0.10	D 1266
4.PHOSPHORUS CONTENT, g/l	MAX	-	-	-	0.0013 2/	0.0013 2/	D 3231
5.COPPER STRIP CORROSION, number	MAX	1	1	1	1	1	D 130
6.OXIDATION STABILITY, mins.	MAX	360	360	360	360	360	D 525
7.EXISTENT GUM, g/100 ml	MAX	0.004	0.004	0.004	0.004	0.004	D 381
8.DISTILLATION, °C							D 86
10 % vol.EVAPORATED	MAX	70	70	70	70	70	
50 % vol.EVAPORATED	MIN	70	70	70	70	70	
	MAX	110	110	110	110	110	
90 % vol.EVAPORATED	MAX	170	170	170	170	170	
FBP, °C	MAX	200	200	200	200	200	
RESIDUE, %vol.	MAX	2.0	2.0	2.0	2.0	2.0	
9.REID VAPOUR PRESSURE@37.8 °C,kPa							
NON-OXYGENATE BLENDS	MAX	62	62	62	62	62	D 323
OXYGENATE BLENDS	MAX	62	62	62	62	62	D 4953
10.BENZENE, %vol.	MAX	3.5	3.5	3.5	3.5	3.5	D 3606

TEST ITEMS	LIMITS	REGULAR GASOLINE	PREMIUM GASOLINE LEADED TYPE I	PREMIUM GASOLINE LEADED TYPE II	PREMIUM GASOLINE UNLEADED TYPE I	PREMIUM GASOLINE UNLEADED TYPE II	TEST METHOD ASTN
11. AROMATIC, %vol.							D 4420
SINCE 1 JAN. 1994	MAX	-	50	50	50	50	
SINCE 1 JAN. 2000	MAX	-	35	35	35	35	
12. COLOUR							
HUE		RED [3]	PALE-YELLOW [4]	PALE-YELLOW [4]	GREEN [5]	GREEN [5]	(1) VISUAL INSPE (2) D 2392
DYE CONTENT, mg/l	MIN	10.0	-	-	4.0	4.0	
INTENSITY	MIN	-	0.5	0.5	-	-	(3) D 1500
	MAX	-	1.0	1.0	-	-	
13. WATER, %wt.							
NON-OXYGENATE BLENDS	MAX	NIL	NIL	NIL	NIL	NIL	VISUAL INSPECT
OXYGENATE BLENDS	MAX	0.7	0.7	0.7	0.7	0.7	E 203
14. OXYGENATED COMPOUNDS, %vol	MIN	-	-	5.5 [6]	-	5.5 [6]	D 4815
	MAX	10.0 [6]	10.0 [6]	10.0 [6]	10.0 [6]	10.0 [6]	
15. PFI/IVDC ADDITIVE							
BEFORE 1 JAN. 1995	MIN	-	X [7]	X [7]	X [7]	X [7]	DCR REQUIREMENT
SINCE 1 JAN. 1995	MIN	X [7]	X [7]	X [7]	X [7]	X [7]	
16. APPEARANCE		BRIGHT AND CLEAR					VISUAL INSPECT

NOTES:

1/ TEST METHOD FOR UNLEADED PREMIUM GASOLINE AND UNLEADED REGULAR GASOLINE

2/ CONDUCT THE TEST WHEN HAVING PHOSPHORUS IN THE ADDITIVE

3/ USE ALKYL DERIVATIVE COMPOUNDS OF AZOBENZENE-4-AZO-2-NAPHTHOL AND USE TEST METHOD (1) OR (2)

4/ USE TEST METHOD (3)

5/ USE 1,4-DIALKYLAMINO ANTHRAQUINONE COMPOUNDS AND 1,3-BENZENEDIOL,2,4-BIS ((ALKYLPHENYL) AZO-) COMPOUNDS IN THE RATIO 9:4 AND USE TEST METHOD (1) OR (2)

6/ MAXIMUM CONTENT OF METHANOL BLEND IS 3.0 % BY VOLUME

7/ X IS A PFI/IVDC ADDITIVE WHICH OIL TRADER IN PURSUANCE OF SECTION 6 MUST SUBMIT THE TYPE,QUANTITY AND BMW 3181 TESTING CERTIFICATE AS PRESCRIBED IN THE ATTACH FORM TEN DAYS BEFORE DISTRIBUTION. THE CHANGING OF X MUST INFORM THE DEPARTMENT OF COMMERCIAL REGISTRAION IN ADVANCE.

DEPARTMENT OF COMMERCIAL REGISTRATION

MINISTRY OF COMMERCE

BANGKOK,THAILAND

AUGUST 28, 1992

SPECIFICATION FOR HIGH SPEED DIESEL

PROPERTIES	LIMITS	NO.1	NO.2	TEST METHODS
1.SPECIFIC GRAVITY	MIN	0.81	0.81	ASTM D 1298
AT 15.6/15.6 °C	MAX	0.87	0.87	
2.CETANE NUMBER OR	MIN	47	47	ASTM D 613
CALCULATED CETANE INDEX	MIN	47	47	ASTM D 976
3.VISCOSITY AT 40 °C, cSt	MIN	1.8	1.8	ASTM D 445
	MAX	4.1	4.1	
4.POUR POINT, °C	MAX	10	10	ASTM D 97
5.SULPHUR CONTENT, % wt.				ASTM D 129 OR
BEFORE SEPTEMBER 1, 1993	MAX	1.0	0.5	EQUIVALENT
SINCE SEPTEMBER 1, 1993	MAX	-	0.5	
SINCE JANUARY 1, 1996	MAX	-	0.25	
SINCE JANUARY 1, 2000	MAX	-	0.05	
6.COPPER STRIP CORROSION,NUMBER	MAX	1	1	ASTM D 130
7.CARBON RESIDUE, %wt.	MAX	0.05	0.05	ASTM D 189
8.WATER AND SEDIMENT, %vol.	MAX	0.05	0.05	ASTM D 2709
9.ASH, %wt.	MAX	0.01	0.01	ASTM D 482
10.FLASH POINT, °C	MIN	52	52	ASTM D 93
11.DISTILLATION				ASTM D 86
90 % RECOVERED, ° C	MAX	357	357	
12.COLOUR	MAX	4.0	4.0	ASTM D 1500
13.DETERGENT ADDITIVE	-	X	X	DCR REQUIRMENT

