Motor vehicle emission regulations and fuel specifications appendix to part 1 2004/2005 update

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ABSTRACT

This appendix must be read in conjunction with **Report No. 5/06**. It employs the same structure and heading numbers as the "Part 1" report, but the headings are preceded by the letter "A" to identify their location in the appendix. It summarises background details to changes in worldwide legislation and regulations governing motor vehicle emissions, fuel specifications and fuel consumption. CONCAWE have adopted this structure to avoid overloading **Report No. 5/06** with material which, whilst important, may not be of interest to the general reader.

KEYWORDS

Appendix to Part 1 (report no. 5/06), vehicle emissions, legislation, automotive fuels, specifications

CONTENTS

INTRODUCTION – HOW TO USE THIS APPENDIX

This report collects together in one place the most important worldwide laws and regulations relating to motor vehicle emissions and automotive fuel specifications. The amount of material to be covered has increased steadily over the years, and this led to a bulky report which was becoming difficult to use and time-consuming to update. As a consequence it was decided in 1996 to divide the report into two sections, as described below:

- **Part 1 described current and future automotive emissions legislation and fuel quality regulations.**
- **Part 2 provided additional details of current and future legislation, plus information of a more historic nature.**

This approach served CONCAWE well for ten years, but it became apparent that:

- The size of both Parts 1 and 2 was increasingly unmanageable.
- Part 2 was over-complicated as it included current and future background material, plus historical information.

In 2006 it was therefore decided that a more radical approach was required:

Part 1 Report	A description of the most important current and future automotive emissions legislation and fuel quality regulations.
Part 1 Appendix	Background information relating to current and future automotive emissions legislation and fuel quality regulations.
Part 2 Report	Historical information, covering outdated legislation and fuel specifications for the period under review.

As a further innovation, the Part 1 Appendix and Part 2 Report have been published on CD-ROM and are included inside the back cover of the Part 1 Report.

All countries from which information is available are included. To make the document easier to use, the amount of background information contained in Part 1 has been limited wherever possible. References to the more comprehensive information contained in the Appendix are included where appropriate. References to sections and tables in the Appendix will contain the prefix "A"; where there is no prefix, the reference will be found in Part 1.

The Appendix must be read in conjunction with the Part 1 Report (No 5/06). The two documents contain all current and new information collected since the publication of Report No. 9/04 and therefore replace previous versions of Part 1.

Part 2 now contains historical data only.

Part 2 is a comprehensive reference document to be used in conjunction with Part 1. It is arranged in exactly the same format as the Part 1 Report and the Appendix, but each Section, Sub-section, Table and Figure Number is prefixed “B”, to signify that it is located in Part 2.

Two innovations were introduced in the last edition with the objective of improving its accessibility:

- Information is now presented on a regional or country-by-country basis
- Where possible, data tables have been grouped together so that readers can readily locate data without having to read the explanatory text.

The format is therefore as follows:

Regional/Country Format

Section	Region/Country
European Region	
1	European Union (including all national adaptations of EU legislation and local regulations)
2	Other European countries, Turkey and Russia
The Americas	
3	US (Federal States)
4	US (California)
5	Canada
6	Central & South America
Far East, Middle East & Africa	
7	Japan
8	Australasia
9	Rest of Asia
10	Middle East and Africa

Two further sections complete the report:

11. World-Wide Harmonization of Test Cycles.
12. Glossary of terms and definitions of the vehicle classifications employed in European and US legislation.

Sub-Section Format

Sub-Section	Subject
1	Emissions Legislation
2	Fuel Specifications
3	Test Procedures
4	Reference Fuels
5	Fuel Consumption & CO_2
6	In-Service Emissions Legislation

Part 1 is kept up to date with regular revisions and this version replaces Report Number 9/04. The title, "**2004/2005 Update**", reflects the actual period under

review, i.e. late 2004 to late 2005 inclusive. CONCAWE, as a European organization, has focused on providing detailed information for Europe. Much attention has also been paid to the United States and Japan as their legislation also influences worldwide trends. Every effort is made to document information from other countries - however, details for some countries are unavailable or the data obtained are often not as complete as that for Europe. Input from readers of this report is always welcomed.

Readers with information which they feel could usefully be incorporated in this report should contact the CONCAWE Secretariat:

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A.1. EUROPEAN UNION

A.1.1. VEHICLE EMISSION LIMITS

A review of prior legislation is given in **Part 2**, **Section B.1.1**. Details of relevant test cycles will be found in this **Appendix**, **Section A.1.3**.

A.1.1.1. Passenger Cars and Light Commercial Vehicles - EU Directive 98/69/EC

The limit values are detailed in the main body of **Part 1**, **Section 1.1.1**.

A.1.1.2. Passenger Cars and Light Commercial Vehicles - "Euro 5" Emissions Proposals

The limit values are detailed in the main body of **Part 1**, **Section 1.1.2**.

A.1.1.3. Heavy Duty Vehicle Emissions - EU Directive 1999/96/EC

The limit values are provided in **Part 1**, **Section 1.1.3**.

Gas Engines

The difficulties experienced by gas engines in following the ETC test cycle were reflected in Directive 2001/27/EC of 10 April 2001, which states that:

> *"While gas engines are able to achieve the emission limits mandated in Directive 1999/96/EC, certain models, by virtue of their design, have difficulty complying with the test cycle validity criteria with respect to the accuracy of response to the changes in speed, torque and power demanded by the European Transient Cycle (ETC). To help stimulate the development of the market for gas-fuelled vehicles, it is appropriate to allow, for gas engines only, a modification of the statistical criteria which assesses the validity of the type-approval test. The development of gas engine technology should be reviewed in the future to confirm or modify this allowance for gas engines."*

Type approval for gas-powered vehicles is complex and further details will be found in **Part 2**, **Section B.1.4.7**.

Other Provisions

The EU Commission has to submit further proposals to the European Parliament and the Council. The proposals must take account of:

- The development of compression ignition engine and gas engine emission control technology including the after treatment technology, taking into account the interdependence of such technology with fuel quality,
- The need to improve the accuracy and repeatability of the current measurement and sampling procedures for very low levels of particulates from engines,
- The development of a worldwide harmonised test cycle for type approval testing.

The initial proposals were to be made by 31 December 2000 and were to include:

– Rules laying down the introduction of an OBD system for heavy duty vehicles from 1 October 2005,
– Provisions on the durability of emission control devices with effect from 1 October 2005,
– Provisions to ensure the conformity of in-service vehicles in the type-approval procedure for vehicles with effect from 1 October 2005,
– Appropriate limits for pollutants currently non-regulated as a consequence of the introduction of alternative fuels.

The EU Commission reported on progress in negotiations for a worldwide harmonised test cycle in December 2001.

By 30 June 2002 the EU Commission was to submit a report to the European Parliament and the Council on requirements for the operation of an on-board monitoring (OBM) system. On the basis of this report the EU Commission was to submit a proposal for measures to enter into force no later than 1 January 2005 to include the technical specifications and corresponding annexes in order to provide for the type-approval of OBM systems.

The EU Commission was to consider by 31 December 2002, available technology with a view to confirming the mandatory NOx standard for 2008. Their report to the European Parliament and Council was to be accompanied, if necessary, by appropriate proposals. Neither of these proposals have yet been published.

The "Split Level" HD Draft Directive

The so-called "Split-Level" draft directive is the second stage of the recasting of Council Directive 70/156/EEC. Once adopted, it will repeal and replace Directive 70/156/EEC. Since 1970, Directive 70/156/EEC has been the main legal instrument available to the European Community to implement the single market in the automobile sector.

The Commission now believes that the time has come to take a further step forward and extend the principles hitherto developed for other categories of vehicles to include commercial vehicles as well. Over time, Directive 70/156/EEC has undergone more than 18 amendments necessary to adapt it to a sector, which is in a permanent state of flux. Consequently, it needs to be made more readable by being rewritten. This is particularly relevant, given that the European Community is embracing new members, and in the light of the fact that a major global agreement on the establishing of international technical regulations has been concluded in Geneva.

Besides all the technical aspects, the proposed directive will lay down the necessary provisions concerning the introduction of a new 'split-level' approach to the regulatory work. If this approach is introduced, the adoption of very complex pieces of legislation would be facilitated. Recent experiences have shown that the inclusion of detailed, advanced technical provisions alongside the essential features in a single directive risks slowing down the adoption procedures.

Consequently, while it is for the European Parliament and the Council to decide on the essential requirements of a regulatory act, it is proposed that the Commission, assisted by a regulatory committee, be entrusted with establishing the detailed technical provisions and practical implementation measures.

A.1.1.4. Motorcycle Emission Standards

Earlier emission limits for motorcycles and mopeds are set out in the so-called multi-directive 97/24/EC of 17 June 1997. This legislation completed the implementation of previous separate directives with regards to motorcycles and mopeds. Since 17 June 1999 EU type approval for motorcycles and mopeds has been mandatory. Details will be found in **Part 2**, **Section B.1.1.3**.

Under Article 5 of Directive 97/24/EC, the Commission was required to submit, within 24 months from the date of adoption of the Directive, a proposal for more stringent limit values and a subsequent stage aimed at further tightening of the limit values. The action was limited to motorcycles, since tighter limit values for mopeds, applied from 17 June 2002, were provided in Directive 97/24/EC. The new regulations were published as Directive 2002/51/EC on 19 July 2002. Amendments to the type approval test were subsequently published in Directive 2003/77/EC, dated 11 August 2003. The limit values are detailed in **Section 1.1.4** of **Part 1**.

The EU Commission were to have published proposals for further amendments to proposed emissions legislation by 1 January 1997 and for this purpose the MVEG issued a mandate to ACEM (the Association of European Motorcycle Manufacturers) to conduct a motorcycle emissions study. The mandate was given in June 1996, for programme completion by January 1998. An emissions research study was then conducted by ACEM members utilising various engine configurations. The objective was to provide an assessment of the cost effectiveness of various measures to reduce motorcycle emissions, consistent with EU air quality objectives. Both technical and non-technical measures (comparable to those studied in the Auto/Oil programme) were taken into account.

Approximately fifty vehicles, representing all types of motorcycles, were tested according to the ECE 40.01 driving cycle. Baseline emissions testing, without emissions control systems, was first conducted. Various emission control technologies were then applied and repeat testing was carried out. Changes in fuel parameters were not included in the programme. The study also examined the environmental impact of motorcycles and the cost-benefit ratios of emissions control technology relative to total vehicle cost. As described above, non-technical measures were also considered.

The conclusions reached by ACEM can be summarised as follows:

- Motorcycle emissions were estimated to contribute an average of 3.7% to the then current total of CO, HC and NOx emitted by the road transport sector. The introduction of the limits described previously suggested that this contribution would not change up to the year 2010.
- According to the manufacturers, there was little scope for further NOx reductions. The motorcycle contribution to NOx emissions from the road transport sector was very small (<0.5%) and it was argued that a lower limit was unlikely to provide any significant improvement to the overall total. With the exception of three-way catalysts, most technologies to reduce CO and HC emissions created a small increase in NOx emissions.
- The manufacturers also stated that not all the available technologies were suitable for all motorcycles. Both packaging limitations and cost were cited, particularly with respect to small commuter machines.

These results were presented to MVEG in 1998 and various other submissions were put forward in the intervening period, e.g. *"The motorcycle emissions situation. A report to the European Commission"* (R.C. Rijkeboer; TNO, 17 June 1999).

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Future EU Motorcycle Emission Standards - Background Information and Additional Details

A technical feasibility and cost-effectiveness assessment identified a single set of new Type I test limits for all motorcycles. This corresponds to a reduction of 60% for HC and CO for four-stroke motorcycles, and 70% for HC and 30% for CO for two-stroke motorcycles. Further reductions in NOx were not considered feasible for four-stroke motorcycles. For two-stroke motorcycles, the application of direct injection technology, which has the greatest reduction potential in terms of CO and HC, is inevitably linked to a moderate increase in NOx and brings the limit in line with that for four-stroke motorcycles. The EU emission inventory confirms the marginal share of motorcycles in total road transport emissions of nitrogen oxides, so that this slight increase is regarded as acceptable. "Enduro" (similar to off-road motorcycles but equipped to drive on the public highway) and trial motorcycles are only sold in small numbers in Europe. In view of their very small contribution to overall emissions, a temporary derogation should be granted in order to allow manufacturers to introduce appropriate technology.

Tricycles and quadricycles are equipped either with spark ignition or diesel engines. In line with emission limits for passenger cars, each category requires a separate set of limit values. The question of particulate emissions needs to be addressed in the future.

Inspection & Maintenance

To ensure compliance with emission limit values, conformity testing of in-service two- and three-wheel motor vehicles (in-service tests) should be introduced from 1 January 2006. Specific requirements for the correct operation of emission-control devices during the normal life of two or three-wheel motor vehicles should be introduced as from 1 January 2006 for up to 30 000 km. It should also be ensured that operating conditions of two- and three-wheel motor vehicles in use correspond to the settings for the test cycle and that no defeat devices or other by-pass arrangements are used. As two- and three-wheel motor vehicles produce an increasing proportion of total CO_2 emissions from transport sources, CO_2 emissions and/or the fuel consumption of two- and three-wheel motor vehicles should be established as soon as possible and incorporated in the Community strategy for reducing road-transport CO_2 emissions.

Inspection and maintenance are regarded as essential to ensure that emission levels of new vehicles do not exceed acceptable in-use levels. In line with the provisions for passenger cars, the limit for CO content of 4.5 % by volume, should be replaced by requirements to measure and record the necessary data for the purpose of roadworthiness testing.

Tax Incentives

Member States should be allowed, by way of tax incentives, to promote more environmentally advanced technologies on the basis of mandatory emission values. Such incentives should satisfy certain conditions intended to avoid distortions of the internal market. This Directive does not affect Member States' right to include emissions of pollutants and other substances in the basis for calculating road traffic taxes on two- and three-wheel vehicles. Member States may offer fiscal or financial incentives for the retrofitting of older two- and three-wheel motor vehicles, if they thereby meet the limit values contained in this Directive or in the earlier version of Directive 97/24/EC.

Future Test Cycle

A new type-approval test cycle should be introduced which will allow a more representative evaluation of the emissions performance, in test conditions that more closely resemble those encountered by vehicles in use, and which takes into account the difference in driving patterns between small and large motorcycles. Additional development work is in progress in order to support the introduction of a new test cycle (see **Part 1**, **Section.11.2**).

Reference Fuels

The reference fuels used for emission testing should be aligned with those applicable to passenger cars, thereby reflecting the changes in the specifications of market fuel.

A.1.1.5. Non-road Mobile Machinery Emissions

EU Directive 97/68/EC set out Stage I and Stage II emission limits for internal combustion engines installed in non-road mobile machinery. These came into effect between 1998 and 2003 and are reported in **Part 2**, **Section B.1.1.5**.

Introduction

The Commission published a Proposed Directive to amend 97/68/EC as COM(2002) 765 final on 27/12/2002. The European Parliament approved the proposal with some amendments on 21 October 2003. The limits come into force between the end of 2005 and 31 December 2014. The legislation also includes limit values for locomotives, railcars and inland waterway vessels, which are beyond the scope of this report. Details of the emission limits and implementation dates will be found in **Part 1**, **Section 1.1.4**.

Objective

Requirements concerning emissions from compression ignition (CI) engines intended for use in non-road mobile machinery (NRMM) and with an engine power of 18-560 kW are covered by Directive 97/68/EC. The Directive includes two stages of emission standards, both of which had entered into force by 31 December 2003 (depending on the power band). In December 2000, the Commission presented a proposal to include small (19 kW or below) spark-ignition (petrol) engines.

Scope (Power Range) of the Directive

Directive 97/68/EC covers CI engines from 18 kW to 560 kW. The corresponding US legislation covers the power band 19-560 kW. To achieve alignment, the lower limit of 19 kW will be used in Directive 97/68/EC from the dates when Stage III enters into force. A definition of railway locomotives is now to be included in accordance with the corresponding US legislation, which means that small engines used in rail-cars will be covered.

Test Procedure

The current procedure for measuring emissions in Directive 97/68/EC is based on a steady-state test cycle - the ISO C1 8-mode cycle. Most non-road engines are used for applications that are largely transient in nature and world-wide cooperation has resulted in a new transient test cycle. The future Stage IIIB standards for particulate matter will be based on this test procedure. For measurement of gaseous emissions it will be optional for the manufacturer to use either the new transient test cycle or the current steady-state test procedure.

Limit values for Stages III and IV

Stage III limit values are being introduced for NOx as well as for PM. They are based on the best available technology, and applied as feasible to NRMM, taking account of the need for global alignment. Accordingly, the Stage III limit values for gaseous pollutants (Stage IIIA) are basically equivalent to the US Tier III standards for the power bands above 37 kW and to the Tier II standards for power band 19 - 37 kW. The PM limit values (Stage IIIB) for the power bands above 37 kW are based on the assumption that PM traps, or other control technology, will be generally available in the non-road sector if enough time is allowed. The Stage IV limit values were introduced by the European Parliament to reflect projected advances in exhaust after-treatment technologies; Stage IV would also require NOx after-treatment. To ensure that the necessary technology is available, the Commission should review technical progress, with a view to confirming the Stage IIIB and IV emissions limit values and proposing any necessary exemptions not later than the end of 2007.

Implementation Dates for Stages III and IV

For the power band above 37 kW, the Stage IIIA limit values can be implemented (in stages) from 2006, since by then manufacturers will have to meet the requirements of the US market. For Stage IIIB limit values on particulates, a longer lead time is needed and these limit values will enter into force in stages between 2010 and 2012. For power band 19 - 37 kW, the corresponding US legislation is to be implemented in 2004. However, for practical reasons, it is not possible to introduce it into the EU before 2006. A specific issue is implementation dates for constant-speed engines. These are exempt in Directive 97/68/EC. However, following the amendment on spark-ignition engines decided upon by the Council and the European Parliament, they will be covered as of 31 December 2006, which is 3 - 6 years later than for other types of engine. To allow manufacturers reasonable time, the implementation dates for these kinds of engines have been adjusted accordingly.

Fuel Quality

The two stages of emission standards in the current Directive 97/68/EC can be met without any specific fuel quality requirements. To meet the Stage IIIB and IV standards for particulates a low-sulphur fuel (below 50 mg/kg) will have to be used. A separate amendment to Directive 98/70/EC will therefore be proposed by the Commission before the entry into force dates of those limit values.

The reference fuel used for type-approval purposes should reflect the fuel quality used under real operating conditions. Since legislation on market fuels in the Member States differs, the current reference fuel specification is a compromise. The most important parameter - sulphur content - must be between 1000 and 2000 mg/kg. The Stage IIIB and IV limit values for particulate emissions will require the use of low sulphur fuel. To reflect this, a reference fuel, equivalent to the one employed for on-road vehicle, is included (see **Part 1, Section A.1.4**). The manufacturer may use this fuel quality when type-approving engines to meet the Stage IIIB limit values, whether mandatory or voluntary. An intermediate quality reference fuel for Stage IIIA approval is also included.

Durability Requirements

At this initial stage, useful life is defined only for the different categories of engines - 3000 - 5000 hours for engines below 37 kW and 8000 hours for engines of 37 kW or over. Manufacturers are required to establish deterioration factors to be used at the type-approval stage. A further stage, to include in-use compliance checks and recalls, could be addressed in a technical review.

A.1.1.6. Tractor Emissions

Directive 2005/13/EC of 21 February 2005 amended Directive 2000/25/EC regarding the emission of gaseous and particulate emissions from agricultural or forestry tractors engines. The limit values are the same as those defined in the Non-Road Mobile Machinery Directive, described in **Part 1**, **Section 1.1.5**.

A.1.1.7. The Clean Air for Europe Programme - EU CAFÉ: Thematic Strategy on Air Pollution

Full details will be found in **Part 1**, **Section 1.1.7**.

A.1.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

The current requirements and future trends for fuel quality are discussed below. More details of the historical background, relevant tables and specifications will be found in **Part 2**, **Sections B.1.2.1** to **B.1.2.14**.

A.1.2.1. Introduction

EU Directive 98/70/EC (dated 13 October 1998) and published in the Official Journal on 28 December of that year, set out new, stringent specifications for automotive fuels. The first phase was introduced in 2000 and mandatory specifications for 2005 were outlined. A further Directive (2003/17/EC) confirmed the 2005 specifications and introduced a new phased-in requirement for gasoline and diesel fuel with a maximum 10 mg/kg sulphur content (see **Part 1**, **Sections 1.2.2** and **1.2.3**).

A.1.2.2. Fuel Specifications for 2005 - EU Directive 2003/17/EC

The limit values are tabled in **Part 1**, **Section 1.2.2**.

A.1.2.3. European (EN) Standards for Gasoline and Diesel Fuel

The requirements of EU Directives 98/70/EC and 2003/17/EC superseded the gasoline and diesel fuel specifications set out in previous European (EN) standards and these were revised accordingly. Full details will be found in **Part 1**, **Section 1.2.3**.

A.1.2.4. Fuel Quality Monitoring

Member States shall monitor compliance with the standards of gasoline and diesel fuels, on the basis of the analytical methods referred to in EN 228 and EN 590 respectively. The Member States shall establish a fuel quality monitoring system which must comply, as a minimum, with the requirements of a new EN standard (published as EN 14274:2001 (E)). The use of an alternative fuel quality monitoring system may be permitted so long as Member States are able to demonstrate that such a system provides results of comparable quality.

Each year by 30 June the Member States shall submit a summary of national fuel quality data for the preceding calendar year. The first summary was to be submitted by 30 June 2002. The format for this summary shall follow that described in a new EN standard. In addition, Member States shall report the total volumes of gasoline and diesel fuel marketed in their territories and the volumes of unleaded gasoline and diesel marketed which contain less than 10 mg/kg of sulphur. Furthermore, the Member States shall report the geographic extent to which gasoline and diesel fuels containing less than 10 mg/kg of sulphur are marketed within their territory.

EN 14274:2001 (E) is a European Standard which describes a fuel quality monitoring system (FQMS) for assessing the quality of gasoline and automotive diesel fuel marketed in any of the Member States within the European Community. Since the specifications for automotive fuels contain climatic related requirements, the FQMS is to be run twice a year, once during the winter period and once during the summer period. Information about the dates for the summer and winter periods in a specific country shall be taken from the corresponding definitions in the country's National Annex to EN 228 and EN 590. For the purposes of this FQMS, grades of gasoline and diesel fuel that constitute less than 10% of the total amount of gasoline and diesel fuel dispensed in any one country may require separate handling.

The standard defines:

- Fuel grades, country size, fuel dispensing sites, sample sizes, summer and winter periods.

It provides the information required to set up the FQMS, defining:

- Country size, regions, the minimum number of samples for fuel grades with market shares of 10% and above and the minimum number of samples for fuel grades with market shares below 10%.
- The number of dispensing sites to be sampled and identification of dispensing sites is also included and the organisation of sampling, laboratory work and reporting is described.

Annexes describe:

- Acceptance criteria for laboratories to be used in the FQMS
- Formats for the final report
- An analytical section
- FQMS Design
- Establishing the number of samples to be taken
- Precision

EN 14275:2001 (E) is a standard which describes a procedure for the drawing of samples of gasoline and diesel engine fuels from fuel dispensers to be used for FQMS EN 14274. This standard does not cover the sampling of LPG. Organisations carrying out the sampling operation shall be accredited to EN 45004.

It defines:

- Outlet samples, sample containers and closures
- Safety Requirements
- Sampling procedures
- Appointed organizations

A.1.2.5. Other European Specifications for Gasoline and Diesel Fuel

Several countries have adopted more stringent regulations for both gasoline and diesel fuel and these are described in **Part 1**, **Section 1.2.5**.

A.1.2.6. Alternative Fuels

Current and draft EN standards for automotive LPG, ethanol and fatty acid methyl esters will be found in **Part 1**, **Sections 1.2.6.1** to **1.2.6.3**. A number of EU member states have promulgated their own specifications and these are tabulated below.

Table A.1.1 Austrian Specification for Vegetable Oil Methylester Diesel Fuel (Önorm Vörnorm C1190, revised 1 January 1995)

Property	Units	Limits	Test Method
Density @ 15°C	kg/m^3	0.87-0.89	ISO 3675/ASTM D4052
Flash point, PM	ºC	100 min	ÖNORM EN 22719
CFPP (01.04-30.09) (01.10-31.03)	ºC	0 max. -15 max.	ÖNORM EN 116
Kinematic viscosity at 20ºC	mm^2/s	6.5-8.0	ISO 3104
Sulphur content	%m	0.02 max.	ÖNORM EN 24260/ISO 8754
Sulphated Ash	%m	0.02 max.	ÖNORM C 1134
Carbon Residue, Conradson (CCR)	%m	0.05 max.	DIN 51 551
Cetane number		48 min	ISO 5165
Neutralisation value	mg KOH/g	0.60 max.	ÖNORM C 1146
Methanol content	%m	0.20 max.	DIN 51413
Free glycerine	%m	0.02 max.	GLC/enzymatic
Total glycerine	%m	0.24 max.	GLC/enzymatic
Phosphorus content	mg/kg	20 max.	ASTM D 3231

Table A.1.2 French Specification for Fatty Acid Methyl Ester

Property		Units	Limits	Method
Appearance		-	Clear & bright @ 15°C	-
Density @ 15°C		kg/m^3	870-900	NF EN ISO 12185
Viscosity @ 40°C		mm^2/s	3.5-5.0	NF EN ISO 3104
Flash Point	min	°C	100	NF EN 22719
Distillation	min @ 360°C	% v/v	95	ASTM D1160
Water content	max	mg/kg	200	NF T 60-700
Cetane Number	min	-	49	NF M 07-035 (2)
Carbon residue (10% v/v residue on distillation at reduced pressure)	max	% m/m	0.30	NF EN ISO 10370
Neutralisation value	max	mg KOH/g	0.50	NF T 60-702
CFPP	max	°C	-10	NF T 60-105
Ester content	min	% m/m	96.5	NF T 60-703
Methanol content	max	% m/m	0.10	NF T 60-701
Phosphorous content	max	mg/kg	10	NF T 60-705
Alkaline metals content	Sodium (max) or Potassium (max)	mg/kg mg/kg	5.0 5.0	NF T 706-1 NF T 706-2
Iodine Number	max	-	115	NF ISO 3961
Free glycerine content	max	% m/m	0.02	NF T 60-704
Monoglycerides content	max	% m/m	0.80	NF T 60-704
Diglycerides content	max	% m/m	0.20	NF T 60-704
Triglycerides content	max	% m/m	0.20	NF T 60-704
Total glycerine content	max	% m/m	0.25	NF T 60-704

Table A.1.3 Italian Specification for Vegetable Oil Methyl Ester Diesel Fuel

Property	Units	Limits	Test Method
Appearance	Visual	Clear & Bright	
Density	@ 15ºC kg/m^3	0.86-0.90	ASTM D1298/ISO 3675
Flash point	PM ºC, min.	100	ASTM D93
Cloud point	ºC max.	0	ASTM D97
Kinematic viscosity at 40ºC	mm^2/s	3.5-5.0	ASTM D189/ISO 3104
Distillation	ºC		ASTM D86
IBP min.		300	
95% v/v max.		360	
Sulphur content	% m/m max.	0.01	ASTM D1552/ISO 8754
Carbon Residue, Conradson (CCR)	% m/m max.	0.5	ASTM D189/ISO 10370
Water content	ppm	700	ASTM D1744
Saponification number	mg/KOH/g min.	170	NGD G33-1976
Total acidity	mg/KOH/g max.	0.05	ASTM D664
Methanol content	% m/m max.	0.2	GLC
Methyl ester	% m/m min.	98	GLC
Monoglycerides	% m/m max.	0.8	GLC
Diglycerides	% m/m max.	0.2	GLC
Triglycerides	% m/m max.	0.1	GLC
Free glycerine	% m/m max.	0.05	GLC
Phosphorus	ppm max.	10	DGF GIII 16A-89

A new specification for blends of FAME at 20 - 30% v/v in diesel fuel has been published by CUNA. This specification does not modify the tax incentive (for blends of FAME up to 30% v/v), but is aimed at giving a better warranty to consumers.

Table A.1.4 Italy - CUNA NC 637-02 - Specification for Blends of Fatty Acids Methyl Ester (FAME) at 20 - 30% v/v in Diesel Fuel

Characteristic	Unit	Limits Min	Limits Max	Test Method
Appearance		Clear and Bright		Visual
Density at 15°C	kg/m^3	820	860	UNI EN ISO 3675 EN ISO 12185
Cetane Number		51.0	-	UNI EN ISO 5165
Flash Point	°C	>55	-	ISO 2719
Polycyclic aromatic hydrocarbons	% (m/m)	-	11	UNI EN 12916
Sulphur content	mg/kg	-	350 until 31/12/04	UNI EN ISO 14596 EN ISO 20846 EN ISO 20847
		-	50.0 10.0	UNI EN ISO 14596 EN ISO 20846
Distillation				UNI EN ISO 3405
% recovered at 250°C	v/v	-	<65	
% recovered at 350°C	v/v	85	-	
95% v/v recovered at	°C	-	360	
CFPP				UNI EN 116
01/04 - 31/10	°C	-	0	
01/11 - 31/03	°C	-	- 10	
Sulphated ash content	% m/m	-	0.01	ISO 3987
Water content	mg/kg	-	200	UNI EN ISO 12937
Carbon residue (on 10% distillation residue)	% m/m	-	0.30	UNI EN ISO 10370
Total contamination	mg/kg	-	24	UNI EN 12662
Copper strip corrosion (3h at 50°C)	index	Class 1		UNI EN ISO 2160
Lubricity, corrected wear scar diameter (wsd 1.4) at 60°C	μm	-	460	ISO 12156-1
Viscosity at 40°C	mm^2/s	2.00	4.60	UNI EN ISO 3104
Total acidity	mg KOH/g	-	0.18	ASTM D664
Oxidation stability	g/m^3	-	25	UNI EN ISO 12205
Methyl oleate	%	43.0	-	prEN 14331
Methyl lineolate		-	34.0	
Methyl linolenate		-	12.0	
Triglyceride content	% m/m	-	<0.10	UNI 22056
FAME content	% v/v	20.0	30.0	prEN 14078
Iodine value	gI_2/100g	-	120	prEN 14214 Annex B

In the UK, 5% blends of FAME are marketed and higher percentage blends are supplied to some fleets.

In France legislation is in place which can be summarised as follows:

- Blends of up to 5% of vegetable oil methyl esters can be used in automotive diesel fuel without any obligation to advise the consumer, provided it meets the French specification for esters.
- Blends of up to 30% are allowed for “captive fleet” applications (mainly city buses).
- Vegetable oil methyl esters enjoy a very favourable tax incentive to encourage their use in automotive diesel fuel and industrial gas oil.

However, the mandatory minimum limit on oxygen content inferred in French air quality legislation is not being implemented.

The market situation is interesting in that, amongst the available vegetable oil methyl esters, only rapeseed methyl ester (RME) currently meets the required specification. Most of the RME is used in refinery blends at the 5% limit. It is still used in some captive fleet applications at concentrations up to 30%. In 1997, RME represented some 0.7% of the total demand for diesel fuel in France.

In Italy, up to 125 000 t of vegetable oil methyl ester can be placed on the market each year with total duty exemption. This concession allows the ester to be sold at a price comparable to conventional diesel fuel but is not available at retail outlets. The amount of methyl ester to enjoy this tax incentive is renegotiated annually, but for the last 2 or 3 years it has been fixed at 125 000 t/yr.

Biofuels Directive - 2003/30/EC (8 May 2003)

The main provisions of the Directive are described in **Part 1**, **Section 1.2.6**.

Introduction

This Directive aims at promoting the use of biofuels or other renewable fuels to replace diesel or gasoline for transport purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources. Unlike the earlier draft proposals, the final Directive only sets out “indicative national targets”, rather than proscribing a timetable for achieving certain market shares for biofuels.

The transport sector accounts for more than 30 % of final energy consumption in the Community and is increasing. This trend is expected to continue, along with increasing CO_2 emissions. The growth will be greater in percentage terms in the candidate countries following their accession to the European Union. The Commission White Paper “European transport policy for 2010: time to decide” expects CO_2 emissions from transport to rise by 50 % between 1990 and 2010, to around 1113 million tonnes. The main responsibility rests with road transport, which accounts for 84 % of transport-related CO_2 emissions. From an ecological point of view, the White Paper therefore calls for dependence on oil (currently 98 %) in the transport sector to be reduced by using alternative fuels, including biofuels.

The Directive also argues that the greater use of biofuels for transport forms a part of the package of measures needed to comply with the Kyoto Protocol, and of any policy to meet further commitments in this respect.

Increased use of biofuels for transport, without ruling out other possible alternative fuels (e.g. LPG and CNG), is one of the tools by which the Community can reduce its dependence on imported energy, influence the transport fuel market and security of supply in the medium and long term. However, this consideration should not detract in any way from the importance of compliance with Community legislation on fuel quality, vehicle emissions and air quality.

National Indicative Targets

Member States should ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets.

Member States shall monitor the effect of the use of biofuels in diesel blends above 5 % by non-adapted vehicles and shall, where appropriate, take measures to ensure compliance with the relevant Community legislation on emission standards.

In the measures that they take, the Member States should consider the overall climate and environmental balance of the various types of biofuels and other renewable fuels. They may give priority to the promotion of fuels showing a good cost-effective environmental balance, while taking into account competitiveness and security of supply.

Member States shall ensure that information is given to the public on the availability of biofuels and other renewable fuels. For mineral oil/ biofuel, blends which exceed the limit value of 5% FAME or 5% of bioethanol, specific labelling at the point of sales shall be imposed.

Reporting

Member States shall report to the Commission, before 1 July each year, on:

- the measures taken to promote the use of biofuels or other renewable fuels to replace diesel or gasoline for transport purposes,
- the national resources allocated to the production of biomass for energy uses other than transport, and
- the total sales of transport fuel and the share of biofuels, pure or blended, and other renewable fuels placed on the market for the preceding year. Where appropriate, Member States shall report on any exceptional conditions in the supply of crude oil or oil products that have affected the marketing of biofuels and other renewable fuels.

In their first report following the entry into force of this Directive, Member States shall indicate the level of their national indicative targets for the first phase. In the report for 2006, Member States shall indicate their national indicative targets for the second phase.

By 31 December 2006 at the latest, and every two years thereafter, the Commission shall draw up an evaluation report for the European Parliament and for the Council on the progress made in the use of biofuels and other renewable fuels in the Member States. This report shall cover at least the following:

a) the cost-effectiveness of the measures taken by Member States in order to promote the use of biofuels and other renewable fuels;

b) the economic aspects and the environmental impact of further increasing the share of biofuels and other renewable fuels;
c) the life-cycle perspective of biofuels and other renewable fuels, with a view to indicating possible measures for the future promotion of those fuels that are climate and environmentally friendly, and that have the potential of becoming competitive and cost-efficient;
d) the sustainability of crops used for the production of biofuels, particularly land use, degree of intensity of cultivation, crop rotation and use of pesticides;
e) the assessment of the use of biofuels and other renewable fuels with respect to their differentiating effects on climate change and their impact on CO_2 emissions reduction;
f) a review of further more long-term options concerning energy efficiency measures in transport.

On the basis of this report, the Commission shall submit, where appropriate, proposals to the European Parliament and to the Council on the adaptation of the system of targets. If this report concludes that the indicative targets are not likely to be achieved for reasons that are unjustified and/or do not relate to new scientific evidence, these proposals shall address national targets, including possible mandatory targets, in the appropriate form.

Implementation Date

Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive by 31 December 2004 at the latest.

Technical Standards for Biofuels

New types of fuel should conform to recognised technical standards if they are to be accepted to a greater extent by customers and vehicle manufacturers and hence penetrate the market. Difficulties may be encountered in ensuring that new types of fuel meet current technical standards, which, to a large extent, have been developed for conventional fossil fuels. The Commission and standardisation bodies should monitor developments and actively adapt and develop standards, particularly volatility aspects, so that new types of fuel can be introduced, whilst maintaining environmental performance requirements.

Bioethanol and biodiesel, when used for vehicles in pure form or as a blend, should comply with the quality standards laid down to ensure optimum engine performance. It is noted that in the case of biodiesel for diesel engines the standard EN 14214 of on FAME could be applied. Accordingly, the CEN should establish appropriate standards for other transport biofuel products in the European Union.

The Directive suggests that as a minimum, the products listed below shall be considered biofuels:

Table A.1.5 Suggested Biofuel Products

Product	Brief Description
Bioethanol	Ethanol produced from biomass and/or the biodegradable fraction of waste, to be used as biofuel
Biodiesel	Methyl-ester produced from vegetable or animal oil, of diesel quality, to be used as biofuel
Biogas	Fuel gas produced from biomass and/or from the biodegradable fraction of waste, that can be purified to natural gas quality, to be used as biofuel, or wood-gas
Biomethanol	Methanol produced from biomass, to be used as biofuel
Biodimethylether	Dimethylether produced from biomass, to be used as biofuel
Bio-ETBE (ethyl-tertiary-butyl-ether)	ETBE produced on the basis of bioethanol. The percentage by volume of bio-ETBE that is calculated as biofuel is 47%
Bio-MTBE (methyl-tertiary-butyl-ether)	A fuel produced on the basis of biomethanol. The percentage by volume of bio-MTBE that is calculated as biofuel is 36%
Synthetic biofuels	Synthetic hydrocarbons or mixtures of synthetic hydrocarbons, which have been produced from biomass
Biohydrogen	Hydrogen produced from biomass, and/or from the biodegradable fraction of waste, to be used as biofuel
Pure vegetable oil	Oil produced from oil plants through pressing, extraction or comparable procedures, crude or refined but chemically unmodified, when compatible with the type of engines involved and the corresponding emission requirements

Water/Diesel Emulsions - France and Italy

France

An excise duty concession is allowed on water/diesel emulsions, provided that they comply with the following specification:

Table A.1.6 Specification for Water/Diesel Fuel Emulsion - France

Characteristic	**Units**	**Limits**		**Method**
		Min.	**Max.**	
Density @ 15°C	kg/m^3	835	870	NF M 07-096
Water content	% m/m	9.0	15.0	NF M 07-104
Stability by centrifuge after 5 minutes				
Phase separation	% v/v	-	9.0	NF M 07-101
(% sediment after 15 min. - % sediment after 5 min.)/10	% v/v/min.	0.3	-	
Viscosity @ 40°C	mm^2/sec	2.5	7.0	NF M 07-097
Sulphur content [(1)]	mg/kg	-	=[S(100-y)]/100]	NF M 07-100
Copper strip corrosion 3h at 50ºC		Class 1		NF M 07-098
Flash point (Cleveland)	°C	70	-	NF M 07-102
Lubricity, corrected wear scar diameter (wsd 1.4) @ 60°C	µm	-	460	NF M 07-103
CFPP	°C	- -	- 15 (W) 0 (S)	NF M 07-099

(1) S: Sulphur content, expressed in mg/kg for diesel fuel conforming to NF EN 590.
y: Water content of the emulsion, expressed in % m/m

Italy

The Italian National Budget Law of 2000 introduced a reduced rate of excise duty for water/diesel emulsions, effective from the 1 October 2000 until 31 December 2005. The emulsions are only available at commercial sites (not open to the general public) and are only allowed for use in medium and heavy duty vehicles.

To enjoy the reduced duty rate the emulsion must comply with the technical specification fixed by the Authorities and issued as a National Standard Specification. The latest version of this specification (dated April 2001) is shown in **Table A.1.7**.

Table A.1.7 Specification for Water/Diesel Fuel Emulsion - Italy

Characteristic	Units	Limits		Method
		Min.	Max.	
Appearance		Milky		Visual
Density @ 15°C	kg/m^3	835	870	EN ISO 3675 EN ISO 12185
Water content	% m/m	12.0	15.0	ISO 8534
Stability by centrifuge after 5 minutes (1)				
Phase separation (2)	% v/v	-	9.0	UNICHIM 1548
Free water		Pass		
Viscosity @ 40°C	mm^2/sec	2.0	7.0	EN ISO 3104
Sulphur content	mg/kg	-	310	EN ISO 14596 (3) EN 24260
Sulphated ash content	% m/m	-	0.01	ISO 3987
Total contaminants	mg/kg	-	24	EN 12662
Copper strip corrosion 3h at 50ºC		Class 1		EN ISO 2160
Flash point	°C	> 55	-	ISO 2592 (4) EN 22719
Total nitrate content, expressed as 2-ethyl-hexyl-nitrate (EHN)	mg/kg	750	-	UNI EN ISO 13759
Lubricity, corrected wear scar diameter (wsd 1,4) @ 60°C	µm	-	460	ISO 12156-1
CFPP (5)	°C	- -	- 10 (W) 0 (S)	EN 116

(1) Stability by centrifuge must be carried out on a sample taken immediately upon delivery.

(2) The term "phase separation" refers to the presence of sedimented emulsion.

(3) In case of dispute EN ISO 3675 and EN ISO 14596 shall be used.

(4) Test method ISO 2592 (Open Cup) shall be used when the flash point is close to the boiling point of water.

(5) For winter grade the addition of an antifreeze agent is allowed, provided the total water content is unchanged.

- The emulsion must be used within 4 months of being delivered from the production depot/plant.
- Mixing of emulsions produced with different technologies is not allowed, nor is mixing in depots with diesel fuel.
- Diesel fuel used in preparing an emulsion must conform to UNI EN 590:2000.
- For the preparation of an emulsion de-ionised water must be used with a maximum conductivity of 30 microsiemens/cm.
- Emulsifiers and additives used must not contain compounds of fluorine, chlorine or heavy metals.

A.1.2.7. Fuels Legislation - Future EU Review

EU Directive 2003/17/EC also required the EU Commission to review various provisions of the Directives no later than 31 December 2005. These review items are summarised **Part 1**, **Section 1.2.7**

A.1.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

A.1.3.1. Introduction

The ECE15 and EUDC cycles for Light Duty and Light Commercial vehicles and the ECE R 49 Heavy Duty procedure remained in use in the EU until 31 December 1999. Details are given in **Part 2**. Thereafter modified or new cycles have been employed and these are described below.

A.1.3.2. NEDC Cycle (Formerly ECE 15 and EUDC) for Light Duty Vehicles

The ECE15+EUDC cycle was modified by EU Directive 98/69/EC to eliminate the initial 40 s "idle stabilisation" period. This increases the severity of the procedure as the engine and its emissions control system have no opportunity to "warm up" before emissions are recorded. The revised procedure is known as the "New European Drive Cycle" (NEDC), sometimes referred to as the MVEG cycle. The review of air quality standards in the Auto/Oil Programme showed that CO standards will be met with existing measures, so the EU Commission did not propose the introduction of a cold start procedure. However, this proposal was subsequently reversed and a cold start test was incorporated in EU Directive 98/69/EC.

The EU "Consolidated Emissions" Directive introduced a durability test for anti-pollution devices fitted to light duty vehicles. The procedure represents an ageing test of 80 000 km. As stated above, a cold temperature (-7ºC) emissions test was incorporated in EU Directive 98/69/EC.

The light duty emissions tests employed in the EU are summarised in **Table A.1.8**, below:

Table A.1.8 Summary of EU Light Duty Emissions Tests

Test Designation	Description
Type I	Emissions test for type approval. ECE15+EUDC cycle, modified effective 01/01/00 to eliminate initial 40 s idle stabilisation period - emissions measurements made from "key on" at start of test.
Type II	Test for idle CO.
Type III	Crankcase gas emissions test.
Type IV	Evaporative emissions test, modified effective 01/01/00.
Type V	Durability of anti-pollution control devices.
Type VI	-7°C cold start CO and HC emissions test, introduced in EU Directive 98/69/EC.
OBD Test	Light duty test, described in Section 1.6.3, introduced in EU Directive 98/69/EC.

- All tests are conducted on spark ignition engines. Compression ignition engines are subject to the Type I and V tests and, where applicable, the OBD test.

Cold Start (-7°C) Requirements

EU Directive 98/69/EC stipulates that, from 1 January 2002, all new types of gasoline powered M_1 and N_1 Class I vehicles must meet certain emissions limits when tested at -7°C. The test (designated the Type VI test) is conducted over the four urban elements of the revised Type I test cycle.

Proposed CO_2 Testing for Light Commercial Vehicles (Class N1)

On 10 October 2000, the Environment Council requested the Commission to study emission reduction measures for Light Commercial Vehicles (LCVs). COM(2001) 543 final (dated 24 October 2001) put forward the Commission proposals for CO_2 testing of light commercial vehicles.

Proposal

The Type I test for the determination of exhaust emissions specified in Annex III of Directive 70/220/EEC is applicable to M_1 and N_1 vehicles. As an alternative, diesel vehicles of category N_1 can be granted type-approval for exhaust emissions pursuant to Directive 88/77/EEC. The same test method employed in Directive 70/220/EEC is used in Directive 80/1268/EEC for the measurement of fuel consumption and CO_2 emissions, but it is currently only applicable to passenger cars. Therefore, the application of the test method can be extended to cover N_1 vehicles as well, in accordance with Directive 70/220/EEC.

It was proposed that the new provisions should apply:

- from 1 July 2003 for *new type-approvals* of vehicles in category N_1;
- from 1 January 2006 for *existing type-approvals* of vehicles in category N_1, class I, and
- 1 January 2007 for *existing type-approvals* in category N_1, class II and III.

The dates which apply to existing type-approvals were aligned with the corresponding dates of Directive 98/69/EC relating to emissions of M_1 and N_1 vehicles. This was in order to avoid recurring type-approval of a particular vehicle type, which would needlessly increase the costs associated with the proposal.

Progress

In September 2002 this proposal passed its first reading in the European Parliament and the Council is expected to adopt a Common Position in the third quarter of 2003. The amendments made will:

- Set a later date (2009) for the implementation of mandatory CO_2 and fuel consumption measurements
- Allow vehicles to be grouped in families and provide for other derogations.

These proposals have unclear repercussions on the accuracy of the CO_2 and fuel consumption values reported. In the light of these developments the Commission will have to consider other legislative measures, which may include

- the introduction of labelling (similar to those introduced for M1 vehicles in Directive 1999/94/EC)
- monitoring of emissions trends for N1 vehicles
- legislation limiting CO_2 emissions from N1 vehicles

The timing for implementation of these measures is dependent on the outcome of discussions at Council and EP level and the results of additional studies.

Background

Light commercial vehicles (N1 vehicles) are defined as vehicles used for the carriage of goods and having a maximum mass not exceeding 3500 kg. The N1 segment covers a wide variety of vehicle types, ranging from the smaller car-derived vans, sport utility and multi-purpose vehicles, to pick-ups and larger vans, the vast majority being diesel fuelled. Currently, around 20 million N1 LCVs are estimated to be on the market and diesel engines dominate, representing approximately 95% of the population. There has been a trend towards heavier vehicles, with the lightest class (N1) now accounting for less than 25% of all new registrations. According to a study for the Commission, sales of N1 vehicles are expected to grow by 2% per annum.

Proposed CO_2 Testing for Passenger Car Air Conditioners

On 10 October 2000, the Environment Council requested the Commission to study emission reduction measures for mobile air conditioning systems used in passenger cars. This source is not covered by existing legislation on fuel consumption and CO_2 measurements and is estimated to increase emissions in the range of 3 - 8%. It is also expected that the use of auxiliary heaters will increase because heat rejection from the engine is decreasing to the point that cabin temperatures cannot be maintained at low ambient temperatures.

Proposal Development

Mobile air conditioning and auxiliary heaters cause greenhouse gas emissions because of:

- Additional fuel consumption resulting from the weight of the equipment
- Additional fuel consumption due to equipment use
- Direct emissions of hydrofluorocarbons from air conditioning equipment (this latter point is covered in other proposals)

The biggest obstacle to the development of reduction measures is the lack of a standardised method for measuring the additional fuel consumption due to the use of this equipment. The Commission has been working closely with the industry concerned and a further study is being launched with the following objectives:

(i) To finalise the development of a test procedure and make proposals for its integration into Directive 80/1268/EEC covering the measurement of CO_2 and fuel consumption
(ii) To study in greater detail the economic aspects associated with the use of the test method
(iii) To develop policy options

Background

Between 1995 and 2002 the penetration of air conditioning systems in the new car market had increased dramatically. The current penetration rate is over 80% and is projected to rise to 90% within the next few years. As described above, the use of auxiliary heaters is also expected to increase.

A.1.3.3. Heavy Duty Testing

A GRPE sub-group was set up to develop a new exhaust emissions procedure for heavy duty vehicles for implementation with the Euro 3 emissions limits in 2000 and reported its conclusions in May 1996. It proposed the adoption of two separate tests, each of about thirty minutes duration. The ESC/ELR cycles comprise a steady-state test (ESC) with an additional dynamic load response test (ELR). The ETC test is a transient cycle. Both cycles offer a substantial improvement over the ECE R49 test.

During the course of its work it compared five candidate cycles with the R49 and US transient cycles on eight engines in four laboratories. It proposed the adoption of two separate tests, each of about 30 mins duration. One was a 13-mode steady-state cycle with an additional dynamic load response test (for smoke measurements) and the other was a transient cycle. In a ranking procedure (taking into account precision, applicability to new technology and fuels, cost and ability to control emissions) both cycles offered a substantial improvement over the ECE R49 test:

Table A.1.9 Ranking of New Test Cycles

Ranking	New Transient	New 13-mode	US Transient	ECE R49
Merit marks min/max	325/434	323/467	262/379	134/283
Ranking min/max (out of 7 tests)	1/2	2/1	4/4	7/6

Comparing the two cycles, the sub-group considered that the steady-state cycle gave better protection against an engine being operated at worse levels of emission control (outside the envelop defined by the cycle) and it required relatively minor changes to test equipment. On the other hand, the transient test cycle was more representative of actual driving patterns and furthermore was better suited to testing engines operating on alternative fuels.

The sub-group suggested that, for the Euro 3 standards, conventional diesel engines should be tested by the steady-state test cycle, whilst diesel engines with advanced emission control systems and all positive-ignition engines should be tested by both procedures. For the Euro 4 standards it was suggested that all engines should be tested by both procedures. With respect to emissions limit values, the sub-group recommended that one set of limits for CO, HC, NOx, particulates and smoke (specifically for the steady-state test) should be established. These would be based on the steady-state procedure, with the limits for the transient test cycle expressed as a product of the steady-state limit values and a correction factor for each pollutant.

The operating conditions for both tests are summarised below.

13-Mode Cycle

For actual driving, the most important criterion is the available power at a given engine speed. The test speeds for the cycle were chosen following an investigation of the power curves of a number of modern engines, which showed that the usable speed range of an engine lies between 50% and 70% of rated power, before and beyond the peak in the power curve respectively. The three test speeds are determined by dividing this speed range into four equal sectors (see lower diagram of **Figure A.1.2**).

In addition to idle, the other 12 modes are set at a combination of the three speeds established above and at 25%, 50%, 75% and 100% load. Weighting factors are assigned to each mode as shown in **Figure A.1.2**. To ensure that there are no rogue operating conditions which give abnormally high emissions, three more modes can be selected within this operating envelope by the personnel certifying the engine. For acceptance, the values measured in these modes must correspond with the emission characteristics measured at the fixed cycle points within established tolerances. The test sequence is selected to test engines with exhaust gas treatment systems at realistic temperatures, it being considered sufficient to hold the engine under each condition for no longer than one minute to reproduce actual operating conditions.

For the dynamic load response test, the engine is preconditioned and then accelerated from 10% load to full throttle at maximum acceleration. In this way the engine runs through all the fuel/air mixture conditions defined by the management system. It is intended that smoke emissions of diesel engines and CO, HC and NOx emissions of alternative-fuelled engines are measured in this way (**Figure A.1.3**).

Transient Cycle

This cycle was developed from data of road speed/power curves of typical driving patterns collected in a collaborative project by German and Swiss authorities for the purpose of updating emissions factors. The data were analysed in terms of road type (motorway, rural and urban), traffic density, road gradients and vehicle weight, distances between congestion or stopping points and vehicle type (lorries, coaches and local buses). The time curve of vehicle speed was normalised for engine speed and torque (**Figure A.1.4**) assuming a vehicle weight of 28 t. The normalised figures were at first integrated into three sub-cycles of 15 mins, but were finally reduced to 10 mins each. The frequency pattern of the cycle is in good agreement with the average data for local and long-distance lorries. For establishing limits, emissions from the three sub-cycles may be measured separately and combined using weighting factors.

A.1.3.4. Motor Cycle Testing

Directive 2003/77/EC defines the test cycles for year 2003 and 2006 motorcycle emissions requirements. These were previously stipulated according to UN ECE R40. For 2003, two preconditioning urban cycles are followed by four measured cycles. In 2006, all six urban cycles are measured and, in addition, an extra-urban cycle is included for machines over 150 cm^2.