NOTES: X IS A DETERGENT ADDITIVE WHICH OIL TRADER IN PURSUANCE OF SECTION 6 MUST SUBMIT THE TYPE,QUANTITY AND TESTING CERTIFICATE AS PRESCRIBED IN THE ATTACH FORM TEN DAYS BEFORE DISTRIBUTION. THE CHANGING OF X MUST INFORM THE DEPARTMENT OF COMMERCIAL REGISTRATION IN ADVANCE.

DEPARTMENT OF COMMERCIAL REGISTRATION

MINISTRY OF COMMERCE

BANGKOK THAILAND

Annex 16b

TWO-STROKE ENGINE OIL IN THAILAND

TRENDS IN QUALITY DEVELOPMENT

PRESENTED BY

MR. SAWAENG BOONYASUWAT
EXECUTIVE DIRECTOR
RESEARCH AND DEVELOPMENT CENTER
PETROLEUM AUTHORITY OF THAILAND (PTT)

AT

THE EXPERT GROUP MEETING
ON
CONSIDERATION OF AUTOMOTIVE FUEL QUALITY STANDARDS
AND
THEIR EFFECT ON MOTOR VEHICLE EMISSIONS
IN THE ASIA-PACIFIC REGION

ORGANIZED BY

UNITED NATION INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

BEIJING, CHINA, P.R.

29 - 31 MARCH 1994

TWO-STROKE ENGINE OIL IN THAILAND
TRENDS IN QUALITY AND DEVELOPMENT

Sawaeng Boonyasuwat
PTT R & D Executive Director

I. INTRODUCTION

The two-stroke motorcycle market in Thailand has undergone a dynamic change over the past 5 years in every respect. The motorcycle population has increased from 4.1 million in 1989 to 7.2 million in 1993, thereby increasing the production of the two-stroke engine oil from 50 million litres to 100 million litres over the same period. The rapid increase in car population including motorcycles in this short period of time has aggravated the traffic situation up to point which is considered critical at present and has led to the problem of air pollution from vehicle emissions.

The government has made every effort to solve both the traffic and the environmental problem at the same time. Several Acts governing emission control have been issued. Regulations governing the marketing of two-stroke engine oil in the country have been enforced. Since 1991, all two-stroke engine oil marketed in Thailand has been required to pass the established TISI 1040-1991 standard (Attachment 1) and meet all the required specifications especially with regard to the level of white smoke.

The Petroleum Authority of Thailand, as the national oil company and one of the four major oil companies in the country, has a dual function: firstly, to serve as the government mechanism for the control the quality and price of petroleum products in the country for the maximum benefit of the consumers and secondly, to conduct petroleum business in competition with the other major oil companies. Both functions call for an active role in research and development to maintain leadership in product quality and environment and assuring a reasonable price for all consumers.

II. TRENDS IN QUALITY AND DEVELOPMENT

Prior to the year 1991, there was hardly any movement to develop the quality or formulation of two-stroke engine oil and domestic regulations governing quality standards were not available. The API standard (TB and TC) was used as the reference standard for quality and inspection. Inspection work, however, was conducted periodically and only as a field test with the prime emphasis given to lubricity only.

In terms of formulation, two-stroke engine oil produced and marketing during that period was entirely mineral oil based and with the emphasis being on lubricity, approximately 5%-8% Bright Stock was blended in the engine oil. The problem of white smoke occurs when this high level of Bright Stock is mixed with only a small amount of additive, especially low quality additive. Two other significant problems related to the quality of two-stroke engine oil which were also overlooked at that time were power loss due to the exhaust port and muffler blocking and engine stalling or misfiring due to spark plug fouling.

The enforcement of the TISI 1040-1991 standard was the starting point of the two-stroke engine oil quality development in every aspect, especially the reaction energy of the component which is the indicator of the white smoke level from the exhaust pipe. Developments in the technology of formulation during this period completely changed the conventional formulation. The decision not to use Bright Stock was the starting point of reducing the problem of white smoke as well as the problems of spark plug fouling and exhaust system blocking. PIB was accepted as the component with excellent quality in reducing white smoke (low reaction energy) which has higher lubricity quality than that of mineral oil and only slightly lower than that of bright stock. At present, PIB of high molecular weight is therefore selected as one of the components of the two-stroke engine oil in Thailand which may have to be blended up to 30% in order to pass the TISI 1040-1991 standard.

The movement in developing global specification and the introduction of the JASO standard in 1992 (Attachment 2) forced the engine oil traders in Thailand to revise and develop their formulation once again. Most companies started to differentiate their product into 2 quality grades i.e. the lower quality grade at an economical price for the lower market and the higher quality grade or the high performance,low smoke type for the upper market.This movement also helps in building up the image of the two-stroke engine oil in Thailand because the JASO standard has obviously pointed out that the quality of smoke specified in Thailand's TISI standard, when compared with the Japanese standard, is actually of medium standard or equivalent to JASO-FB grade only. The addition of PIB by more than 30% will unnecessarily increase the Production cost.

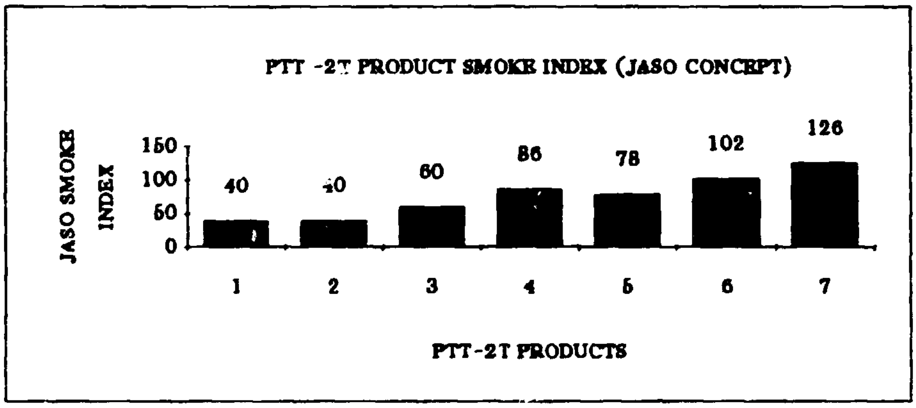
In the future, competition in the two-stroke engine oil in the lower market will be in terms of price while in the upper market, competition will be in terms of performance and high quality, synthetic oil will start to find its place in the market. Some motorcycle manufacturers have introduced a computer system to control oil injection in several high performance, sport type two-stroke engines which evidently gives better lubricity and are more economical besides contributing effectively towards the reduction of white smoke (as high as 50%).

With regard to standards, changes in the future may involve the revision of the TISI 1040-1991 standard to make it more stringent on the level of white smoke emission by upgrading the TISI standard to the equivalent JASO-FC or even higher. Thailand may also move in the direction of using the JASO standard if it is eventually accepted as the global standard. The decision will be based on the comparative study of the advantages and disadvantages of both standards in which the Petroleum Authority of Thailand, as the national oil company, is also involved.

III. PTT'S ROLE IN THE DEVELOPMENT OF LOW EMISSION, TWO-STROKE ENGINE OIL & STANDARDS

As the leading organization in the production and supply of low-smoke, two-stroke or 2T engine oil in Thailand with the pool of expertise available in its Research and Development Center, the Petroleum Authority of Thailand (PTT) has continuously played a significant role in setting the trends and directions for the development of low-smoke 2T engine oil in Thailand which can be highlighted by the following activities:

a) PTT has continuously developed the quality of its two-stroke oil in the market, especially with regard to white smoke. The quality of PTT 2T engine oil is ranked very high under the JASO concept as shown in the following figure:



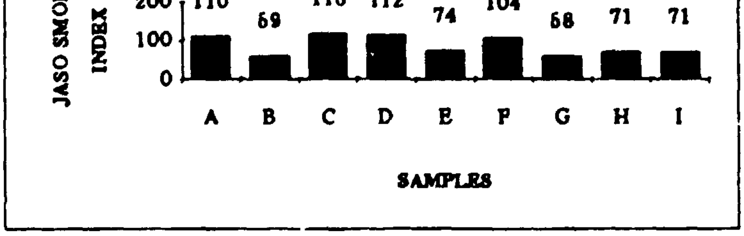
1. PTT 2T (Obsolete 1990)
2. PTT- High Speed 2T (Obsolete 1990)
3. Average Commercial 2T
4. PTT Low-Smoke, High Speed 2T-F1 (Obsolete 1992)
5. PTT Low-Smoke High Speed 2T (Market)
6. PTT THUNDER (Market)
7. PTT GAMMA (New Product - Fully Synthetic Type)

b) PTT conducted research work to determine the appropriate level of PIB which is the major component used for the reduction of white smoke in two-stroke engine oil and submitted a proposal to the Customs Department for consideration in reducing import tax on PIB from 40% to 5%. The effort was a success and contributed significantly towards the government effort in reducing environmental pollution from white smoke.

c) The PTT Research and Development Center was assigned by TISI (The Thai Industrial Standards Institute) to be the certified engine laboratory for conducting tests on both the physical and chemical properties of the 2T engine oil marketed in the country as well as engine performance in accordance with the TISI 1040-1991 standard. Data and information were collected during the period of the testing and loop-holes in the TISI standard as well as the testing method were studied in preparation of the proposal for the revision of this standard which can be expected in 1994.

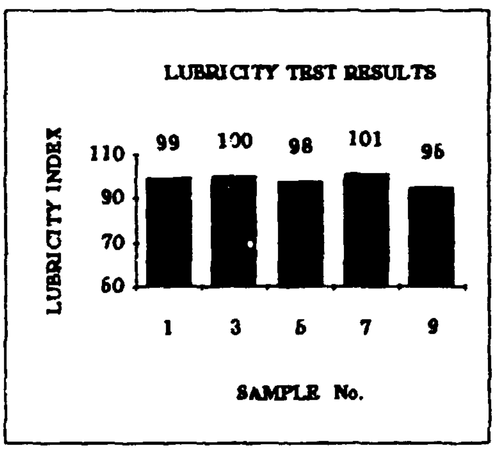
d) PTT has continuously conducted studies on the composition of white smoke and its toxicity. As white smoke emission is chain reaction combustion by product which is unrelated to other types of emission gas in the exhaust pipe and there are very few reports on its toxicity for example irritation in the mucous membrane systems including the eyes and the respiratory system, the PTT Research and Development Center, in cooperation with the Environmental Science Faculty, Asian Institute of Technology (AIT), are therefore conducting a study on the composition and toxicity of white smoke which is expected to be completed by 1995.