A.1.3.5. Illustration of Current European Test Cycles

Figure A.1.1 LD Test Cycle (Type 1 Test)

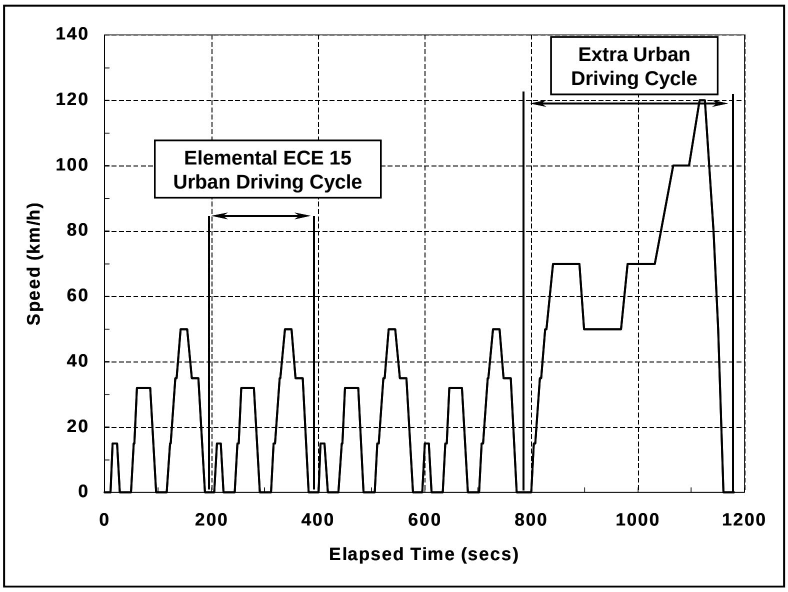


Figure A.1.2 ESC/ELR HD 13-mode cycle

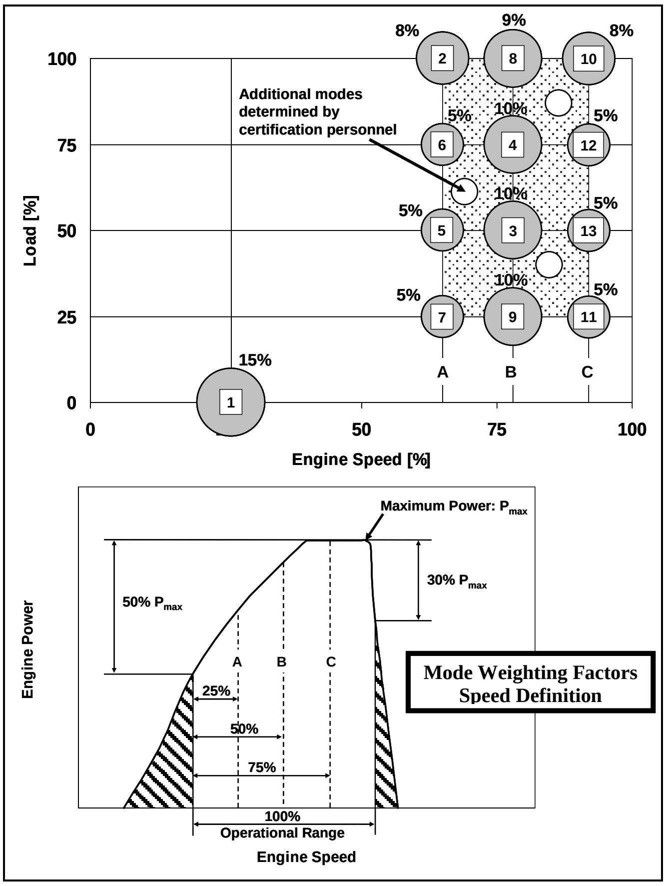


Figure A.1.3 ELR dynamic response test for smoke emissions

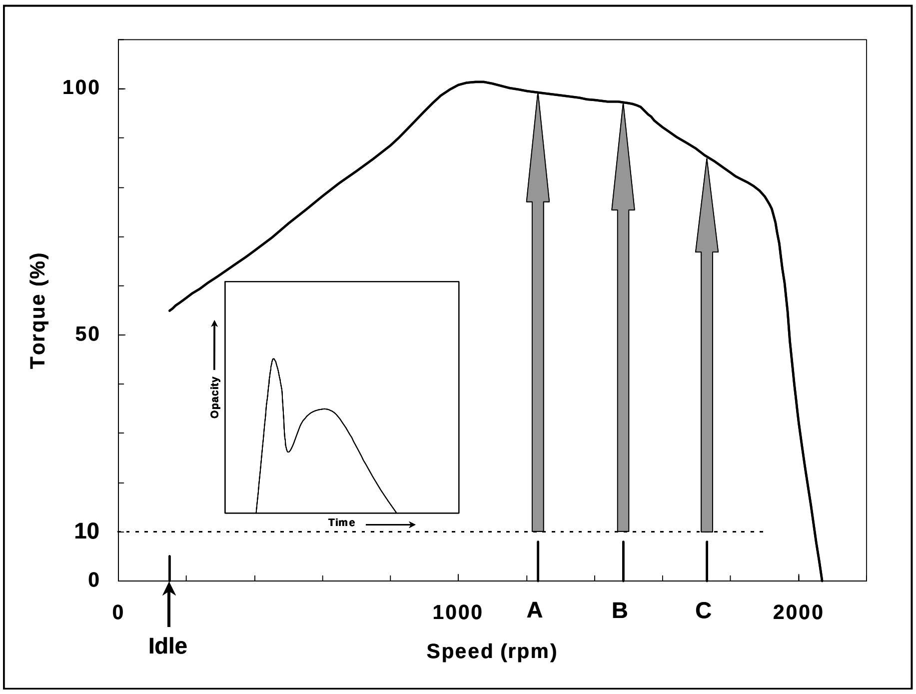
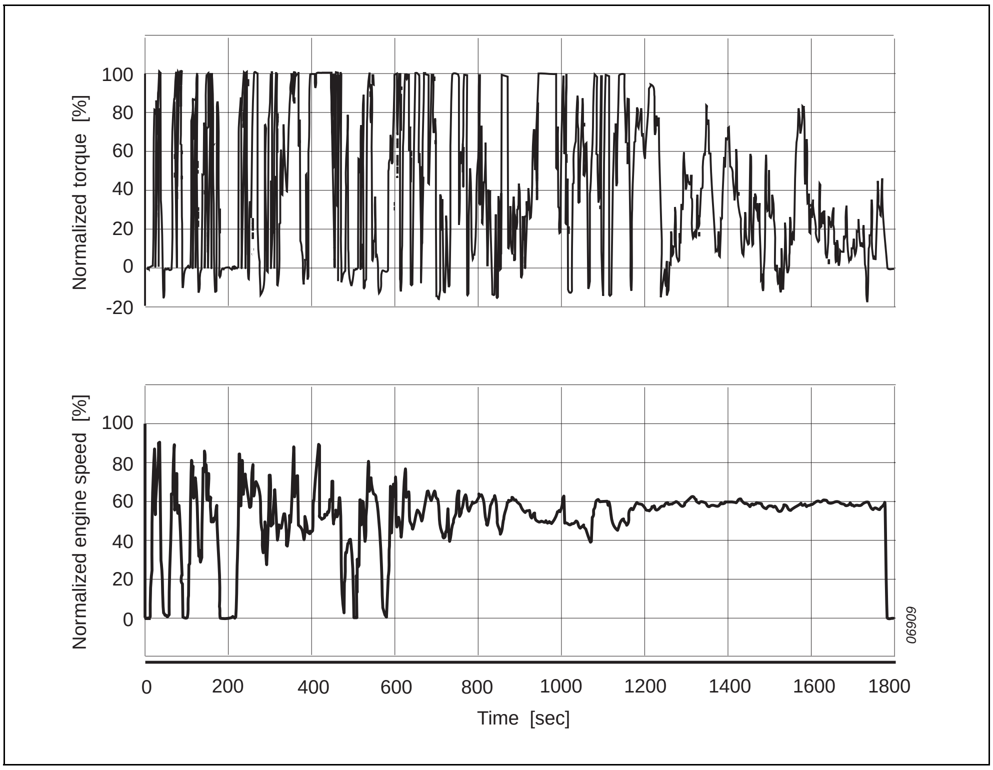


Figure A.1.4 ETC HD Transient cycle



A.1.3.6. Year 2000 EU Evaporative Emissions Procedures

The test is substantially different from both the previous EU and current EPA procedures and is summarised in **Table A.1.10** below.

Table A.1.10 Year 2000 EU Evaporative Emissions Test Procedure

VEHICLE PRECONDITIONING	3000 km run-in period with no excessive loading. Verification of age of canister.
FUEL DRAIN AND REFILL	Fill to 40 ± 2% nominal capacity. Fuel temperature 10-14°C, ambient temperature 20-30°C
CANISTER LOAD TO BREAKTHROUGH	Starting temperature 20°C. Repeated diurnal heat builds up to 35°C until 2-gram HC breakthrough
FUEL DRAIN AND REFILL	As above
PRELIMINARY DRIVE	Drive one ECE 15 + two EUDC cycles, starting temperature 20-30°C
SOAK	12-36 h at 20-30°C
TEST DRIVE	One ECE 15 + two EUDC cycles. Emissions tests optional
PRECONDITIONING DRIVE	One hot-start ECE 15 cycle
HOT SOAK TEST	Within 2 mins of engine shut-off: 60 ± 0.5 mins at 23-31°C in SHED
PRECONDITIONING SOAK	Duration 6 - 36 h, with min 6 h at 20 ± 2°C
DIURNAL TEST	24 h; start temperature 20°C, maximum temperature 35°C in SHED
END	Calculation of total hydrocarbon evaporative emissions from Hot Soak and Diurnal tests

A.1.4. REFERENCE FUELS

A.1.4.1. Introduction

Type approval and conformity of production testing is, of necessity, conducted under carefully controlled conditions which are specified in the relevant emissions legislation. This control naturally extends to the fuels used in such testing, and these are generally described as “reference”, “certification” or “homologation” fuels.

Reference fuels should be specified with much tighter limits than those pertaining in the market. This is essential as variations in fuel characteristics can create variations in emissions performance which might result in an incorrect pass (or fail) of the test. The actual level specified has been much debated and reference fuel characteristics are typically set to represent a “market average” **-** this principle has been accepted in Europe.

Vehicles or engines in service are likely to encounter fuels of differing characteristics, albeit still within market specification, and this can result in variation in emissions performance. For example, a diesel engine certified on a reference fuel of 835 kg/m^3 density may subsequently be run on a market fuel with a density of 845 kg/m^3, which could lead to an increase in emissions. It has been suggested that it would therefore be prudent to set reference fuel specifications closer to the “worse case” market fuel to avoid this type of anomaly. It has equally been argued that market specifications be tightened to overcome such difficulties but this is unlikely to provide a cost-effective solution. On balance, setting reference fuel specifications based on average market qualities should ensure that overall emissions control targets are realised across the market.

Current EU reference fuels are tabulated in **Part 1**, **Section 1.4**. Details of superseded grades will be found in **Part 2**. **Section B.1.4**.

A.1.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

A.1.5.1. Introduction

There are currently no formal fuel consumption or CO_2 limits for motor vehicles within the EU. However the EU Council of Ministers has called on numerous occasions for measures to reduce greenhouse gases emissions, which will indirectly act as a move to introduce fuel consumption regulations. Such calls have received even greater emphasis since the Kyoto Protocol was signed in December 1997.

Previous proposals for legislation on vehicle fuel economy have always run into difficulties, particularly because larger cars would be disadvantaged. Additionally, such legislation would require fiscal incentives and taxation policies which would be both complex and cut across the principle of subsidiarity. However, the EU Commission published in December 1995 a Communication on “A Community strategy to reduce CO_2 emissions from passenger cars and to improve fuel economy”. Since then the Commission has continued to liaise with the Council regarding its proposed strategy on a fuel economy monitoring system and a scheme for fuel economy labelling. This strategy has been criticised for its leniency in view of the continuing failure of many countries to meet their commitments regarding greenhouse gas emissions. Subsequently on 2 July 1996, the EU Commissioners for the Environment and for Industry issued a public invitation for the motor industry to begin discussions “with a view to concluding an agreement at European level on the improvement of vehicle fuel efficiency”. This resulted in a voluntary agreement (29 July 1998) for vehicle manufacturers to reduce the fuel consumption of their products by 25% compared to 1995, and to achieve a target of 140 g/km CO_2 emissions for the average of new car sales in the EU by 2008.

A.1.5.2. The Kyoto Protocol

The Kyoto Protocol commits the industrialised countries to legally binding emissions reductions of greenhouse gases by 2008-2012 and the EU is in the process of developing a strategy to meet its protocol commitments. The EU Commission’s communication on climate change [COM(98) 353 of 3 June 1998] was announced as “a first step in such a strategy” and put a series of questions to the Council of Ministers. A key point is that Member States have the major responsibility for meeting the Kyoto reduction target. The EU, as a signatory of, and future party to the Protocol, has the responsibility to ensure that Member State’s actions are consistent with the treaty and that their obligations are met. It also has an important role in complementing and supporting the Member States with common and coordinated policies and measures. The achievements made were reviewed at an environmental conference held in the Hague, the Netherlands, in late 2000.

A.1.5.3. Passenger Cars

The average fuel consumption of passenger cars improved during the 1970’s and early 1980’s, due, in part, to fuel price increases. However, this trend has reversed in recent years, with heavier and more powerful cars increasing in popularity, partly as a result of improved safety requirements. The EU Commission consider that reductions in average fuel consumption can be arrived at in two ways: via technical improvements and by consumers choosing lower consumption vehicles (“down-sizing”).

The strategy to reduce CO_2 emissions from passenger cars by improving their fuel economy was set out in COM(95) 689 final of 20 December 1995 and the subsequent Council conclusion of 25 June 1996. The objective was to achieve a fleet average CO_2 emission value of 120 g/km by 2005 (or 2010 at the latest) for all new cars. This objective can be met by a series of complementary measures:

1. An environmental agreement with the automotive industry under which the industry would commit itself to reducing the average CO_2 emissions of new cars sold;
2. Fiscal measures (vehicle taxation);
3. A consumer information scheme "to influence the market".

The EU Commission has introduced legislation for a monitoring system on the average CO_2 emissions from cars and for a consumer information scheme. This was published as the Decision of EP and Council 1753/2000/EC of 22 June 2000 [Official Journal, J L 202 (10 August 2000)]. Item (1), above, has been the subject of discussions between the EU Commission and ACEA. The European motor industry has responded with a number of proposals, the latest being published on 29 May 1998. In this document, ACEA made a series of commitments:

- No later than 2000, some manufacturers would introduce models emitting 120 g CO_2/km or less.
- A target fleet average for new car sales of 140 g CO_2/km will be achieved by 2008. According to ACEA, this represents an average CO_2 reduction of 25%, compared to 1995.
- In 2003, ACEA will review the potential for achieving the Community's goal of 120 g CO_2/km by 2012.
- For 2003, ACEA considers an estimated target range of 165-170 g CO_2/km to be "appropriate".

Details of the final agreement between the EU Commission and ACEA were published in COM(98)495 (29 July 1998) "Implementing the Community Strategy to reduce CO_2 Emissions from cars: an Environmental Agreement with the European Automobile Industry". A monitoring system will be set up to follow the development of the average CO_2 emissions on new passenger cars and will address any problems which might arise in achieving the CO_2 objective of the agreement.

A.1.5.4. Test Procedure

Following a work programme conducted by the MVEG (Motor Vehicle Emissions Group of the Commission of the European Communities) during 1992/3, an amendment to Council Directive 80/1268/EC was approved on 1 January 1994. This related to the measurement of fuel consumption of motor vehicles, to include the measurement and reporting of carbon dioxide emissions in its scope. Tests were carried out over the Urban and Extra Urban test cycles, as described in the 91/441/EEC Directive for exhaust emissions. From the year 2000 the revised Type I test, laid down in EU Directive 98/69/EC, will apply. One figure for the combined cycle is reported for carbon dioxide, whereas fuel consumption is reported for the two cycles, both separately and combined.

A.1.5.5. Other European Legislation

Denmark

All passenger cars which are subject to duty and were registered for the first time after 1 July 1997 are subject to a duty on their fuel consumption (Consolidation Act no 360, 2 June 1997 with later additions). The fuel consumption is declared and measured by the manufacturer in accordance with 93/116/EC.

Germany

A limited tax exemption was granted for the following vehicles:

- < 120g CO_2/km ("5 litre" car) (First registered before 1 January 2000.)
- < 90g CO_2/km ("3 litre" car)

Italy

In an annex to the National Budget Law for 1999, a "carbon tax" was introduced. From 1999 to 2005 the excise duties on all fossil fuels were to be progressively modified to favour natural gas and discourage the use of coal. Globally, the duties on fossil fuels were designed to be higher in 2005 compared to 1999 and the "net income" from this further taxation was to be used to ease taxes in other areas. This tax scheme was approved by the EU: Council Decision 2000/446/EC of 17/07/00 [published in the Official Journal L180 (19/07/00)]. Due to the increase of fuel prices during the year 2000, the Government decided to put the programme on "stand-by" until the situation stabilised.

United Kingdom

Private cars and light commercial vehicles (GVW < 3500 kg)

For vehicles registered before March 2001 there is an annual flat rate charge of road fund licence for engines over 1.549 litres and a lower charge for engines of 1.549 litres and below. For new cars a graduated system, based on CO_2 emission ratings was introduced on 1 March 2001, see **Table A.1.11**, below.

Table A.1.11 Road Fund License Charges for Private Vehicles (Cars, Taxis and Light Vans) Registered Before 1 March 2001

Private/Light Goods Vehicle Engine Capacity (Cubic Centimetres)	Tax Rate (GBP, £)	
	12 Months	6 Months
Not over 1549	110.00	60.50
Over 1549	170.00	93.50

From April 2002, there was a fundamental change in the way company cars were taxed to help to protect the environment. Cleaner, more fuel efficient cars were rewarded by linking the road fund license charge and National Insurance contributions to the car's exhaust emissions, in particular its carbon dioxide (CO_2) emissions.

A.1.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

A.1.6.1. In-Service Emissions Testing

EU Directive 92/55/EEC, dated June 1992 and amending EU Directive 77/143/EEC, legislates in-service emissions limits in vehicle roadworthiness tests. Details will be found in **Part 1**, **Section 1.6.1**.

Descriptions of the test protocols adopted by both EU and other European countries before 92/55/EEC was introduced will be found in **Part 2**, **Sections B.1.6.3**.

A.1.6.2. Control of Compliance of Vehicles in Service

The Auto/Oil programme identified improved inspection and maintenance as being a highly cost-effective means of reducing pollutant emissions. It is estimated that the worst 10% of the vehicles on the road cause 50% of the pollution. Following the completion of a study during 1996, the EU Commission came forward during 1997 with proposals to strengthen the requirements of the 92/55/EEC Directive.

EU Directive 98/69/EC introduced revised criteria for in-service conformity checks. The details of in-service checks are summarised in **Table A.1.12**.

Table A.1.12 EU In-Service Conformity

Selection Criteria	**Service**	Minimum: 15 000 km or 6 months Maximum: 80 000 km or 5 years
	Maintenance Record	Vehicle must have been properly maintained and not subject to "unauthorised major repair".
	Improper Use	Vehicle is unsuitable for check if there are indications of general misuse, misfuelling or tampering. Vehicle is also unsuitable if the OBD system indicates it has been used for any length of time after a fault code was stored
Diagnosis and Maintenance	**Checks**	Routine items (e.g. air filter, drive belts, etc.) must be checked
	OBD	Must function correctly (rectification of faults identified during a preconditioning cycle is permitted)
	Ignition System	Replace any defective components
	Compression	Vehicle is unsuitable if compression is "unsatisfactory"
	Engine	Adjust to manufacturers specification
	Service	Conduct if within 800 km of a scheduled service
	Fuel	Use reference fuel, unless manufacturer accepts market fuel
In-Service Testing	**Emissions Test**	Type I test
	OBD	Check for correct functionality
Plan of Remedial Measures	**1.**	When the Type Approval Authority is certain that a vehicle type is not in conformity, it must request a remedial plan from the manufacturer
	2.	The plan must be submitted within 60 working days (extensions may be granted if manufacturer demonstrates additional time is required)
	3.	Plan must be approved/rejected within 30 working days
	4.	Remedial measures must apply to all vehicles likely to be affected by the same defect

EU Proposals for the Application of Portable Emissions Measurement Systems (PEMS) in Heavy Duty Vehicle In Use Compliance

Directive 2005/55/EC introduces requirements regarding in-use conformity checking for heavy-duty vehicles. For several reasons it is impractical to apply an in-use conformity checking scheme for heavy-duty vehicles which requires extraction of engines to compare pollutant emissions against legislative limits. Therefore, it has been proposed to develop a protocol for in-use conformity checking of heavy-duty vehicles based on the use of Portable Emission Measurement Systems (PEMS).

The Commission, heavy-duty manufacturers and instrument suppliers have been running a programme evaluating the application of PEMS to measurement of emissions from Heavy Duty Vehicles. One outcome has been the development of a test protocol for measuring emissions of gaseous pollutants. Work on the adaptation of the protocol for the measurement of particulate matter using PEMS is ongoing. As a next step in the development of the PEMS approach, the

Commission is considering development of a pilot programme to further evaluate the suitability of using PEMS for in-use compliance procedures for heavy duty vehicles.

A.1.6.3. OBD

Introduction

EU Directive 98/69/EC stipulates the requirements and tests required for the OBD systems which have been fitted to light duty vehicles from 2000. The system must be capable of detecting some form of deterioration or malfunction over the entire life of the vehicle. Access to the system for inspection, diagnosis, servicing etc., must be unrestricted and standardised. Directive 2002/80/EC includes further guidance on the required infrastructure for OBD equipment. Details will be found in **Part 1**, **Section 1.6.3**.

The EU Commission's original proposals also included more stringent values for introduction in 2005 and these are shown below:

A.1.6.4. Heavy Duty OBD

EU Directive 1999/96/EC stipulates that, from 1 October 2005, new types of vehicles, and from 1 October 2006, all types of vehicles, shall be equipped with an OBD system or an on-board measurement system (OBM) to monitor in-service exhaust emissions. The EU Commission was to propose provisions to this effect to the European Parliament and the Council by 31 December 2000. These proposals are described in **Part 1**, **Section 1.6.4**.

A.2. OTHER EUROPEAN COUNTRIES, TURKEY AND RUSSIA

A.2.1. VEHICLE EMISSION LIMITS

A.2.1.1. Central and Eastern European Countries

Most Central and Eastern European countries apply some combination of ECE and EU regulations. Many of these states joined the EU on 1 May 2004 and have adopted the appropriate emissions legislation:

- Passenger Cars and Light Commercial Vehicles - EU Directive 98/69/EC,
- Heavy Duty Vehicle Emissions - EU Directives 1999/96/EC and 2001/27/EC.

A.2.1.2. Russia

Russian emissions limits are detailed in **Part 1**, **Section 2.1.2**.

A.2.1.3. Central and Eastern European Gasoline Specifications (excluding Russia)

Data for Belarus and the Ukraine will be found in **Part 1**, **Section 2.1.3**.

A.2.1.4. Turkey Gasoline Specifications

Turkey's current specifications include 95 and 98 RON unleaded and 95 RON lead replacement grades. Details are shown in **Part 1**, **Section 2.1.4**. Earlier specifications, including leaded grades will be found in **Part 2**, **Section B.2.2.4**.

A.2.1.5. Russia Gasoline Specifications

The latest Russian specifications were introduced in 1999 and cover four grades. Details are tabulated in **Part 1**, **Section 2.1.5**.

A.2.1.6. Central and Eastern European Diesel Fuel Specifications (excluding Russia)

See **Part 1**, **Section 2.1.6**.

A.2.1.7. Turkey Diesel Fuel Specification

See **Part 1**, **Section 2.1.7**.

A.3. US FEDERAL REGULATIONS

A.3.1. VEHICLE EMISSION LIMITS

A.3.1.1. Tier 2 Motor Vehicle Emission Standards

Different Tier 2 phase-in schedules have been established for two different groups of vehicles as well as two different sets of interim standards for 2004 and later model year vehicles not yet phased-in to the Tier 2 standards. The standards are described in full in **Part 1**, **Section 3.1.1**. Some additional information is recorded below.

NOx Credits and Debits

While the manufacturer will be free to certify a test group to any applicable bin of standards, it will have to ensure that the sales-weighted average of NOx standards from all of its test groups of Tier 2 vehicles meet a full useful life standard of 0.07 g/mi. Manufacturers must determine their compliance with the corporate average NOx standard at the end of the model year by computing a sales weighted average of the full useful life NOx standards from each bin. Manufacturers must use the following formula:

Corporate Average NOx =
[∑(Tier 2 NOx std for each bin) × (sales for each bin)]/[Total Tier 2 sales]

Manufacturers with year-end corporate average NOx emissions for their Tier 2 vehicles below 0.07 g/mile could generate Tier 2 NOx credits. Credits could be saved (banked) for use in a future model year or for trading (sale) to another manufacturer. Manufacturers would consume credits if their corporate average NOx emissions were above 0.07 g/mile. The Tier 2 standards will apply regardless of the fuel the vehicle is designed for, and there would be no restrictions on averaging, banking or trading of credits across vehicles of different fuel types. Consequently, a gasoline fuelled LDV might help a manufacturer generate NOx credits in one year that could be banked for the next year when they could be used to average against NOx emissions of a diesel fuelled LDT.

Incentives for Ultra-Clean Vehicles

Manufacturers, at the beginning of the programme, can weight LDV/Ts certified to the lowest two bins more heavily when calculating their fleet average NOx emissions. Under this provision, which applies through the 2005 model year, manufacturers may apply a multiplier to the number of LDV/Ts sold that are certified to bins 1 and 2 (ZEVs and SULEVs in California terms). This adjusted number will be used in the calculation of fleet average NOx emissions for a given model year and will allow manufacturers having vehicles certified to these bins to generate additional credits (or use fewer credits) that year.

The multipliers that manufacturers may use are found in **Table A.3.1** below:

Table A.3.1 Multipliers for Additional Credits for Bin 1 And 2 LDV/LDT

Bin	Model Year	Multiplier
2	2001, 2002, 2003, 2004, 2005	1.5
1	2001, 2002, 2003, 2004, 2005	2.0

A.3.1.2. Future Motor Vehicle Emission Standards - Tier 2 Limits: Background Information and Additional Details

Introduction

The EPA submitted its Tier 2 Report to Congress in July 1998. The study examined the question of the need for a further reduction in emissions from light duty motor vehicles in order to attain, or maintain, the National Ambient Air Quality Standards (NAAQS). The Agency concluded that more stringent vehicle standards were needed to meet the ozone and particulate air quality standards.

The standards incorporate concepts from the federal National LEV programme (NLEV). The programme takes the corporate averaging concept and other provisions from NLEV but changes the focus from NMOG to NOx. The emission standards used for this average calculation are different in several respects from those of the California LEV II programme, but are designed to allow harmonisation of federal and California vehicle technology. As discussed below, the Tier 2 corporate average NOx level to be met through these requirements ultimately applies to all of a manufacturer's Light Duty Vehicles and Light Duty Trucks (subject to two different phase-in schedules), regardless of what fuel is used.

The EPA have introduced the concept of a “Corporate Average NOx Standard”, which would ultimately require each manufacturer's average NOx emissions over all of its Tier 2 vehicles each model year to meet a NOx standard of 0.07 g/mile. Manufacturers would have the flexibility to certify Tier 2 vehicles to different sets of exhaust standards (referred to as “bins”), but would have to choose the bins so that their corporate sales weighted average NOx level for their Tier 2 vehicles was no more than the 0.07 g/mile.

Objectives

The EPA’s first goal is to bring all LDVs and LDTs under the same set of emission standards. Historically, LDTs - and especially the heavier trucks in the LDT3 and LDT4 categories - have been subject to less stringent emission standards than LDVs (passenger cars). In recent years the proportion of light truck sales has grown to approximately 50 percent. Many of these LDTs are minivans, passenger vans, sport utility vehicles and pick-up trucks that are used primarily or solely for personal transportation; i.e., they are used like passenger cars.

The second principle of the vehicle programme is to employ the same Tier 2 standards for all LDVs and LDTs, regardless of the fuel they are designed to use. The same exhaust emission standards and useful life periods will apply whether the vehicle is built to operate on gasoline or diesel fuel or on an alternative fuel such as methanol or natural gas. Diesel powered LDVs and LDTs tend to be used in the same applications as their gasoline counterparts, and the EPA believe they should meet the same standards.

Light Duty Diesel Provisions

Changes were subsequently made to the light duty diesel provisions (Federal Register / Vol. 67, No. 235 / Friday, 6 December 2002). The EPA took this action to modify the Tier 2 programme to provide for the certification of cleaner diesel engines than were anticipated during the interim Tier 2 programme (through the 2006 model year).

The revised regulation states that, for diesel vehicles certified to bin 9 or bin 10, intermediate life standards are optional regardless of whether the manufacturer certifies the test group to a full useful life of 120 000 miles or 150 000 miles.

Tier 2 Corporate Averages

The EPA claim that the value of a corporate average standard is that the programme's air quality goals would be met while allowing manufacturers the flexibility to certify some models above or below the standard. Each manufacturer would determine its year-end corporate average NOx level by computing a sales-weighted average of the NOx standards from the various bins to which it certified any Tier 2 vehicles. The manufacturer would be in compliance with the standard if its corporate average NOx emissions for its Tier 2 vehicles met the 0.07 g/mile level.

The EPA recognise that the Tier 2 standards pose greater technological challenges for larger light duty trucks than for LDVs and smaller trucks and has suggested that that additional lead-time is appropriate for HLDTs. HLDTs have historically been subject to the least stringent vehicle-based standards. Also, HLDTs were not subject to the voluntary emission reductions implemented for LDVs, LDT1s and LDT2s in the NLEV programme. Consequently the EPA have designed separate phase-in programmes for the two groups. The approach would provide HLDTs with extra time before they would need to begin phase-in to the Tier 2 standards and also provide two additional years for them to fully comply.

The EPA is seeking comment on whether it should conduct a technology review of the Tier 2 standards in the future. The Alliance of Automobile Manufacturers has proposed such a review, principally designed to assess the status of Tier 2 technology development. Some manufacturers have suggested that the approach of applying the same standard to cars and light-duty trucks presents sufficient challenge as to raise serious uncertainty about compliance for the larger vehicles, even by the year 2008. In addition, manufacturers have indicated that there are questions of feasibility for introduction of advanced technologies for improved fuel economy, such as lean burn, fuel cell, and hybrid electric technology.

The review could assess the feasibility of the standards relative to the state of technology development for HLDTs. Further, the review could consider gasoline and diesel fuel quality and its impact on the effectiveness of aftertreatment, and whether lower sulphur levels are necessary for HLDTs to meet the Tier 2 standards. The EPA may also examine the feasibility of the standards for vehicles using technologies to advance fuel economy. In addition, the review could consider whether additional air quality improvements are necessary and the feasibility of additional reductions of vehicle emissions to achieve such air quality improvements.

Tier 2 NOx Credits and Debits

To provide manufacturers with greater flexibility and with incentives to certify, produce and sell Tier 2 vehicles as early as possible, the EPA are proposing that manufacturers could utilise alternative phase in schedules. Under such schedules, a manufacturer could certify vehicles to bins having NOx standards of 0.07 g/mile or below in years prior to the first required phase-in year and then phase its remaining vehicles in over a more gradual phase-in schedule that would still lead to 100% compliance by 2007 (2009 for HLDTs). To the extent that a manufacturer's corporate average NOx level of its “early Tier 2**”** vehicles was below 0.07 g/mile, the manufacturer could bank NOx credits for later use. The early banking of HLDT NOx credits will not begin until the 2004 model year. This provides a four year period during which early credits could be generated for use in the 2008/2009 HLDT Tier 2 phase-in.

When a manufacturer has a NOx deficit at the end of a model year - that is, its corporate average NOx level is above the required corporate average NOx standard - EPA are proposing that the manufacturer be allowed to carry that deficit forward into the next model year. Such a carry-forward could only occur after the manufacturer used any banked credits. If the deficit still existed and the manufacturer chose not to (or was unable to) purchase credits, the deficit could be carried over. At the end of that next model year, the deficit would need to be covered with an appropriate number of NOx credits that the manufacturer generated or purchased. Any remaining deficit would be subject to an enforcement action. To prevent deficits from being carried forward indefinitely, the manufacturer would not be permitted to run a deficit for two years in a row.

A.3.1.3. Emissions Compliance Programmes for New Light Duty Vehicles and Light Duty Trucks

The EPA proposed a new compliance assurance programme (referred to as “CAP 2000”) on 23 July 1998. This was subsequently adopted as a Final Rule and published in the Federal Register on 4 May 1999 (Volume 64, Number 85). CAP 2000 was claimed to simplify and streamline the procedures manufacturers must follow to obtain pre-production emission certification of new motor vehicles.

According to the EPA, the new certification programme provided the same environmental benefits as the previous procedures while significantly reducing the certification cost for manufacturers and giving manufacturers more control of production timing. The EPA also adopted a requirement that manufacturers test in-use motor vehicles to monitor compliance with emission standards. Manufacturers will test samples of in-use vehicles when they are approximately one and four years old. These test data will be used to improve the process which predicts in-use compliance and will determine the need for further action by the Agency or the manufacturer to address any in-use emission compliance problems. CAP 2000 was implemented beginning with MY 2001 vehicles. Manufacturers were allowed to voluntarily opt-in to the CAP 2000 procedures beginning with the 2000 model year.

Three programmes are currently in place to ensure that automotive manufacturers design and build light duty vehicles and light duty trucks which comply with mandated emission standards for their useful lives:

1. Certification
2. Assembly line testing (known as Selective Enforcement Audits or SEAs)
3. Recall.

To verify the compliance predictions made for certification, manufacturers are required to conduct testing of in-use vehicles and to report the results to the EPA. The significant amounts of in-use data generated by this testing will enhance the

Agency's recall programme and can be used for studies of in-use vehicle emission control performance in general. The in-use data will also obviate the need for most SEA testing. Important in-use data are also available from other sources, including emission control repair statistics and I/M test results.

The California Air Resources Board (CARB) has adopted a regulation parallel to CAP 2000.

A.3.1.4. Heavy Duty Highway Diesel Engine Legislation

HD Diesel Engine/Vehicle Standards

A new Final Rule on emissions from "Highway Heavy Duty Engines" was published in the Federal Register on 21 October 1997 (Volume 62, Number 203). Earlier standards are tabulated in **Part 2**, **Section B.3.1.7**.

In this action, the EPA adopted a new emission standard and related provisions for diesel heavy duty engines (HDEs) intended for highway operation, beginning with MY 2004. The EPA is adopting the NMHC + NOx emission standards and these are described in **Part 1**, **Section 3.1.2**.

A.3.1.5. 2005 Motor Cycle Emissions Standards

The EPA has published a new final rule for highway motorcycles, including those with engines with displacements of less than 50 cc. The rule, 40 CFR Parts 86, 90, 1045, and 1051, was published in the Federal Register, Vol. 69, No. 10 on Wednesday, 15 January, 2004. Details will be found in **Part 1**, **Section 3.1.3**.

Proposed Motor Cycle Emissions Standards - Background Information and Additional Details

For highway motorcycles the EPA are harmonizing standards with the California programme, but with some additional flexibilities. This is a two-phase programme that would result in reductions of HC + NOx of about 50 percent when fully phased in. The rule emphasises the importance the EPA places on the work to develop a global motorcycle emissions test (see **Part 1, Section 11.2**). If an international test procedure is agreed upon by the participating nations, the EPA will propose adopting the global test cycle as part of the US regulations.

Special provisions have been made for small manufacturers (those with fewer than 500 employees and producing fewer than 3000 motorcycles per year). The EPA are also adopting an emission-credit programme comparable to the existing California ARB regulations.

A.3.1.6. Non-road Diesel Emissions Standards

The standards are described in detail in **Part 1**, **Section 3.1.4**.

Non-road Diesel Emissions -
Background Information and Additional Details

In their June 1994 final rule, the EPA set a first phase of emission standards ("Tier 1 standards") for non-road diesel engines rated 37 kW and above. An important consideration was harmonization with standards for non-road engines adopted or under consideration in California, Europe, and elsewhere in the world. While some differences remain between the EPA's final rule and the European standards, the EPA plans to continue its harmonization work with other governments. One major area in which a coordinated effort is being pursued is the development of a more effective particulate emission control programme, including the evaluation and possible modification of the certification test cycle.

Voluntary Low-Emitting Engine Programme

Central to the voluntary standards is the need to demonstrate superior control of particulate emissions. Because of the sensitivity of particulate emissions to test cycles, testing on a transient cycle is an important element of the programme for Blue Sky Series engines. The EPA has begun work towards developing transient test cycles for non-road equipment, but there is not yet any established or proven cycle. The highway test cycle, while not developed for non-road engine operation, would result in a significant degree of control for non-road equipment. The EPA has therefore specified the highway transient test cycle to evaluate emission levels relative to the voluntary standards. If the EPA adopts a transient test for certifying non-road engines in the future, the Agency will accordingly re-evaluate the test cycle and standards for Blue Sky Series engines.

To best align with future emission standards, Tier 3 emission levels, where applicable, were chosen as the best level for defining Blue Sky Series engines. This represents a reduction of approximately 40% beyond the Tier 2 NMHC + NOx levels. For PM emissions and for engines with no Tier 3 standards, a calculated level corresponding to a 40% reduction beyond Tier 2 levels will be used to qualify as a Blue Sky Series engine.

Averaging, Banking, and Trading

In this final rule, the EPA replaced the existing non-road engine averaging, banking, and trading (ABT) programme with a comprehensive new programme. The revised ABT programme is intended to enhance the flexibility offered to engine manufacturers so that they can meet the stringent NMHC + NOx standards and the PM standards being adopted. The ABT programme also encourages the early introduction of cleaner engines.

HD Otto-Cycle Engine Standards

Exhaust emissions from new 2007 and later model year Otto-cycle HDEs shall not exceed the limits set out in **Part 1**, **Section 3.1.2.2.**

In-Use Emissions Control

Where noted, some of the provisions below also apply to 2004 and later MY Otto-cycle engines. The in-use provisions include both:

- revisions of existing regulations, including useful life, emissions-related maintenance, and emissions defect and performance warranties, plus
- new provisions regarding maintenance and repair of emissions controls after the end of the useful life, including manufacturer requirements and engine rebuild provisions.

All of the following changes to the regulations are effective beginning with the 2004 model year.

1. *Useful Life* - The revised useful life for the heavy heavy duty diesel engine service class will be 435 000 miles, 22 000 hours, or 10 years, whichever occurs first, for all pollutants beginning in model year 2004. The EPA is also establishing a useful life years interval of 10 years for all heavy duty engine service classes, Otto-cycle and diesel- cycle, and all pollutants.

2. *Emissions Related Maintenance* - The EPA is finalising the changes to emission related maintenance intervals shown in **Table A.3.2**, with compliance beginning in 2004. The intervals are in miles or hours, whichever occurs first. The term “Add-on emissions-related component” is defined as a component whose sole or primary purpose is to reduce emissions or whose failure will significantly degrade emissions control and whose function is not integral to the design and performance of the engine. The EPA is not changing the interval for EGR filters and coolers from its current interval of 50 000 miles (1500 h).

Table A.3.2 HD Engines - Changes to Minimum Emission-Related Maintenance Intervals

Intended Service Class	Component or System	Change to Minimum Maintenance Interval
Otto-cycle engines	EGR system (except filters and coolers)	Increase from 50 000 miles (1500 h) to 100 000 miles (3000 h).
Light HDDEs	EGR system (except filters and coolers)	Increase from 50 000 miles (1500 h) to 100 000 miles (3000 h).
	Add-on emissions related components, catalytic converters	Establish 100 000 mile (3000 h) interval.
Medium & heavy HDDEs	EGR system (except filters and coolers)	Increase from 50 000 miles (1500 h) to 150 000 miles (4500 h).
	Add-on emissions related components, catalytic converters	Establish 150 000 miles (4500 h) interval.

3. *Emissions Defect and Performance Warranties* - The warranty period shall not be less than the basic mechanical warranty of the particular engine as provided to the purchaser. This change to the warranty provisions apply to both diesel and Otto-cycle engines.

4. *Additional Manufacturer Requirements* - Starting in 2004, The EPA is requiring that manufacturers include in the engine service manual, maintenance which may be needed for emissions related components after the end of the engine's regulatory useful life, including intervals and procedures for determining whether or not maintenance or repair is needed. The recommended practices must also include instructions for accessing and responding to any emissions-related diagnostic codes that may be stored in on-board monitoring systems.

5. *Engine Rebuilding Provisions* - The regulations require that parties involved in the process of rebuilding or re-manufacturing model year 2004 and later engines must follow certain provisions to avoid their actions being characterised as tampering with the engine and its emissions controls.

California has introduced virtually identical legislation to that described above.

A.3.1.7. Non-Road Large Spark Ignition Engines Exhaust Emissions

The standards are described in detail in **Part 1**, **Section 3.1.5**.

Non-Road Large Spark Ignition Engines Exhaust Emissions - Background Information and Additional Details

In October 1998, California ARB adopted emission standards for Large SI engines. The EPA are extending these requirements to the rest of the US in the near term and are also revising the emission standards and adding various provisions in the long term. The near-term and the long-term emission standards are based on three-way catalytic converters with electronic fuelling systems to control emissions, and differ primarily in terms of how well the controls are optimized. An important element of the control programme is the attempted harmonization with the requirements adopted by California ARB.

Field-testing Standards

Starting in 2007, the following Tier 2 exhaust emission standards apply for emission measurements with the field-testing procedures described later:

Table A.3.3 Non-Road Large Spark Ignition Engines Tier 2 Field Testing Emissions Standards

Engine Type	Emission Standard (g/kW-hr) (1)	
	HC + NOx	CO
Standard duty	3.8	6.5
Severe duty	3.8	200.0

(1) For natural gas-fuelled engines, there is no requirement to measure non-methane hydrocarbon emissions or total hydrocarbon emissions for testing to show that the engine meets these emission standards; that is, it may be assumed that HC emissions are equal to zero.

The following formula may be applied to determine alternate emission standards instead of the standards above:

$$(HC + NOx) \times CO^{0.791} \leq 16.78$$

HC + NOx emission levels may not exceed 3.8 g/kW-hr and CO emission levels may not exceed 31.0 g/kWh. The following table illustrates a range of possible values:

Table A.3.4 Examples of Possible Tier 2 Field-Testing Emission Standards

HC + NOx (g/kWh)	CO (g/kWh)
3.8	6.5
3.1	8.5
2.4	11.7
1.8	16.8
1.4	23.1
1.1	31.0

For engines that require enrichment at high loads to protect the engine, alternate Tier 2 standards of 2.7 g/kWh for HC+NOx and 31.0 g/kW-hr for CO can be requested by the engine manufacturer for steady-state testing. If this is approved, the transient testing standards and the field-testing standards must still be met.

Voluntary "Blue Sky" Standards for Large SI Engines

The EPA are adopting voluntary Blue Sky standards for these engines. A target of 0.8 g/kW-hr (0.6 g/hp-hr) HC + NOx and 4.4 g/kW-hr (3.3 g/hp-hr) CO is being set as a qualifying level for Blue Sky Series engines. The corresponding field-testing standards for Blue Sky Series engines are 1.1 g/kW-hr (0.8 g/hp-hr) HC + NOx and 6.6 g/kW-hr (4.9 g/hp-hr) CO.

Averaging, Banking, or Trading Emission Credits

An averaging, banking, and trading programme for certifying engines is not included.

Crankcase Emissions

Manufacturers may choose one of two methods for controlling crankcase emissions. First, adding positive crankcase ventilation prevents crankcase emissions. An alternative method addresses specific concerns related to turbocharged engines or engines operating in severe duty environments. Where closed crankcases are impractical, manufacturers may measure crankcase emissions during any emission testing and add crankcase emissions to measured exhaust emissions for comparing with the standards.

Diagnosing Malfunctions

Manufacturers must design their Large SI engines to diagnose malfunctioning emission-control systems starting with the 2007 model year. This diagnostic requirement focuses solely on maintaining stoichiometric control of air-fuel ratios.

Warranty

Manufacturers must provide an emission-related warranty for at least the first half of an engine's useful life (in operating hours) or three years, whichever comes first. These periods must be longer if the manufacturer offers a longer mechanical warranty for the engine or any of its components; this includes extended warranties that are available for an extra price. The emission-related warranty includes components related to controlling evaporative and crankcase emissions.

In-Use Testing Provisions

Consistent with the California ARB programme, the EPA are requiring engine manufacturers to conduct emission tests on a small number of field-aged engines to show they meet emission standards. The EPA may generally select up to 25% of a manufacturer's engine families in a given year to be subject to in-use testing. Most companies will need to test at most one engine family per year.

Useful life Durability Provisions

A useful life period of seven years or until the engine accumulates at least 5000 operating hours, whichever comes first, will apply. This figure represents a minimum value and may increase as a result of data showing that an engine model is designed to last longer. Some engines are designed for operation in severe duty applications with a shorter expected lifetime. The EPA are allowing manufacturers to request a shorter useful life for an engine family based on information showing that engines in the family rarely operate beyond the alternative useful-life period. For example, if engines powering concrete saws are typically scrapped after 2000 hours of operation, this would form the basis for establishing a shorter useful-life period for those engines. Manufacturers relying on design based certification to meet the evaporative requirements must use good engineering judgment to show that emission controls will work for at least seven years. This also applies for systems designed to address crankcase emissions.

A.3.1.8. Non-Road Recreational Engines Exhaust Emissions

The standards are described in detail in **Part 1**, **Section 3.1.6**.

Non-Road Recreational Engines Permeation Emissions

In the original proposal the EPA only specified exhaust emission controls for recreational vehicles. However, the issue of control of evaporative emissions related to permeation from fuel tanks and fuel hoses has been raised. The EPA are therefore adopting performance standards intended to reduce permeation emissions from recreational vehicles. The standards, which apply to new vehicles starting in 2008, are nominally based on manufacturers reducing permeation emissions from new vehicles by about 90% overall.

The provisions apply even if the recreational vehicle manufacturer exercises the option to use an engine certified under another programme such as the small spark ignition requirements in 40 CFR part 90. These standards would require these vehicle manufacturers to use low permeability fuel tanks and hoses. The EPA are including snowmobiles in this standard because it is common practice for snowmobiles to be stored in the off-season with fuel in the tank.

Permeation Emission Standards

The EPA are finalizing new standards that will require an 85% reduction in plastic fuel tank permeation and a 95% reduction in fuel system hose permeation from new recreational vehicles beginning in 2008. These standards and their implementation dates are given in the Table below. The **Appendix to Part 1**, **Section A.3.3.8** describes the test procedures associated with these standards. Test temperatures are included in the table because they represent an important parameter in defining the emission levels.

Table A.3.5 Permeation Standards for Recreational Vehicles

Emission component	Implementation date	Standard ($g/m^2/day$) (1)	Test temperature
Fuel Tank Permeation	2008	1.5	28 °C (82 °F)
Hose Permeation	2008	15	23 °C (73 °F)

(1) The permeation standards are based on the inside surface areas of the hoses and fuel tanks. Although volume is generally used to characterize fuel tank emission rates, the EPA base the standard on inside surface area because permeation is a function of surface area. In addition, the surface to volume ratio of a fuel tank changes with capacity and geometry of the tank. Two similar shaped tanks of different volumes or two different shaped tanks of the same volume could have different g/gallon/day permeation rates even if they were made of the same material and used the same emission control technology. Therefore, the EPA believe that using a $g/m^2/day$ form of the standard more accurately represents the emissions characteristics of a fuel tank and minimizes complexity.

Averaging, Banking and Trading

The EPA are finalizing ABT for fuel tanks to facilitate the implementation of the standard across a variety of tank designs. To meet the standard on average, manufacturers would be able to divide their fuel tanks into different emission families and certify each of their emission families to a different Family Emissions Level (FEL).

Crankcase Emissions

The EPA are requiring that new off-highway motorcycles and ATVs not emit crankcase vapours directly to the atmosphere. This requirement will phase in beginning in 2006 and be fully phased in by 2007. New snowmobiles must also have closed crankcases, beginning in 2006. This requirement is relevant only for four-stroke snowmobiles since two-stroke engines, by virtue of their operation, have closed crankcases.

Durability Requirements

Table A.3.6 Durability Requirements for Recreational Vehicles

Type	Useful Life (1)		
	Years	Kilometres	Hours
Off-highway motorcycles (2)	5	10 000	-
ATVs (2)	5	10 000	1000
Snowmobiles (3)	5	8000	400

(1) Whichever occurs first.

(2) The EPA consider the 10 000 kilometre and 1000 hour values to be minimum values for useful life, with the requirement that manufacturers must comply for a longer period if the average life of their vehicles is longer than this minimum value. The values being finalized will harmonize the EPA's useful life intervals with those contained in the California programme. Generally, this will allow the same emission test data to be used for certification under both programmes. However, this remains the minimum useful life and longer useful life intervals could be required in cases where the basic mechanical warranty of the engine or the advertised operating life is longer than the minimum interval.

(3) Longer useful life intervals are required where the basic mechanical warranty of the engine or the advertised operating life is longer than the minimum interval and the manufacturer may alternatively base the longer useful life on the average service life of the vehicles where necessary data are available.

- For off-highway motorcycle, ATVs, and snowmobiles, manufacturers must provide an emission-related warranty for at least half of the minimum useful life period. These periods could be longer if the manufacturer offers a longer mechanical warranty for the engine or any of its components; this includes extended warranties that are available for an extra price.

A.3.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.3.2.1. ASTM Gasoline Specifications

The ASTM fuel specifications have been largely made redundant by the requirements of the Clean Air Act Amendments which now govern the quality requirements of automotive fuels. The specifications for gasoline and diesel fuel will be found in **Part 2**, **Sections B.3.2.1** and **B.3.2.6**. The ASTM LPG specification is still current and is therefore included in the **Appendix to Part 1, Section A.3.2.8**.

A.3.2.2. Conventional Gasoline

Federal and State Summer RVP Standards - Conventional Gasoline Only

Federal volatility regulations (40 CFR 80.27) apply to “designated volatility non-attainment areas” and to “designated volatility attainment areas,” as defined in 40 CFR 80.2(cc) and 80.2(dd), respectively. The following table lists RVP limits by county, which may not coincide precisely with the borders of a non-attainment or attainment area. This does not include RVP limits which may apply through voluntary agreements for the supply of lower RVP fuel than that required for an area.

Table A.3.7 Federal and State Summer RVP Standards - Conventional Gasoline Only

State	County/Parish (Cities shown in parentheses)	Month & RVP (psi, max)				
		May	June	July	Aug	Sept 1-15
AL	Jefferson (Birmingham), Shelby	9.0	7.0 (1)	7.0	7.0	7.0
AL	All Others	9.0	9.0	9.0	9.0	9.0
AR	All counties	9.0	9.0	9.0	9.0	9.0
AZ	Maricopa [part], (Phoenix)	9.0	7.0 (1)	7.0	7.0	7.0 (30/09)
AZ	All others	9.0	9.0	9.0	9.0	9.0
CA	[See EPA RFG list] (2)					
CO	6-County CMSA, (Denver/Boulder) [See 'Notes' for county names and status of proposed change of 7.8 psi standard to 9.0 psi]	9.0	7.8	7.8	7.8	7.8
CO	All others	9.0	9.0	9.0	9.0	9.0
CT	[See EPA RFG list] (2)					
DC	(See EPA RFG list) (2)					
DE	(See EPA RFG list) (2)					
FL	Broward, Dade (Miami), Duval, Hillsborough, Palm Beach, Pinellas	9.0	7.8	7.8	7.8	7.8
FL	All others	9.0	9.0	9.0	9.0	9.0
GA	(Atlanta area) [See 'Notes' for list of 45 counties affected]	9.0	7.0 (1)	7.0	7.0	7.0
GA	All others	9.0	9.0	9.0	9.0	9.0
ID	All counties	9.0	9.0	9.0	9.0	9.0
IL	Madison (E. St. Louis), Monroe, St. Clair	9.0	7.2 (1)	7.2	7.2	7.2
IL	All other conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
IL	[See EPA RFG list] (2)					
IN	Clark, Floyd	9.0	7.8 (1)	7.8	7.8	7.8
IN	All other conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
IN	[See EPA RFG list] (2)					
IA	All counties	9.0	9.0	9.0	9.0	9.0
KS	Johnson (Kansas City), Wyandotte	9.0	7.0 (1)	7.0	7.0	7.0
KS	All others	9.0	9.0	9.0	9.0	9.0
KY	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
KY	[See EPA RFG list] (2)					
LA	Ascension, Beauregard, Calcasieu, E Baton Rouge, Grant, Iberville, Jefferson, Lafayette, Lafourche, Livingston, Orlean (New Orleans), Point Coupee, St Bernard, St Charles, St James, St Mary, W Baton Rouge	9.0	7.8	7.8	7.8	7.8
LA	All others	9.0	9.0	9.0	9.0	9.0
MA	[See EPA RFG list] (2)					

State	County/Parish (Cities shown in parentheses)	Month & RVP (psi, max)				
		May	June	July	Aug	Sept 1-15
MD	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
MD	[See EPA RFG list] (2)					
ME	Androscoggin, Cumberland (Portland), Kennebec (Augusta), Knox, Lincoln, Sagadahoc, York	7.8 (1)	7.8	7.8	7.8	7.8
ME	All others	9.0	9.0	9.0	9.0	9.0
MI	Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw (Ann Arbor), Wayne (Detroit)	9.0	7.8 (1)	7.8	7.8	7.8
MI	All others	9.0	9.0	9.0	9.0	9.0
MN	All counties	9.0	9.0	9.0	9.0	9.0
MT	All counties	9.0	9.0	9.0	9.0	9.0
MO	[See EPA RFG list] (2)					
MO	Clay (Kansas City), Jackson,	9.0	7.0 (1)	7.0	7.0	7.0
MO	All other conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
MS	All counties	9.0	9.0	9.0	9.0	9.0
NC	Davidson, Davie [part]	9.0	7.8	7.8	7.8	7.8
MN	All counties	9.0	9.0	9.0	9.0	9.0
NC	Durham, Forsyth, Gaston, Granville [part], Guilford, Mecklenburgh (Charlotte), Wake (Raleigh)	9.0	7.8	7.8	7.8	7.8
NC	All others	9.0	9.0	9.0	9.0	9.0
NE	All counties	9.0	9.0	9.0	9.0	9.0
NH	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
NH	[See EPA RFG list] (2)					
NJ	[See EPA RFG list] (2)					
NM	All counties	9.0	9.0	9.0	9.0	9.0
ND	All counties	9.0	9.0	9.0	9.0	9.0
NV	Washoe (Reno)	9.0	7.8	7.8	7.8	7.8
NV	All others	9.0	9.0	9.0	9.0	9.0
NY	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
NY	[See EPA RFG list] (2)					
OH	All counties	9.0	9.0	9.0	9.0	9.0
OK	All counties	9.0	9.0	9.0	9.0	9.0
OR	Clackamas, Multnomah (Portland), Washington, Marion [part] (Salem), Polk [part]	9.0	7.8	7.8	7.8	7.8
OR	All others	9.0	9.0	9.0	9.0	9.0
PA	Allegheny (Pittsburgh), Armstrong, Beaver, Butler, Fayette, Washington, Westmoreland	9.0	7.8 (1)	7.8	7.8	7.8
PA	All other conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
PA	[See EPA RFG list] (2)					

State	County/Parish (Cities shown in parentheses)	Month & RVP (psi, max)				
		May	June	July	Aug	Sept 1-15
RI	[See EPA RFG list] (2)					
SC	All counties	9.0	9.0	9.0	9.0	9.0
SD	All counties	9.0	9.0	9.0	9.0	9.0
TN	Davidson (Nashville), Rutherford, Shelby (Memphis), Sumner, Williamson, Wilson	9.0	7.8	7.8	7.8	7.8
TN	All others	9.0	9.0	9.0	9.0	9.0
TX	Eastern Texas [see 'Notes' section for 95 counties affected]	7.8 (1)	7.8	7.8	7.8	7.8 (01/10)
TX	El Paso (El Paso)	9.0	7.0 (1)	7.0	7.0	7.0
TX	Hardin, Jefferson, Orange	9.0	7.8	7.8	7.8	7.8
TX	All other conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
TX	[See EPA RFG List] (2)					
UT	Davis, Salt Lake (Salt Lake City)	9.0	7.8	7.8	7.8	7.8
UT	All others	9.0	9.0	9.0	9.0	9.0
VA	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
VA	[See EPA RFG List] (2)					
VT	All counties	9.0	9.0	9.0	9.0	9.0
WA	All counties	9.0	9.0	9.0	9.0	9.0
WV	All counties	9.0	9.0	9.0	9.0	9.0
WI	All conventional gasoline counties	9.0	9.0	9.0	9.0	9.0
WI	[See EPA RFG List] (2)					
WY	All counties	9.0	9.0	9.0	9.0	9.0

(1) State run programme with federally-approved State Implementation Plan (SIP).