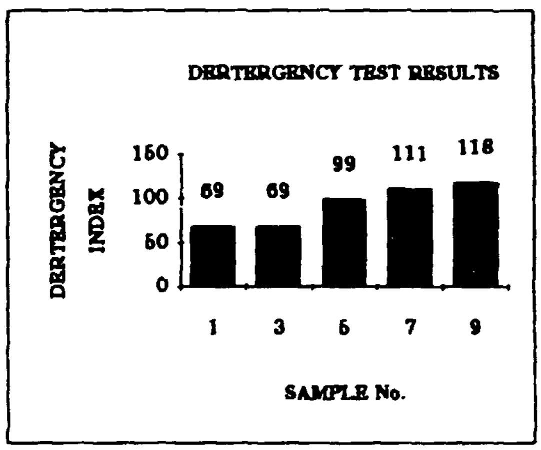
e) After 2 years of consistent research work on the quality of the 2T engine oil with regard to white smoke and the effect of PIB on the volume of white smoke emission as well as other related engine performances for use as reference in the revision and upgrading of the TISI standard, the PTT Research and Development Center has developed a pool of information on the quality of 2T engine oil marketed in Thailand as well as loop-holes in the present TISI standard, particularly with regard to white smoke emission as follows:

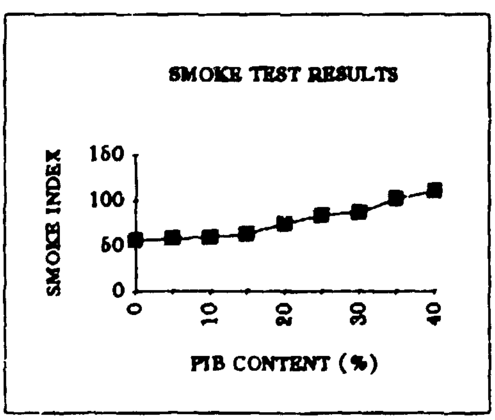


9 Commercial brands of 2T engine oil have passed the smoke test in accordance with the TISI 1040-1991 standard which indicates that more than 50% of the product marketed in Thailand is lower than the JASO-FC standard in terms of smoke level.

In using PIB as the component for the reduction of white smoke, it is essential to study the appropriate molecular weight and volume of PIB used as well as the effect of PIB on the other properties of the 2T engine oil. The PTT Research and Development Center is therefore conducting a detailed study in this respect by comparing differences in the properties of 2T engine oil, when blended with PIB in various proportions, in a total of 9 samples (other components e.g. additive and base oil remain the same). After conducting tests in accordance with the JASO standard concept, the results can be summarized as follows:







Main component of the samples:

1. Base Oil without Bright Stock
2. Dearomatic Solvent
3. PIB of High Molecular Weight (5% Different each Formulation)
4. High Performance Additive Package

According to the study, PIB of high molecular weight has the same lubricity quality as that of Base Oil. However, when blended with more than 20% PIB, the detergency quality in the engine oil becomes evidently remarkable and the level of white smoke emission substantially reduced. The PTT Research and Development Center will submit the result of this study together with other information and data to TISI for consideration in revising the TISI 1040-1991 standard by 1994.

IV. CONCLUSION

The Petroleum Authority of Thailand (PTT) has played a significant role in the development of the two-stroke engine oil in Thailand. Although further changes can be expected, the development of the two-stroke engine oil in Thailand will, undoubtedly, be heading towards higher quality in every respect, especially with regard to white smoke, which is due to the expected revision of the TISI 1040-1991 standard. Thailand may also move to adopt the global standard which has its origin from the JASO standard in the future. With regard to motorcycle technology, the present government regulation restricts the cylinder volume of motorcycles manufactured in the country to not more than 150 cc. but the current technology has made it possible to manufacture motorcycles with as high as 34 horsepower. This new technology may be a problem when the government enforces the motorcycle emission standard, Level 1, in 1993. In the future, when more severe emission standards (Level 2 and 3) are introduced, it is likely that the technology of catalytic converter will be applied. In all circumstances, the Petroleum Authority of Thailand stands side by side with the government for optimum quality, standard and environment for the benefit of the nation and the people as a whole.

Attachment 1

THAI INDUSTRIAL STANDARD FOR TWO STROKE ENGINE OIL
(TISI 1040-1991)

1. STANDARD ENGINE : KAWASAKI KH 125 M
2. CRITERIA : PERFORMANCE REQUIREMENTS

TEST ITEM		EVALUATION	LIMIT
DETERGENCY	STEP 1 (5 HR.)	RING STICKING	MIN 8
		PISTON CLEANLINESS	MIN 48
		EXHAUST PORT BLOCKING	0 %
	STEP 2 (3 HR.)	RING STICKING	MIN 8
		PISTON CLEANLINESS	MIN 35
		EXHAUST PORT BLOCKING	MAX 10 %
LUBRICITY		PISTON & RING SCUFFING	NONE
SMOKE		SMOKE LEVEL	MAX 30 %

Attachment 2

JASO TWO STROKE ENGINE OIL STANDARD

1. STANDARD ENGINE

TEST ITEM	TEST ENGINE
LUBRICITY DETERGENCY	HONDA AF27
EXHAUST SMOKE EXHAUST SYSTEM BLOCKING	SUZUKI GENERATOR SX 800 R

2. CRITERIA : PERFORMANCE REQUIREMENTS

EVALUATING ITEMS	CLASSICIFICATION			JATRE-1
	FA	FB	FC	
LUBRICITY	MIN 90	MIN 95	MIN 95	100
DETERGENCY	MIN 80	MIN 85	MIN 95	100
EXHAUST SMOKE	MIN 40	MIN 45	MIN 85	100
EXHAUST SYSTEM BLOCKING	MIN 30	MIN 45	MIN 90	100

COUNTRY PAPER OF VIETNAM

Ladies and Gentlemen ,

First of all I'd like to introduce myself. I'm Ha, engineer from Vietnam. I'm now working in the Hanoi office for Standardization, Measurement and Quality Control. I'd like to thank UNIDO and the Chinese Communication Minitry for giving me the chance to be present here today to discuss with my colleagues problems of our common concern.

As you know, Vietnam's economy has just entered a new phase of development from a still backward economy; so the quality problems are not so strictly required. However, Vietnam has introduced a system of quality standards. Here I shall discuss automotive fuel standards. Vietnam standards for leaded motor gasoline and diesel are given in table 1 and table 2.

Vietnam has begun to exploit and export crude oil but we have not got any oil refinery so most of automotive fuels and lubricants have to be imported. Before 1990, our main source of oil supplies came from the former Soviet Union, so Vietnam standard (TCVN) were mainly built on the basis of those of the former Soviet Union (GOST). But nowadays, automotive fuels are mainly imported from Asiatic countries, such as Singapore and the Philipines so Vietnam's General Company of petroleum and lubricant (Petrolimex) has defined (by regulations) that the norms set for imported automotive fuels and lubricants must be higher than Vietnam standards. And test methods are to be decided upon TCVN or ASTM in accordance with the conditions of equipment. The general requirements for imported gasoline, diesel and kerosene are given in tables 3 ; 4 ; 5 ; 6.

Most of the imported fuels and lubricants are products of Shell, Castrol, BP, Apolo ... Recently SAE 40 X M lubricant has been produced in Vietnam from materials and on formulas of Shell and its API service classification is SG/CD. In Vietnam SAE (Society of Automotive Engineers) and API (American Petroleum Institute) are now being introduced to users.

However, modern world's trend today is that the quality of petroleum products must meet the strict requirement for environmental protection. So suitable standards are now being set in Vietnam in accordance with the trend of development in order that Vietnam petroleum products can be sold on the international commercial market. Forecasts of target requirement for automotive fuel are given in table 7.

Qualities of Vietnam petroleum products will be developed as follows :

- For gasoline : Octane index should meet the requirement of generations of modern engines, lead and aromatics content should be reduced to satisfy the standards of environmental protection.
- For kerosene : the sulfur content will be reduced to the minimum and the smoke point is kept to a minimum.

- For diesel : the sulfur content should be reduced and the Cetane index increases in order to satisfy the requirements of environment and engine.

- For lubricant : Due to the allsidedness and the competition on the lubricant market, such qualities of lubricant as visconsity and long life must be higher.

And as you know, the degree of environmental pollution does not only depend on the quality of the fuel but on the kind of engine that uses it as well. In Vietnam most of the vehicles were made before 1970 and do not have any form of pollution control equipment fitted and they use leaded gasoline, diesel, mazout and even kerosene, which has left us a great deal of environmental problems to solve.

The quality of fuels and the type of engines affect the consumption of fuels. The consumption of diesel fuel is considerably higher than that of gasoline. Due to insufficient data, we can only give here an overall forecast of fuel consumption in Vietnam from 1993 to 2000 in table 10.

Current fuel and lubricant prices, taxes are given in table 11.

But infact the system of quality control of imported fuels is not yet well regulated so low quality and cheap fuels such as gasoline of high sulfur and lead content, even mixture of naphta and product of petroleum have been imported and sold to customers. This has badly affected the environment.

In order to solve the problem, Vietnam Petrolimex has defined statute of fuel quality control: This statute relies on the following references :

- Branch standard TCN 16-90. Liquid fuel and lubricants. Quality management.
- Branch standard TC N 14-90. Liquid fuel and lubricants. Regulation on delivery.
- Laws on quality of goods. Hanoi 1991
- Standards for quality of petrol products and lubricant.
- TCN 1-1994. Draft TCN worked out by the Ministry of Commerce on security against poison on contact with leaded gasolines

The statute consists of :

- Regulation on imported and exported fuels and their circulation in Vietnam.
- Regulation of fuel quality procedures : Regular test, sampling, requirement and test method, analytic method.
- Regulation on transport, contain and preservation of liquid petroleum products.
- Regulation to deliver and receive.
- Regulation to settle bad quality fuels.
- Discharged and reprocessed oil.
- Direction on use of petrol.
- Management procedures.

Nowadays, apart from small private "oil-selling spots" over 1000 filling stations have been opened by Petrolimex offering State-Standard quality petrol of reasonable prices and quick service. A network of quality control laboratories has also been set up, of which two have been recognized to be of State level.

With this, I'd like to end my report on the subject : Automotive fuel quality standards and their efffect on Motor Vehicle Emission in Vietnam.

Thank you for your attention.

Table 1. LEADED MOTOR GASOLINE FOR VIETNAM (TCVN 5690-92)

No	Property	Limiting values			Test method TCVN
		Regular	Premium	Super	
1	2	3	4	5	6
1	Octane number				
	- Research octane number, RON	83	92	98	2703-78
	- Motor octane number, MON	76	83 - 83	89	2702-78
2	Lead, g Pb/l, max	0,15	0,4	0,4	4274 - 86
3	Distillation				2689 - 78
	- First boiling point , ^{o}C, min	40	40	35	
	- 10% VOL, ^{o}C, max	75	75	70	
	- 50% VOL, ^{o}C, max	120	120	115	
	- 90% VOL, ^{o}C, max	185	185	180	
	- FBP, ^{o}C, max	205	205	195	
	- Residue, % VOL, max	1,5	1,5	1,5	
	- Residue and loss, % VOL, max	4	4	4	
4	Copper strip corrosion, (3h at 50^{o}C), class.	N-1	N-1	N-1	2694 - 78
5	Gum (solvent washed), mg/100ml, max				3178 - 79
	- For import	4	4	4	
	- For use	10	7,0	7,0	
6	Vapour pressure at 37,8^{o}C, kPa	67	67	74	3790 - 78
7	Sulfur content % (m/m), max	0,15	0,15	0,10	2708 - 78
8	Acid number, mg KOH/100ml, max	3	3	3	2695 - 78
9	Sediment and water, % (m/m)	None	None	None	2706 - 78
10	Oxidation stability, min, min	480	480	480	3791 - 83
11	Density at 20^{o}C, g/cm^3				3893 - 84

Table 2. AUTOMOTIVE DIESEL FUELS FOR VIETNAM (TCVN 5689 - 92)