(2) Indicates there are counties or areas in counties in the state which have reformulated gasoline (RFG) requirements. See EPA's "List of Federal Reformulated Gasoline Programme Areas," January, 2002. RFG areas must meet a VOC emissions performance reduction standard as per 40 CFR 80.4l.

Denver/Boulder: The applicable federal volatility standard from June 1 to September 15 is 7.8 psi. EPA has proposed changing this to 9.0 psi, and is preparing a final rule responding to the comment received on this proposal. The final rule was expected to be issued and effective beginning with the 2003 ozone season. CMSA counties include: Adams (partial), Arapahoe (partial), Boulder (partial), Denver, Douglas, and Jefferson.

Atlanta area counties include: Banks, Barrow, Bartow, Butts, Carroll, Chattooga, Cherokee, Clarke, Clayton, Cobb, Coweta, Dawson, DeKalb, Douglas, Fayette, Floyd, Forsyth, Fulton, Gordon, Gwinnett, Hall, Haralson, Heard, Henry, Jackson, Jasper, Jones, Lamar, Lumpkin, Madison, Meriwether, Monroe, Morgan, Newton, Oconee, Paulding, Pickens, Pike, Polk, Putnam, Rockdale, Spalding, Troup, Upson, and Walton.

Eastern Texas Counties include: Anderson, Angelina, Aransas, Atascosa, Austin, Bastrop, Bee, Bell, Bexar, Bosque, Bowie, Brazos, Burleson, Caldwell, Calhoun, Camp, Cass, Cherokee, Colorado, Comal, Cooke, Coryell, De Witt, Delta, Ellis, Falls, Fannin, Fayette, Franklin, Freestone, Goliad, Gonzales, Grayson, Gregg, Grimes, Guadalupe, Harrison, Hays, Henderson, Hill, Hood, Hopkins, Houston, Hunt, Jackson, Jasper, Johnson, Karnes, Kaufman, Lamar, Lavaca, Lee, Leon, Limestone, Live Oak, Madison, Marion, Matagorda, McLennan, Milam, Morris, Nacogdoches, Navarro, Newton, Nueces, Panola, Parker, Polk, Rains, Red River, Refugio, Robertson, Rockwall, Rusk, Sabine, San Jacinto, San Patricio, San Augustine, Shelby, Smith, Somervell, Titus, Travis, Trinity, Tyler, Upshur, VanZandt, Victoria, Walker, Washington, Wharton, Williamson, Wilson, Wise, and Wood.

Federal Fuel Volatility Regulations at 40 CFR 80.27:

Standards for May are maximum standards for all regulated parties except retailers and wholesale purchaser-consumers. Standards for 1 June to 15 September are maximum standards for all regulated parties including retailers and wholesale purchaser-consumers. Gasoline alcohol blends meeting 80.27(d) have l.0 psi waiver of applicable federal RVP standard. Alaska, Hawaii, and U. S. territories are exempted from federal volatility regulations.

Tier 2 Gasoline Sulphur Standards

The US EPA announced its final ruling on Tier 2 Motor Vehicle emissions standards and gasoline sulphur requirements (Federal Register; Volume 65, No. 28 of 10/02/00). The sulphur requirements are tabulated in **Part 1**, **Section 3.2.2.2**.

According to the EPA, their gasoline sulphur programme balances the goal of enabling Tier 2 emission control technologies with the goal of lowering sulphur. The latter is to be accomplished as early as the refining industry can practically achieve the required levels. To meet both of these goals, the standards are combined with a sulphur averaging, banking, and trading (ABT) programme.

Beginning in 2005, every refinery must meet an annual Refinery Average standard of 30 mg/kg sulphur. If a corporation owns more than one refinery, the annual sales-weighted average sulphur of all refineries has to meet the Corporate Average requirement starting in 2004. An importer's annual average sulphur level must meet the corporate pool average standard in 2004 and the refinery average from 2005 onwards. The sulphur content of any gasoline sold in the US must not exceed the Per-Gallon Cap. The new sulphur regulations apply to all parts of the US including Puerto Rico. Californian gasoline is, however, exempt since CARB has established sulphur limits which already meet the EPA's approval. Gasoline sold in parts of the Western US (the Geographic Phase-in-Area, or GPA) and that produced by “small” refiners can follow a less severe phase-in programme. However, this gasoline must meet the final limits by 2007 and 2008, respectively. Importers cannot be granted “small refiner” status.

These standards would represent the maximum allowable average sulphur levels for each refiner, measured across all refineries owned and operated by that refiner, rather than at each refinery. In 2006 and beyond, there is no corporate pool average standard. Every refinery will have to meet the 30 mg/kg average refinery gate limit, although refiners can use any banked/purchased credits to meet this standard. Thus, in 2006 and beyond, the majority of gasoline would average 30 mg/kg, although some individual refineries could average slightly more or less.

To ensure that gasoline sulphur levels do not exceed a maximum level which the EPA believe “hinders the emissions performance of Tier 2 vehicles”, caps are set on the sulphur content of every batch of gasoline produced or imported into the country. As shown above, these caps decline over time, ultimately resulting in a per-gallon limit of 80 mg/kg in 2006 and beyond.

To assist in complying with the sulphur regulations the EPA allows refineries, corporations and importers to generate credits which may be banked and traded to meet average sulphur requirements. Credits can be awarded from year 2000 onwards for early production of low sulphur fuel; their value varies with the extent of sulphur reduction.

A.3.2.3. Reformulated Gasolines

Introduction

Section 107(d) of the Clean Air Act, (as amended in 1990) required States to identify all areas that do not meet the national ambient air quality standards (NAAQS) for ozone, and directed EPA to designate these areas as ozone non-attainment areas. Section 181 of the Act required EPA to classify each area as a marginal, moderate, serious, severe or extreme ozone non-attainment area.

Mandated RFG Programme Areas

The Act mandated the sale of reformulated gasoline ("RFG") in the nine worst ozone non-attainment areas beginning January 1, 1995. EPA determined the nine covered areas to be the metropolitan areas of Baltimore, Chicago, Hartford, Houston, Los Angeles, Milwaukee, New York City, Philadelphia, and San Diego.

Any ozone non-attainment area that is reclassified as severe becomes a mandated RFG programme area. Inclusion in the RFG programme occurs one year following the date of reclassification. For example, Sacramento was reclassified from serious to severe on 1 June, 1995 and became a mandatory RFG area effective 1June, 1996.

The Energy Policy Act of August 2005, removes the requirement to include oxygenates in reformulated gasoline. However, it also calls for a tripling of the use of ethanol by 2012, so it will be interesting to see how the market develops.

RFG Programme Opt-In Areas

Any area that is currently or previously designated in non-attainment for ozone under the national one-hour ozone standard may be included in the RFG programme at the request of the Governor of the relevant State. EPA requires the sale of RFG in the "opt-in" areas within a year of an application being received. Although EPA has discretion to establish the effective date for the sale of RFG in these areas, EPA does not have discretion to deny a Governor's request. The effective date for a potential opt-in area may be extended beyond one year, based on a determination by EPA that there is insufficient domestic capacity to produce RFG (63 FR 52093, 29 Sep., 1998).

The cities and states listed above represent about 30% of all gasoline sold in the United States. If all ozone non-attainment areas had decided to opt into the programme, over 50% of the gasoline sold in the US would have been reformulated. In the event, there has been customer resistance in some areas to reformulated gasolines, particularly those containing MTBE. Groundwater contamination with MTBE has also raised questions regarding its suitability as a gasoline component.

RFG Programme Opt-Out Areas and Procedures

During the development of the RFG rule, a number of States inquired as to whether they would be permitted to opt out of the RFG programme at a future date, or opt out of certain requirements. The final RFG regulations, issued on December 15, 1993 (56 FR 7716), did not include procedures for opting out of the RFG programme. EPA first adopted procedures that apply to opt-out petitions received by 31 December, 1997. These interim procedures allowed States to opt-out ninety days after EPA approval of their petition.

In late 1997, EPA implemented restrictions on opt outs for the period 1 January, 1998 until 31 December, 2003. EPA's objective was to provide a stable regulatory environment that would not unreasonably inhibit cost recovery, which could lead to supply problems and cost fluctuations that might diminish the appeal and cost-effectiveness of the RFG programme. EPA was concerned about the investment decisions the refining industry had to make to achieve the more stringent Phase II emissions reductions. Unanticipated changes in demand, due to opt-outs, could make cost recovery of investment difficult.

The above Rule did not address the question of whether the EPA has the discretion to allow attainment areas to opt into the programme. The EPA wishes to allow areas which have recently been re-designated as attainment areas under the Clean Air Act to opt back into the reformulated gasoline programme. The proposal is targeted at areas which would like to use reformulated gasoline as a contingency measure to ensure that they do not slip back into non-attainment status.

Ethanol

The EPA introduced a ruling allowing refiners to add up to 10% v/v of ethanol in the summer months rather than the statutory 7.7% v/v limit allowed in reformulated gasoline. However refiners are required to produce a lower volatility blend stock as the rule does not provide a waiver on RVP to allow for the increased volatility of the ethanol. Furthermore, the ruling only applies to reformulated gasoline blended by the Simple Model (which expired in 1998). Blending under the complex model is NOx rather than ethanol limited. In July 1997, the EPA proposed a minor relaxation in that refiners would be required to meet average NOx reduction targets, rather than a “per-gallon” NOx reduction standard.

Record Keeping

The implications of all these regulations, in terms of administrative burden alone, has not been estimated. However, a vast array of records must be kept accurately, since missing data, any misclassification of gasoline, inconsistency between blending and shipping data, or other record-keeping problems constitute a violation of the regulations. The associated penalty is up to USD 25 000 per day, per violation.

The EPA continue to believe that reformulated gasoline (RFG) is an effective way to reduce smog precursors such as volatile organic compounds (VOCs) and oxides of nitrogen (NOx). The first phase of the RFG programme, from 1995 through 1999, required average reductions of smog-forming volatile organic compounds and toxics of 17% each, and NOx was reduced by 1.5%. The second phase of the RFG programme is claimed to achieve even greater average benefits: a 27% reduction in VOCs, a 22% reduction in toxics, and a 7% reduction in NOx emissions. The EPA suggest that this is equivalent to taking more than 16 million vehicles off the road.

Figure A.3.1 *US Non-attainment cities and "opt-in" states.*

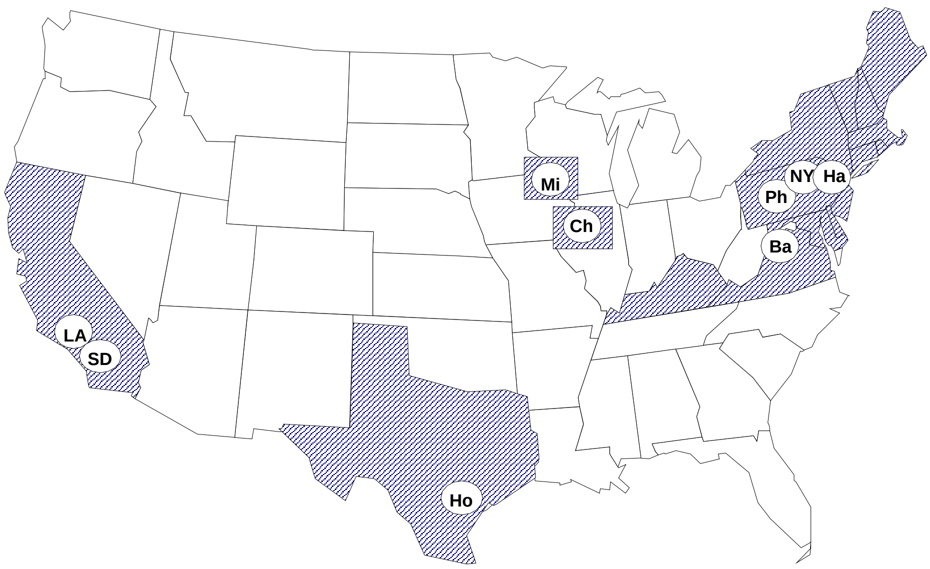


Table A.3.8 RFG Clean Air Act Required Areas

California		
El Dorado County (partial) (1)	Riverside County (partial)	Sutter County (partial) (1)
Kent County (partial) (2)	Sacramento County (1)	Tulare County
Kings County (2)	San Bernardino County (partial)	Ventura County
Los Angeles County	San Diego County	Yolo County (1)
Madera County (2)	San Joaquin (2)	Sutter County (partial) (1)
Merced County (2)	Solano County (partial) (1)	Tulare County
Orange County	Stanislaus County	Ventura County
Placer County (partial) (1)	San Bernardino County (partial)	Yolo County (1)
Connecticut		
Fairfield County (partial)	Middlesex County (partial)	Tolland County (partial)
Hartford County	New Haven County (partial)	
Litchfield County (partial)	New London County (partial)	
Delaware		
New Castle County	Kent County	
District of Columbia		
Entire District of Columbia		
Georgia (3)		
Cherokee County	Douglas County	Henry County
Clayton County	Fayette County	Paulding County
Cobb County	Forsyth County	Rockdale County
Coweta County	Fulton County	
DeKalb County	Gwinnett County	
Illinois		
Cook County	Kane County	McHenry County
Du Page County	Kendall County (partial)	Will County
Grundy County (partial)	Lake County	
Indiana		
Lake County	Porter County	
Louisiana (4)		
Ascenscion Parish	Iberville Parish	West Baton Rouge Parish
East Baton Rouge Parish	Livingston Parish	
Maryland		
Anne Arundel County	Charles County	Howard County
Baltimore County	Cecil County	Montgomery County
Calvert County	Frederick County	Prince George's County
Carroll County	Hartford County	The City of Baltimore

New Jersey		
Bergen County	Hudson County	Ocean County
Burlington County	Hunterdon County	Passaic County
Camden County	Mercer County	Salem County
Cumberland County	Middlesex County	Somerset County
Essex County	Monmouth County	Sussex County
Gloucester County	Morris County	Union County
New York		
Bronx County	Orange County	Rockland County
Kings County	Putnam	Suffolk County
Nassau County	Queens County	Westchester County
New York County	Richmond County	
Pennsylvania		
Bucks County	Delaware County	Philadelphia County
Chester County	Montgomery County	
Texas		
Brazoria County	Galveston County	Montgomery County
Chambers County	Harris County	Waller County
Fort Bend County	Liberty County	
Virginia		
Alexandria	Falls Church	Prince William County
Arlington County	Loudoun County	Stafford County
Fairfax	Manassas	
Fairfax County	Manassas Park	
Wisconsin		
Kenosha County	Ozaukee County	Washington County
Milwaukee County	Racine County	Waukesha County

(1) Sacramento, CA area was reclassified from Serious to Severe ozone non-attainment 1 effective June, 1995. RFG was required as of 1 June, 1996.

(2) San Joaquin Valley, CA area (excluding East Kern County) was reclassified as Severe ozone non-attainment effective 10 December, 2001. RFG was required as of 10 December, 2002.

(3) Atlanta, GA area was reclassified to Severe ozone non-attainment effective 1 January, 2004. RFG was required as of 1 January, 2005.

(4) Baton Rouge, LA area was reclassified to Severe ozone non-attainment effective 23 June, 2003. RFG was required as of 23 June, 2004.

Table A.3.9 RFG "Opt-In" Areas (Voluntary)

Connecticut		
Litchfield County (partial)	Middlesex County (partial)	Tolland County (partial)
Hartford County (partial)	New London County (partial)	Windham County
Delaware		
Sussex non-attainment area	Sussex County	
Kentucky		
Boone County	Campbell County	Kenton County
Bullitt County (partial)	Jefferson County	Oldham County (partial)
Maryland		
Kent County	Queen Anne's County	
Massachusetts		
Barnstable County	Franklin County	Norfolk County
Berkshire County	Hampden County	Plymouth County
Bristol County	Hampshire County	Suffolk County
Dukes County	Middlesex County	Worcester County
Essex County	Nantucket County	
Missouri (Effective Opt-In Date: 01/06/99)		
St. Louis County	Franklin County	St. Charles County
St Louis (city)	Jefferson County	
New Hampshire		
Hillsborough County	Merrimack County	
Rockingham County	Strafford County	
New Jersey		
Atlantic County	Cape May County	Warren County
New York		
Dutchess County	Essex County (partial)	
Rhode Island		
Bristol County	Newport County	Washington County
Kent County	Providence County	
Texas		
Collin County	Denton County	
Dallas County	Tarrant County	
Virginia		
Charles City County	Henrico County	Portsmouth
Chesapeake	Hopewell	Richmond
Chesterfield County	James City County	Suffolk
Colonial Heights	Newport News	Virginia Beach
Hampton	Norfolk	Williamsburg
Hanover County	Poquoson	York County

Table A.3.10 RFG "Opt-Out" Areas

Arizona [(1)]		
Phoenix, AZ non-attainment area		Maricopa County (partial)
Maine		
Androscoggin County	Kennebec County	Sagadahoc County
Cumberland County	Knox County	Waldo County [(2)]
Hancock County [(2)]	Lincoln County	York County
Pennsylvania		
Adams County	Cumberland County	Monroe County
Allegheny County	Dauphin County	Northampton County
Armstrong County	Erie County	Perry County
Beaver County	Fayette County	Somerset County
Berks County	Lackawanna County	Washington County
Blair County	Lancaster County	Westmoreland County
Butler County	Lebanon County	Wyoming County
Cambria County	Lehigh County	York County
Carbon County	Luzerne County	
Columbia County	Mercer, PA	
New York [(3)]		
Albany County	Jefferson County	Rensselear County
Erie County	Montgomery County	Saratoga County
Greene County	Niagara County	Schenectady County

(1) Phoenix opted into the RFG programme in 1997; retail stations were required to supply RFG by 4 August, 1997. In September 1997, the Governor of Arizona submitted an RFG opt-out petition for purposes of adopting a more stringent state RFG programme in Phoenix. EPA approved the opt-out petition which became effective on 10 June, 1998.

(2) The Maine "Opt-Out" areas withdrew from the federal RFG programme before it went into effect on 1 January, 1995

(3) A proposed rule to remove the New York "opt-out" areas from the requirements of the reformulated gasoline programme was published 14 June, 1995. [On 1 January, 1995, a temporary exemption of the RFG requirements in these areas went into effect. On 1 July, 1995 this stay was extended until the Agency took final action]. The final rule, published 8 July, 1996 [61 FR 35673], formally removed these areas from the list of RFG covered areas and provided states with general opt-out procedures. The July final rule was superseded by a final rule published 20 October, 1997 [62 FR 54552], revising the opt-out procedures.

Use of MTBE in the Federal States

On 14 September 1999 the Director of the EPA Office of Mobile Services made a statement to the US House of Representatives Subcommittee on Energy and Environment “to put the issues surrounding the use of MTBE and ethanol in perspective”.

Neither the Clean Air Act nor EPA requires the use of MTBE in RFG. The CAAA of 1990 required that RFG contain 2.0% m/m minimum oxygen; but it did not specify which oxygenate to use. Both ethanol and MTBE are employed in the current RFG programme, with fuel suppliers choosing to use MTBE in about 80% of the RFG.

Despite the air quality aspects of oxygenates in RFG, the EPA admit that there is growing concern about contamination of drinking water by MTBE. For the most part, levels detected in drinking water have been quite low. As of June, 1999, 3.7% of California's drinking water systems sampled have detected MTBE. Most of those detections are below the state's secondary standard (or taste and odour action level) of 5 ppb.

The US Geological Survey has reported that about 3% of groundwater wells in RFG programme areas have detections of MTBE at or above 5 ppb. MTBE detections at higher concentrations in groundwater result primarily from leaking underground fuel storage tanks, and possibly from spills at distribution facilities. These leaks are unacceptable regardless of whether or not MTBE is present in the gasoline. However, the presence of MTBE at these sites suggests the need for improved early warning systems for underground storage tank leaks. The Agency's underground storage tank programme is expected to substantially reduce future leaks of all fuels and additives, including MTBE, from underground fuel storage tanks. Underground tanks were required to be upgraded, closed, or replaced to meet these requirements by December 1998.

In response to concerns associated with the use of oxygenates in gasoline, the Administrator established a panel of leading experts whose objective was to assess the issues posed by the use of oxygenates in gasoline. The panel presented its recommendations to the Clean Air Act Advisory Committee in late July 1999:

- Enhance water protection and monitoring
- Prevent leaks through improvement of existing programmes
- Remediate existing contamination
- Amend the Clean Air Act to remove the requirement that federal reformulated gas contain 2% m/m oxygen
- Maintain current air quality benefits (no environmental backsliding)
- Reduce the use of MTBE
- Accelerate research on MTBE substitutes

The EPA aims to address the panel's recommendations to the extent possible within the Agency's current administrative authority. This will include strengthening underground storage tank and drinking water protection programmes, and where possible, providing more flexibility to states and refiners as they move to decrease the use of MTBE in gasoline.

The EPA intends *“to provide a targeted legislative solution that maintains our air quality gains and allows for the reduction of MTBE, while preserving the important role of renewable fuels like ethanol.”* Furthermore, *“As MTBE use is reduced, ethanol is clearly the most likely substitute for MTBE and is already used to meet the oxygen standard in Milwaukee and Chicago. We believe it is likely that substantial amounts of ethanol will continue to be used in the federal RFG programme. The EPA is working closely with all fuel providers to assure a smooth transition to the second phase of the RFG programme.”*

The Energy Policy Act of August 2005 removes the requirement to include oxygenates in reformulated gasoline. However, it also calls for a tripling of the use of ethanol by 2012, so it will be interesting to see how the market develops. As of July 2005, the following states have either a partial or complete ban on methyl tertiary-butyl ether (MTBE):

Table A.3.11 US State Phase-Out of MTBE

State (EPA Region)	Phase-Out Date	Complete or Partial Ban	Applicability to Other Oxygenates	Date of adoption
IA (7)	01/07/00	Partial: no more than trace amounts (0.5% v/v MTBE)	MTBE only	11/05/00 Replaced previous limit of 2% (v/v)
MN (5)	02/07/00 (partial) 02/07/05 (complete)	Partial then complete: no more than 1/3 of 1% oxygenate as of 02/07/00; complete ban as of 02/07/05	(1)	Early 2000
NE (7)	13/07/00	Partial: no more than 1% (v/v) MTBE	MTBE only	11/04/00
SD (8)	01/07/01	Partial: no more than trace amounts (less than 0.5% v/v)	MTBE only	28/02/01 Replaced previous limit of 2% (v/v)
CO (8)	30/04/02	Complete ban by 30/04/02	MTBE only	23/05/00
CA (9)	Originally 31/12/02; delayed to 31/12/03	Complete ban by 31/12/02, but later Exec. Order required CARB to implement by 31/07/02 a one-year delay in ban. On 25/07/02, CARB delayed the ban by 1 year.	MTBE only	09/10/99 (Orig. E.O. issued 25/03//99; later E.O. issued 15/03/02)
MI (5)	01/06/03	Complete ban by 01/06/03; can be extended if determined by 01/06/02 that phase-out date is not achievable.	MTBE only	01/06/00 (Orig. phase-out date 01/10/03; extended to 01/01/04 on 18/06/03)
CT (1)	01/01/04	Complete ban by 01/01/04, planned in conjunction with NESCAUM regional fuels task force	MTBE only	01/06/00 (Orig. phase-out date 01/10/03; extended to 01/01/04 on 18/06/03)
NY (2)	01/01/04	Complete ban as of 01/01/04	MTBE only	24/05/00
WA (10)	01/01/04	Partial: may not be intentionally added to fuel, or knowingly mixed in gasoline above 0.6% v/v	MTBE only	10/05/01
KS (7)	01/07/04	Partial: may not sell or deliver any motor vehicle fuel containing more than 0.5% (v/v) MTBE	MTBE only	19/04/01
IL (5)	24/07/04	Partial: may not use, sell or manufacture MTBE as a fuel additive, but may sell motor fuel containing trace amounts of MTBE (0.5% v/v or less)	MTBE only	24/07/01 (original ban) revised 24/06/02 to allow trace amounts
IN (5)	24/07/04	Partial: no more than 0.5% (v/v) MTBE in gasoline	MTBE only	14/03/02
WI (5)	01/08/04	Partial: no more than 0.5% (v/v) MTBE in gasoline	MTBE only	11/08/03
AZ (9)	01/01/05	Partial: no more than 0.3% (v/v) MTBE in gasoline	MTBE only	11/05/04
OH (5)	01/07/05	Partial: no more than 0.5% (v/v) MTBE in motor vehicle fuels	MTBE only	29/05/02
MO (7)	31/07/05	Partial: no more than 0.5% (v/v) MTBE in gasoline sold or stored	MTBE only	11/07/02
KY (4)	01/01/06	Partial: no more than trace amounts of MTBE in fuel after this date	MTBE only	23/04/02
ME (1)	01/01/07	Partial: no more than 0.5% (v/v) MTBE in gasoline sold	MTBE only	14/04/04
NH (1)	01/01/07	Partial: no more than 0.5% (v/v) in gasoline sold or stored	(2)	10/05/05

State (EPA Region)	Phase-Out Date	Complete or Partial Ban	Applicability to Other Oxygenates	Date of adoption
VT (1)	01/01/07	Complete	MTBE only	23/05/05
RI (1)	01/06/07	Partial: no more than 0.5% (v/v) MTBE and other oxygenates in gasoline	(3)	06/07/05
NC (4)	01/01/08	Partial: no more than 0.5% (v/v) MTBE in gasoline	MTBE only	21/06/05

(1) MTBE, ETBE, and TAME.

(2) MTBE, other gasoline ethers, or tertiary butyl alcohol (TBA).

(3) MTBE & "other oxygenates-methanol, Isopropanol, n-Propanol, N-butonal, sec-butanol, tert-butanol, tert-pentalol (tert-amylalcohol), Ethyl tert butyl ether (ETBE), disapropyl ether (DIPE), tert butyl alcohol (TBA), Iso-butanol, tertamylmethylene ether (TAME)

A.3.2.4. Reformulated Gasoline – Simple and Complex Models

All reformulated gasoline must contain a minimum of 2.0% m/m oxygen, a maximum of 1.0% v/v benzene and must not contain heavy metals. Sulphur, T90E and olefins contents are not reduced, but may not be higher than a refiners' 1990 average. A summary of the regulation is given in **Table A.3.12**. In addition, they must meet certain VOC, air toxics and NOx emissions performance requirements, judged against qualities produced in 1990 (see **Tables A.3.13** and **A.3.14**). Emissions performance will be calculated on the basis of empirical "models".

For the first 3 years (1995-1997), refiners were allowed to use a "simple model" to certify their reformulated gasolines. Besides the compositional constraints with respect to oxygen, benzene and heavy metals, the simple model was designed to reduce VOC emissions by limiting RVP (deemed to be equivalent to a 15% VOC reduction) and total air toxics. The latter were calculated from benzene, 1,3-butadiene, polycyclic organic, formaldehyde and acetaldehyde emissions using formulae given in **Tables A.3.16** to **A.3.19**.

From 1 January 1998, refiners have been required to use a "complex model" for certification. The complex model is a set of equations correlating a gasoline's properties to its emissions characteristics. Refiners could also have used this complex model for the first 3 years, which would have given them more flexibility in meeting the requirements. Refiners can comply with the standards either on a batch (per gallon) basis or on a quarterly average basis. Average limits are more severe overall, but have more latitude on a per gallon basis.

The complex emissions model uses formulae to calculate total VOCs, air toxics and NOx reductions. The exhaust VOC formulae use regression equations based on the RVP, distillation parameters (E200 and E300, in °F) and sulphur, oxygen, aromatics and olefins contents within the ranges given in **Table A.3.28**, together with weighting factors based on the emissions characteristics of old and new technology vehicles (**Table A.3.27**). These weighting factors may be changed in future years to match the characteristics of the car population.

Calculations of NOx emissions are given in **Table A.3.20**, and are based on regression equations based on similar fuel properties to the VOC equations with acceptable ranges given in **Table A.3.32** and by applying the same weighting factors. Toxics emissions calculations are given in **Table A.3.25**, based on similar fuel properties to the VOC, plus benzene and oxygenate contents and the same weighting factors. They include exhaust emissions of benzene, formaldehyde, acetaldehyde, 1,3-butadiene and non-exhaust emissions of benzene.

The acceptable ranges of fuel properties are given in **Table A.3.28** and the allowable ranges of fuel properties for the purposes of the calculations are given in **Tables A.3.31** and **Table A.3.24** for VOC and NOx emissions respectively. The reader is referred to the Federal Register (Vol. 59 No 32, p.7820-21) for the corrections required to the formulae for fuel characteristics falling outside these ranges.

Supplies of conventional gasolines will also be regulated to prevent any increase in emissions (the so-called “anti-dumping” rule). For the first three years olefins, sulphur, and T90E were not allowed to exceed their 1990 values by more than 25% and aromatics and benzene were controlled by means of a formula (BEE, see footnote to **Table A.3.15**). From 1997, emissions of benzene, toxics and NOx have not been allowed to exceed 1990 values and VOC emissions are controlled by regional RVP limits.

All refiners, blenders and importers, even those not supplying reformulated gasoline, were required to provide data of the characteristics of their gasoline production to the EPA for the baseline year 1990, in terms of batches of finished gasoline or components used in blending. Similar data was required for subsequent years. For refiners unable or unwilling to submit an individual baseline, the EPA calculated a statutory 1990 baseline from market survey data. This data was used by the EPA to judge a supplier’s performance against the requirements of the Act and to prevent dumping of unsuitable components into the conventional gasoline pool. Incremental volumes were judged against the parameters of the statutory baseline (see **Table A.3.15**).

This last provision applies particularly to foreign refineries, which must export to the US reformulated gasolines complying with the statutory baseline values for olefins, T90 and sulphur content. Therefore, while US refiners have been allowed to run their production at each refinery at usual levels, foreign producers have had to comply with three more parameters. In particular, the olefins content limit of the EPA 1990 baseline of 9-12% v/v max. is difficult to meet in refineries with catalytic crackers.

The EPA’s Renewable Oxygen Rule (ROR) for a Renewable Oxygen Standard (ROS) was overturned by a federal appeals court. If the rule had stood it would have required reformulated gasolines to contain 15% renewable oxygenates, such as ethanol or ETBE by 1 January 1995 and 30% by 1 January 1996.

Table A.3.12 RFG - Fixed Specification Requirements

Parameter	Batch Basis	Average Basis
Benzene % v/v max.	1.0	0.95 1.3 allowed on a batch
Oxygen % m/m	2.0 - 2.7	
Heavy Metals	None without an EPA waiver	
T90E **Sulphur** **Olefins**	Average no greater than refiners 1990 average	
Detergent Additives	Compulsory	

Table A.3.13 RFG - Phase I: Emission Targets (1995-1997 Simple and Complex Models***)***
(All emission reductions are relative to 1990 baseline quality)

Parameter	Simple model (1995-1997)		Simple + Complex	Complex Model (1995-1999)		
	RVP (psi, min)		Toxics (% reduction)	VOC (% reduction, min)		NOx (% reduction, min)
Region	1 South*	2 North*	All	1 South*	2 North*	All
Batches	7.2	8.1	15.0	35.1*	15.6	Zero
Average	7.2	8.1	16.5	36.6*	17.1	1.5

* Calculated relative to the Clean Air Act baseline of 8.7 psi. See Map, **Figure A.3.1**. Reduction relative to 7.8 psi is similar to Region 2

Table A.3.14 RFG Phase II (2000 onwards) - Complex Model
(All emission reductions are relative to 1990 baseline quality)

Parameters	VOC (% reduction, min)		Toxics (% reduction)	NOx (% reduction, min))
Region	1 South*	2 North*	All	All
Batches	27.5	25.9	20.0	5.5
Average	29.0	27.4	21.5	6.8

* See map **Figure A.3.1**

Table A.3.15 RFG Statutory Baseline Parameters - 1990 Average Quality [(1)]

Gravity	59.1	**Volatility**	
Benzene [(2)]	1.6% v/v	**T50**	207ºF
Aromatics	28.6% v/v	**T90**	332ºF
Olefins	10.8% v/v	**E200° F**	46% v/v
Sulphur	338 ppm	**RVP**	8.7 psi

(1) Cannot exceed 1990 values.

(2) Benzene Exhaust Emissions, BEE mg/mile =
1.884 + (0.949 x % benzene) + (0.113 x [% aromatics - % benzene])

Table A.3.16 Formulae for Toxics Emissions, Simple Model [(1)]
Calculation of Total Toxics Reductions

$$\text{Total Toxics Reduction \%, Summer 1} = \frac{100\{53.2 - (\text{toxics emissions, summer 1, mg/mile})\}}{53.2}$$

$$\text{Total Toxics Reduction \%, Summer 2} = \frac{100\{52.1 - (\text{toxics emissions, summer 2, mg/mile})\}}{52.1}$$

$$\text{Total Toxics Reduction \%, Winter} = \frac{100\{55.5 - (\text{toxics emissions, winter, mg/mile})\}}{55.5.}$$

The toxics emissions for the summer regions and winter are given in **Tables A.3.17** and **A.3.18**

(1) The model may not be used to determine the VOC or toxics if the following parameters fall outside the limits shown; benzene 0 - 2.5% v/v, RVP 6.6 - 9.0 psi, oxygenates 0-3.5% m/m aromatics 10-45% v/v

Table A.3.17 Formulae for Toxics Emissions, Simple Model [(1)]
Calculation of Toxic Emissions, Summer, Regions 1 & 2, mg/mile[(2)]

Toxic emissions =
exhaust benzene + evaporative benzene + running loss benzene + refuelling benzene + formaldehyde + acetaldehyde + 1,3-butadiene + polycyclic organic matter

Exhaust benzene =

$$\{1.884 + 0.949(\text{benzene}) + 0.113\frac{(\text{aromatics - benzene})}{100}\} \times 1000[\text{exh VOC}]$$

Evaporative benzene emissions = Hot soak benzene + Diurnal benzene emissions

Hot soak benzene emissions =

$$(\text{benzene}) \times 0.679[\text{evap VOC}] \times 1000 \times \{1.4448 - \frac{0.0684(\text{MTBE})}{2.0} - \frac{0.080274(\text{RVP})\}}{100}$$

Diurnal benzene emissions =

$$(\text{benzene}) \times 0.321[\text{evap VOC}] \times 1000 \times \{1.3758 - \frac{0.0579(\text{MTBE})\}}{2.0} - \frac{0.080274(\text{RVP})\}}{100}$$

Running loss benzene emissions =

$$(\text{benzene}) \times [\text{runloss VOC}] \times 1000 \times \{1.4448 - \frac{0.0684(\text{MTBE})}{2.0} - \frac{0.080274(\text{RVP})}{100}\}$$

Refuelling benzene emissions =

$$(\text{benzene}) \times [\text{refuel VOC}] \times 1000 \times \{1.3972 - \frac{0.0591(\text{MTBE})}{2.0} - \frac{0.081507(\text{RVP})}{100}\}$$

1,3-Butadiene emissions = 5.56 x [exh VOC]

Polycyclic organic emissions = 3.15 x [exh VOC]

Formaldehyde [(3,4)] =

$$12.56[\text{exh VOC}] \times \{1 + \frac{0.421(\text{MTBE+TAME})}{2.7} + \frac{0.358(\text{EtOH})}{3.55} + \frac{0.137(\text{ETBE+ETAE})}{2.7}\}$$

Acetaldehyde [(3,4)] =

$$8.91[\text{exh VOC}] \times \{1 + \frac{0.078(\text{MTBE+TAME})}{2.7} + \frac{0.865(\text{EtOH})}{3.55} + \frac{0.867(\text{ETBE + ETAE})}{2.7}\}$$

(1) The model may not be used to determine the VOC or toxics if the following parameters fall outside the limits shown; benzene 0 - 2.5% v/v, RVP 6.6 - 9.0 psi, oxygenates 0 -3.5% m/m aromatics 10-45% v/v.

(2) Terms in curved ( ) brackets are fuel components in % v/v, oxygenates in % m/m or RVP in psi. Terms in square [ ] brackets are emissions quoted in g/mile.

(3) Formaldehyde and acetaldehyde calculated only on fuels containing oxygenates.

(4) When calculating formaldehyde and acetaldehyde, oxygen in the form of alcohol homologues with molecular mass greater than ethanol shall be evaluated as ethanol. Oxygen in the form of methyl ethers other than TAME and MTBE shall be evaluated as MTBE. Oxygen in the form of ethyl ethers or non-methyl and non-ethyl ethers shall be evaluated as ETBE.

- The formulae for the calculation of VOC emissions for Summer, Regions 1 and 2, and Winter are given in **Table A.3.19**.

Table A.3.18 Formulae for Toxics Emissions, Simple Model
Calculation of Winter Toxic Emissions (mg/mile)

Toxic emissions = exhaust benzene + formaldehyde + acetaldehyde + 1,3-butadiene + polycyclic organic matter
Exhaust benzene = $\{1.884 + 0.949(\text{benzene}) + 0.113\frac{(\text{aromatics - benzene})}{100}\} \times 1000[\text{exh VOC}]$
1,3-Butadiene emissions = 5.56 x [exh VOC]
Polycyclic organic emissions = 2.13 x [exh VOC]
Formaldehyde and acetaldehyde are calculated as for summer toxic emissions above using the summer exhaust VOC factors.

- Notes as above

Table A.3.19 Formulae for Toxics Emissions, Simple Model (1)
Calculation of VOC Emissions Terms, g/mile (2)

Summer Region 1 (3)
Exhaust non-methane VOC emissions [exh VOC] = $0.444 \times \{1 - \frac{0.127(\text{oxygen content})}{2.7}\}$
Evaporative VOC emissions [evap VOC] = $0.7952 - 0.2461(\text{RVP}) + 0.02293(\text{RVP})^2$
Running loss VOC emissions [runloss VOC] = $0.734 + 0.1096(\text{RVP}) + 0.002791(\text{RVP})^2$
Refuelling VOC emissions [refuel VOC] = 0.04 x {0.1667(RVP) - 0.45}
Summer Region 2 (3)
Evaporative VOC emissions [evap VOC] = $0.813 - 0.2393(\text{RVP}) + 0.021239(\text{RVP})^2$
Running loss VOC emissions [runloss VOC] = $0.2963 - 0.1306(\text{RVP}) + 0.016255(\text{RVP})^2$
Exhaust non-methane VOC [exh VOC] and Refuelling VOC [refuel VOC] emissions as per Summer Region 1
Winter (3)
Exhaust non-methane VOC emissions [exh VOC] = $0.656 \times \{1 \times \frac{0.127(\text{oxygen content})}{2.7}\}$
There are no terms for evaporative VOC [evap VOC], running loss VOC [runloss VOC] or refuelling VOC [refuel VOC] emissions for the winter period.

(1) The model may not be used to determine the VOC or toxics if the following parameters fall outside the limits shown; benzene 0 - 2.5% v/v, RVP 6.6 - 9.0 psi, oxygenates 0 -3.5% m, aromatics 10-45% v/v.

(2) Terms in curved ( ) brackets are fuel components in % v/v, oxygenates in % m/m or RVP in psi. Terms in square [ ] brackets are emissions quoted in g/mile.

(3) Summer period 1 May to 15 September, Winter period 16 September to 30 April.

Table A.3.20 Complex Model Formulae - Calculation of NOx Emissions

NOx emissions, mg/mile = $NOx(b) + \frac{NOx(b) \times Y_{NOx}(t)}{100}$

where,

NOx(b) = baseline exhaust NOx emissions, mg/mile (see **Table A.3.26**)

$Y_{NOx}(t)$ = performance of target fuel(% change from baseline) = $\left\{w_1 \times \frac{\exp. n_1(t)}{\exp. n_1(b)} + w_2 \times \frac{\exp. n_2(t)}{\exp. n_2(b)} - 1\right\} \times 100$

w_1, w_2 = weighting factors for normal and higher emitters (see **Table A.3.27**)

$n_1(t)$, $n_2(t)$ = NOx equations for normal and higher emitters, target fuel (1)

$n_1(b)$, $n_2(b)$ = NOx equations for normal and higher emitters, base fuel (1)

n_1 = 0.0018571(oxygen) + 0.0006921(sulphur) + 0.0090744(RVP) + 0.0009310(E200) + 0.0008460(E300) + 0.0083632(aromatics) - 0.002774(olefins) - 6.63 x 10^{-7}(sulphur)^2 -0.000119(aromatics)^2 + 0.0003665(olefins)^2

n_2 = 0.000252(sulphur) - 0.00913(oxygen) - 0.01397(RVP) + 0.000931(E200) - 0.00401(E300) + 0.007097(aromatics) - 0.00276(olefins) + 0.0003665(olefins)^2 - 7.995 x 10^{-5}(aromatics)^2

(1) For winter NOx emissions, RVP for both the baseline and target fuels is taken as 8.7 psi.

Table A.3.21 Complex Model Formulae
Calculation of Exhaust Volatile Organic Compounds Emissions

Exhaust VOC Emissions, mg/mile = $VOC(b) + \frac{VOC(b) \times Y_{voc}(t)}{100}$, where

VOC(b) = baseline exhaust VOC emissions, mg/mile (see **Table A.3.25)**

$Y_{voc}(t)$ = % change VOC from baseline = $\left\{w_1 \times \frac{\exp. v_1(t)}{\exp. v_1(b)} + w_2 \times \frac{\exp. v_2(t)}{\exp. v_2(b)} - 1\right\} \times 100$

w_1, w_2 = weighting factors for normal and higher emitters (see **Table A.3.27**)

$v_1(t)$, $v_2(t)$ = VOC equations for normal and higher emitters , target fuel (1)

$v_1(b)$, $v_2(b)$ = VOC equations for normal and higher emitters , base fuel (1)

v_1 = 0.0005219(sulphur) - 0.003641(oxygen) + 0.0289749(RVP) - 0.01447(E200) + 0.0001072(E200)^2 - 0.068624(E300) + 0.0004087(E300)^2 + 0.0323712(aromatics) - 0.002858(olefins) - 0.0003481(aromatics x E300)

v_2 = 0.043295(RVP) - 0.003626(oxygen) - 0.000054(sulphur) - 0.013504(E200) - 0.062327(E300) + 0.0282042(aromatics) - 0.002858(olefins) + 0.000106(E200)^2 + 0.000408(E300)^2 - 0.000287(aromatics)(E300)

(1) For winter exhaust VOC emissions, RVP for both the baseline and target fuels is 8.7 psi.

- For fuels with E200 and E300 exceeding the upper limit given in **Table A.3.31** the values are taken as equal to the upper limits.
- For fuels with E200, E300 and aromatics outside the limits given in **Table A.3.31** the value of $Y_{voc}(t)$ is modified by an additional term as given in Federal Register Vol. 59 No.32 p.7820-21.

Table A.3.22 Complex Model Formulae - Non-Exhaust VOC Emissions

Non-Exhaust VOC Emissions (g/mile)	Phase I (1995-1999)		Phase II (2000 and after)	
	Region I	Region II	Region I	Region II
Diurnal VOC	$0.00736(RVP)^2$ - 0.0790(RVP) + 0.2553	$0.006818(RVP)^2$ - 0.07682(RVP) + 0.2610	$0.007385(RVP)^2$ - 0.08981(RVP) + 0.3158	$0.004775(RVP)^2$ - 0.05872(RVP) + 0.21306
Hot soak VOC	$0.01557(RVP)^2$ - 0.1671(RVP) + 0.5399	$0.014421(RVP)^2$ - 0.16248(RVP) +0.5520	$0.006654(RVP)^2$ - 0.08009(RVP) +0.2846	$0.006078(RVP)^2$ - 0.07474(RVP) +0.27117
Running loss VOC	$0.00279(RVP)^2$ - 0.1096(RVP) - 0.7340	$0.016255(RVP)^2$ - 0.1306(RVP) +0.2963	$0.017768(RVP)^2$ - 0.18746(RVP) +0.6146	$0.016169(RVP)^2$ - 0.17206(RVP) +0.56724
Refuelling VOC	0.006668(RVP) - 0.0180	0.006668(RVP) - 0.0180	0.0004767(RVP) +0.011859	0.004767(RVP) +0.011859
Total non-exhaust VOC(1)	$0.02572(RVP)^2$ - 0.349032(RVP) + 0.0432	$0.037494(RVP)^2$ - 0.363232(RVP) +1.0913	$0.031807(RVP)^2$ - 0.3568833(RVP) +1.226859	$0.027022(RVP)^2$ - 0.300753(RVP) + 1.063329

(1) Total non-exhaust VOC is sum of diurnal, hot soak, running loss and refuelling VOC emissions

- RVP expressed in psi.

Table A.3.23 Complex Model Formulae - Calculation of Winter Non-Exhaust VOC Emissions

Total non-exhaust VOC emissions shall be set at zero under winter conditions

Table A.3.24 Complex Model Formulae Calculation of Change in Total VOC Emissions (1)

Change in Total VOC Emissions (%)	Formula (g/mile)	
	Phase I	Phase II
Summer, Region 1	100 x (Total VOC - 1.306) / 1.306	100 x (Total VOC - 1.4663) / 1.4663
Summer, Region 2	100 x (Total VOC - 1.215) / 1.215	100 x (Total VOC - 1.3991) / 1.3391
Winter	100 x (Total VOC - 0.660) / 0.660	100 x (Total VOC - 1.341) / 1.341

(1) Total VOC emissions, g/mile = [exhaust VOC (mg/mile)]/1000 + non-exhaust VOC (g/mile).

Table A.3.25 Complex Model Formulae
Calculation of Toxics Emissions

Summer toxics emissions = exhaust benzene + formaldehyde + acetaldehyde + 1,3-butadiene + polycyclic organic matter + non-exhaust benzene emissions Exhaust benzene, formaldehyde, acetaldehyde and 1,3-butadiene emissions are calculated using an equation of the type: Emissions = $\frac{E(b) + E(b) \times YE(t)}{100}$ where, E(b) = baseline emission, mg/mile (see **Table A.3.30**) YE(t) = $\{(W1 \times \frac{expE1(t)}{expE1(b)} + W2 \times \frac{expE2(t)}{expE2(b)} - 1\}$ W1, W2 = weighting factors for normal and higher emitters (see **Table A.3.27**) E1(t), E2(t) = equations for normal and higher emitters, target fuel E1(b), E2(b) = equations for normal and higher emitters, base fuel E1 for exhaust benzene, b1= 0.0006197(sulphur) - 0.003376(E200) + 0.0265500(aromatics)+ 0.2223900(benzene) E2 for exhaust benzene, b2= 0.0003370(sulphur) + 0.0112510(E300) + 0.0118820(aromatics) + 0.2223180(benzene) -0.096047(oxygen) E1 for formaldehyde, f1 = 0.0462131(MTBE) - 0.010226(E300) - 0.007166(aromatics) E2 for formaldehyde, f2 = 0.0462131(MTBE) - 0.010226(E300) -0.007166(aromatics) - 0.031352(olefins) E1 for acetaldehyde, a1 = 0.0002631(sulphur) + 0.0397860(RVP) - 0.012172(E300) - 0.005525(aromatics) - 0.009594(MTBE) + 0.3165800(ETBE) + 0.2492500(ethanol) E2 for acetaldehyde, a2 = 0.0002627(sulphur) - 0.012157(E300) - 0.005548(aromatics) - 0.055980(MTBE) + 0.3164665(ETBE) + 0.2493259(ethanol) E1 for 1.3-butadiene, d1 = 0.0001552(sulphur) - 0.007253(E200) - 0.014866(E300) - 0.004005(aromatics) + 0.0282350(olefins) E2 for 1,3-butadiene, d2 = 0.0436960(olefins) - 0.060771(oxygenate) - 0.007311(E200) - 0.008058(E300) - 0.004005(aromatics) Polycyclic organic matter emissions = 0.003355 x VOC exhaust emissions
Non-exhaust benzene emissions = diurnal + hot soak + running loss + refuelling benzene emissions, where:
Hot soak benzene emissions = 10 x (benzene) x (hot soak VOC emissions)(1) x {1.4448 - 0.0342(MTBE) - 0.080274(RVP)}
Diurnal benzene emissions = 10 x (benzene) x (diurnal VOC emissions)(1) x {1.3758 - 0.0290(MTBE) - 0.080274(RVP)}
Running loss benzene emissions = 10 x (benzene) x (running loss VOC emissions)(1) x {1.4448 - 0.0342(MTBE) - 0.080274(RVP)} Benzene refuelling emissions = 10 x (benzene) x (refuelling VOC emissions)(1) x {1.3972 - 0.0296(MTBE) - 0.081507(RVP)}

(1) As calculated for appropriate Phase and Region in **Table A.3.32**.