No	Property	Test method TCVN	Limiting values	
			Regular	Premium
1	2	5	3	4
1	Cetane index, min	3180-79	45	50
2	Distillation temperature, ^{o}C, max	2698 - 78		
	- 50% VOL		290	290
	- 90% VOL		370	370
3	Kin Viscosity at $20^{o}C$, mm^2/s	3171 - 79	3,5 - 6,0	4,5 - 8.0
4	Flash point, ^{o}C, min	2693 - 78		
	- For regular		50	65
	- For super		65	70
5	Pour point	3753 - 83		
	- In Winter (Northern Province) from 1st October to 31st March		-5	-5
	- In Summer from 1st April to 30th April		-5	-5
6	Ash, % (m/m), max	2690 - 78	0,02	0,02
7	Sediment, % (m/m)	2706 - 78	None	None
8	Water, % (m/m)	2692 - 78	None	None
9	Gum (solvent washed), mg/100ml, max,	3178 - 79	50	50
10	Total sulfur, % (m/m), max	2708 - 78	1,0	1,0
11	Sulfur in Mercaptan, % (m/m)	2685 - 78	0,01	0,01
12	Ramsbottom carbon residue on 10% distillation residue, % mass, max	2704 - 78	0,30	0,30
13	Copper strip corrosion (3h at $50^{o}C$), max	2694 - 78	N - 1	N - 1
14	Acid number, mg KOH/100ml	2695 - 78	10	10
15	Density at $20^{o}C$, g/cm^3	3893 - 84	0,86	0,86

Table 3. REQUIREMENTS FOR IMPORTED LEADED MOTOR GASOLINE

No	Property	Test method ASTM	Limits
1	2	3	4
1	Octane number		
	- Motor octane number (MON)	D 2700	min 76
	- Research octane number (RON)	D2966	min 83
2	Lead. g Pb/l	D 2547	max 0.13
3	Distillation temperature, ^{o}C	D 86	
	- First boiling point		min 35
	- 10% VOL		max 75
	- 50% VOL		max 120
	- 90% VOL		max 185
	- Final boiling point		max 200
	- Residue, % VOL		max 1,5
	- Residue and loss, % VOL		max 4,0
4	Copper strip corrosion (3h at $50^{o}C$), class	D 130	max N - 1
5	Gum (solvent washed) mg/100ml	D 381	max 4,0
6	Vapour pressure at $37,8^{o}C$, kPa	D 323	max 40
7	Sulfur content, % (m/m)	D1266	max 0,1
8	Acid number, mg KOH / 100 ml	D 974	max 3,0
9	Sediment and water, % (m/m)	D 2709	None
10	Oxidation stability, min	D525	min 400
11	Density at $15^{o}C$. g/cm^3	D 1298	max 0,74

Table 4. REQUIREMENTS FOR IMPORTED DIESEL

No	Property	Test method ASTM	Limits
1	2	3	4
1	Cetane number		min 48
2	Distillation temperature. ^{o}C	D 86	max
	- 50% VOL		290
	- 90% VOL		370
3	Kin Viscosity at $20^{o}C$. mm^2/s	D 445	min 2,7
			max 5,0
4	Flash point, ^{o}C	D 93	min 50
5	Pour point ^{o}C	D 97	max -9
6	Ash, % (m/m)	D 482	max 0,02
7	Sediment, % (m/m)	D 2709	None
8	Water, % (m/m)	D 95	0,05

1	2	3	4
9	Gum (solvent washed), mg/100ml	D 381	max 50
10	Sulfur content, % (m/m)	D 1551	max 1,0
11	Sulfur in Mercaptan, % (m/m)	D 3223	max 0,01
12	Ramsbottom carbon residue on 10% distillation residue, % mass	D 189	max 0,3
13	Copper strip corrosion (3h at 50^{O}C)	D 130	max N - 1
14	Acid number, mg KOH/100ml	D 3242	max 10
15	Density at 15^{O}C, g/cm^{3}	D 1293	max 0,84
16	Colour, ASTM	D 1500	max N - 2

Table 5. REQUIREMENTS FOR IMPORTED KEROSENE

No	Property	Limit	Test method ASTM
1	2	3	4
1	Density at 15^{O}C, g/cm^{3}, max	0,815	D 1298
2	Distillation		D 86
	- First boiling point, ^{O}C, min	150	
	- Final boiling point, ^{O}C, max	300	
3	Flash point, ^{O}C	40	D 93
4	Sulfur content, % (m/m), max	0,1	D 129
5	Smoke point, mm	20 -25	D 1322

Table 6. REQUIREMENTS FOR IMPORTED MAZOUT

No	Property	Limit	Test method ASTM
1	2	3	4
1	Kinematic viscosity		D 445
	- At 50^{O}C, cst	120 - 160	
2	Flash point, Tag closed tester, ^{O}C, min	85	D 93
3	Sulfur content, % (m/m), max	2,5	D 129
4	Water, % (m/m)	0,5 - 1,0	D 95
5	Pour point, ^{O}C, max	+ 10	D 97
6	Density at 15^{O}C, g/cm^{3}	0,95 - 0,98	D 1298
7	Ash, % (m/m), max	0,1	D 482
8	Carbon residue, % (m/m), max	12	D 189
9	Caloricity, kcal/kg, min	10200	D 240
10	Sediment, % (m/m)	0,25	D 473

Table 7. FORECASTING QUALITY STANDARD FOR LEADED MOTOR GASOLINE

No	Property	Units	Test method ASTM	Premium		Regular	
				2000-2005	2005-2010	2000-2005	2005-2010
1	2	3	4	5	6	7	8
1	Research octane number, RON	min	D 2966	93	95	85	87
2	Lead, max	g/l	D 2547		None	0.15	None
3	Vapour pressure at 37.8°C (RVP)	mBar max	D 323	600	550	600	550
4	Sulfur content	% (m/m) max	D 1266	0,15	None	0.15	None
5	Benzene	% VOL max	D 4420	3,5	2,0	-	-
6	Aromatics	% VOL max	D 4420	50	35	-	-