Table A.3.26 Baseline Data for Calculating Complex Equations
Baseline Exhaust Emissions

Exhaust Pollutant (mg/mile)	Phase I (1995-1999)		Phase II (2000 and after)	
	Summer	**Winter**	**Summer**	**Winter**
VOC	446	660	907	1341
NOx	660	750	1340	1540
Benzene	26.10	37.57	53.54	77.62
Acetaldehyde	2.19	3.57	4.44	7.25
Formaldehyde	4.85	7.73	9.70	15.34
1,3-Butadiene	4.31	7.27	9.38	15.84
Poly Organic Matter	1.50	2.21	3.04	4.50

Table A.3.27 Baseline Data for Calculating Complex Equations
Weighting Factors for Normal and Higher Emitters

	Phase I (1995-1999)		Phase II (2000 and after)	
	VOC+Toxics	**NOx**	**VOC+Toxics**	**NOx**
Normal Emitters (w_1)	0.52	0.82	0.444	0.738
Higher Emitters (w_2)	0.48	0.18	0.556	0.262

Table A.3.28 Baseline Data for Calculating Complex Equations
Fuel Properties and Acceptable Range for models

Baseline Fuel Properties			Limits of Simple Model	Acceptable Range (Complex)	
Fuel Property	**Summer**	**Winter**		**Reformulated**	**Conventional**
Oxygen (% m/m)	0.0	0.0	0 - 3.5	0.0 - 3.7	0.0 - 3.70
Sulphur (ppm)	339	338		0.0 - 500.0	0.0 - 100.0
RVP (psi)	8.7	11.5	6.6 - 9.0	6.4 - 10.0	6.4 - 11.0
E200 (%v/v)	41.0	50.0		30.0 - 70.0	30 .0- 70.0
E300 (%v/v)	83.0	83.0		70.0 - 100.0	70.0 - 100.0
Aromatics (% v/v)	32.0	26.4	10 - 45	0.0 - 50.0	0.0 - 55.0
Olefins (% v/v)	9.2	11.9		0.0 - 25.0	0.0 - 30.0
Benzene (% v/v)	1.53	1.64	0 - 2.5	0.0 - 2.0	0.0 - 4.9

Table A.3.29 Baseline Data for Calculating Complex Equations
Non-Exhaust Emissions

Non-Exhaust Pollutant (mg/mile)	Phase I (1995-1999)		Phase II (2000 and after)	
	Region 1	Region 2	Region 1	Region 2
VOC	860	769	559	492
Benzene	9.66	8.63	6.24	5.50

Table A.3.30 Baseline Data for Calculating Complex Equations
Total VOC, NOx and Toxics Emissions

Pollutant (mg/mile)	Phase I (1995-1999)		Phase II (2000 and after)	
	Region I	Region II	Region I	Region II
Summer				
NOx	660.0	660.0	1340.0	1340.0
VOC	1306.5	1215.1	1466.3	1399.1
Toxics	48.61	47.58	86.34	85.61
Winter				
NOx	750.0	750.0	1540.0	1540.0
VOC	660.0	660.0	1341.0	1341.0
Toxics	58.36	58.36	120.55	120.55

Table A.3.31 Baseline Data for Calculating Complex Equations
Allowable Ranges of E200, E300 and Aromatics for Exhaust VOC Equations

Fuel Parameter	Phase I (1995-1999)		Phase II (2000 and after)	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit
E200, % v/v	33.00	65.83	33.00	65.52
E300, % v/v	72.00	80.32 + {0.390 x (aromatics)}	72.00	79.75 + {0.385 x (aromatics)}
Aromatics, % v/v	18.00	46.00	18.00	46.00

Table A.3.32 Baseline Data for Calculating Complex Equations
Allowable Ranges of Sulphur, Olefins, Aromatics and E300 for NOx Equations

Fuel Parameter	Phase I (1995-1999)		Phase II (2000 and after)	
	Lower Limit	**Upper Limit**	**Lower Limit**	**Upper Limit**
Sulphur, ppm	10.0	450.0	10.0	450.0
E300, % v/v	70.0	95.0	70.0	95.0
Olefins, % v/v	3.77	19.0	3.77	19.0
Aromatics, % v/v	18.0	36.2	18.0	36.8

Oxygenated Gasolines

One section of the Clean Air Act calls for cities which do not meet ambient air CO standards in winter to use gasoline containing oxygenates to give 2.7% m/m oxygen. This requirement is described in more detail in **Part 1**, **Section 3.2.2.5**.

Reformulated and Oxygenated Gasoline Market Shares

Although reformulated gasoline dominates the Californian market (accounting for about 99% of gasoline sales), the overall US situation is somewhat different. It is described in more detail in **Part 1**, **Section 3.2.2.6**.

A.3.2.5. Deposit Control Additives

The Clean Air Act Amendments require that “effective 1 January 1995, all gasolines in the US must contain additives to prevent the accumulation of deposits in engines and fuel supply systems”. The Act provides no definition of additives or deposits and no guidance as to which parts of the fuel system are to be considered but, as with the CARB requirements, the EPA defines additive performance by requiring certification of additives in a port fuel injector (PFI) keep clean test and the BMW intake valve deposit (IVD) test, using fuels with certain minimum quality requirements.

The EPA had some experience to work on because, since 1 January 1992, all gasolines sold or supplied in California had been required to contain deposit control additives which are certified by the CARB for effectiveness.

As with the CARB requirements, the EPA proposal defined additive performance by requiring certification of additives in a port fuel injector (PFI) keep clean test and the BMW intake valve deposit (IVD) test, using fuels with certain minimum specification requirements. Note that, in addition, CARB requires a PFI clean up test.

The PFI keep clean test uses a 2.2-litre Chrysler turbo-charged engine. Under the EPA’s proposal 10 000 miles must be accumulated on a vehicle using repetitions of a standard PFI test cycle comprising 15 mins at 55 mph, followed by a 45-minute shutdown soak period. As the method is not yet fully standardised the EPA is proposing to use a draft ASTM procedure. The EPA will require a performance equivalent to the CARB standard; i.e., no injector may experience a flow restriction greater than 5%.

The BMW IVD Test uses a 1985 BMW 318i four-cylinder eight-valve naturally aspirated engine. Deposits are accumulated in a road driving cycle involving 70% highway, 20% suburban and 10% city driving. The CARB pass requirement is a maximum average deposit on the four intake valves of not more than 100 mg after 10 000 miles. The EPA is considering alternative limits of 100 mg maximum on any single valve after 10 000 miles or 25 mg on any single valve after 5 000 miles. Either requirement is significantly more severe than the CARB standard. The CARB, however, also stipulates a PFI clean-up requirement. In this test, deposits must be built up on at least one injector to give a minimum of 10% flow restriction. Then the cleanliness of all injectors must be restored to less than 5% flow restriction within a further 10 000 miles of test cycles using the test gasoline.

Since 1 January 1996, all gasolines have to contain detergent additives certified by the EPA for effectiveness. The certification establishes the minimum amount of additive that must be used and limits for some properties of the base gasoline (T90E, olefins, aromatics, sulphur and oxygenates by type). The EPA is proposing four major generic categories for certification, depending on the definition of the base fuel quality, i.e.

- National
- Specific to the Petroleum Administration for Defense Districts (PADD)
- Fuel specific
- CARB (PADD V)

Gasolines blended with detergents certified under the generic national certification can be marketed anywhere in the US. However, the base gasoline cannot exceed the limits given in **Table A.3.33**. Such additive certification requires passing the BMW and PFI tests in four different test fuels, taken from four different refineries or distribution systems, and at least two different PADDs. **Table A.3.34** lists the minimum properties for each of these fuels. If the properties of the base gasoline exceed the limitations given in **Table A.3.33**, then an additive must be used meeting a more severe national certification level using fuels with higher values than those given in **Table A.3.34**.

Gasolines sold only within a given PADD must still have base gasoline qualities meeting the requirements given in **Table A.3.33** but the test fuel qualities can be restricted to those specified for that district. Like the national requirements, base gasolines having properties exceeding those in **Table A.3.34** must use deposit control additives certified in test fuels with properties representing the more severe base gasoline. Gasolines using detergents with fuel-specific certification must remain segregated from production through distribution to the end user. The test fuels in a segregated system must meet or exceed the segregated gasoline's 65th percentile level for critical fuel properties. For each detergent blending facility, weekly gasoline samples must be taken and analyzed for the four critical properties. This data base serves to demonstrate that base gasolines continue to have properties within those detailed in **Table A.3.33**. If any single measurement exceeds specification, a statistical distribution curve for each property must be prepared (using the past year's data). The 65th percentile then becomes the minimum level for certification of the test fuel. Such an occurrence may require new testing and detergent certification.

New statistical distribution curves must be prepared twice a year, employing a full year's data. If the new 65th percentile for any property exceeds the previous 75th percentile, then the detergent must be certified with the test fuel at the new 65th percentile. The detergent blender has 90 days to comply with the new requirement.

Because it will be very difficult to enforce compliance by means of analytical testing for additive addition, the EPA propose to institute a system in which fuel marketers must maintain records of additive inventories and usage. For blending installations using automated additive injection equipment a weekly mass balance will be required. For non-automated systems an additive balance record must be obtained by recording every addition made (even to batches as small as road tankers). These records must be kept for at least 5 years and no tolerance below the amount stipulated for certification will be allowed. Weekly analyses of the critical fuel parameters must also be made, initially for six months to characterise the gasoline pool, and then indefinitely to ensure compliance.

Table A.3.33 Maximum Allowed Compositional Limits for Base Gasoline

Generic Certification	Sulphur % m/m	T90E ° F	Olefins % v/v	Aromatics % v/v
National	0.085	356	18.7	41.2
PADD I	0.071	358	22.2	42.5
PADD II	0.089	352	14.4	38.3
PADD III	0.075	358	18.2	39.5
PADD IV	0.106	344	19.4	31.2
PADD V	0.04	352	11.5	44.2

Table A.3.34 Required Minimal Fuel Parameter Values for Certification

Test Fuel		**Sulphur % m/m**	**T90E ° F**	**Olefins % v/v**	**Aromatics % v/v**	**MTBE % v/v**	**EtOH % v/v**
National	TF 1	0.033	340	-	-	None	10
	TF 2	-	340	10.7	-	15	None
	TF 3	0.033	-	10.7	-	None	None
	TF 4	-	336	-	29.2	None	None
PADD I	TF 1	0.036	344	-	-	None	10
	TF 2	-	344	13.3	-	15	None
	TF 3	0.036	-	13.3	-	None	None
	TF 4	-	338	-	29.2	None	None
PADD II	TF 1	0.035	340	-	-	None	10
	TF 2	-	340	9.5	-	15	None
	TF 3	0.033	-	8.9	-	None	None
	TF 4	-	338	-	28.6	None	None
PADD III	TF 1	0.030	344	-	-	None	10
	TF 2	-	344	12.7	-	15	None
	TF 3	0.030	-	12.7	-	None	None
	TF 4	-	340	-	29.1	None	None
PADD IV	TF 1	0.052	329	-	-	None	10
	TF 2	-	329	11.2	-	15	none
	TF 3	0.045	-	10.5	-	None	None
	TF 4	-	331	-	24.6	None	none
PADD V	TF 1	0.015	335	-	-	None	10
	TF 2	-	336	7.0	-	15	none
	TF 3	0.016	-	7.0	-	None	None

(1) The Defense Districts comprise the following States:
PADD I; Connecticut, Delaware, District of Columbia, Florida, Georgia, Maine, Maryland, Massachusetts, New York, New Hampshire, New Jersey, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, West Virginia;
PADD II; Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, South Dakota, Tennessee, Wisconsin;
PADD III; Alabama, Arkansas, Louisiana, Mississippi, New Mexico, Texas;
PADD IV; Colorado, Idaho, Montana, Utah, Wyoming;
PADD V; Arizona, California, Nevada, Oregon, Washington.

A.3.2.6. ASTM Diesel Fuel Specification

The ASTM D975-94 specification covers both automotive and industrial grades. The two grades for high speed diesels and for heavy mobile service are given in **Part 2**, **Section B.3.2.6**.

A.3.2.7. Legislated Quality Requirements - EPA Diesel Fuel Standards

On-Road Diesel Fuel Standards

These requirements are described in more detail in **Part 1**, **Section 3.2.3.2**.

Background - Advance Notice of Proposed Rulemaking

On 13 May 1999 the EPA published an ANPRM in the Federal Register (Volume 64, Number 92) setting out new quality proposals for diesel fuel. The notice was based on the view that fuel quality changes would bring about large environmental benefits through the enabling of a new generation of diesel emission control technologies. The advance notice sought comment on all potentially beneficial diesel fuel quality changes but the Agency believe that the most promising change would be fuel desulphurisation. The EPA stated that this would "enable" new engine and after-treatment technologies which, "although highly effective, are sensitive to sulphur".

The EPA reviewed the then current data and concluded that most fuel parameters had relatively small, and sometimes conflicting, effects on emissions. However, the Agency's final analysis was that *"reducing the sulphur content of diesel fuel has the potential to provide large indirect technology-enabling benefits in addition to some amount of direct emission benefits. In fact, sulphur reduction appears to be the only fuel change with potential to enable new technologies needed to meet Tier 2 light duty or anticipated future heavy duty standards".*

Therefore, although other specifications changes have been under consideration, the EPA believes that sulphur control is the most likely means of achieving cost-effective diesel fuel emission reductions.

Refiner Flexibility Provisions

Temporary Compliance Option (i.e., phase-in): Allows a refinery to produce up to 20% of its highway diesel fuel each year at 500 mg/kg. The remaining 80% must meet 15 mg/kg. Batches of 500 mg/kg fuel must be segregated in the distribution system. Beginning 1 January 2010, all highway diesel fuel must meet 15 mg/kg, unless the refinery has banked credits (see below), in which case it can continue to produce 500 mg/kg fuel until 31 May 2010, or until credits run out, whichever is earlier. A refinery will be allowed a 5% deficit carry-over to account for potential problems in meeting the 80%, 15 mg/kg requirement, provided the deficit is made up the following compliance year.

PADD-Based Averaging, Banking and Trading (ABT) Programme: As part of the Temporary Compliance Option, a PADD-based ABT programme is available.

Credits: Early credits can be generated from 1 June 2005, but the refiner must segregate the fuel in the distribution system, and can only generate credits for the gallons actually verified to be sold at retail as 15 mg/kg diesel fuel. Highway diesel fuel produced at 15 mg/kg prior to 1 June 2005 can also generate credits under certain limited circumstances. The ability of refineries to generate credits will end on 31 December 2009. Refineries will be allowed to use credits, including early credits, until 31 May 2010, after which point all credits expire and all highway diesel fuel must meet 15 mg/kg.

Alaska, Hawaii, California, and Other Special States: Alternative arrangements exist for Alaska and Hawaii. If any state (such as California) adopts a state-specific EPA-approved highway diesel programme, then refineries in that state cannot participate in the federal credit programme.

Special Provisions Applicable to the Geographic Phase-In Area (GPA): US refineries in the Tier 2 GPA that produce both gasoline and highway diesel can receive a two-year extension of the interim GPA gasoline standards until 31 December 2008 and full details will be found in the legislation.

Small Refiner Flexibilities: Qualifying small refiners have three options for increased flexibility and these are detailed in the legislation.

Other Fuel Parameters

The EPA is taking no action on fuel properties other than sulphur.

Standards and identification requirements for additives

The EPA is not limiting the sulphur level of additives, but is relying on market forces to ensure that additives do not result in the 15 mg/kg limit being exceeded. However, additives that exceed 15 mg/kg sulphur are limited to a 1% v/v concentration in the fuel, and must have special language in product transfer documents. Blenders that blend additives above 15 mg/kg sulphur are liable if their actions result in finished fuel exceeding the 15 mg/kg cap.

Quality assurance test method

Any ASTM sulphur test method may be used for quality assurance testing if the protocols of the ASTM method are followed and the alternative method is correlated to the method provided

Legislated Quality Requirements - EPA Non-Road Diesel Fuel Standards

On 29 June, 2004 the EPA published its final rule on Tier 4 emission and fuel standards for non-road diesel engines (Federal Register/Vol. 69, No. 124). This comprehensive national programme regulates non-road diesel engines and diesel fuel as a system. The rule finalized a two-step sulphur standard for non-road, locomotive and marine (NRLM) diesel fuel and is described in more detail in **Part 1**, **Section 3.2.3.3**.

A.3.2.8. Alternative Fuels

ASTM D 1835 Specification for Automotive LPG

The specification for automotive LPG is technically equivalent to the GPA Standard 2140 HD-5 Grade (see **Table A.3.35**).

Table A.3.35 US National Specification for Automotive LPG (Special Duty Propane Grade, ASTM D 1835)

Property	**Special Duty Propane** [(1)]	**ASTM Test Method**
Vapour Pressure at 100°F (37.8°C), max. psig	208	D 1267 or D 2598
Vapour Pressure at 100°F (37.8°C), max. kPa	1430	
Volatile Residue evap temperature 95% max. °F	-37	D 1837
Volatile Residue evap temperature 95% max. °C	-38.3	
or Butane and heavier max., % v/v	2.5	D 2163
Propylene content max. % v/v	5.0	D 2163
Residual matter		
residue on evaporation 100 ml, max. ml	0.05	D 2158
oil stain observation	pass [(2)]	D 2158
Copper strip corrosion, max.	No.1	D 1838
Sulphur, max. ppm m/m	120	D 2784
Moisture content	pass	D 2713

(1) Equivalent to GPA Standard 2140 HD-5 Grade which also requires 85% v/v min propane content.

(2) Shall not yield a persistent ring when 0.3 ml of solvent residue mixture is added to a filter paper in 0.1 ml increments and examined in daylight after 2 min.

ASTM D 6751 – 03a Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels

This specification covers biodiesel (B100) Grades S15 and S500 for use as a blend component with diesel fuel oils defined by Specification D 975 Grades 1-D, 2-D, and low sulphur 1-D and 2-D. Biodiesel may be blended with fuel oils whose sulphur or aromatic levels are outside Specification D 975 Grades, provided the finished mixture meets pertinent national and local specifications and requirements for these properties.

This specification, unless otherwise provided by agreement between the purchaser and the supplier, prescribes the required properties of biodiesel fuel at the time and place of delivery. Nothing in this specification shall preclude observance of federal, state, or local regulations which may be more restrictive.

Table A.3.36 ASTM D 6751–03a Requirements for Biodiesel (B100) (1)

Property	**Test Method (2)**	**Grade S15 Limits**	**Grade S500 Limits**	**Units**
Flash point (closed cup)	D 93	130.0 min	130.0 min	°C
Water and sediment	D 2709	0.050 max	0.050 max	% v/v
Kinematic viscosity, 40°C	D 445	1.9-6.0 (3)	1.9–6.0 (3)	mm^2/s
Sulphated ash	D 874	0.020 max	0.020 max	% m/m
Sulphur (4)	D 5453	0.0015 max (15)	0.05 max (500)	% m/m (ppm)
Copper strip corrosion	D 130	No. 3 max	No. 3 max	
Cetane number	D 613	47 min	47 min	
Cloud point	D 2500	Report (5)	Report (5)	°C
Carbon residue (6)	D 4530	0.050 max	0.050 max	% m/m
Acid number	D 664	0.80 max	0.80 max	mg KOH/g
Free glycerine	D 6584	0.020	0.020	% m/m
Total glycerine	D 6584	0.240	0.240	% m/m
Phosphorus content	D 4951	0.001 max	0.001 max	% m/m
Distillation temperature, Atmospheric equivalent temperature, 90 % recovered	D 1160	360 max	360 max	°C

(1) To meet special operating conditions, modifications of individual limiting requirements may be agreed upon between purchaser, seller, and manufacturer.

(2) The test methods indicated are the approved referee methods. Other acceptable methods are indicated in the standard.

(3) The 6.0 mm^2/s upper viscosity limit is higher than petroleum based diesel fuel and should be taken into consideration when blending.

(4) Other sulphur limits can apply in selected areas in the United States and in other countries.

(5) The cloud point of biodiesel is generally higher than petroleum based diesel fuel and should be taken into consideration when blending.

(6) Carbon residue shall be run on the 100 % sample. Carbon residue gives a measure of the carbon depositing tendencies of a fuel oil. While not directly correlating with engine deposits, this property is considered an approximation. Although biodiesel is in the distillate boiling range, most biodiesels boil at approximately the same temperature and it is difficult to leave a 10 % residual upon distillation. Thus, a 100 % sample is used to replace the 10 % residual sample, with the calculation executed as if it were the 10 % residual. The final weight flask charge/original weight flask charge of Test Method D 4530-93 is a constant 20/200.

ASTM D 4806–03 Specification for Denatured Fuel Ethanol

This specification covers nominally anhydrous denatured fuel ethanol intended to be blended with unleaded or leaded gasolines at 1 to 10% v/v for use as a spark-ignition automotive engine fuel. The values given in parentheses are for information only

When fuel ethanol is denatured (as specified in the next Section), it shall conform to the following requirements at the time of blending with a gasoline.

Table A.3.37 ASTM D 4806–03 Fuel Ethanol Characteristics

Characteristic		**Limit**
Ethanol	% v/v min	92.1
Methanol	% v/v max	0.5
Solvent-washed gum	mg/100 ml, max	5.0
Water content	% v/v max	1 (1)
Denaturant content	% v/v min	1.96
	% v/v max	4.76
Specific gravity		(2)
Inorganic Chloride content	mass ppm (mg/l), max	40 (32)
Copper content	mg/kg, max	0.1
Acidity (as acetic acid CH3COOH)	mass % (mg/l), max	0.007 (56) (3)
pHe		6.5 to 9.0 (4)
Appearance		(5)

(1) In some cases, a lower water content may be necessary to avoid phase separation of a gasoline-ethanol blend at very low temperatures. This reduced water content, measured at the time of delivery, shall be agreed upon between the supplier and purchaser.

(2) If denatured fuel ethanol is prepared by the addition of denaturants to undenatured fuel ethanol after it has been produced rather than during the dehydration process, the 15.56/15.56°C (60/60°F) specific gravity in air of the undenatured fuel ethanol shall be in the range from 0.7937–0.7977.

(3) Denatured fuel ethanol may contain additives such as corrosion inhibitors and detergents that may affect the titratable acidity (acidity as acetic acid) of the finished fuel ethanol. Although the base fuel ethanol may meet the acidity specification, the effect of these additives may produce an apparent high titratable acidity of the finished product. Contact the ethanol supplier if there is a question regarding the titratable acidity of the denatured fuel ethanol to verify that the base ethanol meets the above acidity requirement.

(4) When the pHe of ethanol used as a fuel for automotive spark-ignition engines is below 6.5, fuel pumps can malfunction as a result of film forming between the brushes and commutator, fuel injectors can fail from corrosive wear, and excessive engine cylinder wear can occur. When the pHe is above 9.0, fuel pump plastic parts can fail. The adverse effects are less when ethanol is used at 10 volume % in a blend with gasoline.

(5) Visibly free of suspended or precipitated contaminants (clear and bright).

The only denaturants used for fuel ethanol shall be natural gasoline, gasoline components, or unleaded gasoline at a minimum concentration of two parts by volume per 100 parts by volume of fuel ethanol.

One denatured formula specifically designed for fuel use by the Bureau of Alcohol, Tobacco, and Firearms (BATF) of the U.S. Treasury Department is Formula C.D.A. 20. It requires that for every 100 gal of ethanol of not less than 195 proof, a total of 2.0 gal of denaturant be added. Another fuel alcohol rendered unfit for beverage use and manufactured at an alcohol fuel plant requires the addition of 2 gal or more of materials listed by the director to each 100 gal of ethanol.

The fuel ethanol formulas approved by the U.S. Treasury Department include materials, which are not allowed by this ASTM specification. This specification prohibits the use of hydrocarbons with an end boiling point higher than 225°C (437°F) as determined by Test Method D 86, although they may be permitted by BATF regulations. Some kerosines, for instance, promote piston scuff in automotive engines. The denaturants permitted by this specification may be included as part of the 10 volume % denatured fuel ethanol blended with a gasoline if they do not exceed five parts by volume per 100 parts by volume of fuel ethanol. This is permitted in the United States by law. Any part of these denaturants that are present at concentrations higher than five parts by volume per 100 parts by volume of fuel ethanol are considered as part of the base gasoline.

Although this specification permits only hydrocarbons in the gasoline boiling range to be used as denaturants, specific mention must be made of some materials that have extremely adverse effects on fuel stability, automotive engines, and fuel systems. These materials shall not be used as denaturants for fuel ethanol under any circumstances. They are as follows:

- methanol which does not meet Specification D 1152,
- pyrroles, turpentine, ketones, and tars (high-molecular weight pyrolysis products of fossil or non-fossil vegetable matter).

While any significant amount of methanol will lower the water tolerance and increase the vapour pressure of a gasoline-ethanol blend, these effects become more serious when methanol is present at more than 2.5 parts by volume per 100 parts by volume of fuel ethanol. Also, methanol which does not meet Specification D 1152 frequently contains impurities such as turpentine and tars. Similarly, ketone denaturants tend to degrade fuel stability or increase the tendency of a gasoline-ethanol blend to corrode metals and attack elastomers. These effects become more serious if the concentration of a ketone such as 4-methyl pentanone (methyl isobutyl ketone) exceeds one part by volume per 100 parts by volume of fuel ethanol. There is no information available on the effects of denaturants other than those mentioned above, but unless a denaturant, such as a higher aliphatic alcohol or ether, is known to have no adverse effect on a gasoline-ethanol blend or on automotive engines or fuel systems, it shall not be used.

A.3.2.9. US Federal Energy Policy Act of 2005

The act is described in detail in **Part 1**, **Section 3.2.5**.

A.3.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

A.3.3.1. Light Duty Vehicle Emissions Test Procedures

Since 1972 the US exhaust emission test procedure has been based on a transient cycle representative of driving patterns in Los Angeles (the LA-4 Cycle). The original 1972 test procedure (US-72) was a two-phase test (Phases I and II in **Figure A.3.2**), covering 7.5 miles in almost 23 mins. From 1975 the procedure was modified such that Phase I is now repeated after a 10 minute hot soak, to form a third phase. The total test length was thus extended to 11.09 miles and the time to 31 mins, plus 10 mins for the hot soak.

The intention of this modified test was to produce a weighted average emission from cold start and hot start tests. It assumed that after the first 505 seconds the engine will be stabilized, and so the stabilized portion is not repeated after the hot start, but assumed to be the same as for the cold start test. The calculation procedure weights the results from the three bags accordingly to give the required result.

The Highway Fuel Economy Test (HWFET) (**Figure A.3.3**) cycle is used to measure fuel economy for the CAFE standards but is also used to measure NOx emissions. In California, a standard is imposed equal to 1.33 times the city NOx limit. In the other 49 states, there is no standard for NOx over the HWFET, but data can be used to demonstrate to EPA that the vehicle is not equipped with "*cycle-beating*" devices.

Emissions are measured using a Constant Volume Sampling (CVS) system and collected in three bags, for each phase of the test, i.e.

Bag 1	0 - 505 seconds
Bag 2	505 -1370 seconds
Bag 3	0 - 505 seconds after 10 minute hot soak

The test begins with a cold start (at 20 - 30°C) after a minimum 12-hour soak. The diluted exhaust gas volume is determined for each bag and used to calculate the mass emissions. Weighting factors for each phase are then applied to give an overall emission figure.

Supplemental Federal Test Procedure (SFTP)

As required by the US Clean Air Act Amendments, EPA re-evaluated typical driving patterns and found that the FTP test cycle does not cover a significant proportion (about 15%) of driving conditions and behaviour. As a result the EPA issued on the 7 February 1995 a Notice of Proposed Rulemaking setting out suggested modifications, and following consultations with the motor industry and CARB, issued a Final Rule on the 15 August 1996. The main new element of the proposal is a Supplemental Federal Test Procedure (SFTP) covering the driving patterns not included in the then current FTP procedure.

The SFTP includes two new single-bag emission test driving cycles, the US06, to represent aggressive and microtransient driving, and the SC03, to represent driving immediately following vehicle start-up (see **Figures A.3.4** and **A.3.5**). The US06 is run with the vehicle in a hot stabilized condition. That is, the vehicle is fully warmed up so that the engine and catalytic converter have reached typical operating temperatures but without air conditioning (A/C). The SC03 follows a 10-minute soak and is run with vehicle A/C, or with proper simulation of air conditioning operation.

The hot stabilized condition is achieved by including several preconditioning options as part of the formal procedure immediately prior to the US06 Cycle. For manufacturers who have concerns about fuel effects on adaptive memory systems, the rule allows manufacturers and, upon manufacturer request, requires the EPA to run the vehicle over the US06 Cycle on the certification test fuel before entering the formal test procedure. High-volume exhaust flow for heavier vehicles run on the US06 will dictate the use on some vehicles of a larger capacity constant volume sampler (CVS) than is needed for current FTP testing. Appropriate shift schedules for manual transmission vehicles are determined by the manufacturer and submitted to EPA for approval.

The rule includes adjustments to the US06 test cycle for low-performance LDVs and LDTs. These adjustments reflect the actual operation of low performance vehicles in use and are designed to minimize problems with high engine and catalyst temperatures. In addition, for US06 Cycle testing of Heavy Light-Duty Trucks (HLDTs), the truck is to be ballasted to curb weight plus 300 lb with the dynamometer inertia weight determined from this same basis, while FTP testing remains at Adjusted Loaded Vehicle Weight.

The required elements for the SC03 include the preconditioning, soak period, test cycle, and air conditioning requirements. Prior to the 10-minute soak period, the vehicle is to be preconditioned to allow engine and catalyst temperatures to stabilise at typical warmed-up operating temperatures.

Immediately following the preconditioning cycle, the vehicle's engine is turned off for a 10-minute soak period with cooling fans directed at the vehicle. The vehicle may be removed from the dynamometer, provided the vehicle is not subjected to unrepresentative cooling of the engine or catalyst. Following the soak period, the vehicle will be run over the SC03 cycle using a full environmental chamber, with vehicle A/C on, for proper representation of start driving, microtransient driving, and air conditioning operation. The ambient test conditions specified in the SC03 test are:

- air temperature of 95°F;
- Approximately 40% relative humidity;
- simulated solar heat intensity of 850 W/m^2
- air flow directed at the vehicle that will provide representative air conditioner system condenser cooling at all vehicle speeds.

Procedures in a standard test cell that simulate actual air conditioning effects will be allowed as an option to using full environmental chambers.

Manufacturers who choose to use an air conditioning simulation beginning with MY 2003 must submit, in advance, a description of the simulation procedure, data supporting the correlation between the simulation and the full environmental chamber, and any vehicle specific parameters to EPA. In general, EPA will conditionally approve any procedure, provided that the procedure can be run by EPA for SEA and in-use enforcement testing and available data, including past correlation testing, does not indicate a correlation problem.

US Federal Cold CO Test Procedure

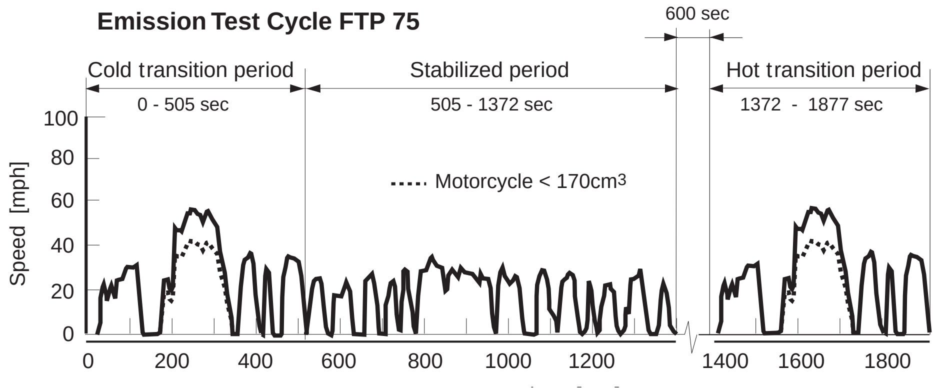
Table A.3.38 below outlines the sequence for the above procedure. This was published as a final rule in the Federal Register, Vol. 57 No. 138, dated 17 July 1992.

Table A.3.38 US Federal Cold CO Test Procedure

Step	Notes
1.	Winter grade fuel (optional use of FTP fuel)
2.*	Full US FTP 75 Cycle (optional use of higher temperature)
3.	No time specifications; uniform vehicle cooling; Oil temperature 20°F±3°F
4.*	12-36 h
5.*	1 hour minimum
6.	If vehicle leaves 20°F soak area to transfer to test area and passes through a warm area it must be restabilized for 6 times the period of exposure to warmer conditions
7.*	Full US FTP 75 Cycle
8.	On dynamometer
9.*	Phase 1 (505 s.) of US FTP 75 Cycle

* Temperature Specifications (°F)	
Average	20 ± 5
Maximum Excursions	10(min), 30(max.)
Three-minute Excursions	15(min), 35(max.)

Figure A.3.2 US Federal City Cycles (Exhaust Emission and Fuel Consumption)



US - 72 Cycle :		US - 72 Test:	
Breakdown:			
Length:	7.5 miles	Cycles/Test:	1
Time:	1371 s	Test lengths:	11.09 miles
Av. velocity:	19.7 mph	Test time:	1371 s
Max. velocity:	56.7 mph	Cold start test procedure	
Idle:	17.4%	Exhaust emission analysis in 2 bags	
Steady speed:	20.0%	Bag 1:	0 - 505 s
Acceleration:	34.0%	Bag 2:	56-1371
Deceleration:	28.8%	Calculation of fuel consumption is derived from the emissions	

US - 75 Cycle:		US - 75 Test:	
Breakdown:			
Length:	11.09 miles	Cycles/Test:	1
Time:	1877 + 600	Test lengths:	11.09 miles
Av. velocity:	21.3 mph	Test time:	1371 s + (600 s stop) + 505 s
Max. velocity:	56.7 mph	The US - 75 test is an expanded US - 72 test.	
Idle:	17.3%	The first 505 s of the cycle will be repeated after a ten min.	
Steady speed:	20.5%	stop at 1371 s.	
Acceleration:	33.7%	Calculation of fuel consumption is derived from the emissions.	
Deceleration:	26.5%	The emission sampling is in 3 bags:	
		Bag 1:	0 - 505 s (43%)
		Bag 2:	506 - 1371 s (100%)
		Bag 3:	0 - 505 s (57%)
			after the 10 mins. stop
		(Source: Ford Motor Company and AVL List GmbH)	

Figure A.3.3 US Federal Highway Cycle (Fuel Consumption, NOx Emissions)

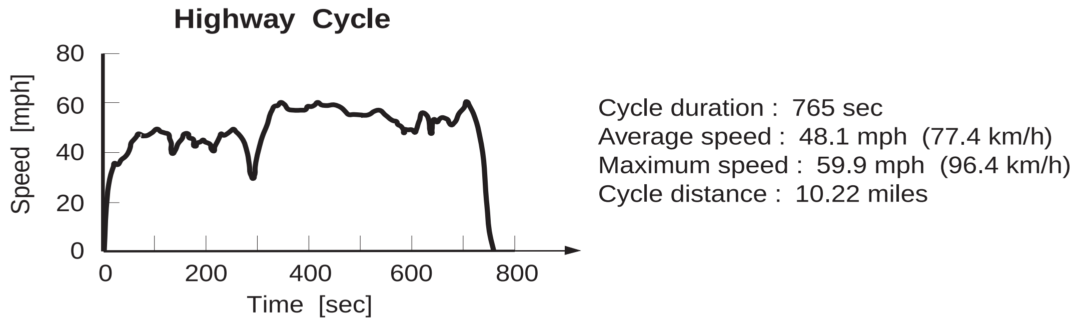


Figure A.3.4 EPA US06 driving schedule

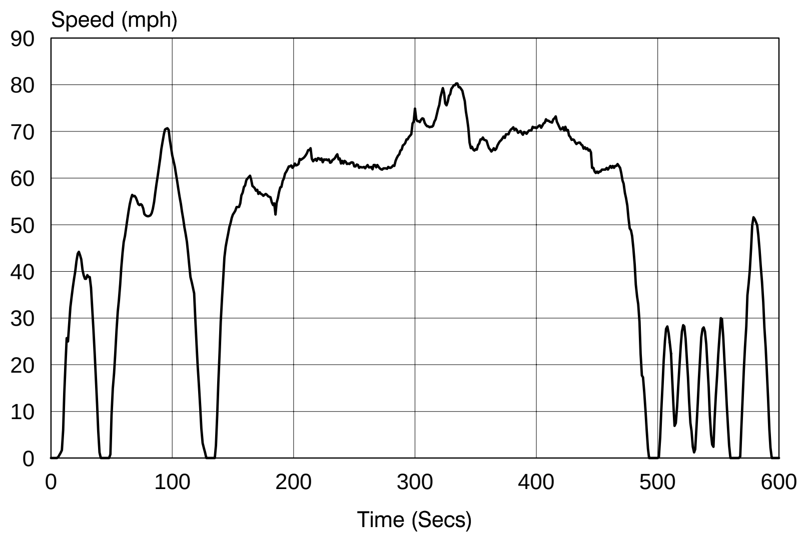
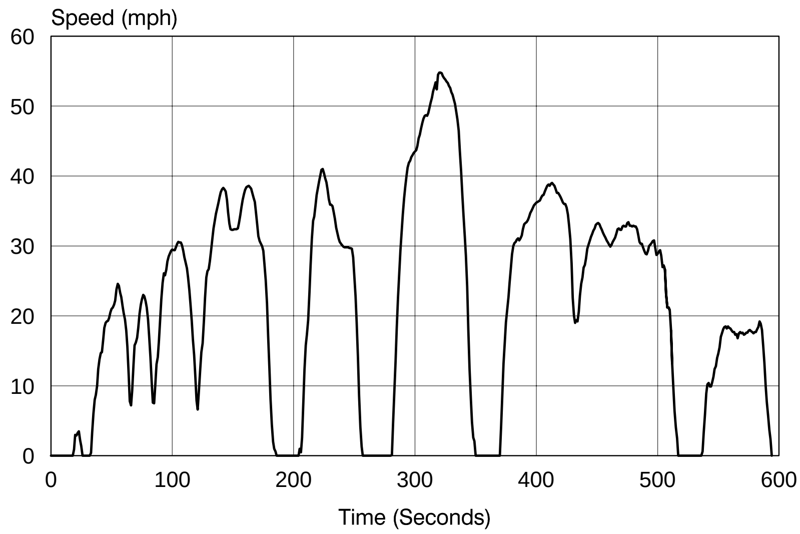


Figure A.3.5 EPA SC03 driving schedule



A.3.3.2. Motorcycle Emissions Test Procedure

The highway motorcycle test procedure is very similar to the test procedure employed for light duty vehicles (i.e., passenger cars and trucks). The highway motorcycle regulations allow Class I motorcycles to be tested on a less severe UDDS cycle than Class II and III motorcycles. This is accomplished by reducing the acceleration and deceleration rates on some the more aggressive ‘‘hills.’’

A.3.3.3. Heavy Duty Exhaust Emission Test Procedures

The US transient test was introduced as an option for certification of heavy duty vehicles in 1984. In 1985, it became mandatory, replacing the previous steady-state test. The reasons for moving to a transient cycle were to make the test more representative of on-highway conditions and to improve repeatability.

It is a popular misconception that the US transient cycle is based on actual driving patterns assessed in the following scenario:

- New York non-freeway
- Los Angeles non-freeway
- New York freeway
- Los Angeles non-freeway (repeated)

Driving patterns were assessed from operational data measured in New York and Los Angeles, but the US transient cycle, as developed from these data, contains the following characteristics:

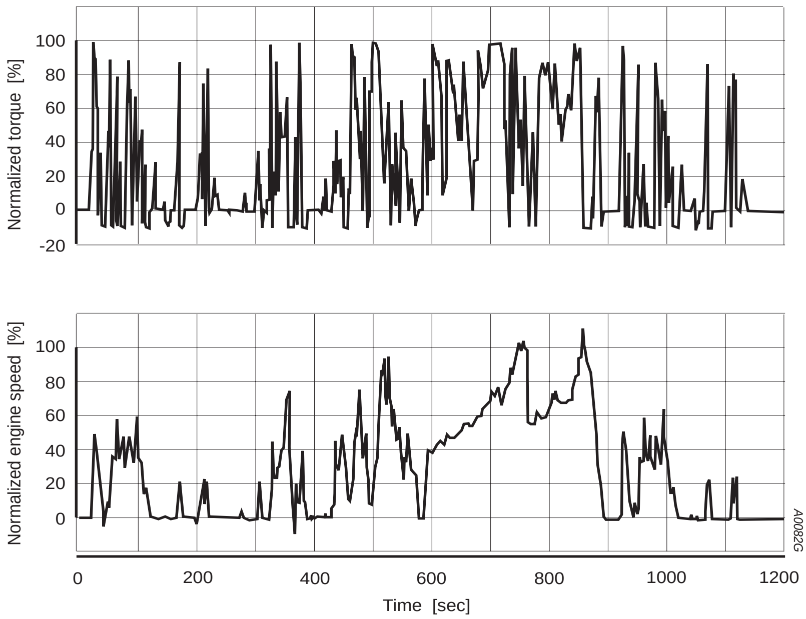
Cold Start	Hot Start
Congested urban	Congested urban
Uncongested urban	Uncongested urban
Expressway	Expressway
Congested urban	Congested urban

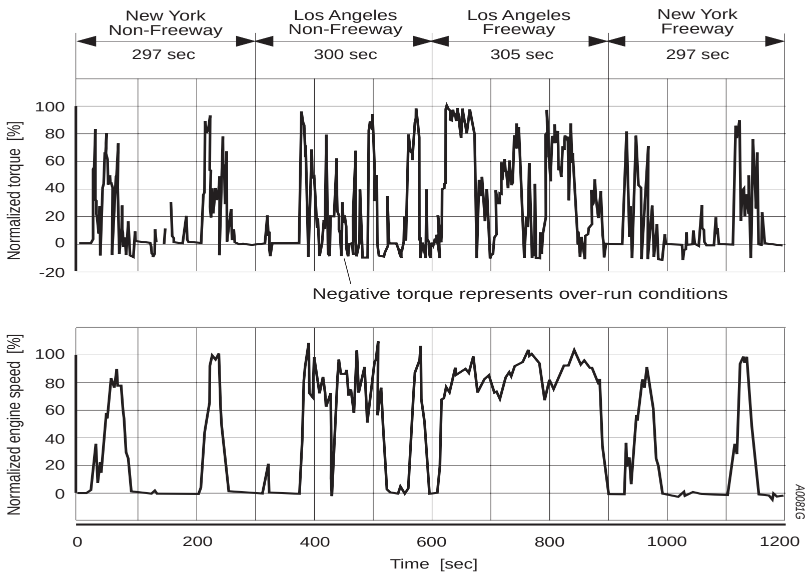
The US transient cycle tests the engine over a full range of load and speed conditions, with equal weighting within the cycle of all operational points. The cycle is run twice, first from a cold start and then, after a 20-minute soak, repeated with a hot start. These two cycles are weighted, 1/7 to 6/7 for the cold and hot cycles respectively.

The 178 seconds of motoring contained in the US transient cycle used to be considered very important. Motoring, or driving the engine by the dynamometer, tests the engine in conditions where, on the road, fuel delivery should not occur although the engine would still be rotating (travelling downhill with the accelerator closed, for example). In these cases it is important to test for fuel dribble from the injector nozzles. However, modern technology nozzles, having low sac volume or valve covering the orifice (VCO) devices, suffer from this to a lesser extent and the need for motoring is open to question. Nevertheless, it seems unlikely that the EPA will alter the motoring requirement.

The emphasis is on urban driving, since any US air quality problems are most acute in major cities. The cycle is therefore not typical of average driving in either the US or Europe. Speed and load traces for heavy duty gasoline and diesel engines over the US Federal Transient Test Cycle are shown in **Figure A.3.6**.

Figure A.3.6 Speed and load traces for heavy duty gasoline engines (above) and diesel engines (below) over the US Federal Transient Test Cycle





EPA has conducted tests to assess the inter-laboratory repeatability of emissions measurement using the US transient procedure. Laboratories at Detroit Diesel, Ford, EPA and Navistar took part in the programme.

Table A.3.39 indicates average emission measurements for each laboratory in g/bhp.h.

Table A.3.39 Reproducibility of the US HD Transient Cycle

Emission	Detroit Diesel	Ford	EPA	Navistar	Standard Deviation	Variance
CO	1.162	1.114	1.66	1.20	0.219	0.048
HC	0.11	0.113	0.103	0.14	0.014	$197x10^{-6}$
NOx	5.277	5.647	5.29	5.09	0.202	0.41
PM	0.169	0.17	0.169	0.166	0.0015	$2.25x10^{-6}$

The improvement in repeatability and reproducibility may be due to the transient cycle but is more likely to reflect the increased accuracy of control, both of the engine and general test conditions. The vastly increased number of data points must also play a large part. The test consists of three 20-minute cycles (one cold start, one hot soak and one hot start cycle) and data relating to engine speed and torque, and the levels of gaseous emissions are monitored once per second. Engine control and data acquisition is by computer and the emissions results are integrated over the test cycle. Speed, torque and power data are subjected to regression analysis and must validate to within closely specified limits.

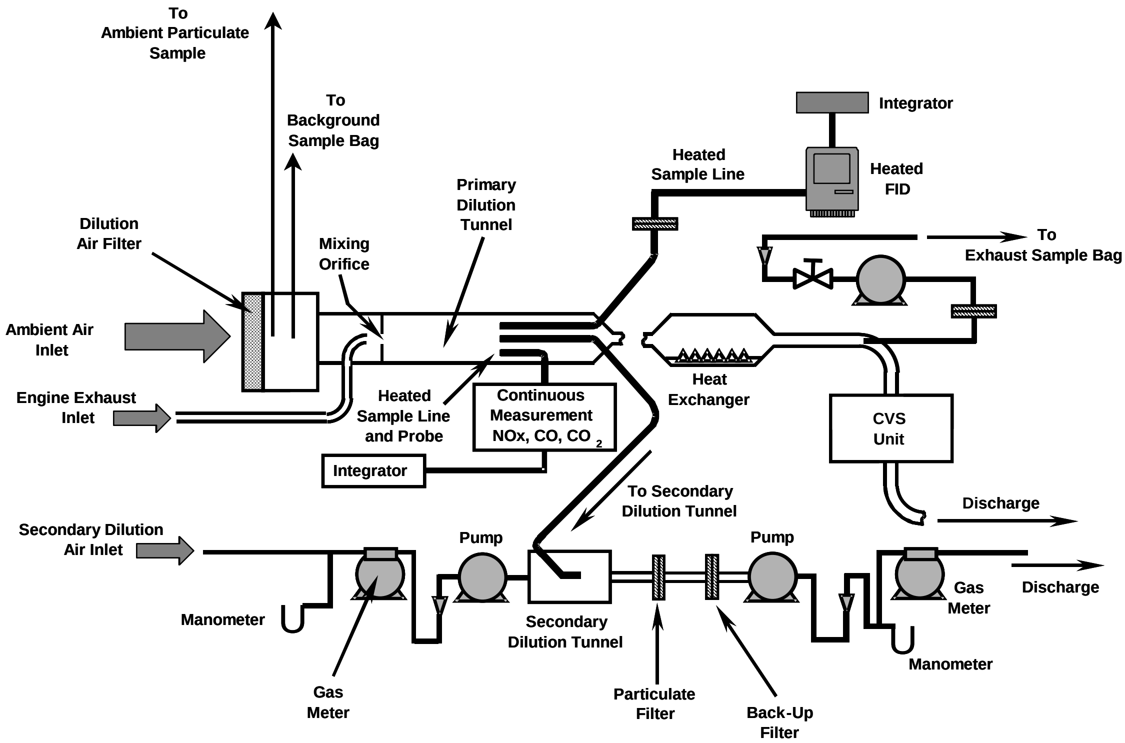
Gaseous emissions sampling is conducted from the primary dilution tunnel. A secondary dilution tunnel is used for the measurement of particulates. A general arrangement of a typical transient test facility is shown in **Figure A.3.7**.

The emissions results are processed in a "*wet*" form and a correction for humidity is applied to NOx. The results are then weighted 1/7 and 6/7 for the cold/hot cycles respectively, and added to form an integrated result.

Particulates measurements are achieved by passing all the flow from the secondary tunnel through a 70 mm diameter Teflon-coated glass fibre filter. After stabilizing in a controlled environment this is weighed. A reference paper allows correction for ambient particulates.

Full details of transient test requirements can be found in the US Federal Register 40 CFR 86 (1985).

Figure A.3.7 Double Dilution Particulate Measurement System



A.3.3.4. Test Procedures for Highway and Non-road Engines – Proposed Rules

On 10 September, 2004, the EPA published a Notice of Proposed Rulemaking (Federal Register/Vol. 69, No. 175). This proposed regulation aims to revise and harmonize test procedures from the various EPA programmes for controlling engine emissions. It will not address emission standards, nor is it intended to change expected emission reductions. Rather, it proposes to amend the regulations, which contain laboratory specifications for equipment and test fuels, instructions for preparing engines and running tests, calculations for determining final emission levels from measured values, and instructions for running emission tests using portable measurement devices outside the laboratory. These regulations currently apply to land-based non-road diesel engines, land-based non-road spark-ignition engines over 19 kilowatts, and recreational vehicles. These proposed revisions will update the regulations to deal more effectively with the more stringent standards recently promulgated by EPA and will also clarify and better define certain elements of the required test procedures. In particular, the proposed amendments will better specify the procedures applicable to field testing.

The action also proposes to apply the regulations to highway heavy-duty diesel engine regulations. This is appropriate because EPA has historically drafted a full set of testing specifications for each vehicle or engine category as each programme was developed over the past three decades. Such a patchwork approach has led to some variation in test parameters across programmes, which will be addressed by adopting a common set of test requirements.

Modified Test Procedures for Highway and Non-road Engines Incorporation of Non-road Test Procedures for Heavy Duty Highway Engines

The EPA have grouped all engine dynamometer and field testing test procedures into one publication entitled, ''Part 1065: Test Procedures.'' For each engine or vehicle sector for which the EPA has recently promulgated standards an individual part has been identified as the standard-setting part for that sector. These standard setting parts then refer to one common set of test procedures in part 1065. The EPA intend in this rule to continue this process of having all engine programmes refer to a common set of procedures by applying part 1065 to all heavy-duty highway engines.

In the past, each engine or vehicle sector had its own set of testing procedures. There are many similarities in test procedures across the various sectors. However, as new regulations were introduced for individual sectors, the more recent regulations feature test procedure updates and improvements that the other sectors did not have. As this process continued, it was recognized that a single set of test procedures would allow for improvements to occur simultaneously across engine and vehicle sectors. A single set of test procedures is simpler to understand and it is easier to move toward international test procedure harmonization.

Some emission-control programmes already rely on the test procedures in part 1065. These programmes regulate land-based non-road diesel engines, recreational vehicles, and non-road spark-ignition engines over 19 kW. The EPA are proposing to adopt the lab-testing and field-testing specifications in part 1065 for all heavy-duty highway engines. These procedures would replace those currently published in subpart N in 40 CFR part 86. The EPA are proposing a gradual transition from the part 86 procedures. EPA will allow the use of part 1065 procedures beginning in the 2006 model year. By the 2008 model year, part 1065 procedures will be required for any new testing.

Reference Fuels

Subpart H of the procedures specify, amongst other items, the test fuels to be employed Because standard-setting for diesel engines now refer to part 1065, the EPA are proposing diesel fuel specifications within that document. These fuel specifications are consistent with those previously adopted, with one exception. EPA propose to eliminate the Cetane Index specification for all diesel fuels because the existing specification for Cetane Number sufficiently determines this property. The EPA propose to eliminate any detailed specification for service accumulation fuel. Instead, it is proposed that service accumulation fuel may be a commercially available in-use fuel. This change helps ensure that testing is representative of in-use engine operation. In addition, the EPA have requested comment on whether or not they should consider revising their specifications for ultra low sulphur diesel test fuel to reflect the expected lower distillation range.

A.3.3.5. Non-Road Large Spark ignition Engine Emissions Test Procedures

For 2004 through 2006 model years, the EPA specify the same steady-state duty cycles adopted by California ARB. For variable-speed engines, this involves the testing based on the ISO C2 duty cycle. A separate duty cycle applies to the large number of Large SI engine providing power for constant-speed applications. Constant-speed testing is based on the ISO D2 duty cycle and this same test applies to constant-speed, non-road diesel engines. Emission values measured on the D2 duty cycle are treated the same as values from the C2 duty cycle; the same numerical standards apply to both cycles.

Manufacturers must generally test engines on both the C2 and D2 duty cycles. Since the C2 cycle includes very little operation at rated speed, it is not effective in ensuring control of emissions for constant-speed engines. The D2 cycle is even less capable of predicting emission performance from variable-speed engines. Manufacturers may, however, choose to certify their engines on only one of these two steady-state duty cycles. In this case, they would need to take steps to make sure C2-certified engines are installed only in variable-speed applications and D2-certified engines are installed only in constant-speed applications.

The 7-mode duty cycle described in the following table should be employed for engines from an engine family that will be used only in variable-speed applications:

Table A.3.40 7-Mode Duty Cycle (1)

Mode No.	Engine speed	Observed torque (2)	Minimum time in mode (minutes)	Weighting factors
1	Maximum test speed	25	3.0	0.06
2	Intermediate test speed	100	3.0	0.02
3	Intermediate test speed	75	3.0	0.05
4	Intermediate test speed	50	3.0	0.32
5	Intermediate test speed	25	3.0	0.30
6	Intermediate test speed	10	3.0	0.10
7	Idle	0	3.0	0.15

(1) This duty cycle is analogous to the C2 cycle specified in ISO 8178-4.
(2) The percent torque is relative to the maximum torque at the given engine speed.

The 5-mode duty cycle described in the following table should be used to certify an engine family for operation only at a single, rated speed:

Table A.3.41 5-Mode Duty Cycle for Constant-Speed Engines (1)

Mode No.	Engine Speed	Torque (2)	Minimum time in mode (minutes)	Weighting factors
1	Maximum test	100	3.0	0.05
2	Maximum test	75	3.0	0.25
3	Maximum test	50	3.0	0.30
4	Maximum test	25	3.0	0.30
5	Maximum test	0	3.0	0.10

(1) This duty cycle is analogous to the D2 cycle specified in ISO 8178-4.
(2) The percent torque is relative to the maximum torque at maximum test speed.

A subset of constant-speed engines are designed to operate only at high load. To address the operating limitations of these engines, the EPA are adopting a modified steady-state duty cycle if the manufacturer provides clear evidence showing that engines rarely operate below 75 percent of full load at rated speed. Since most Large SI engines are clearly capable of operating for extended periods at light loads, it is expected that these provisions will apply to very few engines. This modified duty cycle consists of two equally weighted points, 75 percent and 100 percent of full load, at rated speed. Since the transient cycle described below involves extensive light-load operation, engines qualifying for this high-load duty cycle would not need to measure emissions over the transient cycle. Note that the field testing emission standards still apply to engines that do not certify to transient duty-cycle standards. The 2-mode duty cycle described in the following table should be used for high-load engines:

Table A.3.42 2-Mode Duty Cycle for High-Load Engines (1)

Mode No.	Engine Speed	Torque (2)	Minimum Time in Mode (mins)	Weighting Factor
1	Maximum test	100	3.0	0.50
2	Maximum test	75	3.0	0.50

(1) This duty cycle is derived from the D1 cycle specified in ISO 8178-4.

(2) The percent torque is relative to the maximum torque at maximum test speed.

Starting in 2007, an expanded set of duty cycles is specified, again with separate treatment for variable-speed and constant-speed applications. The test procedure is comprised of three segments:

- a warm-up segment,
- a transient segment,
- a steady-state segment.

Ambient temperatures in the laboratory must be between 20° and 30° C (68° and 86° F) during duty-cycle testing.

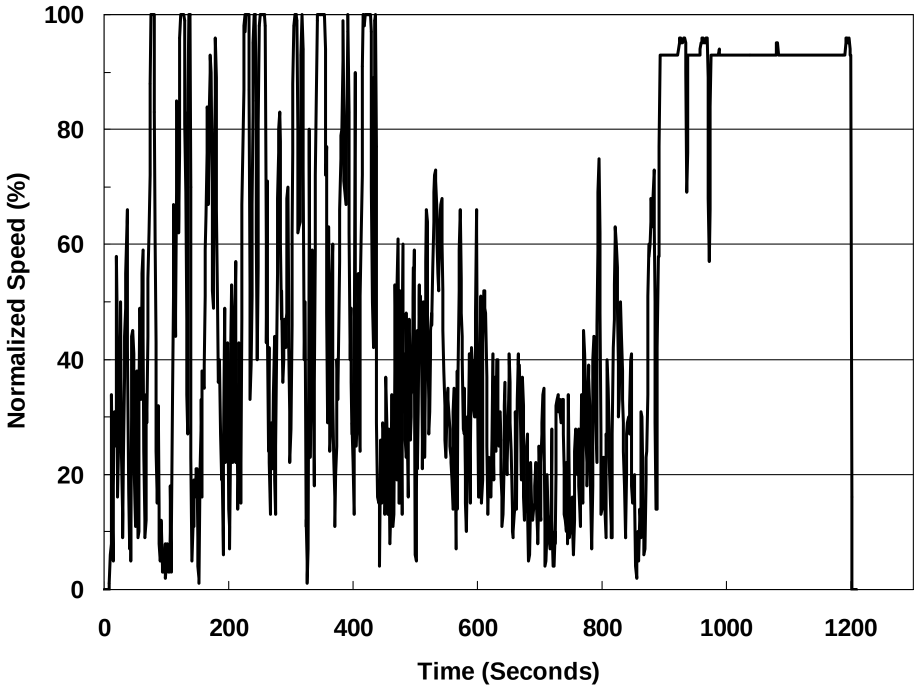
A separate transient duty cycle applies to engines that are certified for constant-speed applications only. These engines maintain a constant speed, but can experience widely varying loads. The transient duty cycle for these engines includes 20 minutes of engine operation based on the way engines work in a welder. Note that manufacturers selling engines for both constant-speed and variable-speed applications may omit the constant-speed transient test, since that type of operation is included in the general transient test.

Reference Fuels for Emission Testing

For gasoline-fuelled Large SI engines, the EPA are adopting the specifications established for testing gasoline fuelled highway vehicles and engines. This includes the revised specification to cap sulphur levels at 80 mg/kg (65 FR 6698, 10 February, 2000). These fuel specifications apply for both exhaust and evaporative emissions.

For LPG, the EPA is adopting the same specifications established by California ARB. For natural gas, specifications similar to those adopted by California ARB will be used.

Figure A.3.8 Large Spark ignition (SI) Composite Transient Cycle



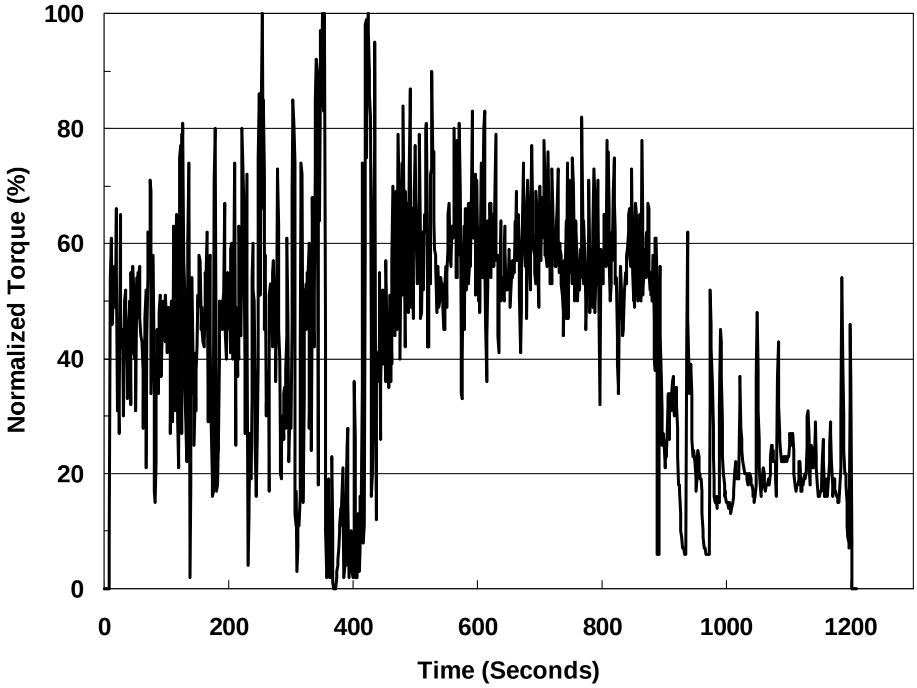
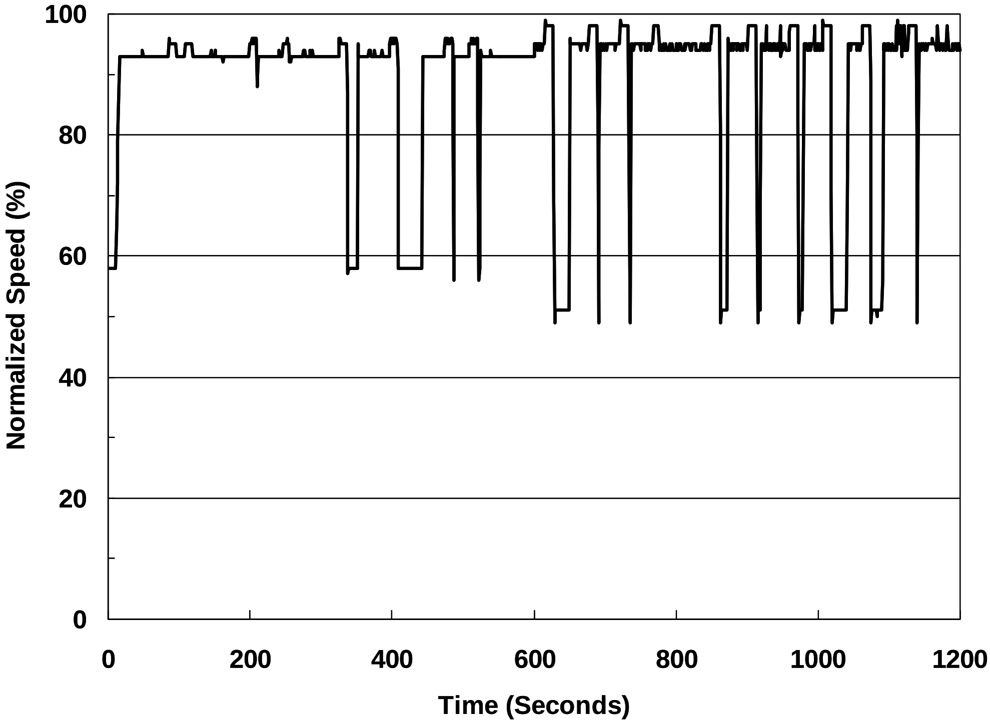
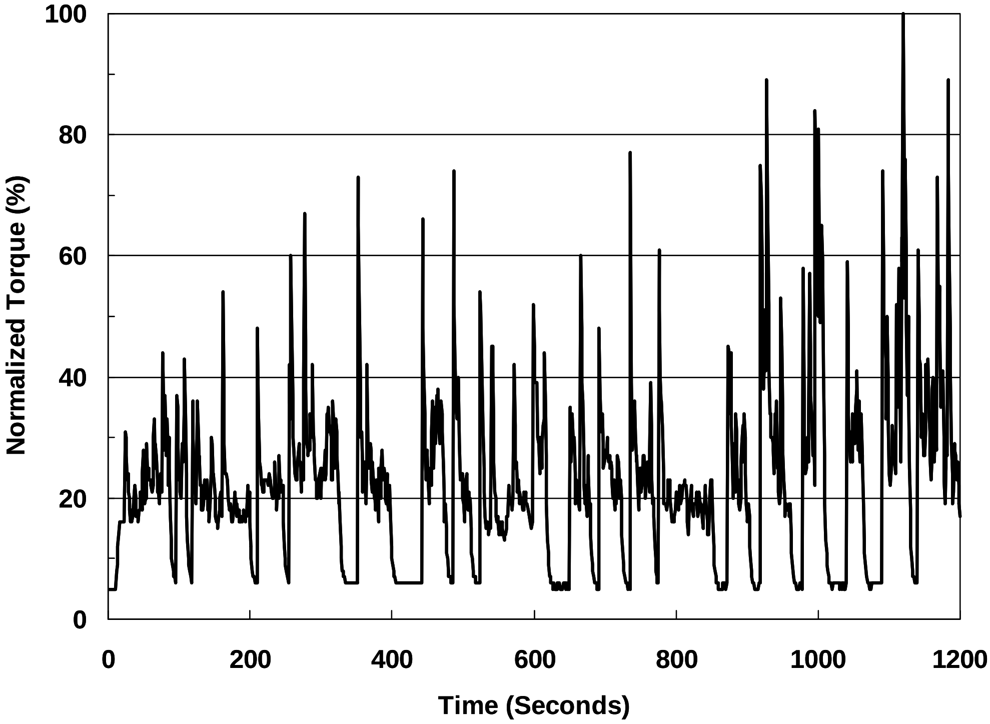


Figure A.3.9 Large Spark ignition (SI) Transient Cycle for Constant-Speed Engines





A.3.3.6. Off-highway Motorcycle and ATV Emissions Test Procedures

Highway Motorcycles

The highway motorcycle test procedure is very similar to the test procedure used for light duty vehicles (i.e., passenger cars and trucks) and is referred to as the Federal Test Procedure (FTP). The highway motorcycle regulations allow Class I motorcycles to be tested on a less severe UDDS cycle than the Class II and III motorcycles. This is accomplished by reducing the acceleration and deceleration rates on some the more aggressive ‘‘hills.’’

Off-highway Motorcycles and ATVs

For testing off-highway motorcycles and ATVs, the EPA specifies the current highway motorcycle test procedure be used for measuring emissions.

The EPA is finalizing the Class I cycle for all ATVs. One of the objectives of the final programme is to allow harmonization with California, allowing manufacturers to use the same FTP test data for both programmes. There is the option to test the smallest ATVs (up to 100 cc) to J1088 standards permanently. These vehicles are typically governed to top speeds below the 36 mph contained in the Class I FTP cycle. Also, the small displacement ATVs may be strenuously tested (i.e. more operation at high loads) on the FTP due to their lower horsepower output. The EPA acknowledge that chassis dynamometers for ATVs could be costly to purchase and difficult to put in place in the near term, especially for smaller manufacturers. The EPA is therefore allowing the use of the J1088 engine test cycle as a transitional option through model year 2008. The J1088 option expires after 2008 and the FTP becomes the required test cycle in 2009. The EPA is currently in discussions with ATV manufacturers to determine whether a new test cycle is appropriate. The J1088 may be discontinued earlier than 2009 if another test procedure is implemented.

Table A.3.43 6-Mode Duty Cycle for Recreational Engines

Mode number	Engine speed (1)	Torque (2)	Minimum time in mode (minutes)	Weighting factors
1	85	100	5.0	0.09
2	85	75	5.0	0.20
3	85	50	5.0	0.29
4	85	25	5.0	0.30
5	85	10	5.0	0.07
6	Idle	0	5.0	0.05

(1) % of maximum test speed.

(2) % of maximum test torque at test speed.

Snowmobiles Emissions Test Procedures

The EPA are adopting the snowmobile duty cycle developed by Southwest Research Institute (SwRI) in cooperation with the International Snowmobile Manufacturers Association (ISMA) for all snowmobile emission testing. The test procedure consists of two main parts; the duty cycle that the snowmobile engine operates over during testing and other testing protocols surrounding the measurement of emissions.

Table A.3.44 Snowmobile Engine Test Cycle (1) (2)

Engine parameter	Mode				
	1	2	3	4	5
Normalized speed	1.00	0.85	0.75	0.65	Idle
Normalized torque	1.00	0.51	0.33	0.19	0.00
Relative weighting (in percent)	12	27	25	31	5

(1) Some provision needs to be made in the snowmobile test procedure to account for the colder ambient temperatures typical of snowmobile operation. The EPA are adopting the option to allow snowmobile testing using either cold engine inlet air temperatures between - 15° C and - 5° C (5° F and 23° F) or warm engine inlet air temperatures between 20° C and 30° C (68° F and 86° F). However, for a snowmobile that does not have temperature compensating capabilities, it could be possible to get a moderate emission reduction due to the increase in air density that results at colder temperatures from the artificially induced test inlet air. These emission reductions would not occur in real operation since actual inlet air would be warmer. Therefore, to use the colder inlet temperature option, a manufacturer must demonstrate that for the given engine family, the temperature of the inlet air within the air box is consistent with the inlet-air temperature test conditions.

The EPA is adopting the fuel specifications laid down for 2004 and later light duty vehicles for all recreational vehicles.

A.3.3.7. Evaporative Emissions Test Procedure

Current EPA Evaporative Emissions Procedures

The EPA issued regulations, effective from 23 April 1993, specifying revised procedures and limits for evaporative emissions, with implementation phased-in over the 1996 to 1999 model years. The regulations apply to light- and heavy-duty vehicles and heavy-duty engines fuelled with gasoline, methanol or gasoline/ methanol mixtures.

The EPA has also specified that, from the 1 January 1996, the dispensing rates from gasoline and methanol pumps may not exceed 10 US gallons (37.9 litres) per minute. Facilities with throughputs below 10 000 gallons per month were given a further 2 years to comply. This requirement is consistent with the dispensing rates specified in the new test measuring spillage during refuelling.

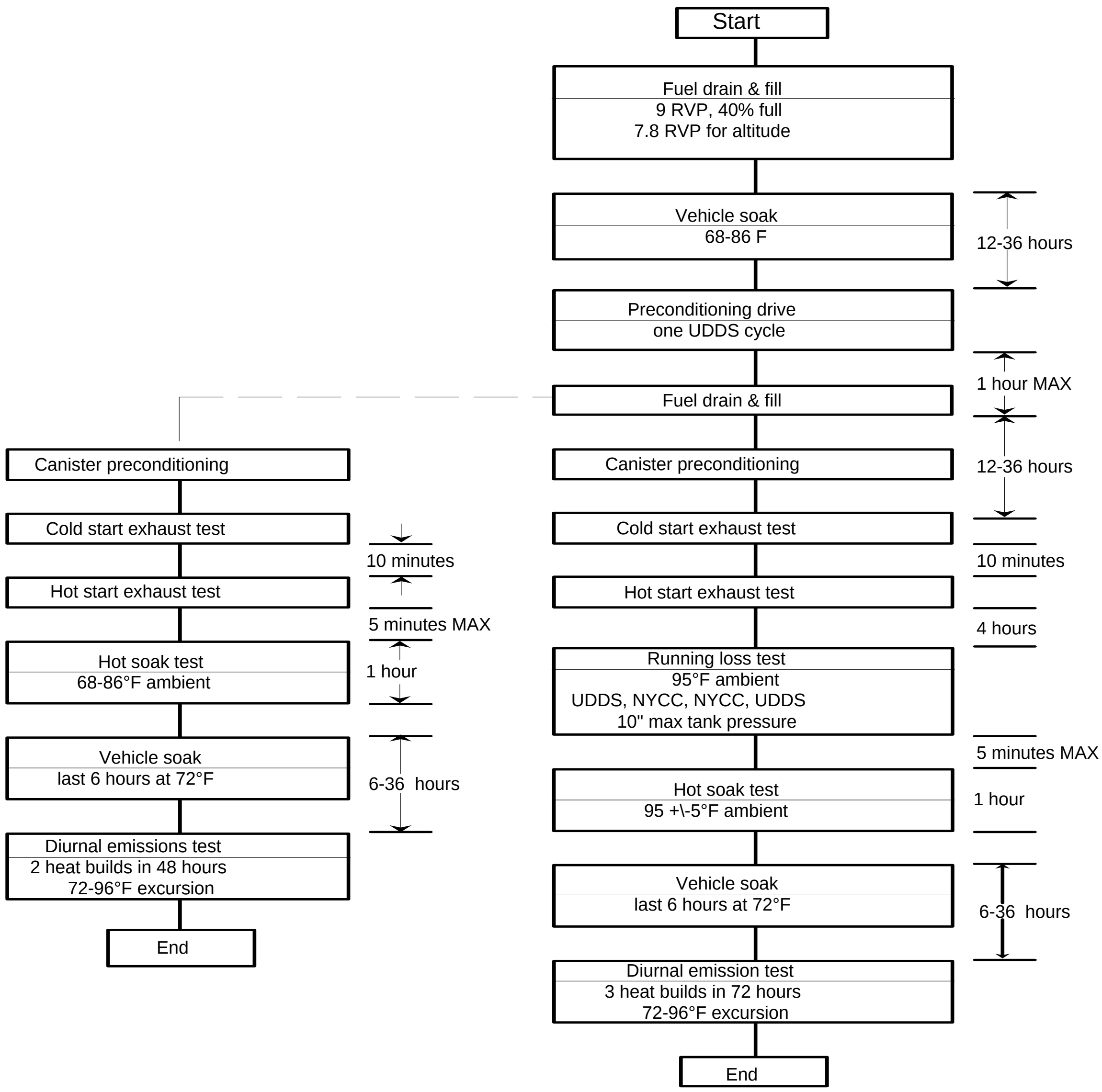
The procedures consist of vehicle preconditioning (including an initial loading of the carbon canister with fuel vapour), exhaust emission testing, a running loss test and three diurnal emissions cycles (**Figure A.3.10**). The full test procedure takes 5 days to complete. Fuel spillage during refuelling, (spit-back) is also measured (see below). A supplemental procedure, omitting the running loss test, but involving two diurnal cycles following the emissions cycles is included. This procedure ensures that all the emissions resulting from purging the evaporative canister are measured during the emission and diurnal cycles and do not escape during the running loss test. Because of its increased severity, the limits specified for this test are more relaxed than those for the three-diurnal sequence. The supplemental procedure can also be used in conjunction with the test procedures devised by the CARB.

The procedures for heavy duty vehicles are similar except that the driving sequence for the running loss test consists of three consecutive UDDS cycles, which reflect the different driving pattern experienced in-service. The testing of heavy-duty engines, without the vehicle chassis or body, requires that the test engine be equipped with a loaded evaporative canister and will be expected to demonstrate a sufficient level of purge during engine testing.

Table A.3.45 Current US Federal Evaporative Emissions Procedure (Implementation began with 1996 model year)

THREE DIURNAL TEST	
FUEL DRAIN/FILL	Drain tank, fill to 40% volume with test fuel (RVP 9 psi/62 kPa or 7.8 psi; 53.8 kPa for altitude testing)
SOAK PERIOD	Soak at 68-86ºF (20-30ºC) for 12-36 h
PRECONDITIONING	Drive over the UDDS (FTP) cycle.
REFUEL/SOAK CANISTER LOADING	Fuel tank is drained and refilled. Soak for 12 h (min) during which the canister is loaded with butane/nitrogen mixture (mass butane 1.5 times bed capacity)
EXHAUST EMISSIONS TEST	Full FTP Cold and Hot Start procedures
SOAK PERIOD	Vehicle stabilized at 95ºF (35ºC)
RUNNING LOSS	Consists of driving sequence of UDDS + NYCC + NYCC + UDDS cycles (Fuel temperature controlled according to a profile, predetermined by a drive under representative summer conditions)
HOT SOAK EMISSIONS	Measured for one hour at 95ºF
SOAK PERIOD	Vehicle stabilized at 72ºF (22.2ºC)
THREE DAY DIURNAL	Emissions measured after three 24 h ambient temperature cycles 72 to 96ºF (22.2 to 35.6ºC). Air circulation and temperatures may be adjusted according to correct any major discrepancy compared with fuel temperatures under outdoor summer conditions.
SUPPLEMENTAL TWO-DIURNAL TEST	
CANISTER LOADING	Loaded with butane/nitrogen mixture until two-gram breakthrough
EXHAUST EMISSIONS TEST	Full FTP Cold and Hot Start procedures.
VEHICLE SOAK	6 h at 72ºF (22.2ºC)
TWO DAY DIURNAL	Emissions measured after two 24h ambient temperatures cycles 72 to 96ºF (22.2 to 35.6ºC)

Figure A.3.10 Current Federal US Evaporative Emissions Test

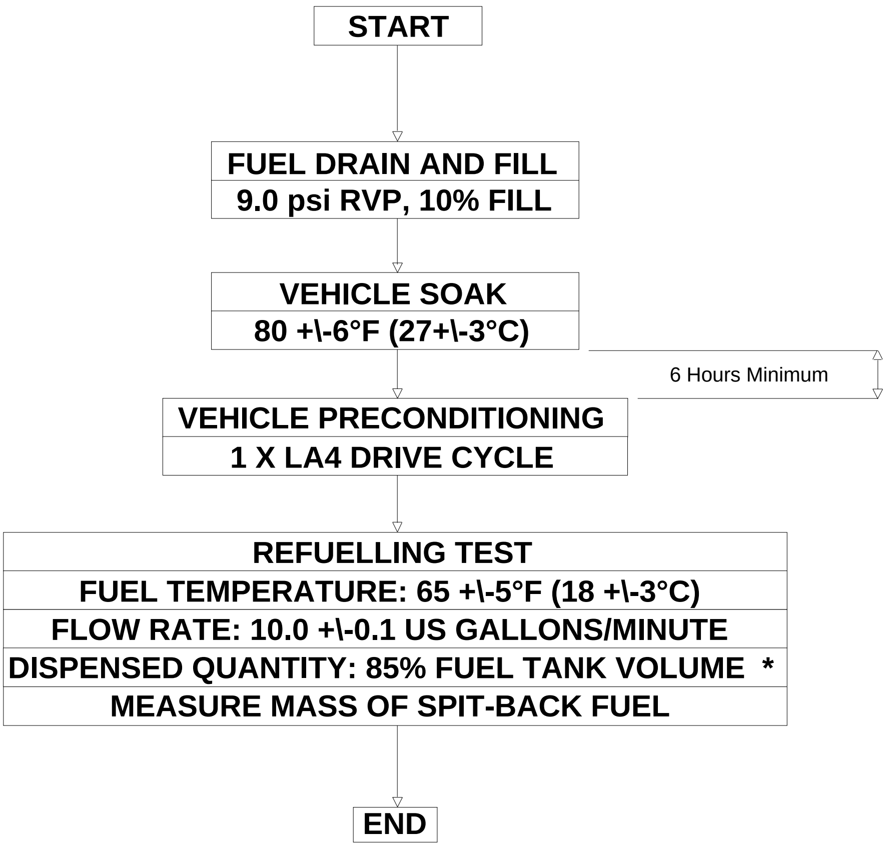


Refuelling - Fuel Spit-back Procedure.

The vehicle is refuelled at a rate of 10 US gal/minute (37.9 l/minute) to test for fuel spit-back emissions. All liquid fuel spit-back which occurs during the test is collected in a bag. The bag (impermeable to hydrocarbons or methanol) should be designed and used so that liquid fuel does not spit back onto the vehicle body etc. The bag must not impede the free flow of displaced gasoline vapour from the filler neck and must be designed to allow the dispensing nozzle to pass through the bag. The dispensing nozzle should be a commercial model, not fitted with vapour recovery equipment.

The sequence for the spit-back test is shown in **Figure A.3.11**.

Figure A.3.11 US Federal Spit-back Test Procedure



A.3.3.8. Permeation Emissions Test Procedure

Test Procedures for Measuring Permeation Emissions From Fuel Tanks

Table A.3.46 Permeation Emissions Test Procedure

Stage	Procedure
Preconditioning	Allow the tank to sit with fuel in it until the hydrocarbon permeation rate has stabilized. Fill the fuel tank with a 10-percent ethanol blend in gasoline (E10) (1), seal, and soak for 20 weeks at 28 ± 5°C
Tank Drain	After the soak period, drain the fuel tank, refill with fresh fuel, and seal
Permeation Measurement	Measure the permeation rate at 28 ± 2°C over a period of at least 2 weeks. Consistent with good engineering judgment, a longer period may be necessary for an accurate measurement for fuel tanks with low permeation rates
Permeation Loss	Measure the weight of the fuel tank before and after testing and take the difference
Permeation Emission Rate	Once the mass change is determined, divide it by the tank surface area and the number of days of soak to obtain the emission rate. As an option, permeation may be measured using alternative methods that will provide equivalent or better accuracy. Such methods include enclosure testing as described in 40 CFR part 86

(1) The fuel used for this testing will be a blend of 90-percent gasoline and 10-percent ethanol. This fuel is consistent with the test fuel used for highway evaporative emission testing.

To determine permeation emissions deterioration factors, the EPA are specifying three durability tests:

1) slosh testing
2) pressure-vacuum cycling
3) ultraviolet exposure.

Table A.3.47 Permeation Emissions Durability Test Procedures

Test	Procedure
Slosh testing	Fill the fuel tank to 40 percent capacity with E10 fuel and rock for 1 million cycles
Pressure-vacuum cycling	10,000 cycles from - 0.5 to + 2.0 psi
Ultraviolet exposure	The procedure assesses potential impacts of UV sunlight (0.2 µm - 0.4 µm) on the durability of the surface treatment. Expose the tank to a UV light of at least 0.40 W-hr/m^2 /min on the tank surface for 15 hours per day for 30 days. Alternatively, expose the tank to direct natural sunlight for an equivalent period of time

Test Procedures for Measuring Permeation Emissions From Fuel System Hoses

The permeation rate of fuel from hoses would be measured at a temperature of 23 ± 2°C using SAE method J3069. The hose must be preconditioned with a fuel soak to ensure that the permeation rate has stabilized. The fuel to be used for this testing would be a blend of 90 percent gasoline and 10 percent ethanol. Alternatively, for purposes of submission of data at certification, permeation could be measured using alternative equipment and procedures that provide equivalent results. To use these alternative methods, manufacturers would have to apply to the EPA and demonstrate equivalence.

Certification Based on Engineering Design Rather Than Through Testing

There are some specific cases where the EPA would allow certification based on design. These special cases are discussed in the text of the regulation.

A.3.3.9. Inspection and Maintenance Procedure - US IM 240

The new US Clean Air Act required the introduction of enhanced inspection and maintenance programmes from 15 November 1992 in the most polluted areas (see **Section A.3.6.3**). The deadline for implementation was delayed until January 1995, a deadline which was not met. The EPA published its proposals on 5 November 1992 and held discussions with manufacturers of I&M equipment prior to publishing its final rule at the end of April 1993. Objections following publication - primarily of the cost of implementation of the procedure compared with simpler methods. This resulted in a further rule being published in April 1995 giving modifications to the programme. These involve changes to the requirements for visual inspection and not to the IM 240 procedure.

Test Procedures

Preconditioning

At the programme Administrator's discretion, vehicles may be preconditioned using any of the following methods:

a) non-loading preconditioning: increase engine speed to approximately 2500 rpm in neutral for up to 4 mins
b) drive the vehicle on the dynamometer at 30 miles/h for up to 240 seconds at road load
c) drive a preliminary transient cycle

Measurement of Exhaust Emissions

The IM 240 procedure for exhaust emissions is a transient test based on 240 seconds of Federal test certification procedures. A trace of the vehicle emission test sequence is given in **Figure A.3.12**.

Emissions of CO, HC and NOx are measured second-by-second over the cycle. The results are summed over four modes and multiplied by a factor. These figures are averaged to give a composite result. If the vehicle fails the appropriate limit, a repeat calculation can be made where the results are calculated over two phases.

Composite Test	Mode	Cycle Portion
	1	0-60 s
	2	61-119 s
	3	120-174 s
	4	175-239 s
Repeat Calculation	**Phase**	**Cycle Portion**
	1	0-93 s
	2	94-239 s

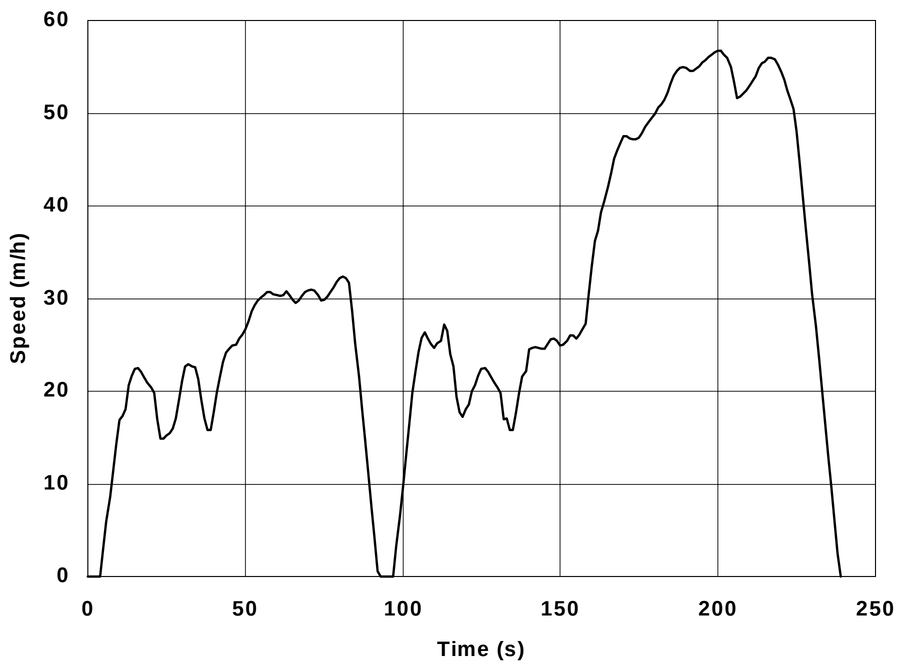
Examination of Evaporative Emissions Control System

The integrity of the evaporative emissions control system is checked by inspection. The canister purge is also tested for flow rate by connecting measuring equipment in series between the canister and the engine, preferably at the canister end of the hose.

Test Criteria and Calculation of Results

The vehicle passes the emissions test if the value for each pollutant is below the standard in the complete test. If for any pollutant the composite emission rate exceeds its standard then an additional analysis of the test results may be carried out which divides the driving cycle into two phases. The vehicle shall have deemed to have passed if the emission rate is below the standard limit in the composite result or in Phase 2 of the Repeat Calculation.

Figure A.3.12 US IM 240 Vehicle Emission Test Sequence



A.3.4. REFERENCE FUELS

US Federal Reference Fuels are tabulated in **Part 1**, **Section 3.4**. However, California has, in some instances, proposed alternative specifications and reference should be made to **Part 1**, **Section 4.4** for further details.

A.3.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

Details will be found in **Part 1**, **Section 3.5** and the CAFE limits, which have remained unaltered since 1991,are tabulated in **Part 2**, **Section B.5.1**.

A.3.5.1. PNGV Programme

In the United States transportation accounts for nearly one-third of CO_2 emissions, with cars and light trucks contributing over half of that total. The “Partnership for a New Generation of Vehicles” (PNGV) is a ten year joint research and development programme between the EPA and General Motors, Ford and Chrysler. It was announced in September 1993 and has the following objectives:

1. Improve US competitiveness in vehicle manufacturing.

2. Implement fuel efficiency and emissions technology for use in conventional vehicles.

3. Develop a vehicle to achieve up to three times the fuel efficiency of a current comparable vehicle by:

   - Designing a mid-size car which achieves 80 mpg (2.94 l/100 km). The size, safety, performance and comfort of a typical current car must be retained.
   - Building a prototype by 2003.

The EPA Office of Transport and Air Quality (OTAQ) is now responsible for the PNGV, which has been renamed the “Clean Automotive Technology Programme”.

A.3.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

There are two aspects to US in-service emissions testing. The first involves surveillance testing to ensure compliance with certification durability requirements (i.e. conformity with the 50 000 mile or full useful life limits). The second extends the rigour of existing inspection and maintenance programmes. The requirements are detailed below.

A.3.6.1. In-Use Surveillance Testing: Non-Routine Testing

The US EPA and California Air Resources Board perform exhaust and evaporative emissions testing on randomly selected customer owned vehicles by engine family. Such vehicles are not tested beyond 75% of their full useful life. The results are compared to the applicable in-use emission standard. If it is determined that the vehicles are in non-compliance, the manufacturer may be required to recall or take other corrective field action (Code of Federal Regulations: 40 CFR Part 86.)

A.3.6.2. In-Use Surveillance Testing: Continuous Vehicle Surveillance

From model year 1992, defects on certain emission-related components/systems of in-use vehicles have to be reported for a period of five years after the end of that model year. A report has to be filed once a minimum of 25 defects have occurred on an individual part. The report includes a description of the defective component(s), a description of the emissions effect of the defect and details of the corrective action taken. Based upon this report, the EPA may request more information to determine if further action, such as a model recall, is necessary.

A.3.6.3. Enhanced Inspection and Maintenance Testing - The New Clean Air Act Amendments and the IM 240 Test Procedure

The EPA issued a Final Rule, effective 7 October 1996, requiring mandatory OBD system checks as a component of I/M programmes. It applies to 1996 model-year and newer vehicles, in both the basic and enhanced I/M programmes, and began on 1 January 1998. With the low-enhanced I/M programmes adopted by Northeast OTR, implementation was put back to 1 January 1999. Failure of the OBD test did not result in a mandatory repair until 1 January 2000. During the intervening period, the EPA gathered data on the effectiveness of OBD.

The new US CAAA called for the introduction of enhanced inspection and maintenance programmes from 15 November 1992 in the most polluted areas. These included certain "*serious*", "*severe*" and "*extreme*" ozone non-attainment areas with populations in excess of 200 000. The Act also mandated enhanced I/M in urban areas located in an "*ozone transport region*" with 100 000 or more residents. At that time this represented an increase in the number of areas requiring I&M programmes from 122 to 181. A final rule was enacted during June 1993 and States were required to submit their detailed inspection programme by November 1993 and promulgate the necessary state legislation.

The proposal required 181 areas of the country to establish emissions testing programmes. The 95 non-attainment areas with "moderate" air pollution problems were required to introduce a basic I&M programme, the 82 more polluted areas were required to implement an enhanced I&M programme. The EPA and the Department of Transport also announced that states would be eligible to federal funds to help defray costs of the programme.

The performance standard proposed for Basic I&M was modelled after the original New Jersey programme (i.e. use of a simple idle test). States required to only have basic I&M programmes could opt for a more stringent programme and could build credits which could be used to offset other pollution control efforts.

The EPA proposed performance standards for Enhanced I&M was based on annual, centralized testing of all 1968 and later model year passenger cars and light duty trucks. A steady-state test could be used for 1968-1985 models, but the “high-tech” IM 240 test was required for 1986 and later model vehicles. Besides emissions tests, the I&M procedures also required a visual inspection for the presence and proper connection of the catalyst, fuel inlet restrictor and evaporative emissions control system. Pressure and purge checks were also required on the carbon canister.

Phase-in standards for the calendar years 1995 and 1996 were given, applying to 1984 model year and newer vehicles. Then followed two sets of final standards, the first applying to vehicles of the 1984 model year and newer, from calendar year 1997. The second standard applied to vehicles certified to Tier 1 limits (including those certified in model years 1994 and 1995), from calendar year 1996. The limits are given in **Table A.3.48** and are the lowest standards that may be applied. Higher limits may be adopted if approved by the Administrator.

The IM 240 test is a transient test based on 240 seconds of the Federal certification test procedures and is claimed to be about three times more accurate in identifying vehicles exceeding emission standards than earlier tests. At the time of its proposal, EPA estimated that the test equipment for IM 240 will be about USD 150 000 and would probably cost the consumer USD 17 per vehicle to administer. Based on the effectiveness of the IM 240 test, EPA concluded that it would be acceptable to require the test only once every 2 years. Also, EPA proposed that states design the programme such that facilities are located within five miles of where 80% of the vehicle owners work or live and that adequate test lanes are present to ensure that there is no more than a 15-minute wait for testing.

Table A.3.48 IM 240 Short Test Emissions Standards

Standard	Effective Date	Vehicle	Age yr	CO g/mile	HC g/mile	NOx g/mile
Phase-in	1995	LD Vehicle	<5	25.0	1.2	3.0
	1996	1984 or younger	>4	30.0	2.0	3.5
		LD Truck	<5	25.0	1.2	3.5
		1984 or younger	<4	30.0	2.0	4.0
Final	1997	LD Vehicle 1984-1995 but pre Tier 1		15.0	0.8	2.0
		LD Truck 1984-1995 but pre Tier 1		15.0	0.8	3.0
Final	1997	Tier 1 LD Vehicle (including 1994/5/6)		15.0	0.7	1.4
		Tier 1 LD Truck (including 1994/5/6)				
		<6000 lb GVW		15.0	0.7	2.0
		>6000 lb GVW		15.0	0.8	2.5

- Evaporative Emissions Control System Purge Test Standard: The Vehicle shall pass the purge test when the total volume of flow exceeds one standard litre. If the total volume of flow is less than 1.0 standard litre at the conclusion of the transient driving cycle the vehicle shall fail.

- Evaporative Emissions Control System integrity: Unless inaccessible, the canister and evaporative system shall be inspected for damage or incorrect connections. The evaporative emissions control system shall be subjected to a pressure test to ensure the absence of leaks.

Implementation of Enhanced I/M Testing

Following the publication of the EPA rule there was an outcry that the IM 240 test was too complicated and expensive to perform and that simpler tests could ensure compliance with emissions requirements. Congress concurred and agreed that states could adopt “Alternative Enhanced I&M” programmes in lieu of the model proposed by EPA, as long as emission reduction benefits of such alternatives were comparable to EPA's programme. As a result, EPA made it somewhat easier for states to adopt decentralized programmes. However, EPA's own studies suggested that such programmes, which allow both the test and repair to occur at the same facility, are only half as effective as programmes which require centralized, test-only facilities. States which chose the low-tech option therefore ran the risk of being required at a later date to convert to high-tech I&M if their programme was unsuccessful.

Following a series of further proposals, Congress passed the National Highway System Act during the first half of 1996. This granted states the right to set up their own tailor-made I/M plans. The current requirements, being much different from the stringent testing regime previously proposed by the EPA, has left many states uncertain how to proceed. State legislatures are wary of approving State Implementation Plans (SIPs) based on the previous uncertainties and the EPA seems unwilling to enforce any action. The situation regarding state implementation programmes is given below:

Table A.3.49 Status of US Inspection and Maintenance Programmes

State	Programme
Alaska, Fairbanks	Basic; annual; BAR-90 two-speed idle test – No changes expected.
Alaska, Anchorage	Basic; annual; BAR-90 two-speed idle test – No changes expected.
Arizona Tucson	Basic test-only; annual; loaded cruise and idle test – No changes expected.
Arizona, Phoenix	Enhanced test-only; biennial; IM 240 and pressure test – No changes expected.
California, basic	Basic test and repair; biennial; two-speed idle test– No changes expected.
California, enhanced	Hybrid test-only/test and repair; two-speed idle test – ASM2 expected to start late 1997 or early 1998.
Colorado, basic	Basic; annual; BAR-94 two-speed idle test – No changes expected.
Colorado, enhanced	Enhanced test-only; IM 240 and filler cap test – No changes expected.
Connecticut	Enhanced test-only; annual (1980 and older)/biennial (1981+); modified IM 240 (first 93 seconds) for 1981+; preconditioned idle for 1968-80 – No changes expected.
Delaware, New Castle & Kent Counties	Low enhanced test-only; biennial; BAR-84/BAR90 with pressure test – In the process of updating from BAR-84 equipment to BAR-90.
Delaware, Sussex County	Basic test-only; biennial; - See above regarding equipment.
District of Columbia	Basic test-only; biennial; idle test – Possibly going to IM 240 by 1988.
Florida	Basic test-only; annual; idle test - No changes expected.
Georgia	Enhanced hybrid test-only/test and repair; ASM1 and two-speed idle tests - No changes expected.
Illinois	Basic test-only; idle test – IM 240 (1981+), idle test (pre-1981) - Filler cap test expected to start in 1998.
Indiana	Enhanced test-only; biennial; modified IM 240 (first 93 seconds) and filler cap test for 1981+; idle test for 1976-80.
Kentucky, Louisville	Basic test-only; BAR-90 (with dynamometer-conditioned second chance) – Proposed changes to ASM type testing on hold.
Louisiana	Basic; annual; anti-tampering visual inspection – BAR-90 two-speed idle testing with filler cap test may begin in 1999.
Maine	No programme currently running – Must have an I & M programme in place by 1998.
Maryland	“Modified basic” test-only; biennial; idle test and voluntary IM 240 – Mandatory IM 240 is expected to start in late 1997.
Massachusetts	Basic test and repair; annual; BAR-84 idle test – Transient loaded mode test (IG 240/RG 240) expected in 1999
Michigan, south-eastern	Programme stopped in 1996 - No changes expected.
Minnesota	Basic test-only; annual; idle test - No changes expected.
Missouri	Basic test and repair; annual; BAR-90 idle test – IM 240 (1981+) is expected to be implemented by 1998.
Nevada, Las Vegas	Low enhanced test and repair; annual; Nevada 94 - No changes expected.
Nevada, Reno	Basic test and repair; annual; Nevada 94 (BAR-90 based test) - No changes expected.

State	Programme
New Hampshire	None – Changes are to be determined, dependent on re-designation requests.
New Jersey	Basic hybrid; annual; BAR-84 idle and voluntaryASM1 test – Mandatory ASM1 (1968+) and idle test (pre-1968) expected to begin in 1998.
New Mexico	Basic test and repair; biennial; BAR-90 two-speed idle test - No changes expected.
New York, New York City	Basic; annual; BAR-90 – NY-Test, similar to RG 240 (1981+), idle test (pre-1981 – Filler cap, anti-tampering and OBD test expected to begin in late 1997 or early 1998.
New York, rest of state	Anti-tampering programme - Filler cap, anti-tampering and OBD test expected to begin in late 1997 or early 1998.
North Carolina	Basic; annual; BAR-90 idle test - No changes expected.
Ohio, Cincinnati, Dayton & Cleveland	Enhanced test-only; biennial IM 240 - No changes expected.
Oregon	Basic test-only; biennial; two-speed idle test – Considering BAR-90 for 1981+ model year.
Pennsylvania	Basic; annual; BAR-84 – Should upgrade to BAR-90 equipment by 1997 in Pittsburgh and 1999 in other areas.
Pennsylvania, Philadelphia	Basic; annual BAR-84 – ASM (1977+), idle test (1966-76) and filler cap test expected to start in 1997.
Rhode Island	Basic test and repair; annual; BAR-80 idle test – Performing a study to determine programme changes which would be implemented by 1998.
Tennessee, Memphis	Basic; annual; two-speed idle test - No changes expected.
Tennessee, Nashville	Basic; annual; idle test - No changes expected.
Texas, Dallas-Fort Worth	Low enhanced hybrid test-only/test and repair; annual; TX 96 (BAR-90 type two-speed idle test) – Considering using a loaded mode test in the future (e.g. ASM).
Texas, Houston	Low enhanced hybrid test-only/test and repair; annual; TX 96 (BAR-90 type two-speed idle test) – Considering using a loaded mode test in the future (e.g. ASM).
Texas, El Paso	Low enhanced hybrid test-only/test and repair; annual; TX 96 (BAR-90 type two-speed idle test) – No changes expected.
Utah, Davis County	Basic test and repair; two-speed idle test – In the process of implementing an OBD check; test-only component will be added by 1998.
Utah, Salt Lake County	Basic test and repair; two-speed idle test – ASM 2 testing will be phased in by January 1998.
Utah, Utah County	Basic test and repair; two-speed idle test – An aggressive remote sensing component and improved technician training will be added.
Utah, Weber County	Basic test and repair; two-speed idle test – No changes expected.
Vermont	No current programme - Will add visual inspection, filler cap test and OBD test in 1997, 1998 and 1999 respectively.
Virginia	No current programme – BAR-90 two-speed idle test may be implemented, contingent upon re-designation request.
Virginia, DC suburbs	Basic; BAR-84 two-speed idle test – ASM 2 (1968+) and evaporative tests expected to start in late 1997.
Washington, Seattle-Tacoma	Low enhanced test-only; biennial; idle/loaded cruise - No changes expected.
Washington, Vancouver and Spokane	Low enhanced test-only; biennial; ASM 1 - No changes expected.
Wisconsin	Enhanced test-only; biennial IM 240 - No changes expected.

- BAR – Bureau of Automobile Repair, the Californian organisation responsible for overseeing I&M testing

A.3.6.4. On-board diagnostic systems

A final Federal rule was established which required manufacturers to install on-board diagnostic (OBD) systems on light-duty vehicles and light-duty trucks beginning with the 1994 model year. The thresholds as defined in the FTP for OBD system identification of emissions-related malfunction or deterioration are as follows:

Table A.3.50 FTP thresholds for OBD system identification of emissions-related malfunction

Component	Threshold Limit
Emission related components (other than those listed below)	before it results in exhaust emission increases of 0.2 HC, 1.7 CO and 0.5 NOx (all in g/mile) or results in leakage or other malfunctions of the vapour recovery or purge systems that result in an evaporative emission increase of 2.0 g/test.
Catalyst deterioration	before it results in an exhaust emissions increase greater than more than 0.4 HC, 3.4 CO, 1.0 NOx (all in g/mile).
Engine misfire	before it results in an exhaust emission increase of more than 0.4 HC, 3.4 CO, or 1.0 NOx (all in g/mile).
Oxygen sensor deterioration	before it results in an exhaust emissions increase greater than 0.2 HC, 1.7 CO or 0.5 NOx (all in g/mile).

In addition to detecting misfire, the system must also identify which cylinders are misfiring and if any other emission related powertrain systems or components have caused an exhaust emission increase. The OBD system must also detect the occurrence of any leakage or malfunction of the vapour recovery systems that result in an evaporative emissions increase of 3.0 g/test for LDVs and LDTs. The diesel OBD only requires monitoring of catalyst malfunction or deterioration of other emission-related powertrain components.

Manufacturers are required to detect these malfunctions only if they occur in actual use. Therefore, if manufacturers are confident that any malfunction will not result in emission increases, they may choose to forego OBD monitoring. However, to ensure compliance the EPA will check in-use emissions.

This rulemaking allowed manufacturers to satisfy the Federal OBD requirement through the 1998 model year by installing systems meeting the California OBD II regulations, which meant that manufacturers could concentrate on designing one system to meet both standards. On 28 May 1997, the EPA published a notice of provisional rulemaking (NPRM) which indefinitely extended acceptance of Californian OBD II as federally compliant. Additionally, the NPRM harmonised the federal emission thresholds above which a component or system is considered malfunctioning with those of California OBD II.

OBD systems checks in I/M programmes become mandatory on 1 January 1998, (1 January 1999 for OTR low-enhanced programmes) and repair of failed systems became mandatory on 1 January 2000.

A.3.6.5. Heavy Duty Smoke Tests

On 3 April 1997, the Environmental Protection Agency (EPA) recommended the use of the SAE J1667 procedure for state-operated in-use testing programs for highway heavy-duty diesel vehicles (HDDV). The SAE J1667 is a snap acceleration test under idle conditions, using engine inertia for loading, and is specifically designed for identifying excessive smoke emissions. Since it is a stationary vehicle test, the SAE J1667 can be conducted either at the roadside or in a test facility.

As a result of that recommendation, several States started using or considered the recommended SAE J1667 test procedure. However, the EPA realised that in order to bring full uniformity among state-operated smoke testing programmes, additional guidance was needed for States to adopt similar opacity limits. On 25 February 1999 the EPA recommended the following specific opacity cut-points:

- 40% for vehicles 1991 and newer
- 55% for vehicles 1990 and older

This guidance was based on the results of a survey conducted by SAE as part of a co-operative agreement with EPA to evaluate state-operated smoke testing programmes. Although the Clean Air Act Amendments of 1990 do not require States to implement in-use testing programmes for highway HDDVs, many States are conducting such tests.

A.3.6.6. Proposed Truck Idling Rules

In about half the country, state and local jurisdictions have passed laws or ordinances limiting a vehicle's idling time. Many of these laws, however, differ from one state to another in terms of the engine idle time limit and exemptions (e.g., temperature). This patchwork of anti-idling laws creates confusion and a general lack of understanding among truck drivers.

On 9 March, 2005 the EPA announced its plans. In an effort to create consistent laws across the country, the EPA will host state/industry workshops to develop a model state or local idling law for heavy-duty trucks and buses. The goal is to develop a consensus approach to eliminating the inconsistencies that exist between current local legislation.

A.4. CALIFORNIAN REGULATIONS

A.4.1. VEHICLE EMISSIONS LIMITS

A.4.1.1. Introduction

California has always set more stringent emission limits than the rest of the US, and established a plan for the progressive reduction of vehicle emissions designed to enable the state to achieve national air quality standards by the year 2010.

Following a 5 November 1998 hearing, the ARB adopted the California "LEV II" regulations, which generally become applicable with the 2004 model year (although earlier certification to the LEV II standards was permitted). The LEV II regulations were formally adopted 5 August 1999 and became operative 27 November 1999. The original LEV standards are now referred to as the "LEV I" standards. The LEV II regulations are the current standards for California and are therefore reported in **Part 1**, **Section 4.1**. Earlier Tier 1 and LEV I limits will be found in **Part 2**, **Sections B.4.1.1** to **B.4.1.7**.

A.4.1.2. The LEV II Regulations

The LEV II exhaust emission standards and requirements will be phased in over the 2004 through 2007 model years. One of the major changes made by the LEV II standards is that all light duty trucks will be subject to the same emission standards as passenger cars, and vehicles under 8500 lbs. gross vehicle weight (including sport utility vehicles) that had previously been treated as medium duty vehicles will start to be treated as light duty trucks. The legislation includes the following:

- The LEV II exhaust emission standards.
- The LEV II emissions standards phase-in requirements (including fleet average NMOG requirements) for passenger cars and light duty trucks, a schedule containing the minimum percentages of 2004-2007 passenger cars and light duty trucks that must be certified to the LEV II rather than LEV I standards and medium duty vehicle phase-in requirements.
  - Calculation of NMOG credits and debits.
  - Test Procedures.
  - LEV II evaporative emission standards, which are phased in during the 2004 - 2006 model years.

This section provides details of NMOG limits, 50°F exhaust emission and cold temperature CO standards. It also describes other requirements, including emission credits, implementation schedules and in-use compliance standards.

Table A.4.1 NMOG LEV I Standards for 2001 through 2006 Model Year Bi-Fuel, Fuel-Flexible and Dual Fuel Vehicles Operating on Gasoline

Vehicle Description		**NMOG Emission Limits (g/mile) Durability Mileage**	
Type, LVW/ALVW	**Emission Category**	**50 000**	**100 000**
All PCs, LDTs, 0-3750 lb LVW (2001 through 2003 model years only, for TLEVs)	TLEV	0.250	0.310
	LEV	0.125	0.156
	ULEV	0.075	0.090
LDTs, 3751-5750 lb LVW (2001 through 2003 model years only, for TLEVs)	TLEV	0.320	0.400
	LEV	0.160	0.200
	ULEV	0.100	0.130
MDVs, 3751-5750 lb ALVW	LEV	0.320	0.460
	ULEV	0.160	0.230
	SULEV	0.100	0.143
MDVs, 5751-8500 lb ALVW	LEV	0.390	0.560
	ULEV	0.195	0.280
	SULEV	0.117	0.167
MDVs, 8501-10 000 lb ALVW	LEV	0.460	0.660
	ULEV	0.230	0.330
	SULEV	0.138	0.197
MDVs, 10 001-14 000 lb ALVW	LEV	0.600	0.860
	ULEV	0.300	0.430
	SULEV	0.180	0.257

- For fuel-flexible, bi-fuel and dual-fuel PCs, LDTs and MDVs, compliance with the NMOG exhaust mass emission standards shall be based on exhaust emission tests both when the vehicle is operated on the gaseous or alcohol fuel it is designed to use, and when the vehicle is operated on gasoline. A manufacturer must demonstrate compliance with the applicable exhaust mass emission standards for NMOG, CO, NOx and formaldehyde when certifying the vehicle for operation on the gaseous or alcohol fuel.
- The standards represent the maximum NMOG emissions when the vehicle is operating on gasoline. A manufacturer shall not apply a reactivity adjustment factor to the exhaust NMOG mass emission result when operating on gasoline. Testing at 50°F is not required for fuel-flexible, bi-fuel and dual-fuel vehicles when operating on gasoline.