Table 8. FORECASTING QUALITY STANDARD FOR KEROSENE

No	Property	Unit	Test method ASTM	2000 - 2005	2005 - 2010
1	Sulfur content	% (m/m) max	D 4294	0,15	0,10
2	Flash point	°C, min	D 93	40	40
3	Smoke point	mm	D 1322	23	23
4	Gum (solvent washed)	mg/ 100ml	D 381	1,0	1,0
5	Colour, SAYBOLT	min	D 156	+ 16	+ 16

Table 9. FORECASTING QUALITY STANDARD FOR DIESEL

No.	Property	Units	Test method ASTM	2000 - 2005		2005 - 2010	
				D1	D2	D1	D2
1	2	3	4	5	6	7	8
1	Cetane index	min	D 976	45	50	48	55
2	Sulfur content	% (m/m) max	D 1551	0,3	0,3	0.05	0.05
3	Pour point	°C	D 97	0	0	0	0
4	Flash points	°C, min	D 93	60	60	60	60
5	Density	g/l	D 1298	0,81 - 0,89	0,81 - 0,89	0,81 - 0,89	0,81 - 0,89

Table 10. FORECASTING CONSUMPTION OF FUELS

Years	Gasoline (10^3ton)	Kerosene (10^3ton)	Diesel (10^3ton)	Diesel (10^3ton)
1993	800,91	288,83	1323,95	65,38
1994	844,27	241,22	1395,63	68,92
1995	902,83	257,95	1492,43	73,70
1996	971,43	277,55	1605,83	79,30
1997	1049,58	299,88	1735,02	85,68
1998	1130,19	322,91	1868,27	92,26
1999	1232,35	352,10	2037,15	100,60
2000	1349,95	385,70	2231,55	110,20

Table 11. TAXES AND PRICES

No	Individual items	Prices	Taxes (%)
1	Car petroleum		40
	- Mogas 83	2600 d/l	
	- Mogas 93	2900 d/l	
2	Diesel oils	2200 d/l	13
3	Mazout		6
4	Kerosene	2700 d/l	4
5	Lubricant for diesel and petroleum engines		4
	- Shell	85000d / 5l (can)	
		14000d/0,7l (can)	
		19000d/l(can)	
	- Castrol	85000d/5l (can)	
		125000d/0,7l(can)	
	- BP	20000d/l (can)	
	- AK	6000d/l(can)	
	- Apolo	12000d/l (can)	
	- SAE 40 W (VIDAMO)	17500d/l	

Table 1. LEADED MOTOR GASOLINE FOR VIETNAM (TCVN 5690-92)

No	Property	Limiting values			Test method TCVN
		Regular	Premium	Super	
1	2	3	4	5	6
1	Octane number				
	- Research octane number, RON	83	92	98	2703-78
	- Motor octane number, MON	76	83 - 83	89	2702-78
2	Lead, g Pb/l, max	0,15	0,4	0,4	4274 - 86
3	Distillation				2689 - 78
	- First boiling point , ^{o}C, min	40	40	35	
	- 10% VOL, ^{o}C, max	75	75	70	
	- 50% VOL, ^{o}C, max	120	120	115	
	- 90% VOL, ^{o}C, max	185	185	180	
	- FBP, ^{o}C, max	205	205	195	
	- Residue, % VOL, max	1,5	1,5	1,5	
	- Residue and loss, % VOL, max	4	4	4	
4	Copper strip corrosion, (3h at 50^{o}C), class.	N-1	N-1	N-1	2694 - 78
5	Gum (solvent washed), mg/100ml, max				3178 - 79
	- For import	4	4	4	
	- For use	10	7,0	7,0	
6	Vapour pressure at 37,8^{o}C, kPa	67	67	74	3790 - 78
7	Sulfur content % (m/m), max	0,15	0,15	0,10	2708 - 78
8	Acid number, mg KOH/100ml, max	3	3	3	2695 - 78
9	Sediment and water, % (m/m)	None	None	None	2706 - 78
10	Oxidation stability, min, min	480	480	480	3791 - 83
11	Density at 20^{o}C, g/cm^3				3893 - 84

Table 2. AUTOMOTIVE DIESEL FUELS FOR VIETNAM (TCVN 5689 - 92)

No	Property	Test method TCVN	Limiting values	
			Regular	Premium
1	2	5	3	4
1	Cetane index, min	3180-79	45	50
2	Distillation temperature, ^{o}C, max	2698 - 78		
	- 50% VOL		290	290
	- 90% VOL		370	370
3	Kin Viscosity at $20^{o}C$, mm^2/s	3171 - 79	3,5 - 6,0	4,5 - 8.0
4	Flash point, ^{o}C, min	2693 - 78		
	- For regular		50	65
	- For super		65	70
5	Pour point	3753 - 83		
	- In Winter (Northern Province) from 1st October to 31st March		-5	-5
	- In Summer from 1st April to 30th April		-5	-5
6	Ash, % (m/m), max	2690 - 78	0,02	0.02
7	Sediment, % (m/m)	2706 - 78	None	None
8	Water, % (m/m)	2692 - 78	None	None
9	Gum (solvent washed), mg/100ml, max,	3178 - 79	50	50
10	Total sulfur, % (m/m), max	2708 - 78	1,0	1.0
11	Sulfur in Mercaptan, % (m/m)	2685 - 78	0,01	0.01
12	Ramsbottom carbon residue on 10% distillation residue, % mass, max	2704 - 78	0,30	0.30
13	Copper strip corrosion (3h at $50^{o}C$), max	2694 - 78	N - 1	N - 1
14	Acid number, mg KOH/100ml	2695 - 78	10	10
15	Density at $20^{o}C$, g/cm^3	3893 - 84	0,86	0.86