Table A.4.2 NMOG LEV II Standards for 2004 and Subsequent Model Year Bi-fuel, Fuel-Flexible and Dual Fuel Vehicles Operating on Gasoline

Vehicle Description		**Emission Limits (g/mile)**	
		Durability Mileage	
Type	**Emission Category**	**50 000**	**120 000**
All PCs; LDTs, 0-8500 lb GVW	LEV	0.125	0.156
	ULEV	0.075	0.090
	SULEV	0.010	0.040
MDVs, 8501-10 000 lb GVW	LEV	n/a	0.230
	ULEV	n/a	0.167
	SULEV	n/a	0.117
MDVs, 10 001-14 000 lb GVW	LEV	n/a	0.280
	ULEV	n/a	0.195
	SULEV	n/a	0.143

- See notes to the preceding table.

Table A.4.3 50°F Exhaust Emission Standards

Limits for Vehicles Certified to the LEV I Standards								
Vehicle Weight Class (lb)	**Emission Limits by Vehicle Category (g/mile)**							
	TLEV		**LEV**		**ULEV**		**SULEV**	
	NMOG	**HCHO**	**NMOG**	**HCHO**	**NMOG**	**HCHO**	**NMOG**	**HCHO**
PCs; LDTs 0 - 3750 LVW	0.25	0.030	0.150	0.030	0.080	0.016	n/a	n/a
LDTs 3751 - 5750 LVW	0.312	0.036	0.180	0.036	0.110	0.018	n/a	n/a
MDVs 3751 - 5750 TW	n/a	n/a	0.320	0.036	0.200	0.018	0.100	0.008
MDVs 5751 - 8500 TW	n/a	n/a	0.390	0.064	0.234	0.032	0.118	0.016
MDVs 8501 - 10 000 TW	n/a	n/a	0.460	0.080	0.276	0.042	0.138	0.020
MDVs 10 001 - 14 000 TW	n/a	n/a	0.600	0.072	0.360	0.036	0.180	0.018
Limits for Vehicles Certified to the LEV II Standards								
PCs; LDTs 0 - 8500 GVW	n/a	n/a	0.150	0.030	0.080	0.016	0.02	0.008
MDVs 8501 - 10 000 GVW	n/a	n/a	0.390	0.064	0.286	0.032	0.200	0.016
MDVs 10 001 - 14 000 GVW	n/a	n/a	0.460	0.080	0.334	0.040	0.234	0.020

- All light- and medium duty TLEVs, LEVs, ULEVs and SULEVs must demonstrate compliance with the above exhaust emission standards for NMOG and formaldehyde measured on the FTP (40 CFR, Part 86, Subpart B) conducted at a nominal test temperature of 50°F. The NMOG mass emission result shall be multiplied by the applicable reactivity adjustment factor, if any, prior to comparing to the applicable adjusted 50 000 mile certification standards detailed above. Emissions of CO and NOx measured at 50°F shall not exceed the standards applicable to vehicles of the same emission category and vehicle type subject to a cold soak and emission test at 68 to 86°F. Natural gas and diesel-fuelled vehicles are exempt from the 50°F test requirements.

Table A.4.4 2001 and Subsequent Model Year Cold Temperature Carbon Monoxide Exhaust Emissions Standards for Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles

Vehicle Type & Weight Class (lb)	CO (g/mile)
All PCs, LDTs 0 - 3750 LVW	10.0
LDTs, 3751 - 5750 LVW LDTs 3751 LVW - 8500 GVW LEV I and Tier 1 MDVs, 0 - 8500 ALVW	12.5

- These standards are applicable to vehicles tested in accordance with 40 CFR Part 86 Subpart C at a nominal temperature of 20°F (-7°C). Natural gas vehicles, diesel-fuelled vehicles, and medium duty vehicles with a gross vehicle weight rating greater than 8500 lb are exempt from these standards.

Table A.4.5 Other Requirements and Emission Credits (1)

Requirement/Credit	Details
Highway NOx Standard	The maximum emissions of oxides of nitrogen measured on the Federal Highway Fuel Economy Test (HWFET; 40 CFR 600 Subpart B) shall not be greater than 1.33 times the applicable PC and LDT standards or 2.0 times the applicable MDV standards. Both the projected emissions and the HWFET standard shall be rounded in accordance with ASTM E29-67 to the nearest 0.1 g/mile (or 0.01 g/mile for vehicles certified to the 0.05 or 0.02 g/mile NOx standards) before being compared.
Requirements for Vehicles Certified to the Optional 150 000 Mile Standards	A vehicle that is certified to the 150 000 mile standards shall generate additional NMOG fleet average credit, or additional vehicle equivalent credits, provided that the manufacturer extends the warranty on high-priced parts to 8 yr or 100 000 miles, whichever occurs first, and agrees to extend the limit on high mileage in-use testing to 150 000 miles. A manufacturer that certifies to the 150 000 mile SULEV standards shall also generate a partial ZEV allocation.
Optional LEV NOx Standard	A manufacturer may certify up to 4% of its light duty truck fleet from 3751 lb LVW - 8500 lb GVW with a maximum base payload of 2500 lb or more, to the LEV, option 1, standard based on projected sales of trucks in this category. Passenger cars and light duty trucks 0 - 3750 lb LVW are not eligible for this option.
NMOG Credit for Vehicles with Zero-Evaporative Emissions	In determining compliance of a vehicle with the applicable exhaust NMOG standard, a gram per mile NMOG factor, based on available data, shall be subtracted from the reactivity-adjusted NMOG exhaust emission results for any vehicle that has been certified to the "zero" evaporative emission standard set forth in title 13, CCR, section 1976(b)(1)(E). This credit shall not apply to a SULEV that generates a partial ZEV allowance.
NMOG Credit for Direct Ozone Reduction Technology	A manufacturer that certifies vehicles equipped with direct ozone reduction technologies shall be eligible to receive NMOG credits that can be applied to the NMOG exhaust emissions of the vehicle when determining compliance with the standard. In order to receive credit, the manufacturer must submit the following information for each vehicle model, including, but not limited to: a demonstration of the airflow rate through the direct ozone reduction device and the ozone-reducing efficiency of the device over the range of speeds encountered in the SFTP test cycle; an evaluation of the durability of the device for the full useful life of the vehicle; and a description of the on-board diagnostic strategy for monitoring the performance of the device in-use. Using the above information, the value of the NMOG credit will be based on the calculated change in the one-hour peak ozone level using an approved airshed model.
NOx Credits for Pre-2004 MDVs Certified to the LEV I LEV or ULEV Standards	Prior to the 2004 model year, a manufacturer may earn a 0.02 g/mile per vehicle NOx credit for MDVs between 6000-8500 lb GVW certified to the LEV I LEV or ULEV standards for PCs and LDTs. The manufacturer may apply the credit on a per vehicle basis to the NOx emissions of LDTs between 6000-8500 lb GVW certified to the PC/LDT LEV or ULEV standards for the 2004 to 2008 model years.

(1) A complex system for calculating NMOG credits and debits has been proposed. Interested readers should refer to the original document for details.

Table A.4.6 Fleet Average NMOG Phase-In Requirements for Passenger Cars and Light Duty Trucks - Volume Production [(1)]

Model Year	**Fleet Average NMOG (g/mile) (50 000 mile Durability Vehicle Basis) [Weight Classes in lb] [(2) (3)]**		**Model Year**	**Fleet Average NMOG (g/mile) (50 000 mile Durability Vehicle Basis) [Weight Classes in lb] [(2) (3)]**	
	All PCs; LDTs 0 - 3750 LVW	**LDTs 3751 LVW - 8500 GVW**		**All PCs; LDTs 0 - 3750 LVW**	**LDTs 3751 LVW - 8500 GVW**
2001	0.070	0.098	2006	0.046	0.062
2002	0.068	0.095	2007	0.043	0.055
2003	0.062	0.093	2008	0.040	0.050
2004	0.053	0.085	2009	0.038	0.047
2005	0.049	0.076	2010+	0.035	0.043

(1) Different limits apply to small manufacturers - See Note 4.

(2) Each manufacturer's fleet average NMOG value for the total number of PCs and LDTs produced and delivered for sale in California shall be calculated as follows:
∑ [Number of vehicles in a test group x applicable emission standard] + ∑ [Number of hybrid electric vehicles in a test group x HEV NMOG factor] = Total Number of Vehicles Produced, including ZEVs and HEVs
The applicable emission standards to be used in the above equation are as follows:

Model Year	**Emission Category**	**Emission Standard Value [Weight Classes in lb]**	
		All PCs; LDTs 0 - 3750 LVW	**LDTs 3751 - 5750 LVW**
2001 and subsequent (AB 965 vehicles only)	Tier 1	0.25	0.3
2001 - 2003	Tier 1	0.25	0.3
2001 - 2006 model year vehicles certified to the "LEV I" standards (For TLEVs, 2001 - 2003 model years only)	TLEVs	0.125	0.160
	LEVs	0.075	0.100
	ULEVs	0.040	0.050
Model Year	**Emission Category**	**All PCs; LDTs 0-3750 LVW**	**LDTs 3751 LVW - 8500 GVW**
2001 and subsequent model year vehicles certified to the "LEV II" standards	LEVs	0.075	0.075
	ULEVs	0.040	0.040
	SULEVs	0.01	0.01
2001 and subsequent model year vehicles certified to the optional 150 000 mile "LEV II" standards for PCs and LDTs	LEVs	0.06	0.06
	ULEVs	0.03	0.03
	SULEVs	0.0085	0.0085

(3) The HEV NMOG factor for light duty vehicles is calculated as follows:
LEV HEV Contribution Factor = 0.075 - [(Zero-emission VMT Factor) x 0.035]
ULEV HEV Contribution Factor = 0.040 - [(Zero-emission VMT Factor) x 0.030]
where Zero-emission VMT Factor for HEVs is determined in accordance with Section C.3 of the "California Exhaust Emission Standards and Test Procedures for 2003 and Subsequent Model Zero-Emission Vehicles, and 2001 and Subsequent Model Hybrid Electric Vehicles, in the Passenger Cars, Light Duty Trucks and Medium Duty Vehicles Classes," as incorporated by reference in section 1962(e), title 13, CCR.

(4) Requirements for Small Volume Manufacturers.
(a) In 2001 through 2003 model years, a small volume manufacturer shall not exceed a fleet average NMOG value of 0.075 g/mile for PCs and LDTs from 0-3750 lb LVW or 0.100 g/mile for LDTs from 3751-5750 lb In 2004 and subsequent model years, a small volume manufacturer shall not exceed a fleet average NMOG value of 0.075 for PCs and LDTs from 0-3750 lb LVW or 0.075 for LDTs from 3751 lb LVW - 8500 lb.

(b) If a manufacturer's average California sales exceeds 4500 units of new PCs, LDTs, MDVs and heavy duty engines based on the average number of vehicles sold for the three previous consecutive model years, the manufacturer shall no longer be treated as a small volume manufacturer and shall comply with the fleet average requirements applicable to larger manufacturers beginning with the fourth model year after the last of the three consecutive model years.
(c) If a manufacturer's average California sales falls below 4500 units of new PCs, LDTs, MDVs and heavy duty engines based on the average number of vehicles sold for the three previous consecutive model years, the manufacturer shall be treated as a small volume manufacturer and shall be subject to the requirements for small volume manufacturers beginning with the next model year.

Table A.4.7 Fleet Average NMOG LEV II Phase-In Requirement

Model Year	PC/LDT1 (%)	LDT2 (%)
2004	25	25
2005	50	50
2006	75	75
2007	100	100

- Beginning in the 2004 model year, a manufacturer, except a small volume manufacturer, shall certify a percentage of its PC and LDT fleet to the LEV II standards according to the above schedule.
- In determining compliance with the phase-in schedule, the fleet shall consist of LEV I and LEV II PCs and LDT1s for the PC/LDT1 calculation, and LEV I and LEV II LDT2s for the LDT2 calculation. LEV I MDVs are not counted in the calculation until they are certified as LEV II LDT2s.
- A manufacturer may use an alternative phase-in schedule to comply with these phase-in requirements as long as equivalent NOx emission reductions are achieved by the 2007 model year from each of the two categories -- PC/LDT1 or LDT2. Model year emission reductions shall be calculated by multiplying the percent of either PC/LDT1 or LDT2 vehicles meeting the LEV II standards in a given model year (based on a manufacturer's projected sales volume of vehicles in each category) by 4 for the 2004 model year, 3 for the 2005 model year, 2 for the 2006 model year and 1 for the 2007 model year. The yearly results for PCs/LDT1s shall be summed together to determine a separate cumulative total for PCs/LDT1s and the yearly results for LDT2s shall be summed together to determine a cumulative total for LDT2s. The cumulative total for each category must be equal to or exceed 500 to be considered equivalent. A manufacturer may add vehicles introduced before the 2004 model year (e.g., the percent of vehicles introduced in 2003 would be multiplied by 5) to the cumulative total.

Table A.4.8 Implementation Schedules for SFTP Emission Standards - PCs and of LDTs Certified to Tier 1 and TLEV (1)

Model Year	Percentage of PC and LDT Fleet
2001	25
2002	50
2003	85
2004 and subsequent	100

(1) Excluding small volume manufacturers.

- For the purposes of the implementation schedule, each manufacturer's PC and LDT fleet shall be defined as the total projected number of Tier 1 and TLEV PCs and LDTs from 0-5750 lb LVW sold in California. As an option, a manufacturer may elect to have its total PC and LDT fleet defined, for the purposes of this implementation schedule only, as the total projected number of the manufacturer's PCs and LDTs, other than zero-emission vehicles, certified and sold in California.

Table A.4.9 Implementation Schedules for SFTP Emission Standards - PCs and of LDTs Certified to LEV, ULEV and SULEV (1)

Model Year	**Percentage**	
	PC, LDT	**MDV**
2001	25	NA
2002	50	NA
2003	85	25
2004	100	50
2005 and subsequent	100	100

(1) Excluding small volume manufacturers.

- A manufacturer may use an "Alternative or Equivalent Phase-in Schedule" to comply with the phase-in requirements. An "Alternative Phase-in" is one that achieves at least equivalent emission reductions by the end of the last model year of the scheduled phase-in. Model-year emission reductions shall be calculated by multiplying the percent of vehicles (based on the manufacturer's projected California sales volume of the applicable vehicle fleet) meeting the new requirements per model year by the number of model years implemented prior to and including the last model year of the scheduled phase-in. The "cumulative total" is the summation of the model year emission reductions (e.g., a four model year 25/50/85/100% phase-in schedule would be calculated as: (25% × 4 yr) + (50% × 3 yr) + (85% × 2 yr) + (100% × 1 year) = 520). Any alternative phase-in that results in an equal or larger cumulative total than the required cumulative total by the end of the last model year of the scheduled phase-in shall be considered acceptable under the following conditions: 1) all vehicles subject to the phase-in shall comply with the respective requirements in the last model year of the required phase-in schedule and 2) if a manufacturer uses the optional phase-in percentage determination, the cumulative total of model year emission reductions as determined only for PCs and LDTs certified must also be equal to or larger than the required cumulative total by end of the 2004 model year. A manufacturer shall be allowed to include vehicles introduced before the first model year of the scheduled phase-in (e.g., in the previous example, 10% introduced one year before the scheduled phase-in begins would be calculated as: (10% × 5 yr) and added to the cumulative total).
- For the purposes of the implementation schedule, each manufacturer's PC and LDT fleet shall be defined as the total projected number of low-emission, ultra-low-emission and super-ultra-low-emission PCs and LDTs from 0-5750 lb loaded vehicle weight sold in California. Each manufacturer's MDV fleet shall be defined as the total projected number of low-emission, ultra-low-emission, and super-ultra-low-emission MDVs less than 8501 lb gross vehicle weight rating sold in California.

Table A.4.10 Intermediate LEV II In-Use Compliance Standards

Emission Category	**Durability Mileage**	**Emission Limits by Vehicle Type (g/mile)**		
		LEV II PCs and LDTs		**LEV II MDVs 8501 - 10 000 lb GVW**
		NMOG	**NOx**	**NOx**
LEV/ULEV	50 000	n/a	0.07	n/a
	120 000	n/a	0.10	0.3
SULEV	120 000	0.02	0.03	0.15

- For test groups certified prior to the 2007 model year, the above intermediate in-use compliance standards apply for the first two model years the test group is certified to the new standard.

Reactivity Adjustment Factors

A reactivity adjustment factor is the ratio of the specific reactivity of a low-emission vehicle designed to operate on a fuel other than conventional gasoline (including a fuel-flexible, bi-fuel or dual-fuel vehicle when operating on any fuel other than conventional gasoline) compared to the NMOG baseline specific reactivity of vehicles in the same vehicle emission category operating on conventional gasoline.

Details of applicable reactivity adjustment factors and procedures for the determination of specific reactivity will be found in **Part 2**, **Section B.4.1.7**.

A.4.1.3. Evaporative Emissions Standards - Light and Medium Duty Vehicles

These are described in detail in **Part 1**, **Section 4.1.3**.

Other Provisions

Zero-emission vehicles shall produce zero fuel evaporative emissions under any and all possible operational modes and conditions.

The optional zero-fuel evaporative emission standards for the three-day and two-day diurnal-plus-hot-soak tests are 0.35 grams per test for passenger cars, 0.50 grams per test for light duty trucks 6000 lbs. GVWR and under, and 0.75 grams per test for light duty trucks from 6001 to 8500 lbs. GVWR. This is to account for vehicle non-fuel evaporative emissions (resulting from paints, upholstery, tires, etc). Vehicles demonstrating compliance with these evaporative emission standards shall also have zero (0.0) grams of fuel evaporative emissions per test for the three-day and two-day diurnal-plus-hot-soak tests. The “useful life” shall be 15 years or 150 000 miles, whichever occurs first. In lieu of demonstrating compliance with the zero (0.0) grams of fuel evaporative emissions per test over the three-day and two-day diurnal-plus-hot-soak tests, the manufacturer may submit for advance approval a test plan to demonstrate that the vehicle has zero (0.0) grams of fuel evaporative emissions throughout its useful life.

In the case of a SULEV vehicle for which a partial ZEV credit is sought, the manufacturer may prior to certification elect to have measured fuel evaporative emissions reduced by a specified value in all certification and in-use testing of the vehicle. This is provided measured mass exhaust emissions of NMOG for the vehicle are increased in all certification and in-use testing. The measured fuel evaporative emissions shall be reduced in increments of 0.1 gram per test, and the measured mass exhaust emissions of NMOG from the vehicle shall be increased by a gram per mile factor, to be determined by the Executive Officer, for every 0.1 gram per test by which the measured fuel evaporative emissions are reduced. For the purpose of this calculation, the evaporative emissions shall be measured, in grams per test, to a minimum of three significant figures.

A.4.1.4. Hybrid Electric and Zero Emissions Vehicles - Exhaust Emission Standards

The standards are described in **Part 1**, **Section 4.1.5**.

A.4.1.5. Current Exhaust Emissions Legislation - Heavy Duty Vehicles

The legislation is described in detail in **Part 1**, **Section 4.1.4**.

A.4.1.6. Exhaust Emission Standards - 1985 and Subsequent Model Heavy Duty Urban Bus Engines and Vehicles

Section 1956.1 of Title 13 of the California Code of Regulations was amended in 2005 to stipulate that the exhaust emissions from new 1985 and subsequent model heavy-duty diesel cycle urban bus engines and vehicles fuelled by methanol, natural gas, liquefied petroleum gas, and petroleum shall not exceed the following:

Table A.4.11 Urban Bus Engine Emissions Limits (1985 – 2003)

Model Year	HC (1) (g/bhp.h)	Optional NMHC (g/bhp.h)	CO (g/bhp.h)	NOx (g/bhp.h)	PM (g/bhp.h)
1985 - 1986	1.3	-	15.5	5.1	-
1987 (2)	1.3	-	15.5	5.1	-
1988 – 1990	1.3	1.2	15.5	6.0	0.60
1991 – 1993 (3)	1.3	1.2	15.5	5.0	0.10
1994 – 1995 (3)	1.3	1.2	15.5	5.0 (4)	0.07
1996 – 2003 (5), (6)	1.3	1.2	15.5	4.0	0.05 (7), (8)

(1) Organic Material Hydrocarbon Equivalent [OMHCE] for methanol-fuelled buses

(2) A manufacturer may certify to the 1988 emission standards one year early as an option

(3) Emissions from methanol-, natural-gas- and LPG-fuelled urban bus engines may be included in the averaging programme for petroleum-fuelled engines other than urban bus engines.

(4) Or optional 3.5 g/bhp.h to 0.5 g/bhp.h NOx

(5) For 1996 and 1997 only, a manufacturer may apply to the Executive Officer for an exemption from the 4.0 g/bhp.h NOx standard, not to exceed 10% of the average of the manufacturer's total urban bus sales in California for the three preceding model years, upon providing technical justification and sales data for each exemption applied for.

(6) 1998 through 2003 model year engines may generate averaging, banking, and trading credits in accordance with the requirements for averaging, banking and trading programmes set forth in "California Exhaust Emission Standards and Test Procedures for 1985 and Subsequent Model Heavy Duty Diesel Engines and Vehicles". Manufacturers may choose to certify 1998 through 2002 model year bus engines produced before 1 October, 2002, to an optional NOx emissions standard between 0.5 g/bhp.h and 2.5 g/bhp.h. A manufacturer may certify to any standard between the values of 2.5 g/bhp.h and 0.5 g/bhp.h, by 0.5 g/bhp.h increments. Manufacturers may not use engines certified to this optional NOx standard for any averaging, banking, or trading programme.

(7) 0.07 PM g/bhp.h in-use

(8) October 1, 2002, PM standard - For diesel-fuelled, dual-fuel, and bi-fuel bus engines except for heavy-duty pilot ignition engines, the PM standard shall be 0.01 g/bhp.h (0.01 PM g/bhp.h in-use) for 2002 and subsequent model year engines produced beginning 1 October, 2002. Manufacturers may choose to meet this standard with an aftertreatment system that reduces PM to 0.01 g/bhp.h.

Table A.4.12 Urban Bus Engine Emissions Limits (2002 forward)

Model Year	NMHC (g/bhp.h)	HCHO (g/bhp.h)	CO (g/bhp.h)	NOx + NMHC (g/bhp.h)	NOx (g/bhp.h)	PM (g/bhp.h)
01/10/2002 - 2006 (1)	-	-	15.5	0.3 – 1.8	-	0.03, 0.02 or 0.01
01/10/2002 - 2003 (2)	-	-	15.5	0.3 – 1.8	-	0.01
2004 – 2006 (3)	-	-	15.5	2.4	-	0.05 (4)
2004 – 2006 (5)	-	0.01	5.0	0.05	0.5	0.01
2007 and later	0.05	0.01	5.0		0.2	0.01

(1) Optional standards, excluding diesel-fuelled, dual-fuel, and bi-fuel engines but including heavy-duty pilot ignition engines. Engines certified to this optional reduced-emission NOx plus NMHC standard may not participate in any averaging, banking, or trading programme. A manufacturer may certify to any standard between the values of 1.8 g/bhp.h to 0.3 g/bhp.h, by 0.3 g/bhp.h NOx + NMHC increments.

(2) Optional standards for diesel-fuelled, dual-fuel, and bi-fuel engines except for heavy-duty pilot ignition engines. Engines certified to this optional reduced emission NOx plus NMHC standard may not participate in any averaging, banking, or trading programme. A manufacturer may certify to any standard between the values of 1.8 g/bhp.h to 0.3 g/bhp.h, by 0.3 g/bhp.h NOx + NMHC increments.

(3) Excludes diesel-fuelled, dual-fuel, and bi-fuel engines but includes heavy-duty pilot ignition engines. Manufacturers may choose to certify to a 2.5 g/bhp.h optional combined NOx + NMHC standard, provided that the NMHC exhaust component certification value shall not exceed 0.5 g/bhp.h. Emissions averaging may be used to meet the combined NOx + NMHC standard, the optional combined NOx + NMHC standard and the PM standard. The combined NOx + NMHC standard and the optional combined NOx + NMHC standard may serve as the certification standard for the higher emitting fuelling mode of an engine certified under the dual fuelling mode certification process set forth in section 1956.8(a)(4), Title 13, CCR.

(4) 0.07 g/bhp.h PM in-use.

(5) For diesel-fuelled, or dual-fuel, and bi-fuel urban bus engines except for heavy-duty pilot ignition engines. As an option, manufacturers may choose to meet the NOx and PM standards with a base engine that is certified to the standards in the line above, equipped with an aftertreatment system that reduces NOx to 0.5 g/bhp.h and PM to 0.01 g/bhp.h. The NMHC, CO, and formaldehyde standards still apply. Manufacturers shall be responsible for full certification, durability, testing, and warranty and other requirements for the base engine. For the aftertreatment system, manufacturers shall not be subject to the certification durability requirements, or in-use recall and enforcement provisions, but are subject to warranty provisions for functionality. Manufacturers may sell diesel-fuelled hybrid-electric buses that are certified to a 1.8 g/bhp.h NOx, and 0.01 g/bhp.h PM, 0.5 g/bhp.h NMHC, and 15.5 g/bhp.h CO standard to any transit agency that has received written authorization from the Executive Officer. The formaldehyde standard does not apply to the HEBs sold pursuant to this subparagraph.

The test procedures for determining compliance with standards applicable to 1985 and subsequent heavy-duty diesel cycle urban bus engines and vehicles and the requirements for participation in the averaging, banking and trading programmes, are set forth in the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles," adopted 12 December, 2002, and the “California Interim Certification Procedures for 2004 and Subsequent Model Hybrid-Electric Vehicles, in the Urban Bus and Heavy-Duty Vehicle Classes”, adopted 24 October, 2002.

A.4.1.7. Fleet Rule for Transit Agencies - Urban Bus Requirements

Introduction

Section 2023.1 of Title 13 of the California Code of Regulations was amended in 2005. The objective of the regulation is to encourage transit agencies that operate urban bus fleets to purchase or lease lower emission alternative-fuel buses, while also providing flexibility to such fleet operators to determine their optimal fleet mix in consideration of such factors as air quality benefits, service availability, cost, efficiency, safety, and convenience. Two paths to compliance with this fleet rule are available: the alternative-fuel path and the diesel path.

Effective Dates

Transit agencies must choose their compliance path, and shall notify ARB of their intent to follow either the diesel or the alternative-fuel path, by 31 January, 2001. A transit agency within the jurisdiction of the South Coast Air Quality Management District may elect to change its compliance path from the diesel path to the alternative-fuel path, provided that the transit agency notifies the Executive Officer of the change by 31 January, 2004.

Alternative Fuel Path Requirements

Transit agencies on the alternative-fuel path shall meet the following requirements:

- Upon approval of the regulation, and through Model Year 2015, at least 85 % of all urban buses purchased or leased each year must be alternative-fuel buses or buses with engines purchased meeting the exhaust emission standards for 1985 and subsequent model heavy duty urban bus engines and vehicles, detailed in Part 1, Section.4.18.
- Beginning 1 October, 2002, only engines certified to an optional PM standard of 0.03 g/bhp.h or lower shall be purchased when making new bus purchases. Total NOx and PM emission reduction requirements and the use of low sulphur fuel are described below.
- Transit agencies on the alternative-fuel path shall not purchase any diesel-fuelled, dual-fuel, or bi-fuel buses with 2004 - 2006 model year engines certified to emissions levels in excess of those specified in the relevant section of **Table A.4.12**.
- Zero-emission bus purchase requirements begin in model year 2008.
- A transit agency on the alternative-fuel path may purchase a bus operated with a heavy-duty pilot ignition engine provided the engine meets the standards set out in **Table A.4.11**.

The Executive Officer may exempt transit agencies on the alternative fuel path from some requirements, provided that:

- A transit agency applies to the Executive Officer for such exemption by 30 June, 2001;
- A transit agency demonstrates to the Executive Officer that it will achieve NOx emissions benefits through 2015 greater than what would have been achieved through compliance with the above, and
- The Executive Officer finds that transit agencies, after consulting with the Engine Manufacturers Association, have demonstrated, or are contractually committed to demonstrate, advanced NOx after-treatment technology.

Diesel Fuel Path Requirements

Transit agencies on the diesel path shall meet the following requirements:

- Transit agencies on the diesel path shall not purchase any diesel fuelled, dual-fuel, or bi-fuel buses with 2004 - 2006 model year engines certified to emissions levels in excess of those specified in **Table A.4.12**. Beginning 1 July, 2003, a transit agency may not purchase alternative fuel buses certified to a PM emission level in excess of the optional standard of 0.03 g/bhp.h when making new bus purchases. Total NOx and PM emission reduction requirements and the use of low sulphur fuel are described below.

- A transit agency on the diesel-fuel path may purchase a bus operated with a heavy-duty pilot ignition engine provided the engine meets the standards set out in **Table A.4.11**.
- Demonstrate a zero-emission bus as required in section 1956.32023.3, title 13, CCR. Zero-emission bus purchase requirements begin in model year 2008.

The Executive Officer may exempt transit agencies on the diesel path from the above, provided that:

- A transit agency applies to the Executive Officer for such exemption by 30 June, 2001;
- A transit agency demonstrates to the Executive Officer that it will achieve NOx emissions benefits through 2015 greater than what would have been achieved through compliance with the above, and
- The Executive Officer finds that transit agencies, after consulting with the Engine Manufacturers Association, have demonstrated, or are contractually committed to demonstrate, advanced NOx aftertreatment technology.

The Executive Officer shall authorize, in writing, a transit agency on the diesel path to purchase one or more diesel-fuelled hybrid-electric bus certified according to the procedure outlined in **Part 1, Section 4.1.7**:

- The transit agency shall submit a mitigation plan and letter requesting approval by January 31, 2005, to the Executive Officer that demonstrates that the transit agency will provide surplus emission reductions from urban buses in its fleet that will offset the NOx emission difference between the certified NOx emission standard of the hybrid-electric bus and 0.5 g/bhp.h. The transit agency may not use NOx emission reductions that are otherwise required by any statute, regulation, or order or the emission reductions that will accrue from the retirement of an urban bus to be replaced by a hybrid-electric bus for the offset;
- The transit agency shall complete implementation of all mitigation measures set forth in the approved plan to offset NOx emissions prior to the receipt of the last diesel-fuelled hybrid-electric bus.

NOx Standards

Beginning 1 October, 2002, no transit agency shall own, operate, or lease an active fleet of urban buses with average NOx emissions in excess of 4.8 g/bhp.h, based on the engine certification standards of the engines in the active fleet. This active fleet average requirement shall be based on urban buses owned, operated, or leased by the transit agency, including diesel buses, alternative-fuel buses, all heavy-duty zero-emission buses, electric trolley buses, and articulated buses, in each transit agency’s active fleet. The Executive Officer may allow zero-emission buses that do not meet the definition of an urban bus to be included in the calculation of the fleet average standard upon written request to the ARB by 31 January, 2002, and upon approval by the Executive Officer. The request shall include a description of the zero-emission buses, the zero-emission technology utilized, and the number of zero emission buses to be used in calculating the NOx fleet average standard. Zero-emission buses not meeting the definition of an urban bus may not be used to satisfy the requirements of the Zero-emission Bus Demonstration Project.

Transit agencies may use ARB-certified NOx retrofit systems to comply with the fleet average requirement (in addition to bus purchases, replacement engines, and retirements). Transit agencies have the option of retiring all 1987 and earlier model year diesel urban buses by 1 October, 2002, to comply with the fleet average standard requirement.

A transit agency established after 1 January, 2005, shall not operate an active fleet of urban buses with an average NOx emission in excess of 4.0 g/bhp.h or the NOx average of the active fleet of the transit agency from which it was formed, whichever is lower. In the case of a merger of two or more transit agencies or parts of two or more transit agencies, the agency shall not operate an active fleet of urban buses with an average NOx emission in excess of 4.0 g/bhp.h or the average of the NOx fleet averages, whichever is lower.

Diesel Particulate Standards

Each transit agency shall reduce the total diesel PM emissions total of the diesel buses in its active fleet relative to its total diesel PM emissions total as of 1 January, 2002, according to the schedule below, and shall operate its diesel buses on diesel fuel with a maximum sulphur content of 15 mg/kg.

Table A.4.13 Transit Bus Diesel Particulate Reduction Schedule

Effective Date	PM (%) Relative to Diesel PM Fleet Total on 01/01/2002	
	Diesel Fuel Path	Alternative Fuel Path
01/01/2004	60	80
01/01/2005	40	60
01/01/2007	15 (1)	40
01/01/2009	15 (1)	

(1) Or equal to 0.01 g/bhp.h times the total number of current diesel-fuelled active fleet buses, whichever is greater.

Beginning on January 1, 2005, a new transit agency may not have a diesel PM emission total exceeding the following values:

- 01/01/2005 -31/12/2009: 0.05g/bhp.h (exhaust emission value) times the total number of diesel-fuelled buses in the active fleet;
- 01/01/2010: 0.01 g/bhp.h (exhaust emission value) times the total number of diesel-fuelled buses in the active fleet.

Certain exemptions to the sulphur rule may apply and interested readers should consult the source documents.

A.4.1.8. California – Refuse Collection Vehicle Emissions Regulations

A final regulation order entitled “Diesel Particulate Matter Control Measure for On-road Heavy-duty Diesel-fuelled Residential and Commercial Solid Waste Collection Vehicles” was adopted in 2004 within Chapter 1, Division 3, Title 13, of the California Code of Regulations

Scope and Applicability

The regulation applies to municipalities that have a contract with owners for residential and commercial solid waste collection service. It also applies to solid waste collection vehicle owners, both private and government entities. These regulations mandate the reduction of diesel particulate matter emissions from 1960 to 2006 model year engines in on-road diesel-fuelled heavy-duty residential and commercial solid waste collection vehicles with a manufacturer's gross vehicle weight rating greater than 14,000 pounds.

Implementation Schedule

The owner must comply with the schedule in **Table A.4.14** for the specified percentage of collection vehicles by each applicable compliance deadline.

Table A.4.14 Implementation Schedule for Solid Waste Collection Vehicles, Model Years 1960 to 2006

Group	Engine Model Years	% of Group using Best Available Control Technology	Compliance Deadline
1	1988 – 2002	10	31/12/2004
		25	31/12/2005
		50	31/12/2006
		100	31/12/2007
2a (1)	1960 – 1987 (Total fleet ≥ 15 collection vehicles)	15	31/12/2005
		40	31/12/006
		60	31/12/2007
		80	31/12/2008
		100	31/12/2009
2b	1960 – 1987 (Total fleet <15 collection vehicles)	25	31/12/2007
		50	31/12/2008
		75	31/12/2009
		100	31/12/2010
3	2003 – 2006 (Includes dual-fuel and bi-fuel engines)	50	31/12/2009
		100	31/12/2010

(1) Group 2a: An owner may not use Level 1 technology as best available control technology on Group 2a engines or collection vehicles.

Calculating the number of vehicles required for implementation and compliance is highly detailed and interested readers should refer to the original legislation. Note also that "compliance extensions" and "control strategy special circumstances" may apply. Beginning 31 December, 2004, an owner has to maintain records, which are again specified in the regulation.

A.4.1.9. Motor Cycle Emissions Standards

Current and future emissions limits are shown in **Part 1**, **Section 4.1.10**.

Background

Under Title II of the CAAA, the US EPA adopted comprehensive regulations to control emissions from on-road motorcycles (Title 40, Code of Federal Regulations, Part 86, Sub-part F (40 CFR 86)). While similar in purpose and scope, the California exhaust emission standards (Title 13, CCR Section 1900) are more stringent than the comparable federal requirements in both magnitude and the pollutants regulated (i.e., HC+NOx rather than HC only for larger capacity engines).

The amendments, approved on 22 November 1999, maintained the approach used in earlier regulations to limit exhaust emissions. The amended standards upheld the then current limits until MY 2004, when the first of two tiers of new standards became effective. The Tier 1 standard for model year 2004 is 1.4 g/km HC+NOx. Beginning in MY 2008, the Tier 2 standard of 0.8 g/km HC+NOx becomes effective. Manufacturers would be allowed to meet the standards on a corporate average basis, with all engine families limited to no more than 2.5 g/km HC+NOx.

For small-volume manufacturers, the amended regulations provide that the Tier 1 standard of 1.4 g/km HC+NOx becomes effective starting in MY 2008. Small-volume manufacturers are defined as those that have combined California Class I (50 cc to 169 cc), Class II (170 cc to 279 cc) and Class III (280 cc and greater) sales of no greater than 300 units in a model year, starting with the 2004 model year. The Tier 2 standard does not yet apply to small-volume manufacturers. However, a planned technology review in 2006 may provide sufficient information to justify proposing a Tier 2 standard for small-volume manufacturers at a later date.

To provide incentives for early compliance with the Tier 2 standard, the regulations specify a set of multiplier factors that provide extra credit to manufacturers that introduce motorcycles which meet the Tier 2 standard or a lower level earlier than the 2008 model year. The use of these credits will make it easier for a manufacturer to comply with the corporate emissions average standard in 2008.

A.4.1.10. Non-road Diesel Emissions Standards

On 28 January 2001 CARB adopted identical standards to those published for the Federal States (see **Part 1**, **Section 3.1.4**).

A.4.1.11. Emission Standards for 2001 and Later Model Year Non-road Large Spark-Ignition Engines

The standards are described in detail in **Part 1**, **Section 4.1.11**.

A.4.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.4.2.1. Gasoline

CARB adopted stringent "*Phase 2*" requirements to replace the previous *"Phase 1"* grade at retail outlets by June 1996. The earlier specification, which includes limits on distillation, olefins content and a very stringent limit on sulphur content is detailed in **Part 2**, **Section B.4.2.1**. The California RFG Phase 2 and RFG Phase 3 standards are shown in **Part 1**, **Section 4.2.1**.

For all properties but vapour pressure (cap limit only) and oxygen content, the value of the regulated property must be less than or equal to the specified limit. With respect to the vapour pressure cap limit and the oxygen content flat and cap limit, the limits are expressed as a range, and the RVP and oxygen content must be less than or equal to the upper limit, and more than or equal to the lower limit. Refiners have two ways of complying with the specifications. The "Flat limits" specifications are for each batch of gasoline produced. The "Averaging Limits" are for the average properties of many batches of gasoline made over a period of time. The property of each batch of "averaging" gasoline cannot exceed the "Cap Limits". A qualifying small refiner may comply with the "small refiner" Phase 3 standards, in place of the Phase 3 standards.

Returning the RFG 3 cap limits for T50 and T90 to the RFG 2 cap limits for those properties, and deletion of an earlier proposed specification for driveability index (DI), reflect earlier Californian resolutions. The marginal flexibility added by the originally proposed RFG 3 cap limits for T50 and T90 is outweighed by the benefits from eliminating DI constraints which are no longer needed as the T50 and T90 caps will maintain existing fuel performance. Revising the RFG 3 T50 flat limit from 211°F to 213°F, and the RFG 3 T50 averaging limit from 201°F to 203°F, reflect earlier Californian resolutions.

Footnote 3 in the table shown in **Part 1, Section 4.2.1** raises the RFG 2 downstream cap limits for vapour pressure and aromatics once producers and importers are allowed to comply with the RFG 3 standards in place of the RFG 2 standards, since downstream RFG 2 can be commingled with RFG 3 meeting the higher RFG 3 cap limits.

As in Phase 2, CARB provides two further options to certify a Phase 3 fuel. One option is to use a Predictive Model which estimates vehicle-emissions from fuel properties. A candidate gasoline is certified if its computed emissions are the same or less than the specification gasoline. This is the same concept as the EPA Complex Model and almost all Californian refiners are now using this option for Phase 2 certification. The last option is to prove a candidate gasoline has the same or lower emissions than the specification fuel via vehicle fleet tests - a very expensive approach which no one has attempted at the time of writing. Use of the predictive model, or averaging limits as shown in the table, allows gasoline without oxygenate to be sold in California, despite the fixed limits for oxygen content in the "Flat limits".

Gasoline - Background Details and Additional Information

On 25 March 1999, the Governor of California announced a three year, eight month phase-out of MTBE from Californian gasoline. He additionally called upon

California's federal delegation to establish a forum for the removal of MTBE without violating the Federal Clean Air Act. The appropriate state regulatory agencies were ordered to devise and carry out a plan to begin the immediate phase-out of MTBE from California gasoline, with 100% removal to be achieved no later than 31 December, 2002. The EPA was asked for an immediate waiver from the oxygen mandate in the CAA, on the understanding that California would still fully meet the air quality emission standards of the Act.

On 9 December 1999 the ARB approved a new set of gasoline rules banning MTBE while “preserving all the air-quality benefits obtained from the state's cleaner-burning gasoline programme.” The new rules, known officially as the Phase 3 gasoline regulation, originally prohibited the formulation of gasoline with MTBE after 31 December 2002.

A further draft regulation delayed the ban on MTBE and other specified oxygenates and refined the prohibition of these materials in California gasoline, with effect from 31 December 2003. However, earlier compliance with the CaRFG Phase 3 Standards before that date was permitted. Any producer or importer wishing to supply from its production or import facility, before 31 December 2003, any final blends of gasoline subject to the CaRFG Phase 3 standards instead of the CaRFG Phase 2 standards could notify the executive officer of its wish to do so. The notification includes all of the following:

1. The approximate date by which it intends to begin supplying from its production or import facility gasoline complying with the CaRFG Phase 3 standards if permitted to do so;
2. A reasonably detailed demonstration of the producer’s or importer’s ability and plans to begin supplying from its production or import facility substantial quantities of one or more grades of gasoline meeting the CaRFG Phase 3 standards on or after the date specified;

Although some non-MTBE gasoline was then sold in certain parts of California, a number of refiners needed up to three years to make the plant modifications required to convert their entire production volume to non-MTBE gasoline.

The ARB also approved an assessment that found no significant air-quality impacts are anticipated from the use of ethanol in gasoline. Federal law currently requires gasoline in Southern California and the greater Sacramento area to contain an oxygenated component. If the law remained in effect, gasoline in those areas as well as the San Joaquin Valley would have to contain ethanol beginning in 2003. The Administration had asked the EPA to waive the oxygen requirement and make the use of ethanol optional throughout California. However, on 12 June 2001 the EPA announced that, given the legal constraints within the CAA, it could not approve the State of California's request to waive the federal oxygen content requirement for RFG. The Agency concluded that there was significant uncertainty over the change in emissions that would result from a waiver. California had not clearly demonstrated what the impact on smog would be from a waiver of the oxygen mandate.

Prohibition of MTBE and Oxygenates Other Than Ethanol in California Gasoline - Basic MTBE prohibitions.

Starting 31 December 2003, no person shall sell, offer for sale, supply or offer for supply California gasoline which has been produced at a California production facility in part by either:

a. adding at the California production facility any methyl tertiary-butyl ether (MTBE) in neat form to the California gasoline or to a blending component used in the gasoline; or
b. using a blending component that contained greater than 0.60 volume percent MTBE when it was supplied to the California production facility.

No person shall sell, offer for sale, supply or offer for supply California gasoline which contains MTBE in concentrations greater than: 0.60% v/v starting 31 December 2003, 0.30% v/v 1 July 2004, 0.15% v/v starting 31 December 2005, and 0.05% v/v starting 1 July 2007.

Phase-in of MTBE prohibitions

The draft regulations set out a timetable for phase-in of the prohibitions for both high and low throughput facilities.

Use of oxygenates other than ethanol or MTBE in California gasoline on or after 31 December 2003.

Starting 31 December 2003, no person shall sell, offer for sale, supply or offer for supply California gasoline which has been produced at a California production facility with the use of any oxygenate other than ethanol or MTBE unless a multimedia evaluation of use of the oxygenate in California gasoline has been conducted and the California Environmental Policy Council has determined that such use will not cause a significant adverse impact on the public health or the environment.

Starting 31 December 2003, no person shall sell, offer for sale, supply or offer for supply California gasoline which contains a total of more than 0.10% m/m oxygen collectively from all of the oxygenates identified below. Starting July 1 2004, no person shall sell, offer for sale, supply or offer for supply California gasoline which contains a total of more than 0.06% m/m oxygen collectively from all of the oxygenates identified below:

Methanol	Isopropanol
n-Propanol	n-Butanol
iso-Butanol	sec-Butanol
tert-Butanol	Tert-pentanol (tert-amylalcohol)
Ethyl tert-butylether (ETBE)	Diisopropylether (DIPE)
Tert-amylmethylether (TAME)	

Again, the draft regulations set out a timetable for phase-in of the prohibitions for both high and low throughput facilities.

California Change-Over from MTBE to Ethanol

During 2003, supply constraints arose in the distribution system when MTBE was replaced by ethanol in gasoline and details will be found in **Part 2**, **Section B.4.2.1**.

A.4.2.2. Diesel Fuel

The ARB introduced a diesel fuel specification of 500 mg/kg sulphur and 10% v/v aromatics (determined by ASTM D1319-84) from 1 October 1993. Other fuel parameters correspond to ASTM D975, meaning that the cetane number can, in theory, be as low as 40. The intention is to provide fuel quality that will ensure low emissions. Other fuels are allowed, provided the supplier can demonstrate equivalent emissions to a reference fuel from engine test data and a number of suppliers have taken advantage of this concession. The current specification for the reference fuel is shown below and a typical certified formulation is given in **Table A.4.16**.

Table A.4.15 Californian Diesel Reference Fuel Specification

Property	Limit
Sulphur % m/m (max.)	0.05
Aromatics % v/v (max.)	10.0
Polycyclic aromatics, % m/m (max.)	1.4
Nitrogen, ppm m/m (max.)	10.0
Natural cetane number, (min)	48.0
API gravity	33-39
Viscosity at 40°C, mm^2/s	2.0-4.1
Flash Point °F (min)	130
Distillation °F (°C):	
IBP	550-610 (290-320)
10%	340-420 (170-215)
50%	400-490 (205-255)
90%	470-560 (245-295)
FBP	580-660 (305-350)

The reference fuel is produced from straight-run California fuel by hydro-dearomatization and testing is carried out over the hot start US Federal heavy-duty transient procedure in a 1991 US heavy duty emissions standard engine. A number of California fuel suppliers have certified *"low emissions"* diesel fuels with alternative compositions by demonstrating with testing that they produce emissions at least as low as the specified reference fuel. Such alternative grades generally have a much higher cetane number and somewhat higher aromatics than the reference fuel. The properties of one of these fuels is given in **Table A.4.16** below, showing that the strict limits given in **Table A.4.15** do not have to be met to achieve the required emissions levels.

Table A.4.16 Example of a Certified Diesel Fuel Formulation

Property	Specification	Test Method
Aromatics % m/m (max.)	19	ASTM D5186-91
Sulphur ppm m/m (max.)	54	ASTM D2622-82
Polycyclic Aromatic Hydrocarbons % m/m (max.)	2.2	ASTM D2425-83
Nitrogen ppm m/m (max.)	484	ASTM D4629-86
Cetane Number (min)	58	ASTM D613-84
Additives	No additive other than cetane improver	

A.4.2.3. Alternative Fuels

Natural Gas

In order to limit the possible increase in pollutant emissions due to variation in natural gas properties, the California Air Resources Board has established specification limits for natural gas sold commercially as vehicle fuel. Both the Air Resources Board and the US EPA have also established limits for natural gas used in emissions certification testing.

Liquefied Petroleum Gas (LPG)

The effects of varying LPG composition on the exhaust hydrocarbon species and reactivity have not been documented. However, according to the Carter reactivity scale (used by the California Air Resources Board), olefins such as propene and butenes are much more reactive in contributing to ozone formation than paraffins such as propane and the butanes. In order to reduce the possibility of emissions increases due to variation in LPG composition, the California Air Resources Board requires that LPG sold for automotive use in California comply with the HD-5 standard in ASTM D 1835. Due to concerns about supply availability, the maximum 5% propene content required by the HD-5 specification was delayed until 1 January 1997. In the intervening period, LPG containing up to 10% propene was permitted.

Table A.4.17 Specification for M-100 Fuel Methanol

Specification	Value	Test Method
Methanol	96% v/v (min.)	As determined by the distillation range below
Distillation	4.0°C (range)	ASTM D 1078-86. At 95% by volume distilled. Must include 64.6 + 0.1ºC
Other alcohols and ethers	2% m/m (max.)	ASTM D 4815-89
Hydrocarbons, gasoline or diesel fuel derived	2% m/m (max.)	ASTM D 4815-89, and then subtract concentration of alcohols, ethers and water from 100 to obtain % hydrocarbons
Specific gravity	0.792 + 0.002 @ 20ºC	ASTM D 891-89
Acidity as acetic acid	0.01% m/m (max.)	ASTM D 1613-85
Total chlorine as chloride	0.0002% m/m (max.)	ASTM D 2988-86
Lead	2 mg/l (max.) [(a)]	ASTM D 3229-88
Phosphorus	0.2 mg/l (max.) [(b)]	ASTM D 3231-89
Sulphur	0.002% m/m (max.)	ASTM D 2622-87
Gum, heptane washed	5 mg/l (max.)	ASTM D 381-86
Total particulates	5mg/l (max.)	ASTM D 2276-89, modified to replace cellulose acetate filter with a 0.8 micron pore size membrane filter
Water	0.3% m/m (max.)	ASTM E 203-75
Appearance	Free of turbidity, suspended matter and sediment	Visually determined at 25°C by Procedure A of ASTM D 4176-86
Bitterant	©	
Odorant	(d)	

(a) No added lead.

(b) No added phosphorous.

(c) The M-100 fuel methanol at ambient conditions must have a distinctive and noxious taste, for purposes of preventing purposeful or inadvertent human consumption. Applicable 1 January 1995.

(d) The M-100 fuel methanol upon vaporisation at ambient conditions must have a distinctive odour potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability. Applicable 1 January 1995.

Table A.4.18 Specification for M-85 Fuel Methanol

Specifications	Value	Test Method
Methanol plus higher alcohols	84% v/v (min.)	Annex A1 to the ASTM D-2 Proposal P-232. Draft 8-9-91
Higher alcohols (C2-C8)	2% v/v (max.)	ASTM D 4815-89
Hydrocarbons + aliphatic ethers [(a)]	13-16% v/v	ASTM D 4815-89, and then subtract concentration of alcohols, ethers and water from 100 to obtain % hydrocarbons
Vapour pressure, dry [(b)]		Methods contained in Title 13, Section 2262 are preferred ASTM D 4953-90 is an alternative method, however, in case of dispute about the vapour pressure, the value determined by the methods contained in Title 13, Section 2262 shall prevail over the value calculated by ASTM D 4953-90, including its precision statement
Luminosity		Shall produce a luminous flame, which is visible under maximum daylight conditions, throughout the entire burn duration
Acidity as acetic acid	0.005% m/m (max.)	ASTM D 1613-85
Total chlorine as chloride	0.0002% m/m (max.)	ASTM D 3120-87 modified for the det. of organic chlorides, and ASTM D 2988-86
Lead	2 mg/l (max.) [(c)]	ASTM D 3229-88
Phosphorous	0.2 mg/l (max.) [(d)]	ASTM D 3231-89
Sulphur	0.004 m/m % (max.)	ASTM D 2622-87
Gum, heptane washed	5 mg/100ml (max.)	ASTM D 381-86
Total particulates	0.6 mg/l (max.)	ASTM D 2276-89, modified to replace cellulose acetate filter with a 0.8 micron pore size membrane filter
Water	0.5% m/m (max.)	ASTM E 203-75
Appearance	Free of turbidity, suspended matter and sediment	Visually determined at 25°C by Proc. A of ASTM D 4176-86

(a) Hydrocarbon fraction shall have a final maximum boiling point of 225° C by ASTM method D 86-90, oxidation stability of 240 mins by ASTM test method D 525-88 and No. 1 maximum copper strip corrosion by ASTM method D 130-88. Ethers must be aliphatic. No manganese added. Adjustment of RVP must be performed using common blending components from the gasoline stream. Starting on 1 April 1996, the hydrocarbon fraction must also meet specifications for benzene, olefin content, aromatic hydrocarbon content, maximum T90 and maximum T50 found in California Code of Regulations, Title 13 sections 2262.3, 2262.4, 2262.7 and 2262.6 (T90 & T50), respectively.

(b) RVP range of 7.0 to 9.0 psi for those geographical areas and times indicated for A, A/B, B/A and B volatility class fuels in Table 2 of ASTM D 4814-91b. RVP range of 9.0 to 13.1 psi for those geographical areas and times indicated for B/C, C/B, C, C/D and D/C volatility fuels. RVP range of 10.9 to 13.1 psi for those geographical areas and times indicated for D, D/E, E/D and E volatility fuels. Geographical areas referenced in this note shall be adjusted to reflect the air basin boundaries set forth in Title 17, California Code of Regulations, sections 60100 through 60113.

(c) No added lead.

(d) No added phosphorus.

Table A.4.19 Specification for E-100 Fuel Ethanol

Specification	Value	Test Method
Ethanol	92% v/v (min.)	ASTM D 3545-90 [a]
Other alcohols and ethers	2% m/m (max.)	ASTM D 4815-89
Hydrocarbons, gasoline or diesel fuel derived	5% m/m (max.)	ASTM D 4815-89, and then subtract concentration of alcohols, ethers and water from 100 to obtain % hydrocarbons
Acidity as acetic acid	0.007% m/m (max.)	ASTM D 1613-85
Total chlorine as chloride	0.0004% m/m (max.)	ASTM D 3120-87 modified for the determination of organic chlorides, and ASTM D 2988-86
Copper	0.07 mg/l (max.)	ASTM D 1688-90 as modified in ASTM D 4806-88
Lead	2 mg/l (max.) [b]	ASTM D 3229-88
Phosphorus	0.2 mg/l (max.) [c]	ASTM D 3231-89
Sulphur	0.002% m/m (max.)	ASTM D 2622-87
Gum, heptane washed	5 mg/l (max.)	ASTM D 381-86
Total particulates	5 mg/l (max.)	ASTM D 2276-89, modified to replace cellulose acetate filter with a 0.8 micron pore size membrane filter
Water	1.25% m/m (max.)	ASTM E 203-75
Appearance	Free of turbidity, suspended matter and sediment	Visually determined at 25°C by Procedure A of ASTM D 4176-86

(a) The denaturant must meet the ASTM D 4806-88 specification for denatured fuel ethanol, except the denaturant cannot be rubber hydrocarbon solvent. The final blend specifications for E-100 take precedence over the ASTM D 4806-88 specifications.

(b) No added lead.

(c) No added phosphorus.

Table A.4.20 Specification for E-85 Fuel Ethanol

Specification	Value	Test Method
Ethanol	79% v/v (min.)	ASTM D 3545-90 [(a)]
Other alcohols	2% v/v (max.)	ASTM D 4815-89
Hydrocarbons + aliphatic ethers [(b)]	15-21% v/v	ASTM D 4815-89, and then subtract concentration of alcohols, ethers and water from 100 to obtain % hydrocarbons. The denaturant is included in this percentage.
Vapour pressure, dry [(c)]		Methods contained in Title 13, Section 2262 must be used. ASTM D 4953-90 is an alternative method, however, in case of dispute about the vapour pressure, the value determined by the methods contained in Title 13, Section 2262 shall prevail over the value calculated by ASTM D 4953-90, including its precision statement
Acidity as acetic acid	0.007% m/m (max.)	ASTM D 1613-85
Total chlorine as chloride	0.0004% m/m (max.)	ASTM D 3120-87 modified for the determination of organic chlorides, and ASTM D 2988-86
Copper	0.07 mg/l (max.)	ASTM D 1688-90 as modified in ASTM D 4806-88
Lead	2 mg/l (max.) [(d)]	ASTM D 3229-88
Phosphorus	0.2 mg/l (max.) [(e)]	ASTM D 3231-89
Sulphur	0.004% m/m (max.)	ASTM D 2622-87
Gum, heptane washed	5 mg/100 ml (max.)	ASTM D 381-86
Total particulates	5 mg/l (max.)	ASTM D 2276-89, modified to replace cellulose acetate filter with a 0.8 micron pore size membrane filter
Water	1.25% m/m (max.)	ASTM E 203-75
Appearance	Free of turbidity, suspended matter and sediment	Visually determined at 25°C by Procedure A of ASTM D 4176-86

(a) The denaturant must meet the ASTM D 4806-88 specification for denatured fuel ethanol, except the denaturant cannot be rubber hydrocarbon solvent. The final blend specifications for E-85 take precedence over the ASTM D 4806-88 specifications.

(b) Hydrocarbon fraction shall have a final maximum boiling point of 225°C by ASTM method D 86-90, oxidation stability of 240 mins by ASTM test method D 525-88 and No. 1 maximum copper strip corrosion by ASTM method D 130-88. Ethers must be aliphatic. No manganese added. Adjustment of RVP must be performed using common blending components from the gasoline stream. Starting 1 April 1996, the hydrocarbon fraction must also meet specification for benzene, olefin content, aromatic hydrocarbon content, maximum T90 and maximum T50 found in California Code of Regulations, Title 13 sections 2262.3, 2262.4, 2262.7 and 2262.6 (T90 & T50), respectively.

(c) RVP range of 6.5 to 8.7 for those geographical areas and times indicated for A, A/B, B/A and B volatility class fuels in Table 2 of ASTM D 4814-91b. RVP range of 7.3 to 9.4 for those geographical areas and times indicated for B/C, C/B, C, C/D and D/C volatility fuels. RVP range of 8.7 to 10.2 for those geographical areas and times indicated for D, D/E, E/D and E volatility fuels. Geographical areas referenced in this note shall be adjusted to reflect the air basin boundaries set forth in Title 17, California Code of Regulations, section 60100 through 60113.

(d) No added lead.

(e) No added phosphorus.

Table A.4.21 Specification for Compressed Natural Gas

Specification	Value	Test Method
Hydrocarbons (expressed as % mole/mole)		
Methane	88.0 (min.)	ASTM D 1945-81
Ethane	6.0 (max.)	ASTM D 1945-81
C_3 and higher HC	3.0 (max.)	ASTM D 1945-81
C_6 and higher HC	0.2 (max.)	ASTM D 1945-81
Other Species (expressed as % mole/mole unless otherwise indicated)		
Hydrogen	0.1 (max.)	ASTM D 2650-88
Carbon Monoxide	0.1 (max.)	ASTM D 2650-88
Oxygen	1.0 (max.)	ASTM D 1945-81
Inert gases		
Sum of CO_2 and N_2	1.5-4.5 (range)	ASTM D 1945-81
Water	(a)	
Particulate matter	(b)	
Odorant	(c)	
Sulphur	16 ppm v/v (max.)	Title 17 CCR Section 94112

(a) The dew point at vehicle fuel storage container pressure shall be at least 10°F below the 99.0% winter design temperature listed in Chapter 24, Table 1, Climatic Conditions for the United States, in the American Society of Heating, Refrigerating and Air Conditioning Engineer's (ASHRAE) Handbook, 1989 fundamentals volume. Testing for water vapour shall be in accordance with ASTM D 1142-90, utilising the Bureau of Mine apparatus.

(b) The compressed natural gas shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fuelling station equipment or the vehicle being fuelled.

(c) The natural gas at ambient conditions must have a distinctive odour potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.

Table A.4.22 Specification for Liquefied Petroleum Gas

Specification	Value	Test Method
Propane	85.0% v/v (min.) [(a)]	ASTM D 2163-87
Vapour pressure at 100°F	208 psi (max.)	ASTM D 1267-89 ASTM D 2598-88 [(b)]
Volatility residue:		
Evaporated temp., 95%	-37°F (max.)	ASTM D 1837-86
or butane and heavier	2.5% v/v (max.)	ASTM D 2163-87
Propene	5.0% v/v (max.) [(c)]	ASTM D 2163-87
Residual matter: residue on evap. of 100 ml oil stain observed.	0.05 ml (max.) pass [(d)]	ASTM D 2158-89 ASTM D 2158-89
Corrosion, copper strip	No. 1 (max.)	ASTM D 1838-89
Sulphur	120 ppm m/m (max.)	ASTM D 2784-89
Moisture content	Pass	ASTM D 2713-86
Odorant	[(e)]	

(a) Propane shall be required to be a minimum of 80.0% v/v starting on 1 January 1993. Starting on 1 January 1999, the minimum propane content shall be 85.0% v/v.

(b) In case of dispute about the vapour pressure of a product, the value actually determined by Test Method ASTM D 1267-89 shall prevail over the value calculated by Practice ASTM D 2598-88.

(c) The propene shall be limited to 10.0% v/v starting 1 January 1993. Starting 1 January 1999, the propene limit shall be 5.0% v/v.

(d) An acceptable product shall not yield a persistent oil ring when 0.3 ml of solvent residue mixture is added to a filter paper, in 0.1 increments and examined in daylight after 2 min. as described in Test Method ASTM 2158-89.

(e) The liquefied petroleum gas upon vaporisation at ambient conditions must have a distinctive odour potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability.

Table A.4.23 Specification for Hydrogen

Specification	Value	Test Method
Hydrogen	98.0 mole % (min.)	ASTM D 1946-90
Combined hydrogen, water, oxygen and nitrogen	99.9 mole % (min.)	ASTM D 1946-90 for hydrogen, nitrogen oxygen; ASTM D 1142-90 for water using the Bureau of Mines apparatus
Total hydrocarbons	0.01 mole % (max.)	ASTM D 1946-90
Particulate mater	[(a)]	
Odorant	[(b)]	

(a) The hydrogen shall not contain dust, sand, dirt, gums, oils, or other substances in an amount sufficient to be injurious to the fuelling station equipment or the vehicle being fuelled.

(b) Starting 1 January 1995, the hydrogen fuel at ambient conditions must have a distinctive odour potent enough for its presence to be detected down to a concentration in air of not over 1/5 (one-fifth) of the lower limit of flammability. This requirement applies only to hydrogen which is introduced into the vehicle fuel storage system in gaseous form.

A.4.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

US Federal procedures are generally used, but a number of specific tests are also employed and these are described below.

A.4.3.1. 50°F Emission Test Procedure

The NMOG, CO, NOx and formaldehyde emissions from all light and medium duty TLEVs, LEVs, ULEVs and SULEVs are measured according to a modified Federal Test at a nominal temperature of 50°F.

A.4.3.2. Procedures for Reactivity Determination

California has adopted a procedure to establish reactivity adjustment factors for exhaust emissions of non-methane organic gases (NMOG) for the purpose of certifying a vehicle of specific emission category and fuel for sale in California.

A.4.3.3. Procedures for Hybrid and Zero Emissions Vehicles

California published, in May 1999, their certification requirements for hybrid and zero emissions vehicles (HEVs and ZEVs, respectively).

ZEVs are exempt from all mileage and service accumulation, durability-data vehicle and emissions-data vehicle testing requirements. Identification of the energy usage in kWh/mile from both the battery output and AC electrical input is required and the operating range (in miles) must be determined on the “All-Electric Range Test”. Where fuel-fired heaters are fitted, details of the system, its exhaust emissions value per mile and the procedure to determine mass emissions from the heater must be provided.

The “All-Electric Range Test” is described in full in the CARB documentation. It specifies the dynamometer (electric), vehicle and battery break-in period and the test, which comprises a “cold soak” between 20°C and 30°C for 12 - 36 hours and a driving schedule. This comprises successive Urban Dynamometer Driving Schedules for determination of the “All-Electric Range - Urban” and successive Highway Fuel Economy Driving Schedules for determination of the “All-Electric Range - Highway”.

For HEVs, the FTP test procedure is used with supplemental requirements regarding the conditioning of the battery and auxiliary power unit. The dynamometer procedure consists of two tests:

Table A.4.24 Summary of Test Procedure for Hybrid and Zero Emissions Vehicles - California

Test Phase	Description
"Cold" Soak	12 to 36 hours, using the Californian 2001 Model Year procedures
"Cold" Start Test	Urban Dynamometer Driving Schedule (7.5 miles, 12.1 km)
10 minute Rest	Vehicle left on the dynamometer
"Hot" Start Test	Urban Dynamometer Driving Schedule (7.5 miles, 12.1 km)

Composite emissions measurements of THC, CO, CO_2, CH_4, and NOx are made for all power units and fuels. In addition, methanol and formaldehyde emissions are measured for methanol fuelled auxiliary power units and PM are recorded for diesel fuelled auxiliary power units.

Similarly, HEVs will also be subjected to Highway Fuel Economy, US06 and SC03 procedures, again involving detailed provisions relating to the condition of both the battery and the auxiliary power unit.

A.4.3.4. Hybrid-Electric Drive System Test Procedures (Revised)

Introduction

These test procedures incorporate by reference SAE J2711, "Recommended Practice for Measuring Fuel Economy and Emissions of Hybrid-Electric and Conventional Heavy Duty Vehicles" (April 2002), modified to apply to HEBs sold in California. For the 2004 through 2006 model years, heavy duty hybrid-electric vehicles may follow these or equivalent procedures provided the manufacturer obtains prior written approval from the Executive Officer (EO).

The test procedure for determining compliance with standards applicable to the turbine or fuel cell used as the motive power in a hybrid-electric bus shall be determined by the Executive Officer on a case-by-case basis.

Fuel Specifications

The test fuel must meet the certification specifications for emissions testing Californian heavy duty diesel and Otto cycle engines.

Driving cycles

Chassis testing includes two separate test cycles:

- one cold start and three hot start tests using the Orange County bus cycle (see below);
- one cold start and three hot start tests using the Urban Dynamometer Driving Schedule (UDDS)

Cold start test cycles include all emission data from the moment the vehicle is started, including the actual start event. The vehicle must be cold soaked for a minimum of 12 hours. The vehicle is started and idled for one minute, after which time the test cycle commences. Emission measurements are taken from one minute before the vehicle is started through test cycle completion.

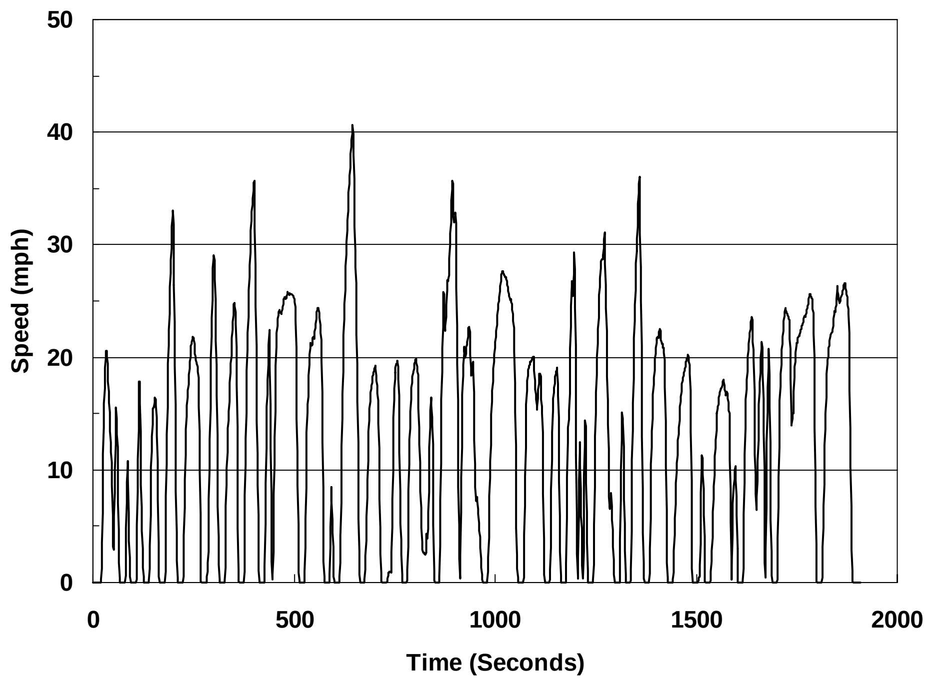
Hot test cycles include all emission data from the moment the vehicle is started, excluding the actual start event. The vehicle is started and warmed to operating temperature utilizing the same test cycle that is used for emission characterization. Multiple back-to-back hot test events must include a 20 to 30 minute key-off condition in between each test event. Once the vehicle is at operating temperature the vehicle is turned off and remains in the key-off position for approximately 20 to 30 minutes. The vehicle is then restarted and idled for one minute, at which time the 30 minute test cycle begins and emission measurements taken.

A.4.3.5. California - Orange County Bus Cycle

The Orange County Bus Cycle is a chassis dynamometer test for heavy duty vehicles. The driving cycle was developed by West Virginia University based on real bus operating data from the Orange County Transportation Authority. It is an intermediate speed test cycle consisting of accelerations, decelerations and cruise operations to reflect transit bus use.

Variable speed over the duration of the cycle is illustrated in **Figure A.4.1**.

Figure A.4.1 Orange County Bus Cycle



A.4.3.6. Test Procedures for 2001 and Later Model Year Non-road Large Spark-Ignition Engines

The test procedures for determining certification and compliance with the standards for exhaust emissions from new non-road LSI engines with engine displacement greater than 1.0 litre were published in “California Exhaust Emission Standards and Test Procedures for New 2001 and Later Non-road Large Spark-ignition Engines,” adopted on the same date. For new non-road LSI engines with engine displacement equal to or less than 1.0 litre the procedure was published in “California Exhaust Emission Standards and Test Procedures for 1995 and Later Small Off-Road Engines," as last amended 23 March 1999.

A.4.3.7. Test Procedures for New Off-Highway Recreational Vehicles and Engines

The test procedures for determining certification and compliance with the standards for exhaust emissions from new off-road motorcycles, all-terrain vehicles, and golf carts are published in “California Exhaust Emission Standards and Test Procedures for 1995 and Later Off-Highway Recreational Vehicles and Engines,” adopted 23 November, 1994, and as last amended 1 September 1999. The test procedures for new specialty vehicles and go-karts, and engines used in such vehicles, and all-terrain vehicle engines will be found in “California Exhaust Emission Standards and Tests Procedures for 1995 and Later Lawn and Garden and Utility Equipment Engines,” adopted 20 March 1992, and last amended 8 April 1993.

A.4.3.8. Evaporative Emissions Test Procedures

In California, CARB has introduced a rigorous evaporative emissions test procedure which takes almost five days to carry out. The test is similar, but not identical, to the US Federal procedure. This procedure is summarized in **Table A.4.25** and includes measurement of running losses and a three-day "*real time*" diurnal emission test.

Table A.4.25 CARB Evaporative Emission Test (from 1995)

Test Sequence	Details	Time (h)	Total time (h)
FUEL DRAIN/FILL	Drain tank, fill to 40% v/v with test fuel	0.3	0.3
SOAK PERIOD	Soak at 20-30°C for 12-36 h	12.0	12.3
PRECONDITIONING	Drive LA-4 cycle or 20-50 miles/day "typical" on-road driving	0.6	12.9
CANISTER PURGE	Purge with air at 25-75 grains/lb humidity at 48 ft^3/h for 300 bed volumes	0.5	13.4
CANISTER LOAD	Load canister to 1.5 times nominal capacity with 50/50 butane/nitrogen at 15 g/h butane	10.0	23.4
FUEL DRAIN/FILL	Drain tank, fill to 40 % v/v with test fuel	0.3	23.7
SOAK PERIOD	Soak at 20-30°C for 12-36 h	12.0	35.7
EXHAUST TEST	Conduct full 3 phase FTP Cold start exhaust emission test	1.1	36.8
STABILIZE FUEL	Stabilize fuel temp to 105°F(40°C) within 1 h	1.2	38.0
RUNNING LOSS	Drive 3 LA-4 cycles at 105°F(40°C) using point source method or SHED on dynamometer. Fuel temp. profile must be matched to road	1.5	39.5
HOT SOAK	Within 5 min seal in SHED at 105°F (40°C). Soak for 1 h	1.1	40.6
STABILIZE FUEL	Stabilize fuel temp at 65°F(18°C) by artificial cooling	4.0	44.6
3 DAY DIURNAL	Park in SHED for 72 h with SHED air temp cycles between 65°C(180°F) and 105°F(40°C) every 24 h. Measure HC emissions every 24 h.	72.0	116.6

A.4.4. REFERENCE FUELS

California has proposed alternative specifications to most of the US Federal Reference Fuels and these are tabulated in **Part 1**, **Section 4.4**. They should therefore be read in conjunction with **Part 1**, **Section 3.4**.

A.4.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

A.4.5.1. Fuel Consumption Regulations

See **Part 1**, **Section 3.5.1**.

A.4.5.2. Proposed Regulations to Control Motor Vehicle Greenhouse Gas Emissions

See **Part 1**, **Section 4.5.2**.

A.4.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

There are two aspects to Californian in-service emissions testing. The first involves surveillance testing to ensure compliance with certification durability requirements (i.e. conformity with the 50 000 miles or full useful life limits). The second extends the rigour of existing inspection and maintenance programmes. The requirements are described below.

A.4.6.1. Inspection and Maintenance Testing

Introduction

The Smog Check Programme is administered by the Bureau of Automotive Repair (BAR), which is a part of the California Department of Consumer Affairs (DCA). The Air Resources Board (ARB), by contrast, is a part of the California Environmental Protection Agency.

Description of I&M Programmes in California

California has two types of inspection programmes. Enhanced I/M (or Smog Check II) is applicable to vehicles in the State's smoggiest urbanized regions and is a more rigorous version of the Basic I/M programme. Both of these programmes are administered by BAR to ensure vehicles stay "clean" as they age. Smog Check helps assure that vehicles continue to comply with applicable emissions standards through proper maintenance and repair of emission control systems or through vehicle retirement when repairs are no longer cost-effective.

Enhanced I/M is required by the federal Clean Air Act for regions with serious ozone or CO pollution problems. These include – the Sacramento Region, San Diego County, San Joaquin Valley, Southeast Desert, South Coast, Ventura County, and, from 2003, the San Francisco Bay Area.. Since ozone is formed in the atmosphere, the testing programme measures the pollutants that cause ozone: HC and NOx.

HC and NOx also react with other chemicals in the atmosphere to form respirable particulate matter.

The distinguishing features of the Enhanced I/M programme include dynamometer testing that allows measurement of NOx emissions, and inspection of vehicles most likely to have high emissions at stations that perform only tests and are prohibited from performing repairs (known as Test-Only stations). Basic I/M is in place in much of the remainder of the State. The Basic programme does not measure NOx emissions, and all testing can be performed at the same station that performs repairs. Basic Smog Check testing is required biennially in other populated parts of the State, and a basic Smog Check is required upon change of vehicle ownership in rural parts of California.

In 2002, about 65% of the California fleet was subject to the enhanced programme, 32% to the basic programme, and the remaining three percent to change of ownership testing. **Table A.4.26** compares the Enhanced and Basic I/M programmes in more detail. The key additional elements of the Enhanced programme are shown in bold.

Table A.4.26 Comparison of Current Smog Check Programmes

	BASIC I/M	**ENHANCED I/M**
Test Frequency	Biennial (plus initial registration and change-of-ownership)	Biennial (plus initial registration and change-of-ownership)
Test Type	Visual and functional test; BAR-90 test (two-speed idle (TSI))	Visual and functional test; **BAR-97 test (loaded-mode; Acceleration Simulation Mode (ASM))**
Vehicles Tested*	PC, LDT, MDV, HDT *(excluding diesel & electric vehicles)*	**PC, LDT, MDV tested with BAR-97;** All-wheel drives & HDT tested with BAR-90 *(excluding diesel & electric vehicles)*
Evaporative Test	Gas cap pressure test	Gas cap pressure test
Pollutants Measured	HC, CO	HC, CO, **NOx**
Model Years Tested	4 year old & newer vehicles exempt; 1973 vehicles & older exempt until 2003 when anything older than 30 years became exempt	4 year old & newer vehicles exempt; 1973 vehicles & older exempt until 2003 when anything older than 30 years became exempt
Repair Cost Waiver and Hardship Extension	One-time $450 (or $250 through economic hardship extension); Gross polluters are eligible for waiver	One-time $450 (or $250 through economic hardship extension); Gross polluters are eligible for waiver
Repair Assistance/Vehicle Retirement	Up to $500 repair assistance, $1,000 vehicle retirement	Up to $500 repair assistance, $1,000 vehicle retirement
Station Types	Test and Repair	Test and Repair; **about 15% of vehicles inspected at Test-Only**
Test Result Transmission	Electronic	Electronic
Cut Points	Two-speed idle cut points	**Initial cut points used in 1998-1999; more stringent NOx cut points instituted in October 1999**

Programme Status

By the year 2000, the Enhanced I/M programme has produced benefits, but the reductions achieved fell short of the SIP target for three primary reasons:

- more rigorous programme elements had not been implemented because they were being phased in over a longer timeframe
- the SIP emission reduction target assumed that additional communities and vehicles would be subject to Enhanced I/M
- legislative changes lessened the effectiveness of the Enhanced I/M programme.

From 2001, several improvements were implemented to provide additional emission reductions beyond those being achieved. These included:

- Adding about six million cars to the enhanced programme, including the Bay Area (which increased the percent of the fleet subject to the enhanced programme from 65% to 87%);
- Increasing the percentage of vehicles directed to Test-Only for their biennial inspections to 36% of the enhanced area fleet;
- Lowering the NOx inspection standards, or cut-points, to the levels specified in the State Implementation Plan (SIP); and
- Starting acceleration simulation mode (ASM) dynamometer testing of heavy-duty gasoline powered trucks up to 9,999 pounds gross vehicle weight rating.

In addition to these improvements, DCA/BAR added a pressure test of the vehicle's evaporative emissions control system to the programme in 2004.

Based on a further programme evaluation in 2004, the following potential improvements have been identified.

- Clean screening the five and six year old vehicles most likely to pass their Smog Check inspections and offsetting any foregone emission reductions through other means.
- Eliminating the existing 30-year rolling exemption and replacing it with an exemption for pre-1976 model year vehicles. This would require a change in State law.
- Inspecting older vehicles annually. This would require a change in State law.
- Inspecting high mileage vehicles annually. This would require a change in State law.
- Establishing more stringent after-repair cut-points for vehicles that fail their Smog Check inspections to ensure that vehicles are fully repaired.
- Improving the enforcement of Smog Check programme requirements
- Adding a smoke test to the Smog Check inspection. This would require a change in State law.
- Excluding newer cars (two years old or less that are still under full warranty) from the requirement for a Smog Check upon change of ownership. This would require a change in State law.

Basic I/M - Smog Check I

Table A.4.27 California Bureau of Automobile Repair (BAR) Limits - Emission and Gross Polluter Standards, Dilution Thresholds and Maximum Idle RPM Limits for BAR-90 Two-speed Test (Effective 1 January 1996)

(1)	MODEL YEAR GROUP	VEHICLE TYPE (by GVWR) [lb]					PASS/FAIL STANDARDS (2)				GROSS POLLUTER STANDARDS (3)				(4)	
		Pass Car	TRUCK (includes motor-home, mini-van & sport utility)													
		≤6000	≤6000	6001 to 8500	8501 to 14 000	≥14 001	IDLE HC	IDLE CO	2500 HC	2500 CO	IDLE HC	IDLE CO	2500 HC	2500 CO	MIN $CO+CO_2$	MAX IDLE RPM
1	1966-1967	X	X				700	5.5	600	4.5	950	8.0	850	7.0	8.0	1100
2	1968-1970	X	X				650	5.5	600	4.5	900	8.0	850	7.0	8.0	1100
3	1971-1974	X	X				550	5.0	400	4.0	800	7.5	650	6.5	8.0	1100
4	1975-1980	X					220	2.0	180	1.7	470	4.5	430	4.2	8.0	1100
5	1981-1983	X					120	1.5	150	1.5	270	3.0	300	3.0	8.0	1100
6	1984-1986	X					120	1.0	150	1.2	270	2.5	300	2.7	7.0	1100
7	1987-1992	X					120	1.0	140	1.0	270	2.5	290	2.5	7.0	1100
8	1993+	X					100	1.0	130	1.0	250	2.5	280	2.5	8.0	1100
9	1975-1978		X				250	2.5	200	3.0	500	5.0	450	5.5	7.0	1100
10	1979-1983		X	X			250	2.0	200	2.0	400	3.5	350	3.5	8.0	1100
11	1984-1987		X	X			150	1.2	180	1.2	300	2.7	330	2.7	7.0	1100
12	1988-1992		X	X			120	1.0	180	1.0	270	2.5	330	2.5	8.0	1100
13	1993+		X				100	1.0	170	1.0	250	2.5	320	2.5	7.0	1100
14	1993+			X			100	1.0	180	1.1	250	2.5	330	2.6	7.0	1200
15	1966-1969			X	X	X	700	5.5	750	5.0	950	8.0	1000	7.5	7.0	1200
16	1970-1973			X	X	X	550	5.0	600	4.5	800	7.5	850	7.0	8.0	1200
17	1974-1978			X	X	X	300	3.0	350	3.5	550	5.5	600	6.0	7.0	1200
18	1979-1983				X	X	250	2.2	250	3.0	400	3.7	400	4.5	7.0	1200
19	1984-1986				X	X	250	1.5	200	1.6	400	3.0	350	3.1	7.0	1200
20	1987-1990				X		220	1.5	200	1.6	370	3.0	350	3.1	7.0	1100
21	1991+				X		150	1.2	150	1.5	300	2.7	300	3.0	7.0	1100
22	1987-1990					X	250	2.5	200	1.6	400	4.0	350	3.1	7.0	1100
23	1991+					X	150	1.5	150	1.5	300	3.0	300	3.0	7.0	1100

(1) Emissions Standards Category

(2) Emission standards used to determine if a vehicle passes the emissions portion of the inspection -- a vehicle passes if the emission levels are equal to or less than the hydrocarbon or carbon monoxide standard for the idle or 2500 rpm inspection.

(3) Emissions standards used to designate a vehicle as a gross polluter. A vehicle is designated as a gross polluter if the emissions levels at the time of the initial inspection, before repairs, are greater than the gross polluter standards for hydrocarbon (ppm) or carbon monoxide (%) for the idle or 2500 rpm inspection.

(4) Minimum CO + CO_2 dilution threshold

- If test data on emission pass/fail rates or gross polluter identification rates indicate adjustments are required, the emission standards may be increased or decreased by CARB by 30% or by the following tolerances, or standards may be set for any specific vehicle and engine configuration which the bureau determines has excessive errors of commission or omission, whichever is necessary to comply with section 44001.5 of the Health and Safety Code:
  CO 1.5%; **$CO+CO_2$** 5%; **HC** 150 ppm Maximum Idle 500 rpm; **NOx** 350 ppm

Enhanced I/M – Smog Check II

Pursuant to Section 43010, Chapter 1, Part 5, Division 26 of the Health and Safety Code, exhaust emissions from light-duty (6,000 pounds or less gross vehicle weight) and medium-duty (8,500 pounds or less gross vehicle weight) gasoline-powered vehicles subject to inspection shall not exceed the standards by vehicle class as shown in **Table A.4.28**.

The inspection consists of exhaust emission measurements from the vehicle with the air injection system (if any) connected. HC, CO and NOx concentrations are determined by non-dispersive infrared instrumentation. The cruise mode test is performed first on a chassis dynamometer at the speeds and loads shown in the following table:

Table A.4.28 Speeds and Loads for the Cruise Mode Test

Loading Class	No. of Cylinders	Vehicle Shipping Weight (lbs)	Speed (mph)	Loading (hp)
1	4 or less	-	4 ± 1	10 ± 1
2	5 or 6	-	40 ± 1	15 ± 1.5
3	7 or more	< 3250	40 ± 1	17.5 ± 1.5
4	7 or more	≥ 3250	40 ± 1	20 ± 1.5

A vehicle which cannot reach the speed and load specified in the table above, or which by its original design cannot be tested at cruise on an inspection centre dynamometer, may be exempted from the cruise mode of the test. Vehicles owned by licensed fleet operators may be exempted from cruise mode test, provided an engine compartment functional inspection is performed on these vehicles, in addition to idle mode test. An idle mode test may be performed on vehicles at one lane inspection centres wherever dynamometers are inoperative.

The idle mode test is performed with the transmission set in neutral with the engine at its normal operating temperature. The cruise mode test is performed with automatic transmission in drive and with manual transmission set in high gear (overdrive disengaged).

In the event of a conflict between the emission standards in **Table A.4.29** and a manufacturer's specifications for a particular engine family or group of vehicles (defined by make, model year, and emission control system), as demonstrated by an excessive failure rate, by valid assembly-line data of the vehicle manufacturer, or by other data available to the executive officer, the executive officer may exempt such engine families or groups of vehicles from the standards in **Table A.4.29** and set appropriate separate emission standards.

Table A.4.29 Two Mode MVIP Standards

Category Number	Model Year	Emission Control System	No. of Cylinders	Idle Standards (1)		40 mph Cruise Standards (1)		
				HC (ppm)	CO (%)	HC (ppm)	CO (%)	NOx (ppm) (2)
1	1955–1965		5 or more	800	8.50	400	6.50	No Std.
2	1966–1970	with air injection	5 or more	450	5.00	350	4.00	2400
3	1966–1970	without air injection	5 or more	550	7.00	350	4.50	3000
4	1971–1972	with air injection	5 or more	300	4.00	200	2.00	2200
5	1971–1972	without air injection	5 or more	450	6.50	250	3.00	3200
6	1973–1974	with air injection	5 or more	200	3.50	150	2.00	1700
7	1973–1974	without air injection	5 or more	450	6.50	250	2.50	2600
8	1955–1967		4 or less	1200	8.00	400	6.50	No Std.
9	1968–1970	with air injection	4 or less	400	5.50	300	4.50	3200
10	1968–1970	without air injection	4 or less	900	7.50	300	6.00	3000
11	1971–1972	with air injection	4 or less	400	5.50	300	4.00	3000
12	1971–1972	without air injection	4 or less	400	6.50	300	5.00	3400
13	1973–1974	with air injection	4 or less	300	4.50	250	4.00	1700
14	1973–1974	without air injection	4 or less	350	6.50	250	4.00	2600
15	1975 +	no catalyst	All	150	3.00	150	1.50	2100
16	1975 +	catalyst without air injection	All	200	4.00	150	1.50	2200
17	1975 +	catalyst with air injection	All	100	1.00	100	1.00	1500
18	1975 +	three – way catalyst	All	80	1.00	80	1.00	1000

(1) HC (ppm) is defined as hydrocarbons in parts per million of hexane by volume, CO (%) is defined as carbon monoxide in percent by volume.

(2) NOx (ppm) is defined as oxides of nitrogen in parts per million in nitric oxide by volume.

Roadside Testing – Light Duty Vehicles

The idle standards quoted above are the maximum allowable emissions of pollutants from light-duty and medium-duty gasoline-powered vehicles when inspected at California Highway Patrol roadside inspection lanes.

The inspection consists of exhaust emission measurements from the vehicle with the air injection system (if any) connected. HC and CO concentrations are determined by non-dispersive infrared instrumentation.

The idle mode test is performed with the transmission in neutral and with the engine at its normal operating temperature.

A.4.6.2. On-Board Diagnostic Systems

Whereas the EPA's enforcement strategy is based on in-use testing as a means of achieving the aim of reducing emissions from cars in use, the CARB approach is to place the emphasis on pre-production vehicle testing and on specifying the standard of the OBD system itself.

The emissions thresholds for California OBD II are 1.5 times the 100 000 mile standard for passenger cars and trucks up to 14 000 lb GVWR (federal vehicles use OBD I between 8500 and 14 000 lb GVWR). Mandatory monitors are: catalyst, heated catalyst, misfire, evaporative emissions equivalent to a 0.02 inch diameter leak, fuel system, oxygen sensor, exhaust gas recirculation, secondary air system, thermostat (beginning in MY 2000) and positive crankcase ventilation (beginning in MY 2002). As CARB's approach focuses on pre-production vehicle testing and specifying the OBD system itself, CARB "Mail Outs" should be consulted for further details.

The regulations apply to all passenger cars, light duty trucks and medium duty vehicles or engines and the system must incorporate the features given below for the various vehicle and engine types.

General requirements

For 1994 model and subsequent years, the OBD system requires a malfunction indicator light (MIL) located on the instrument panel. This must automatically inform the operator in the event of a malfunction of:

- Any powertrain components which can affect emissions,
- Any component that gives an input, or receives an output, from the on-board computer,
- The computer itself.

An on-board diagnostic system must be capable of identifying the likely area of the malfunction by storing fault codes in the computer memory and providing a means of access to these codes.

Catalyst monitoring systems

From 1994, a monitor is required for proper performance of the catalyst system, both for emissions performance and for proper catalyst heating. For non-LEVs, catalyst system deterioration must be detected before emissions increase by 1.5 times the standard compared to the emission level, using a representative catalyst system, aged by 4000 miles of operation. After 1998, fulfilment of federal OBD requirements will be an acceptable alternative. The requirements do not apply to diesel engines

For TLEV systems, the threshold malfunction criterion is twice the applicable FTP HC standard, plus the emissions from a test run with a representative 4000-mile catalyst system (or 125 h of operation for medium-duty vehicle engines on a dynamometer).

For LEVs, a malfunction must be detected when the catalyst system average FTP NMHC efficiency falls below 50%, as measured across the catalyst, or when the threshold value of 2.5 times the applicable FTP HC standard, plus the emission level with a representative 4000-mile catalyst system is exceeded. From 1998, the severity of the latter requirement was increased to 1.5 times the applicable FTP HC standard without the additional catalyst system margin. There was, however, a phase-in period: 30%, 60% and 100% being required to comply in 1998, 1999 and 2000 model years respectively.

Provisional limits for ULEV applications were set at 1.5 times the standard emission threshold.

Engine misfire monitoring systems

For gasoline vehicles from 1997, a monitoring system for engine misfire, either of a specific cylinder, or group of cylinders, each of which must be identified, has been required over all positive torque operating conditions. It must detect misfire (in 1000 revolution increments in a demonstration test) before it is frequent enough for emissions to exceed 1.5 times the standards, or before the misfire rate is sufficient to cause a vehicle to fail an Inspection and Maintenance test. It must also detect misfire rates (in 200 revolution increments) which are high enough to damage the catalyst. The requirements were phased in with 50, 75, 90 and 100% compliance over the 1997-2000 model years.

Misfire detection for diesel vehicles was not required until the 1998 model year and requires a monitor for misfire in a specific cylinder or number of cylinders, diagnosed on the basis of the absence of combustion. This is to be assessed once during the first engine start-up portion of a cycle and once under driving cycle conditions.

Evaporative system integrity

A diagnostic system was required from 1994, which verifies the air flow from the complete evaporative system. In addition from 1996, the diagnostic system was also required to monitor the evaporative system for loss of HC vapour into the atmosphere by performing a pressure or vacuum check of the complete system.

The leakage to be detected is equivalent to that from a 0.04 inch diameter hole in any part of the evaporative system, excluding tubing and connections. Beginning with the 2000 model year, manufacturers were required to phase in systems to detect leakage equivalent to that from a 0.02 inch diameter hole, with 50, 75 and 100% coverage in the 2000, 2001 and 2002 model years respectively.

Other monitoring requirements

The diagnostic system is required to monitor for the malfunction of any electronic powertrain component or system which either supplies an input to, or receives commands from the on-board computer.

The diagnostic system is required to monitor the output voltage, response rate and any other parameter which can affect emissions of all primary and secondary oxygen sensors. A check is required on the EGR system to ensure that it complies with manufacturers tolerances and complies with specified maximum and minimum flow rates. Any vehicle fitted with a secondary air system should be capable of monitoring the proper function of the secondary air delivery system and air switching valve. For each of the above systems a malfunction is indicated if the vehicle exceeds the applicable FTP standard by 1.5 times.

Chlorofluorocarbons have been phased out as air conditioning system refrigerants, but any vehicles employing such refrigerants must have a suitable monitoring system for leaks.

A.4.6.3. Heavy Duty Smoke Tests

In April 1991, CARB introduced a road-side smoke test. This was subsequently suspended so that staff could focus on reformulated fuels but was reintroduced on 1 June 1998. Inspections comprise SAE J1667 exhaust opacity measurements with the following limit values:

- Pre-1991 engines: 55% opacity (maximum)
- 1991 and newer engines: 40% opacity (maximum).

A.4.6.4. Truck Idling Rules

A new Regulation, referred to as section 2485, was adopted on 31 January 2005. This regulation is included within Chapter 10 - Mobile Source Operational Controls, Article 1 - Motor Vehicles, Division 3. Air Resources Board, title 13, California Code of Regulations. Its purpose is to reduce public exposure to diesel particulate matter and other air contaminants by limiting the idling of diesel-fuelled commercial motor vehicles. It applies to diesel-fuelled commercial motor vehicles that operate in the State of California with gross vehicle weight ratings of greater than 10,000 pounds that are or must be licensed for operation on highways. This specifically includes both Californian and non-Californian based vehicles.

Requirements

On or after February 1, 2005, the driver of any vehicle subject to this section:

- shall not idle the vehicle's primary diesel engine for greater than 5.0 minutes at any location, with certain exceptions; and
- shall not operate a diesel-fuelled auxiliary power system (APS) to power a heater, air conditioner, or any ancillary equipment on that vehicle during sleeping or resting in a sleeper berth for greater than 5.0 minutes at any location when within 100 feet of a restricted area, except as noted below. (Note: "Restricted area" means any property zoned for individual or multifamily housing units that has one or more such units on it.)

Exceptions

The requirements do not apply for the period or periods during which:

1. a bus is idling for
   (a) up to 10.0 minutes prior to passenger boarding, or
   (b) when passengers are onboard;
2. idling of the primary diesel engine is necessary to power a heater, air conditioner, or any ancillary equipment during sleeping or resting in a sleeper berth. This provision does not apply when operating within 100 feet of a restricted area;
3. idling when the vehicle must remain motionless due to traffic conditions, an official traffic control device, or an official traffic control signal over which the driver has no control, or at the direction of a peace officer, or operating a diesel-fuelled APS at the direction of a peace officer;
4. idling when the vehicle is queuing that at all times is beyond 100 feet from any restricted area;
5. idling of the primary engine or operating a diesel-fuelled APS when forced to remain motionless due to immediate adverse weather conditions affecting the

safe operation of the vehicle or due to mechanical difficulties over which the driver has no control;

6. idling to verify that the vehicle is in safe operating condition as required by law and that all equipment is in good working order, either as part of a daily vehicle inspection or as otherwise needed, provided that such engine idling is mandatory for such verification;
7. idling of the primary engine or operating a diesel-fuelled APS is mandatory for testing, servicing, repairing, or diagnostic purposes;
8. idling when positioning or providing a power source for equipment or operations, other than transporting passengers or propulsion, which involve a power take off or equivalent mechanism and is powered by the primary engine for:
   (a) controlling cargo temperature, operating a lift, crane, pump, drill, hoist, mixer (such as a ready mix concrete truck), or other auxiliary equipment;
   (b) providing mechanical extension to perform work functions for which the vehicle was designed and where substitute alternate means to idling are not reasonably available; or
   (c) collection of solid waste or recyclable material by an entity authorized by contract, license, or permit by a school or local government;
9. idling of the primary engine or operating a diesel-fuelled APS when operating defrosters, heaters, air conditioners, or other equipment solely to prevent a safety or health emergency;
10. idling of the primary engine or operating a diesel-fuelled APS by authorized emergency vehicles while in the course of providing services for which the vehicle is designed;
11. idling of military tactical vehicles during periods of training; and
12. idling when operating equipment such as a wheelchair or people assisted lift as prescribed by the Americans with Disabilities Act;

Enforcement

This regulation may be enforced by the Air Resources Board; peace officers and their authorized representatives; and air pollution control or air quality management districts.

Penalties

The driver of a violating vehicle is subject to a minimum civil penalty of 100 dollars and to criminal penalties as specified in the Health and Safety Code and the Vehicle Code.

A.5. CANADA REGULATIONS

A.5.1. VEHICLE EMISSIONS LIMITS

1997 regulations and 2001 - 2003 legislation relating to light duty vehicles and light duty trucks will be found in **Part 2**, **Sections B.5.1.1** and **B.5.1.2** respectively.

A.5.1.1. 2004 Emissions Legislation - Light Duty Vehicles and Light Duty Trucks

Introduction

On 12 December 2002, the Canadian Government published its new On-Road Vehicle and Engine Emission Regulations under the Canadian Environmental Protection Act, 1999 (P.C. 2002-2164 - 12 December, 2002; 01-01-2003 Canada Gazette Part II, Vol. 137, No. 1). These Regulations applied to vehicles and engines that are manufactured or imported into Canada on or after January 1 2004. They essentially established emission standards and test procedures for on-road vehicles and engines that aligned with those of the US EPA.

Prescribed Classes of Vehicles and Engines

The Regulations specify the classes of on-road vehicles and engines that are subject to the emission requirements. These classes are aligned with corresponding US EPA rules and the prescribed classes of vehicles and engines are summarized in **Table A.5.1**. In the Regulations, vehicle classes are defined based on a number of characteristic features, with the primary one being “gross vehicle weight rating” (GVWR), which is the maximum design laden weight of the vehicle.

Table A.5.1 Prescribed Classes of Vehicles and Engines

Class	GVWR, kg (lb.)
Motorcycle	≤ 793 kg (1749)
Light Duty Vehicle	≤ 3856 (8500)
Light Duty Truck	≤ 3856 (8500)
light light duty truck	≤ 2722 (6000)
heavy light duty truck	> 2722 - 3856 (> 6000 - 8500)
Medium Duty Passenger Vehicle (1)	3856 - 4536 (8500 - 10 000)
Complete Heavy Duty Vehicle	3856 - 6350 (8500 - 14 000)
(Otto-cycle (2) Only) Heavy Duty Vehicle/ Heavy Duty Engine	> 3856 (8500)
light heavy duty engine	< 8847 (< 19 500)
medium heavy duty engine	8847 - 14 971 (19 500 - 33 000)
heavy heavy duty engine	> 14 971 (> 33 000)

(1) The new “medium duty passenger vehicle” class is designed to subject heavier passenger-type vehicles, such as vans and sport utility vehicles, to the same set of emission standards as light duty vehicles instead of the heavy duty vehicle emission standards.

(2) "Complete heavy duty vehicle" is similarly a new subclass of heavy duty vehicle that will be subject to standards and testing procedures resembling those for light duty vehicles. These types of vehicles are newly subject to chassis-based standards defined in terms of emissions per unit distance (g/km or g/mile) while heavy duty engine-based standards are expressed in terms of emissions per unit of work (g/MJ or g/bhp-hr).

- The Regulations do not apply to on-road vehicles and engines that are being exported outside of Canada; those that are solely for purposes of exhibition, demonstration, evaluation or testing, with the exception of a required declaration; or those that are 15 years old or older.

Fleet Average NOx Standards

The average NOx value for a company's fleet that is composed of all of its light duty vehicles and light light duty trucks of a model year set out in column 1 of **Table A.5.2** shall not exceed the applicable fleet average NOx standard set out in column 2:

Table A.5.2 Fleet Average NOx Standards (1) - Light Duty Vehicles and Light Light Duty Trucks

Item	Column 1	Column 2
	Model Year	Fleet Average NOx Standard (grams/mile)
1.	2004	0.25
2.	2005	0.19
3.	2006	0.13
4.	2007	0.07
5.	2008	0.07

(1) The average NOx value for a company's fleet that is composed of all of its heavy light duty trucks and medium duty passenger vehicles of a model year set out in column 1 of the table to this section shall not exceed the applicable fleet average NOx standard set out in column 2:

Table A.5.3 Fleet Average NOx Standards (1) - Heavy Light Duty Trucks and Medium Duty Passenger Vehicles

Item	Column 1	Column 2
	Model Year	Fleet Average NOx Standard (grams/mile)
1.	2004	0.53
2.	2005	0.43
3.	2006	0.33
4.	2007	0.20
5.	2008	0.14

(1) The average NOx value for a company's fleet that is composed of all of its light duty vehicles, light duty trucks and medium duty passenger vehicles of the 2009 and later model years shall not exceed 0.07 grams per mile.

Table A.5.4 Light Duty Vehicle, Light Duty Truck and Medium Duty Passenger Vehicle Full Useful Life Exhaust Emission Standards (1)

Bin	**Exhaust Emission Standards (g/mile)**				
	NOx	**NMOG**	**CO**	**Formaldehyde**	**PM**
11 (2)	0.9	0.280	7.3	0.032	0.12
10 (3)	0.6	0.156/0.230	4.2/6.4	0.018/0.027	0.08
9 (3)	0.3	0.090/0.180	4.2	0.018	0.06
8	0.20	0.125/0.156	4.2	0.018	0.02
7	0.15	0.090	4.2	0.018	0.02
6	0.10	0.090	4.2	0.018	0.01
5	0.07	0.090	4.2	0.018	0.01
4	0.04	0.070	2.1	0.011	0.01
3	0.03	0.055	2.1	0.011	0.01
2	0.02	0.010	2.1	0.004	0.01
1	0.00	0.000	0.0	0.000	0.00

(1) Beginning in the 2009 model year, applicable standards are limited to bins 1 to 8 for all light duty vehicles, light duty trucks and medium duty passenger vehicles.

(2) Bin 11 is only for medium duty passenger vehicles and is available up to and including the 2008 model year.

(3) Bins 9 and 10 are only available during the 2004 to 2006 model years for light duty vehicles and light light duty trucks and up to and including 2008 for heavy light duty trucks and medium duty passenger vehicles. Bins 8 through 10 contain additional temporary, less stringent standards for certain pollutants and for certain vehicles.

Evaporative Emission Standards

Vehicles other than diesel heavy duty vehicles are required to meet more stringent standards for controlling diurnal and hot soak evaporative emissions. These new standards generally represent a 50 percent improvement in the control of these emissions relative to earlier limits and will be phased in over MY 2004 to 2007 for light duty vehicles and light light duty trucks and over MY 2008 to 2009 for heavy light duty trucks, medium duty passenger vehicles and Otto-cycle heavy duty vehicles.

The Regulations introduced new refuelling emission standards for medium duty passenger vehicles and complete heavy duty vehicles that are the same as those applicable to heavy light duty trucks and which require a capture efficiency of about 95 percent. In the case of medium duty passenger vehicles, the refuelling emission standards were phased-in from the beginning in the 2004 MY with full compliance in MY 2006. For complete heavy duty vehicles, the phase-in of refuelling emission standards began in MY 2005 with full compliance in 2006.

A.5.1.2. Heavy Duty Vehicles and Engines - 2005/2009 Emissions Legislation

The new chassis-based exhaust emission standards and phase-in schedules for complete heavy duty vehicles are summarized in **Table A.5.5**:

Table A.5.5 Complete Heavy Duty Vehicle Exhaust Emission Standards

	GVWR kg (lb.)	Exhaust Emission Standards (g/mile)				
		NOx	**NMOG/ NMHC**	**Formaldehyde**	**CO**	**PM**
Phase 1 (2005)	3856 - 4536 (8500 - 10 000)	0.9	0.280 (1)	-	7.3	-
	4536 - 6350 (10 000 - 14 000)	1.0	0.330 (1)	-	8.1	-
Phase 2 (2008 - 2009)	3856 - 4536 (8500 - 10 000)	0.2	0.195 (2)	0.032	7.3	0.02
	4536 - 6350 (10 000 - 14 000)	0.4	0.230 (2)	0.040	8.	0.02

(1) Emission standard specified as NMOG. “Non-methane hydrocarbons” (NMHC) or “total hydrocarbons” (THC) measurements are also accepted

(2) Emission standard specified as NMHC

The new exhaust emission standards and phase-in schedules for diesel heavy duty engines, other than those used in “medium duty passenger vehicles”, are summarized in **Table A.5.6**:

Table A.5.6 Exhaust Emission Standards for Diesel Heavy Duty Engines

	Exhaust Emission Standards, g/bhp-hr (g/MJ)				
	NOx	**NMHC**	**NOx + NMHC**	**CO**	**PM**
Phase 1 (2004)	-	-	2.4 (0.89) (1)	15.5 (5.77)	0.10 (0.037) (2)
Phase 2 2007 - 2010)	0.2 (0.075)	0.14 (0.052)	-	15.5 (5.77)	0.0037 (0.01)

(1) Emission standard can increase to 2.5 g/bhp-hr (0.93 g/MJ) if NMHC 0.5 g/bhp-hr (0.19 g/MJ)

(2) For urban buses, the standard is 0.05 g/bhp-hr (0.019 g/MJ) for certification testing and 0.07 g/bhp-hr (0.026 g/MJ) for in-use testing

The new exhaust emission standards and phase-in schedules for Otto-cycle heavy duty engines, other than those used in medium duty passenger vehicles or complete heavy duty vehicles are summarized in **Table A.5.7**:

Table A.5.7 Exhaust Emission Standards for Otto-Cycle Heavy Duty Engines

	GVWR kg (lb.)	Exhaust Emission Standards (g/mile)				
		NOx	**NMHC**	**NOx + NMHC**	**CO**	**PM**
Current (2004)	≤ 6350 (≤ 14 000)	4.0 (1.49)	1.1 (0.41) (1)	-	14.4 (5.36)	-
	> 6350 (> 14 000)	4.0 (1.49)	1.9 (0.71) (1)	-	37.1 (13.8)	-
Phase 1 (2005 - 2006)	≤ 6350 (≤ 14 000)	-	-	1.0 (0.37)	14.4 (5.36)	-
	> 6350 (> 14 000)	-	-	1.0 (0.37)	37.1 (13.8)	-
Phase 2 (2008 - 2009)	> 3856 (> 8500)	0.2 (0.075)	0.14 (0.052)	-	14.4 (5.36)	0.01 (0.0037)

(1) Emission standard specified in total hydrocarbons and is for engines fuelled with gasoline or liquefied petroleum gas

The Phase 1 and 2 programmes will retain an engine-based approach for incomplete Otto-cycle vehicles with a GVWR of up to 6350 kg (14 000 lb.) and all Otto-cycle vehicles with a GVWR above 6350 kg (14 000 lb.). The Phase 2 Otto-cycle standards for NOx, NMHC and PM are identical to those for diesel-fuelled vehicles and engines shown in **Table A.5.6**.

Other Exhaust Emission Standards for Heavy Duty Engines

The Regulations include additional standards designed to control exhaust emissions under modes of operation not covered by the Federal Test Procedure for heavy duty engines, such as:

- the opacity of smoke emitted from diesel heavy duty engines during engine acceleration and lugging modes of operation; and,
- beginning in the 2007 MY, a steady-state “Supplemental Emission Test” and, for in-use engines, a “Not-to-Exceed” test procedure both designed to more closely represent the range of real-world driving conditions of diesel heavy duty vehicles.