Table 3. REQUIREMENTS FOR IMPORTED LEADED MOTOR GASOLINE

No	Property	Test method ASTM	Limits
1	2	3	4
1	Octane number		
	- Motor octane number (MON)	D 2700	min 76
	- Research octane number (RON)	D2966	min 83
2	Lead. g Pb/l	D 2547	max 0.13
3	Distillation temperature, ^{o}C	D 86	
	- First boiling point		min 35
	- 10% VOL		max 75
	- 50% VOL		max 120
	- 90% VOL		max 185
	- Final boiling point		max 200
	- Residue, % VOL		max 1,5
	- Residue and loss, % VOL		max 4,0
4	Copper strip corrosion (3h at 50^{o}C), class	D 130	max N - 1
5	Gum (solvent washed) mg/100ml	D 381	max 4,0
6	Vapour pressure at 37,8^{o}C, kPa	D 323	max 40
7	Sulfur content, % (m/m)	D1266	max 0,1
8	Acid number, mg KOH / 100 ml	D 974	max 3,0
9	Sediment and water, % (m/m)	D 2709	None
10	Oxidation stability, min	D525	min 400
11	Density at 15^{o}C. g/cm^3	D 1298	max 0,74

Table 4. REQUIREMENTS FOR IMPORTED DIESEL

No	Property	Test method ASTM	Limits
1	2	3	4
1	Cetane number		min 48
2	Distillation temperature, ^{o}C	D 86	max
	- 50% VOL		290
	- 90% VOL		370
3	Kin Viscosity at 20^{o}C, mm^2/s	D 445	min 2,7
			max 5,0
4	Flash point, ^{o}C	D 93	min 50
5	Pour point ^{o}C	D 97	max -9
6	Ash, % (m/m)	D 482	max 0,02
7	Sediment, % (m/m)	D 2709	None
8	Water, % (m/m)	D 95	0,05

1	2	3	4
9	Gum (solvent washed), mg/100ml	D 381	max 50
10	Sulfur content, % (m/m)	D 1551	max 1,0
11	Sulfur in Mercaptan, % (m/m)	D 3223	max 0,01
12	Ramsbottom carbon residue on 10% distillation residue, % mass	D 189	max 0,3
13	Copper strip corrosion (3h at 50^{O}C)	D 130	max N - 1
14	Acid number, mg KOH/100ml	D 3242	max 10
15	Density at 15^{O}C, g/cm^3	D 1293	max 0,84
16	Colour, ASTM	D 1500	max N - 2

Table 5. REQUIREMENTS FOR IMPORTED KEROSENE

No	Property	Limit	Test method ASTM
1	2	3	4
1	Density at 15^{O}C, g/cm^3, max	0,815	D 1298
2	Distillation		D 86
	- First boiling point, ^{O}C, min	150	
	- Final boiling point, ^{O}C, max	300	
3	Flash point, ^{O}C	40	D 93
4	Sulfur content, % (m/m), max	0,1	D 129
5	Smoke point, mm	20 -25	D 1322

Table 6. REQUIREMENTS FOR IMPORTED MAZOUT

No	Property	Limit	Test method ASTM
1	2	3	4
1	Kinematic viscosity		D 445
	- At 50^{O}C, cst	120 - 160	
2	Flash point, Tag closed tester, ^{O}C, min	85	D 93
3	Sulfur content, % (m/m), max	2,5	D 129
4	Water, % (m/m)	0,5 - 1,0	D 95
5	Pour point, ^{O}C, max	+ 10	D 97
6	Density at 15^{O}C, g/cm^3	0,95 - 0,98	D 1298
7	Ash, % (m/m), max	0,1	D 482
8	Carbon residue, % (m/m), max	12	D 189
9	Caloricity, kcal/kg, min	10200	D 240
10	Sediment, % (m/m)	0,25	D 473

Table 7. FORECASTING QUALITY STANDARD FOR LEADED MOTOR GASOLINE

No	Property	Units	Test method ASTM	Premium		Regular	
				2000-2005	2005-2010	2000-2005	2005-2010
1	2	3	4	5	6	7	8
1	Research octane number, RON	min	D 2966	93	95	85	87
2	Lead, max	g/l	D 2547		None	0.15	None
3	Vapour pressure at 37.8°C (RVP)	mBar max	D 323	600	550	600	550
4	Sulfur content	% (m/m) max	D 1266	0.15	None	0.15	None
5	Benzene	% VOL max	D 4420	3,5	2,0	-	-
6	Aromatics	% VOL max	D 4420	50	35	-	-

Table 8. FORECASTING QUALITY STANDARD FOR KEROSENE

No	Property	Unit	Test method ASTM	2000 - 2005	2005 - 2010
1	Sulfur content	% (m/m) max	D 4294	0,15	0,10
2	Flash point	°C, min	D 93	40	40
3	Smoke point	mm	D 1322	23	23
4	Gum (solvent washed)	mg/ 100ml	D 381	1,0	1.0
5	Colour, SAYBOLT	min	D 156	+ 16	+ 16

Table 9. FORECASTING QUALITY STANDARD FOR DIESEL

No.	Property	Units	Test method ASTM	2000 - 2005		2005 - 2010	
				D1	D2	D1	D2
1	2	3	4	5	6	7	8
1	Cetane index	min	D 976	45	50	48	55
2	Sulfur content	% (m/m) max	D 1551	0,3	0.3	0.05	0.05
3	Pour point	°C	D 97	0	0	0	0
4	Flash points	°C, min	D 93	60	60	60	60
5	Density	g/l	D 1298	0.81 - 0.89	0.81 - 0.89	0.81 - 0.89	0.81 - 0.89

Table 10. FORECASTING CONSUMPTION OF FUELS

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