A.5.1.3. 2006 Emissions Legislation - Motorcycles

The exhaust emission limits for total hydrocarbons and CO from motorcycles are 5.0 g/km (8.0 g/mile) and 12 g/km (19 g/mile), respectively, which are aligned with current US federal rules. In August 2002, the US EPA published a notice of proposed rulemaking to phase in more stringent emission standards for on-road motorcycles beginning in the 2006 model year. To the extent possible, the Regulations are structured to maintain alignment with the US standards as they are updated. The Department plans to review the final US rule and take any necessary steps to ensure appropriate alignment with US standards.

A.5.1.4. Current Emissions Legislation - Background Details and Additional Information

Technical Emission Standards

These technical standards correspond to those of the US EPA and sections of the US Code of Federal Regulations and are incorporated by reference to ensure that the specified standards are identical in both countries. This continues the past approach under the Motor Vehicle Safety Act. The Regulations ensure that vehicles and engines meeting new more stringent exhaust emission standards will begin entering the Canadian market in MY 2004 and will be phased-in over the 2004 to 2010 MY period. The phase-in schedules vary by standard and by vehicle class and can be summarized as follows:

- Tier 2 standards for light duty vehicles and light light duty trucks: (2004 - 2007);
- Tier 2 standards for heavy light duty trucks and medium duty passenger vehicles: (2004 - 2009);
- Phase 1 (2005) and Phase 2 (2008 - 2009) standards for complete heavy duty vehicles;
- Phase 1 (2004 - 2006) and Phase 2 (2007 - 2010) standards for heavy duty engines.

During any phase-in period, every model of vehicle or engine that is certified by the US EPA, and that is sold concurrently in Canada and the United States, is required to meet the same emission standards in Canada as in the United States. Canadian vehicles will therefore have progressively improved emission performance without specifying interim phase-in percentages in the Regulations. The final phased-in standards apply to all vehicles and engines sold in Canada, in the model year that they apply, to 100 percent of a class of vehicles or engines in the United States.

Vehicles and engines are required to comply with emission standards for a defined “full useful life”. The full useful life is specified in years or as accumulated mileage, whichever comes first, and varies depending on the class or subclass of vehicles or engines. Under the Regulations, the full useful life for light duty vehicles and light light duty trucks is extended from the current 10 years/160 000 km to 10 years/192 000 km. The full useful life for the new classes of medium duty passenger vehicles and complete heavy duty vehicles is established to be 11 years/192 000 km, equivalent to the current requirement for heavy light duty trucks.

The distance component of the full useful life remains the same for heavy duty vehicles and engines, except for heavy heavy duty diesel engines where it is extended from 467 000 km to 700 000 km. While the time component for some heavy duty emission standards is currently eight years, it will be set at ten years for all such standards. In the case of motorcycles, the full useful life remains at up to five years/30 000 km, depending on the motorcycle’s engine displacement.

Exhaust Emission Standards

The new exhaust emission standards align with the US Tier 2 emission standards. Manufacturers certify every vehicle to one of eleven “bins”, each of which contains standards for NOx, non-methane organic gases (NMOG), CO, formaldehyde and PM. Formaldehyde and NMOG are newly regulated under the Regulations, although NMOG limits effectively replace previous non-methane hydrocarbon

(NMHC) standards. The manufacturers' choices of bin within which to certify each vehicle is limited by the obligation to comply with the fleet average NOx emissions standards.

Fleet Average NOx Emission Standards

The Regulations establish fleet average NOx emission standards for MY 2004 and later. The objective of the fleet averaging provisions is to create a regulatory framework that will achieve a Canadian vehicle fleet emission performance comparable with the US.

Each new light duty vehicle, light duty truck and medium duty passenger vehicle is required to be certified to a "bin" containing specific emission standards for NOx and other pollutants. Based on vehicle sales from each "bin", a company calculates a sales weighted "fleet average NOx value" for each model year. The emission bins, fleet average NOx emission standards, timing of phase-ins and methods of calculating fleet average NOx values are consistent with the US Tier 2 emission programme.

When the standards are fully phased in (i.e., in 2009), a company's combined fleet of light duty vehicles, light duty trucks and medium duty passenger vehicles will be subject to a single fleet average NOx emission standard of 0.07 g/mile, corresponding to the NOx standard in bin 5. A company can, in any model year, generate NOx emission credits by achieving a fleet average NOx value that is lower than the standard. These credits can be used in a subsequent model year to offset a NOx emissions deficit (the fleet average NOx value exceeds the standard). A deficit must be offset no later than the third model year following the year in which it is incurred. NOx emission credits may also be transferred to another company. There are provisions identical with the United States, to promote the early introduction of cleaner vehicles or more durable emission control systems. Additional NOx emission credits can be earned by, for example, certifying vehicles to bins 1 or 2 during MY 2004 through 2005 or by certifying vehicles to an extended useful life of 15 years/240 000 km.

During the phase-in period leading up to the final fleet average NOx standard in the 2009 model year, the Regulations specify:

- for light duty vehicles and light light duty trucks, a progressively tightening fleet average NOx standard based on the US phase-in for MY 2004 to 2006 culminating in 2007 in the final fleet average standard specified above for 2009 (i.e., 0.07 g/mile); and
- for heavy light duty trucks and medium duty passenger vehicles, a progressively tightening fleet average NOx standard based on the US phase-in for MY 2004 to 2008 culminating in the final fleet average standard in 2009 (i.e., 0.07 g/mile).

Other Exhaust Emission Standards

The Regulations include additional standards designed to control exhaust emissions from light duty vehicles, light duty trucks and medium duty passenger vehicles under modes of operation that are not covered by the conventional Federal Test Procedure, such as:

- aggressive driving (high rates of speed or acceleration), and the use of air conditioning during high ambient temperatures through the Supplemental Federal Test Procedures;
- cold weather operation through the cold temperature carbon monoxide emission standard applicable to gasoline-fuelled vehicles;
- highway driving conditions through the Highway NOx emissions standards for light duty vehicles and light duty trucks as measured over the Federal Highway Fuel Economy Test; and
- conditions that may be encountered during the types of tests used in inspection and maintenance programmes through the Certification Short Test exhaust emission standards for gasoline-fuelled light duty vehicles, light duty trucks and medium duty passenger vehicles (i.e., this standard addresses the compatibility of emission control systems with the types of emission tests used in state or provincial vehicle inspection and maintenance programmes).

Crankcase Emission Standards

The Regulations require that no crankcase emissions be discharged from most prescribed classes of vehicles and engines, consistent with the current regulations. Beginning in MY 2007, a long-standing exception applying to turbocharged heavy duty diesel engines will be removed. There is an allowance that crankcase emissions from turbocharged heavy duty diesel engines may continue to be discharged to the atmosphere, but only if the combined total of the crankcase emissions and the other exhaust emissions are below the applicable exhaust emission standards.

A.5.1.5. Summary of Future Actions - Non-Road engines

The Department intends to proceed with the development of emissions control programmes for non-road engines aligned with the corresponding US federal emissions control programmes. These include:

- Development of proposed regulations corresponding to the US EPA Phase 2 programme for spark-ignition gasoline utility engines;
- Development of proposed regulations corresponding to the US EPA Tier 2 programme for compression-ignition non-road engines;
- Development of proposed regulations corresponding to the US EPA programme for spark-ignition marine engines.

The Department will also consider the development of:

- A Tier 3 programme for compression-ignition non-road engines when the full scope of the US EPA programme is available;
- Emissions control programmes for large spark-ignition engines, recreational vehicles using gasoline engines, and stern drive and inboard gasoline-powered marine engines aligned with the US EPA programmes once these programmes are finalized in the US.

A.5.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.5.2.1. Gasoline Regulations

Benzene

The "Benzene in Gasoline" Regulations were published in Canada Gazette II on 26 November 1997 as SOR/97-493 and are described in **Part 1**, **Section 5.2.1**.

Vapour pressure

Under a voluntary initiative undertaken by the petroleum industry in consultation with the provincial ministers and the Canadian Council of the Ministers of Environment (CCME), vapour pressure was reduced to 10.5 psi (72.5 kPa) in the summer of 1990. Further details will be found in **Part 1**, **Section 5.2.1**.

Sulphur

The final Sulphur in Gasoline Regulations were published in the Canada Gazette, Part II, 23 June 1999 and are described in **Part 1**, **Section 5.2.1**.

MTBE and other Aliphatic Ethers

In Canada, MTBE is permitted and controlled by the Canadian General Standards Board specification for oxygenates that permits up to 15% v/v in gasoline. MTBE usage is significantly less that in the US. Further details will be found in **Part 1**, **Section 5.2.1**.

Gasoline Dispensing Rate Regulations

A regulation under the Canadian Environmental Protection Act, to lower the gasoline dispensing rate at service stations was passed on 16 February, 2000. This was in response to air quality issues including smog and airborne toxics (benzene). The regulation controls and reduces vehicle refuelling emissions (VOCs) by up to 95% by limiting the fuel dispensing rate to 38 l/min, effective 1 February, 2001.

British Columbia Cleaner Gasoline Regulations

In 1995 British Columbia adopted a regulation that gradually reduces sulphur, aromatics and olefin content or, alternatively, gasoline emissions levels (NOx and Toxics, as calculated by the US EPA complex Model), from its baseline gasoline (average 1993). Further details will be found in **Part 1**, **Section 5.2.1**.

A.5.2.2. Unleaded Automotive Gasoline Standard (CAN/CGSB-3.5-2004)

Scope

This standard applies to four grades of gasoline to which no lead or phosphorus compounds have been added. They are intended for use in spark ignition engines under a wide range of climatic conditions. Gasoline specified in this standard may contain methyl tertiary butyl ether (MTBE) or other aliphatic ethers. Provincial and federal regulations control some parameters included in this standard. Where such regulations establish more restrictive limits than those given in this standard, the regulated limits shall apply.

The standard was published in November 2004, and amended in August 2005. It supersedes CAN/CGSB-3.5-99.

Octane Grades

See **Table A.5.8**, below.

Vapour Pressure Classes

There are nine vapour pressure classes, numbered 1 to 9. When finished gasoline is blended with a component that can increase the vapour pressure of the blend, the vapour pressure limits apply to the blended product at the point of blending.

Distillation Classes

There are five distillation classes, designated A to E.

The vapour pressure and distillation classes shall be for the date and geographical area of intended use, with compliance at one of the following:

- Primary terminals
- Point of entry into Canada
- Point of blending (to the blended product)

Table A.5.8 Gasoline Antiknock Performance

Grade	Antiknock Index (1) [R +M]/2 (Min.)	MON (Min.)
Grade 1 — Regular	87.0	82.0
Grade 2 — Mid-grade	89.0	-
Grade 3 — Premium	91.0	-
Grade 4 — Super-Premium	93.0	-

(1) Antiknock performance is a function of the Antiknock Index. The [R + M]/2 values for Grades 1 to 4 shall not be less than the minimum specified in **Table A.5.8**, with the adjustment for altitude and climatic conditions specified in **Table A.5.9**. ASTM Methods D 26993, D 27003 or D 2885 may be used, (The latter two are referee method(s) to be used in the event of a dispute).

Table A.5.9 Seasonal and Geographical Schedule of Antiknock Index Reductions to Adjust for Altitude and Climatic Conditions

Zone	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
Coastal B.C., New Brunswick, Nova Scotia, P.E.I. and the island of Newfoundland	0	0	0	0	0	0	0	0	0	0	0	0
Interior B.C., Alberta and Yukon	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Saskatchewan	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Manitoba, N.W.T., Nunavut and N.W. Ontario	1.0	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ontario (except N.W. Ontario), Quebec and Labrador	0.5	0.5	0	0	0	0.5	0.5	0.5	0	0	0	0.5

Table A.5.10 Vapour Pressure Class and Distillation Class Characteristics

Vapour Pressure Class (1)	Vapour Pressure (kPa) (2)		Distillation Class	Distillation Temperature °C (4)						Driveability Index (DI) °C
				10%		50%		90%	FBP	
	min (3)	max		min	max	min (3)	max	max	max	max
1	38	55								
2	41	62								
3 (5)	41	72	A	35	70	70	120	190	225	597
4	41	79	B	35	70	70	120	190	225	590
5	48	86	C	-	66	70	117	190	225	575
6	59	97	D	-	55	70	113	185	225	560
7	69	107	E	-	50	70 (6)	110	185	225	550

(1) The intent of Vapour Pressure Classes 1, 2 and 3 is to limit gasoline vapour pressure to minimize evaporative losses. The use of Vapour Pressure Classes 1, 2 and 3 may also be mandated in provincial regulations. A summary of applicable provincial regulations is given below.

(2) May be measured by ASTM methods D 4953, D 5190, D 5191, D 5482, or D 6378. ASTM D 5191 is the referee method to be used in the event of a dispute. Vapour pressures determined using ASTM D 5190 or D 5191 are required to be converted to dry vapour pressure equivalents, using the equations in ASTM D 5190 and D 5191, before using the values to judge compliance with the limits given in this standard. The precision and bias statement developed for ASTM D 5482 did not include fuels above 83 kPa. Users are cautioned to develop their own supporting data to establish correlation with the referee method when this method is used to test such fuels. The D 6378 test method showed a bias versus ASTM D 5191 (the referee test method).

(3) The minimum vapour pressure limits exist to help minimize formation of a flammable mixture in the vapour space of fuel tanks at low temperatures. Where fuel is normally delivered once per year, in Zones VII and VIII, the minimum Vapour Pressure should be 90 kPa at point of delivery: the intent is to provide cold temperature startability.

(4) The ASTM Test Method D 86 employed for these measurements utilises either manual or automated equipment. In cases of dispute, the automatic test method shall be selected as the referee test method.

(5) Gasoline with a 50% distillation point below 75°C may need an additive(s) to avoid carburettor icing.

(6) Class 3 was created voluntarily in order to reduce evaporative emissions in bulk distribution and during vehicle refuelling.

(7) Gasoline with a 50% distillation point (T50) greater than or equal to 65°C but less than 70°C may be provided if the vapour pressure is less than or equal to 107 – 2 × (70 – T50), where (65°C ≤T50 <70°C).

Table A.5.11 Seasonal and Geographical Schedule [1] for Vapour Pressure Classes and Distillation Classes

Geographical Area [2]	**JAN.**	**FEB.**	**MAR.**	**APR.**	**MAY**	**JUNE**	**JULY**	**AUG.**	**SEP.**	**OCT.**	**NOV.**	**DEC.**
I [3]	7E	7E	7E	6C/6B	5B/3B	3B	3B	3B	3B/5B	6B/6C	7E	7E
IA [2, 3]	7E	7E	7E	6B/3B	3A	2A	2A/1A	1A/2A	3A/5A	6B/6C	7E	7E
II [3]	7E	7E	7E	7D/7C	6C/5C	5C	3B	5C	6C	7D	7E	7E
III [3]	7E	7E	7E	7D/7C	6B/5B	3B	3B	3B	3B/6B	6B/7D	7E	7E
IV [3]	7E	7E	7E	7C/6B	5B/3B	3B	3B	3B	3B/5B	6B/6C	7E	7E
IVA [2, 3]	7E	7E	7E	6C/6B	5A/3A	2A	2A	2A	2A/5A	6A/6C	7E	7E
IVB [3, 4]	7E	7E	7E	7C/6B	5A/3A	2A	2A	2A	3A/5A	6B/6C	7E	7E
V	7E	7E	7E	7E	6D	5C	5C	5C	6C	7D	7E	7E
VA [5, 3]	7E	7E	7E	7D/7B	6B/3B	3B	3B	3B	3B/6B	7B/7D	7E	7E
VI [3]	7E	7E	7E	7D/7B	6B/3B	3B	3B	3B	3B/5B	6B/6C	7E	7E
VII	7E	7E	7E	7D	6D	6D	6D	6D	6D	7D	7E	7E
VIII	7E	7E	7E	7E	7E	7E	6D	6D	7D	7E	7E	7E

(1) This schedule includes a two-week period for turning over inventory at service stations. A longer turnover period at times close to seasonal changes could result in degradation of vehicle performance.

(2) The approximate geographical areas are illustrated in **Figure A.5.1**. Area IA corresponds to the Lower Fraser Valley and means that part of British Columbia bounded on the north by latitude 49°30', on the west by longitude 123°20', and on the east by longitude 121°15'. Area IVA is that part of Ontario that lies south of a straight line passing through Arnprior and Grand Bend. Where the line so described runs across a local municipality, the entire local municipality is part of Area IVA. For the period May 15 to September 14, Ontario Regulation 271/91 prohibits an Ontario refinery from shipping gasoline with a vapour pressure greater than 62 kPa into Area IVA. During this same period, this regulation also prohibits the sale or container to container transfer of gasoline imported into Area IVA that has a vapour pressure greater than 62 kPa.

(3) Where two sets of classes are indicated, the first set listed shall be supplied during the first fifteen days of the month and the second set during the remainder of the month except for Vapour Pressure Class 1 in Area IA, which covers the period July 16 to August 14.

(4) Area IVB is that part of south-western Quebec defined by the volatility boundaries in the provincial regulation Petroleum Products Regulation.

(5) Area VA is that portion of the island of Newfoundland that is south of latitude 49°N, as defined in the Newfoundland and Labrador Environmental Protection Act and Regulations.

Table A.5.12 Other Specified Limiting Values

Property	Limit Values		Test Methods	
	min	**max**	**ASTM**	**CGSB**
Copper strip corrosion, (3 h at 50°C)	-	No. 1	D 130	
Corrosion, steel in water	-	B+	NACE TM0172	
Solvent washed gum content, (mg/100 ml)	-	5	D 381	
Lead content, (mg/l)	-	5	D 3237	
Manganese content, (mg/l)	-	18	D 3831	
Oxidation stability, min (Induction period) (1)	240	-	D 525	
Phosphorus content, (mg/l)	-	1.3	D 3231	
Sulphur content, mg/kg	-	300 (2)	D 2622 D 3120 D 5453 (3)	
Aliphatic ether content, (% m/m) oxygen (4, 5)	-	2.7 (6)	D 4815 D 5599	CAN/CGSB-3.0 No. 14.3 (3)
Alcohol content (5)				
Methanol, (% v/v)	-	0.30	D 4815 D 5599	CAN/CGSB-3.0 No. 14.3 (3)
Other alcohols, (% m/m)	-	0.50	D 4815 D 5599	CAN/CGSB-3.0 No. 14.3 (3)
Benzene content, (% v/v) (7)	-	1.5		CAN/CGSB-3.0 No. 14.3
BEN (7)	Report	Report		

(1) Oxidation stability may degrade over time. Suppliers should make appropriate allowances in order that this detailed requirement is met at point of sale.

(2) The maximum sulphur concentration was 0.10 weight % until 1 January, 2004.

(3) Referee method(s) to be used in the event of a dispute.

(4) MTBE and other aliphatic ethers are allowed provided they have:
- a minimum of five carbon atoms
- a final boiling point less than or equal to the gasoline's 90% distillation point limit.

(5) Small quantities of methanol and other alcohols are permitted to mitigate problems associated with water pickup. If aliphatic ethers, methanol and other alcohols are added in combination, the total oxygen content allowed from such additions remains at a maximum of 2.7% by mass.

(6) When reporting this parameter, metered (measured) volumes may be used in place of analytical tests when the component is added.

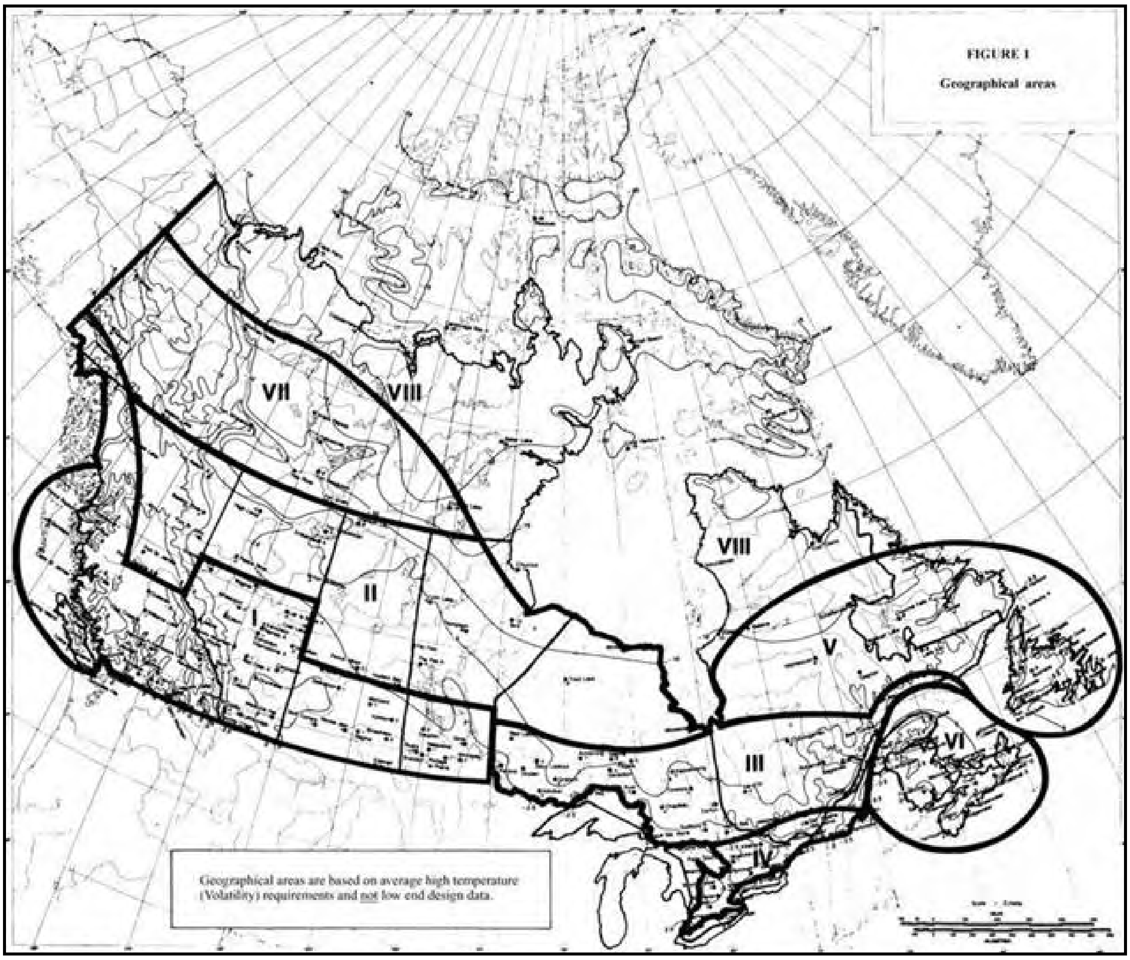
(7) In this standard, benzene content and BEN requirements shall conform to the Benzene in Gasoline Regulations, Schedule 1. In accordance with the regulation, the maximum benzene content allowed for any complying gasoline is 1.5% by volume; this applies to primary suppliers (manufacturers, importers or blenders) who elect to produce gasoline to an annual pool average of 0.95%. The regulation also permits primary suppliers to elect a 1.0% by volume flat limit without any associated yearly pool average. A number of options exist for the BEN limit; for details consult the Benzene in Gasoline Regulations.

Deposit Control Additives

All gasoline retailed in Canada shall contain a deposit control additive sufficient to meet either:

- an intake valve deposit requirement of less than 100 mg average deposit mass per valve after a 16 093.0 km (10 000 mile) driving cycle, or less than 25 mg average deposit mass per valve after a 8046.5 km (5000 mile) driving cycle as specified by ASTM D 5500, or
- an intake valve deposit requirement of less than 135 mg average deposit mass per valve after a 100 h dynamometer test cycle as specified by ASTM D 6201.

Figure A.5.1 Geographical Areas for Vapour Pressure Classes and Distillation Classes



Provincial and Territorial Regulations

Province or Territory	Regulation
British Columbia	General Requirements and Vapour Pressure - The general requirements and vapour pressure are controlled under the latest version of the Cleaner Gasoline Regulation (B.C. Reg. 498/95).
Ontario	Vapour Pressure - Vapour pressure is controlled under the latest version of Ontario Regulation (O. Reg.) 271/91, as amended by O. Reg. 45/97.
	Sulphur - See the reporting requirements under the Environmental Protection Act: Reporting Requirements - Sulphur Levels in Gasoline (O. Reg. 212/02).
Quebec	General Requirements - The general requirements are controlled under the latest version of the R`eglement sur les produits p´etroliers or Petroleum Products Regulation [c. P-29.1, r.2]. In this regulation, Quebec specifications for automotive gasolines, diesel, stove oil, furnace oil and heavy fuel oil are listed.
Manitoba	General Requirements and Vapour Pressure - The general requirements and vapour pressure are controlled under the latest version of Dangerous Goods Handling and Transportation Act, including the Dangerous Goods Handling and Transportation Regulation and the Storage and Handling of Petroleum Products and Allied Products Regulation.
Prince Edward Island	General Requirements - The general requirements are controlled under the Petroleum Products Act Regulations (EC38/91).
Newfoundland and Labrador	Vapour Pressure - Vapour pressure is controlled under the Environmental Protection Act and Regulations - Gasoline Volatility Control Regulations.
Nova Scotia	Vapour Pressure - Vapour pressure is controlled under the Environment Act and Regulations - Air Quality Regulations (N.S. Reg. 55/95).
New Brunswick	Vapour Pressure - Vapour pressure is controlled under the Clean Air Act and Regulations - Air Quality Regulation (N.B. Reg. 97-133).
Yukon	General Requirements - The general requirements are controlled under the Gasoline Handling Act and Regulations - Gasoline Handling Regulations (O. C. 1972/137).

A.5.2.3. Unleaded Automotive Gasoline (containing Ethanol) Standard (CAN/CGSB3.511-93)

Scope

This standard applies to four grades of oxygenated gasoline to which no lead or phosphorus compounds have been added and in which the oxygenate consists essentially of ethanol. They are intended for use in spark ignition engines under a wide range of climatic conditions.

The standard was originally published in September 1993 and superseded CANKGSB-3.5 11-M90. It has been amended five times, the last update being published in December 1997.

Octane Grades

See **Table A.5.13** below.

Volatility Classes

The following volatility classes apply at the point of retail sale: A, B, C and D. The following volatility classes apply at the primary terminal or at the point of entry into Canada: Al and A2.

Table A.5.13 Gasoline Antiknock Performance

Grade	Antiknock Index (1) [R +M]/2 (Min.)	MON (Min.)	Colour
Grade 1 — Regular	87.0	82.0	Undyed
Grade 2 — Mid-grade	89.0	-	Not specified
Grade 3 — Premium	91.0	-	Green
Grade 4 — Super-Premium	93.0	-	Not specified

(1) Antiknock performance is a function of the Antiknock Index. The [R + M]/2 values for Grades 1 to 4 shall not be less than the minimum specified in **Table A.5.13**, with the adjustment for altitude and climatic conditions specified in **Table A.5.16**. ASTM Methods D 26993, D 27003 or D 2885 may be used, (The latter two are referee method(s) to be used in the event of a dispute).

Table A.5.14 Detailed Requirements

Characteristic	Grades 1, 2, 3 and 4		Test Method ASTM (except par. 7.9)
	min	max	
Copper Corrosion 3 h at 50°C		No. 1	D 130
Existent Gum, (mg/100 ml)		5.0	D 381
Lead Content, (mg Pb/l)		5.0	D 3237
Manganese Content, (mg Mn/l)		18.0	D 3831
Oxidation Stability, Minutes (Induction Period)	240		D 525
Phosphorus Content, (mg P/l)		1.3	D 3231
Sulphur, (% m/m)		0.10	D 1266 D 2622 D 3120 (Note 2) D 4294
Corrosion, Steel in Water		B+	NACE TM0172
Oxygen Content, (% m/m)	0.5	3.7	(Par. 10.2.1)
Ethanol, % v/v of Oxygenate	50.0		D 4815
Methanol Content, (% v/v)		0.3	D 4815
Antiknock Performance	See Tables ?? and ??		D 2699 and D 2700 (Note 2) D 2885
Vapour Pressure	See Tables 2A and 2B		D 4953 (Note 3) D 5190 (Note 3) D 5191 (Notes 2 and 3)
Distillation	See Tables 2A and 2B		D 86
Water Tolerance	See Table 2B and par. 9.2		D 4814, Annex A3 (Note 4)

Ethanol Requirements

The ethanol used in the preparation of oxygenated unleaded gasoline shall comply with the specified limiting values. The specified limiting values must not be changed. This precludes any allowances for the test method precision and for adding or subtracting digits.

Table A.5.15 Ethanol Limit Values

Ethanol Characteristic	Max	Test Method
Copper content, (mg Cu/l)	0.1	ASTM D 1688 (1)
Acidity (as acetic acid), mg/l, (% m/m)		
-In absence of corrosion inhibitors and detergents	30 (0.0038)	ASTM D 1613
-In presence of corrosion inhibitors and detergents (2)	42 (0.0053)	
Water, (% m/m)	1.0	E 203
Ethanol denaturants, (% v/v)	5.0	(3)
Chloride Content, (mg Cl/l)	10.0	ASTM D 512 (4)

(1) Test in accordance with ASTM D 1688, Test Method A, Atomic Absorption, Direct, modified as follows:

The modification of ASTM D 1688, Test Method A consists of mixing reagent grade ethanol (which may be denatured according to Excise Act, Specially Denatured Alcohol Grade 1-G or 1-K) in place of water as the solvent or diluent for the preparation of reagents and standard solutions. Caution: This must NOT be done to prepare the stock copper solution described in ASTM D 1688 Test Method A, because a violent reaction may occur between the acid and the ethanol. Use water, as specified, in the acid stock solution part of the procedure to prepare the stock copper solution and use ethanol for the rinse and final dilution only.

(2) Corrosion inhibitors and detergents may affect the titratable acidity (acetic acid).

(3) Ethanol denaturants shall consist of a hydrocarbon mixture according to Excise Act, Denatured Alcohol Grade No. 2-F with a final boiling point less than 225°C in accordance with ASTM D 86.

(4) Chloride Content - Test in accordance with ASTM D 512, Test Method C, Ion-Selective Electrode Method.

Table A.5.16 Seasonal and Geographical Schedule of Antiknock Index Reductions to Adjust for Altitude and Climatic Conditions

Zone	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
Coastal B.C., New Brunswick, Nova Scotia, P.E.I. and the island of Newfoundland	0	0	0	0	0	0	0	0	0	0	0	0
Interior B.C., Alberta and Yukon	1.0	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Saskatchewan	1.0	1.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Manitoba, N.W.T., Nunavut and N.W. Ontario	1.0	0.5	0.5	0	0	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Ontario (except N.W. Ontario), Quebec and Labrador	0.5	0.5	0	0	0	0.5	0.5	0.5	0	0	0	0.5

Table A.5.17 Volatility Class Characteristics and Water Tolerance

Volatility Class (1)	Vapour Pressure, (kPa)		Distillation Temperature (°C)					Water Tolerance (°C)
			10%		50%		90%	
	min	max	min	max	min (2)	max	max	max
A1	41	72	35	65	70	120	190	- 10
A2	41	62	35	65	70	120	190	- 10
A	41	79	35	65	70	120	190	- 10
B	48	86	-	60	70	117	190	- 20
C	59	97	-	55	70	113	185	- 30
D	69	107	-	50	70 (3)	110	185	- 40

(1) The following volatility classes apply at the primary terminal or at the point of entry into Canada: Al and A2. The following volatility classes apply at the point of retail sale: A, B, C and D

(2) Gasoline with a 50% distillation point below 75°C may need an additive to avoid carburettor icing.

(3) Gasoline with a 50% distillation point greater than 65°C but less than 70°C may be provided if the Vapour Pressure is below 97 kPa to avoid warm engine drivability problems.

Table A.5.18 Seasonal and Geographical Schedule for Volatility Classes

Geographical Area (1)	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
I (2, 3)	D	D	D	C	B	A	A	A	B	C	D	D
					B/A1	A1	A1	A1	A11B			
IA (1, 2, 3)	D	D	D	C	B	A	A	A	B	C	D	D
				C/A1	A2	A2	A2	A2	A11B			
II	D	D	D	D	C/B	B	A	B	C	D	D	D
III (2, 3)	D	D	D	D	C1B	B/A	A	A/B	B/C	C1D	D	D
					C/A1	A1	A1	A1	A1/C			
IV (2, 3)	D	D	D	D/C	B	A	A	A	B	C	D	D
					B/A1	A1	A1	A1	A11B			
IVA (1, 2, 3)	D	D	D	D/C	B	A	A	A	B	C	D	D
					B/A1	A2	A2	A2	A1/B			
V (2, 4)	D	D	D	D	C	B	B	B	C	D	D	D
					C/A1	A1	A1	A1	A1/C			
VI (2)	D	D	D	D	C	B	A	A	B	C	D	D
					C/A1	A1	A1	A1	A11B			
VII	D	D	D	D	C	B	B	B	C	D	D	D
VIII	D	D	D	D	D	D	C	C	D	D	D	D

(1) The approximate geographical areas are illustrated in **Figure A.5.1**. Area IA corresponds to the Lower Fraser Valley and means that part of British Columbia bounded on the north by latitude 49°30', on the west by longitude 123°20', and on the east by longitude 121°15'. Area IVA is that part of Ontario that lies south of a straight line passing through Arnprior and Grand Bend. Where the line so described runs across a local municipality, the entire local municipality is part of Area IVA.

(2) Where two volatility classes are indicated, the first class listed shall be supplied during the first fifteen days of the month and the second class during the remainder of the month.

(3) Where two sets of volatility classes are indicated for a specific geographic area, the upper set applies to the point of sale and the lower set applies to the primary terminals contained within that geographic area.

(4) In Area V, Class AI applies to the Island of Newfoundland only.

A.5.2.4. Diesel Fuel Regulations

Sulphur

Environment Canada introduced a regulation requiring 500 mg/kg maximum sulphur content for all Canadian diesel fuel used for on-road applications. Canada Gazette II was issued on 19 February, 1997 as the final regulation, with an implementation date of 1 January 1998.

British Columbia Diesel Fuel Regulations

In 1994 British Columbia adopted a regulation requiring low sulphur diesel fuel (500 mg/kg) in the Lower Fraser Valley and, as of 1 April 1995, throughout the entire province.

A.5.2.5. Automotive Low-Sulphur Diesel Fuel Standard (CAN/CGSB-3.517-2000)

Scope

The supply of low-sulphur diesel fuel (less than 500 mg/kg) to on-road (also called on-highway) vehicles was required as of January1, 1998. The supply of ultra low-sulphur diesel fuel (less than 15 mg/kg) to on-road vehicles is required by mid 2006.

The standard was first published in December 2000 and has subsequently been amended twice. It was last updated in September 2004 and details will be found in **Part 1**, **Section 5.2.5**.

A.5.2.6. Regular Sulphur Diesel Fuel Standard (CAN/CGSB-3.6-2000)

Scope

This standard applies to two types of diesel fuel, Type A and Type B, that are suitable for use in high-speed diesel engines. Both types may be used in off-road diesel-powered equipment. Type A is intended for use when ambient temperatures require better low temperature properties than those exhibited by Type B.

The standard was first published in December 2000 and supersedes CAN/CGSB-3.6-M90. It has been amended twice, the last revision being issued in September 2004. The standard will be found in **Part 1**, **Section 5.2.6**.

A.5.2.7. Automotive Low-Sulphur Biodiesel Fuel Standard (CAN/CGSB-3.520-2005)

Scope

This standard applies to two types of automotive low-sulphur (LS) diesel fuel containing low levels of biodiesel esters, Type A-LS, Bx and Type B-LS, Bx. Bx represents biodiesel fuel containing x percent by volume of biodiesel ester component in the range of 1.0 to 5%. Fuel to this standard is intended for use in high-speed diesel engines that require low-sulphur diesel fuel to meet emission control regulations and high-speed diesel-powered equipment.

The standard was first published in April 2005 and is tabulated in **Part 1**, **Section 5.2.7**.

A.5.2.8. Future Automotive Fuel Standards

On 19 February 2001, the Environment Minister made public the details of a ten year Plan of Action for cleaner vehicles, engines and fuels as an integral part of the Government of Canada's Clean Air Strategy. Environment Canada plans to continue its approach of generally aligning Canadian environmental fuel requirements with those of the US, while taking into consideration environmental standards developed by the European Union.

Cleaner Fuels - Summary

The Plan details several measures for cleaner fuels:

- Environment Canada will conduct further analysis on the composition of gasoline to determine if additional controls on gasoline quality have the potential to reduce emissions of toxic substances from vehicles;
- a Canada Gazette notice will be published requesting information on the use and release into the environment of the gasoline additive MTBE;
- reducing the level of sulphur by 2006 in on-road diesel fuel used by trucks and buses, by aligning Canadian requirements with those in the United States;
- establishing a new limit for sulphur in non-road diesel fuel used in construction and agricultural equipment;
- establishing a comprehensive database on diesel fuel quality in order to monitor fuel quality.

Environment Canada will investigate complementary measures to regulations, such as economic instruments, to promote the early introduction of cleaner fuels into Canada.

Gasoline - Air Toxics

The *Benzene in Gasoline Regulations* include controls on the Benzene Emissions Number (BEN). These controls indirectly constrain the levels of aromatics in Canadian gasoline. Expanding the BEN to a Toxics Emissions Number (TEN) would probably result in indirect restrictions on both aromatics and olefins. At present, it is not clear what additional environmental benefits could be achieved by explicit controls on aromatics and olefins, nor is it known what components might replace the aromatics and olefins in the gasoline if reductions were mandated for those substances. Environment Canada therefore believes that it is premature to initiate any actions on controlling aromatics and olefins beyond the possible indirect controls through a limit on TEN.

At present, Environment Canada is not considering regulatory action to control the level of aromatics or olefins in Canadian gasoline. Environment Canada will closely monitor international programmes examining issues related to aromatics and olefins, and will continue to analyse data from such programmes.

Gasoline Sulphur

The federal *Sulphur in Gasoline Regulations* were passed in 1999 and come into effect in mid 2002, with 30 mg/kg gasoline required in 2005. It is expected that due to the 2002 - 2004 interim averaging provisions, considerable quantities of 30 mg/kg gasoline will be available by mid-2003. Although it is expected that in time sulphur levels well below 30 mg/kg will be required for allowing continued improvements in vehicle emissions control technologies, it is not clear when this low level of sulphur will be required.

No additional regulatory action to further reduce sulphur in gasoline is currently being considered. Environment Canada will closely monitor international programmes examining the issue of sulphur, and will continue to analyse data from such programmes.

Gasoline Driveability Index (DI)

Environment Canada is not currently considering regulatory action to control the driveability index. The Department will maintain close contact with international programmes examining the issue of the Driveability Index, and will continue to analyse data from such programmes. In addition, Environment Canada considers it prudent to gather information on the input parameters to DI, specifically the distillation values of gasoline (T10, T50, T90) and the concentration of oxygen (by type of oxygenate).

Diesel Fuel - Sulphur (On-road)

In June 2001, Environment Canada issued a discussion paper seeking stakeholders' comments on the proposed approach to regulate the level of sulphur in on-road diesel to 15 mg/kg, by mid-2006, harmonized with the US EPA rulemaking. The Canadian Petroleum Product Institute (CPPI) indicated that a phased-in approach (requiring gradual introduction into the market place, from 80% in 2006, to 100% in 2010) was not appropriate to the Canadian situation. This currently means being prepared to offer 15 mg/kg maximum sulphur diesel in the market by September 2006. This quality of fuel has been determined to be needed by the emission control systems expected to be installed on new 2007 on-road diesel engines that will be arriving in the market at the same time. CPPI recommends that Environment Canada should, however, keep aware of the process in the US and maintain flexibility to adjust should the US rules be amended for level or timing.

Diesel Fuel - Sulphur (Non-road)

Environment Canada plans to recommend a regulatory limit for sulphur in non-road diesel. The limit would be established in the same time frame that the EPA plans for developing limits for sulphur in US non-road diesel. In preparation for this, Environment Canada will gather information on where non-road diesel is used, the effects of sulphur reduction on emissions, and the costs of reducing sulphur in diesel for use in all non-road engines and vehicles, including rail and marine applications.

Diesel Fuel - Other Parameters

Environment Canada is of the view that there is currently insufficient evidence regarding the effects on emissions, engines and emission control equipment of parameters other than sulphur to justify setting requirements for these characteristics. Environment Canada will continue to closely monitor the results from fuel programmes to understand the effects of such parameters on emissions and to analyse data from such programmes. The Department will also continue to undertake its own tests on Canadian diesel fuel.

Environment Canada considers it prudent to gather more information on the composition of Canadian diesel fuel (both for on-road and non-road diesel), particularly on cetane, aromatics and PAH levels (information on sulphur and density levels is already collected under the Fuels Information Regulations). This information is important in order to assess the effect of potential fuel controls that might be considered in the future.

Actions to Promote Early Introduction of Cleaner Fuels

Environment Canada will explore complementary measures to regulations, such as economic instruments and other measures, to promote the early introduction of cleaner fuels including low sulphur fuels. Environment Canada also intends to continue to explore with other federal departments the purchase of cleaner fuels for use in government vehicles and facilities. Environment Canada will assess measures to ensure that they should have the desired impacts.

A.5.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

Canada has adopted US Federal test procedures.

A.5.4. REFERENCE FUELS

As Canadian emissions standards are harmonised with the US Federal standards, similar certification fuels are employed.

A.5.5. FUEL ECONOMY AND CO_2 REGULATIONS

An agreement on climate change action was signed by the Government of Canada and the Canadian automobile industry on 5 April 2005. This is described in **Part 1**, **Section A.5.5**

A.5.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

These regulations apply to vehicles and engines that are manufactured in Canada, or imported into Canada, on or after January 1, 2004 and are described in **Part 1**, **Section A.5.6**.

A.6. CENTRAL & SOUTH AMERICA REGULATIONS

A.6.1. VEHICLE EMISSIONS LIMITS

Introduction

A number of countries in South America have introduced emissions limits based generally on US or EU regulations.

A.6.1.1. Argentina

The vehicle emissions regulations were published in the Official Bulletin No. 27.919 dated 27 June 1994. The limits for light duty vehicles closely follow Brazilian legislation but with later implementation dates.

Table A.6.1 Argentine vehicle emissions limits (US FTP 75 and HD cycles)

Vehicle		Effective Date	CO (g/km)	HC (g/km)	NOx (g/km)	PM (g/km)(3)	CO at idle (2) (%v/v)	HC at idle (2) (ppm)	evaporative emissions (g/test) (2)
passenger cars light duty ≤2.8t	all vehicles	01/07/94	-	-	-	-	3.0	600	-
	new vehicles	01/01/95	12.0	1.2	1.4	0.373	2.5	400	6.0
	all imports	01/01/97(4)	2.0	0.3	0.6	0.124	0.5	250	6.0
	all new reg.	01/01/98	6.2	0.5	1.43	0.16 (6)	0.5	250	-
heavy duty >2.8t	all vehicles	01/01/95	11.2	2.4	14.4	0.4/0.68	3.0	600	-
		01/01/97	11.2	2.4	14.4	0.4/0.68	2.5	400	-
	urban buses	01/01/96	4.9	1.23	9.0	0.4/0.68	-	-	-
	all diesels	01/01/98	4.0	1.1	7.0	0.15/0.255	-	-	-

(1) Crankcase emissions are not allowed from any naturally aspirated engine. For turbo-charged engines, crankcase HC emissions are added to the exhaust emissions.
(2) Gasoline engines only.
(3) Diesel vehicles only, heavy duty smoke emissions to ECE r 24.01, dual limits apply to vehicles with max power above/below 85 kW.
(4) 01/01/99 for all new registrations.
(5) Emissions compliance must be guaranteed for 80 000 km or 5 yr for passenger cars and light duty vehicles and 160 000 km or 5 yr for heavy duty vehicles, whichever occurs first. These guarantees are not required for vehicles certified at emission levels 10% below the applicable standards.
(6) PM 0.31 g/km for vehicles <1700 kg.

A.6.1.2. Brazil

Light Duty Vehicles

The Brazilian Congress passed law No. 8723, effective 1 October 1993, setting strict emission standards for passenger vehicles covering the rest of the decade. The limits are measured using the US FTP 75. The limits do not correspond exactly with US standards but the 1992 standard lay between US 1973 and 1975 limits. The 1997 standard was equivalent to US 1981 standard. More stringent limit values were planned for introduction in 2000.

The law also empowers state environmental agencies with more effective enforcement, including the operation of vehicle inspection stations. Another two regulations have been established by CONAMA. One requires manufacturers to provide the information needed for establishing tune-up and maintenance standards. The other establishes minimum requirements for inspection and maintenance programmes, which involves a two speed test with 30 seconds preconditioning. Sao Paulo introduced the first inspection programme beginning in 1995. It is planned to require the annual inspection of cars more than 2 years old. Cars that exceed limits will not be permitted on the road until repaired.

Table A.6.2 Light Duty Emission Standards (5) - Brazil (US FTP - 75 Test Cycle)

Year	Vehicle (5)	CO (g/km)	CO Idle (3) (% v/v)	HC (g/km)	RCHO (1) (g/km)	NOx (g/km)	PM (2) (g/km)	Evap (4) (g/test)
01/01/92	cars	24	3.0	2.1	0.15	2.0	-	6.0
01/01/92	utility	12	2.5	1.2		1.4		6.0
01/01/97	all	2.0	0.5	0.3	0.03	0.6	0.05	6.0
2000		proposed to bring limits in line with US 1983 limits						

(1) Aldehydes (RCHO) limit for alcohol fuelled vehicles only

(2) Diesel-fuelled vehicles only

(3) Idle CO for alcohol and gasoline vehicles only.

(4) Evaporative emissions expressed as propane for gasohol and ethanol for alcohol fuelled vehicles.

(5) Diesel engined passenger cars not allowed

Heavy Duty Vehicles

New emission standards were established for heavy duty vehicles by the National Environmental Council (CONAMA) on 31 August 1993 (see **Table A.6.3**). A revised implementation schedule introduced the limits in four Phases (I - IV), with a more rapid introduction for urban buses and imported vehicles. The limits for Phase IV were to be confirmed by the end of 1994.

Manufacturers of light duty trucks, including utility vehicles, pick-ups etc. (over 2000 kg GVW) have the option to chose either the LDV or HDV test procedures for certification. As a result, light duty trucks with low speed diesel engines are still technically feasible while high speed diesels have to be tested by the FTP procedure and comply with the 0.05 g/km particulate emission standard. Although diesel engines are not presently allowed for most LDVs, a particulate standard has been adopted in case regulations change.

Table A.6.3 Heavy Duty Emission Standards - Brazil (ECE R49 test cycle)

Vehicle Class	Date	Phase	% Vehicles	CO g/kWh	HC g/kWh	NOx g/kWh	PM g/kWh	Smoke k (2)
All Vehicles	01/01/96	II	20	11.2	2.45	14.4	-	2.5
		III	80	4.9	1.23	9.0	0.4 (1)	2.5
	01/01/00	III	20	4.9	1.23	9.0	0.4 (1)	2.5
		IV	80	4.0	1.1	7.0	0.15	-
	01/01/00	IV	100	4.0	1.1	7.0	0.15	-
All Imports	01/01/94	III	100	4.9	1.23	9.0	0.4 (1)	2.5
	01/01/98	IV	100	4.0	1.1	7.0	0.15	-
Buses	01/01/96	III	80	4.9	1.23	9.0	-	2.5
		III	80	4.9	1.23	9.0	0.4 (1)	-
	01/01/98	III	20	4.9	1.23	9.0	0.4 (1)	-
		IV	80	4.0	1.1	7.0	0.15	-
	01/01/02	IV	100	4.0	1.1	7.0	0.15	-

(1) Particulate emissions (PM) 0.7 g/kWh for engines up to 85 kWh, 0.4 g/kWh for engines up to 85 kWh.

(2) k = soot (g/m^3) x gas flow (l/s)

(3) Crankcase emissions must be nil, except for some turbo-charged diesel engines if there is a technical justification

(4) Emissions must be warranted for 80 000 km for LDVs, 160 000 km for HDVs, or alternatively emissions must be 10% below the limits set.

A.6.1.3. Chile

Legislation was implemented by the Ministerio de Transportes y Telecomumicaciones which required all new cars to meet US emission limits. This applied from September 1993 to the greater Santiago area, which has a significant smog problem, and from September 1994 and 1995 respectively for heavy duty vehicles in the rest of the country. Such vehicles will be permitted to use the roads in Santiago at all times, while the existing non-catalyst cars will be subject to a 20% off-the-road restriction on weekdays. 91 RON unleaded gasoline will be made available for the new catalyst equipped cars. Retrofitting some of the older vehicles with catalysts is also under consideration.

Table A.6.4 Chilean vehicle emissions legislation

Vehicle		Effective Date	CO (g/km)	HC (g/km)	NOx (g/km)	PM [4] (g/km)	Test Cycle
Passenger cars		1995	2.11	0.25	0.62	0.125	FTP 75
Light & medium duty	gvw <3860 kg	1995	6.20	0.50	1.43	0.16 [2]	FTP 75
			(g/kWh)	**(g/kWh)**	**(g/kWh)**	**(g/kWh)**	
Heavy duty diesel	gvw ≥3860 kg	01/09/94	4.5	1.1	8.0	0.36 [3]	ECE R 49 [1]
		01/09/98	4.0	1.1	7.0	0.15	
			(g/bhp.h)	**(g/bhp.h)**	**(g/bhp.h)**	**(g/bhp.h)**	
		01/09/94	15.5	1.3	6.0	0.36	US HDDTC [1]
		01/09/98	15.5	1.3	5.0	0.10	
Heavy duty gasoline	gvw ≥3860 kg	current	37.1	1.9	5.0	-	US HDDTC
Santiago urban bus		01/09/93	15.5	1.3	5.0	0.25	US HDDTC [1]
		01/09/96	15.5	1.3	5.0	0.10	
			(g/kWh)	**(g/kWh)**	**(g/kWh)**	**(g/kWh)**	
		01/09/93	4.5	1.1	8.0	0.36 [3]	ECE R 49 [1]
		01/09/96	4.0	1.1	7.0	0.15	

(1) Alternative limits

(2) PM 0.31 g/km for vehicles >1700 kg curb weight

(3) For engines ≤85 kW the PM limit is 0.61 g/kWh

(4) For diesel engines only

(5) For gasoline engines, no crankcase emissions allowed and evaporative emissions 2 g/test for passenger cars, light and medium duty vehicles, 4 g/test for heavy duty vehicles

A.6.1.4. Colombia

Colombia promulgated emissions legislation in 1996 for three classes of road vehicle (light, medium and heavy; gasoline or diesel). These came into effect in 1997 for imported vehicles and applied to locally assembled models from 1998. In addition, in-use limits have been developed which will apply to all road vehicles.

A.6.1.5. Costa Rica

Vehicle emissions regulations in Costa Rica were introduced in 1995 according to regulation Ley de Transito por Vias Publicas Terrestres, Section V. They can be specified according to US or ECE regulations. The limits for the US test methods are given in **Tables A.6.5** and **A.6.6**.

Table A.6.5 Costa Rican emissions regulations (1995)

Vehicle Category	Test Procedure (1)	Emission Limits (1)
Gasoline passenger car and light duty vehicles (gvw ≤3500 lb)	FTP 75 ECE R 83	US 1981 91/441/EEC
Diesel passenger car and light duty vehicles (gvw ≤3500 lb)	FTP 75 ECE R 83 ECE R 24	US 1988 91/441/EEC ECE R 24.03
Heavy Duty Vehicles >3500 lb	US HDDTC ECE R 49 ECE R 24	US 1991 91/542/EEC ECE R 24.03

(1) Optional US or ECE

Table A.6.6 Costa Rican vehicle emissions limits, implemented in 1995 according to US test procedures.

Vehicle	gvw	CO	NMHC	NOx	PM
Gasoline	≤1800 kg	5.7 g/km	0.25 g/km	0.63 g/km	
	1800 - 2800 kg	6.2 g/km	0.50 g/km	1.10 g/km	
	2800 - 6400 kg	19.2 g/kWh	1.2 g/kWh	10.6 g/kWh	
	>6400 kg	49.8 g/kWh	2.3 g/kWh	10.6 g/kWh	
Diesel	≤3500 kg				1.1 g/test
	>3500 kg				0.36 g/kWh

A.6.1.6. Mexico

On 6 June 1988 the Mexican authorities announced a decision to introduce more stringent standards for light duty vehicles, culminating in full US 1981 limits by 1993. With respect to heavy duty vehicles, standards were introduced for the years 1994 and 1998, equivalent to the US Federal 1994 and 1998 limits. The limits are given in **Table A..6.7**.

Table A.6.7 Mexican Emissions Standards (US FTP 75 procedure)

Vehicle Type		Effective Date	CO (g/mile)	HC (g/mile)	NOx (g/mile)	PM
Cars		1993	3.4	0.41	1.00	
Light Duty Vehicles	**gvw <6012 lb**	1994	14.0	1.00	2.30	
Light Duty Vehicles	**gvw 6013-6614 lb**	1994	14.0	1.00	2.30	
			(g/bhp.h)	**(g/bhp.h)**	**(g/bhp.h)**	**(g/bhp.h)**
Heavy Duty Trucks	**gvw >8500 lb**	1994	15.5	1.3	5.0	0.10/0.07 (1)
		1998	15.5	1.3	4.0	0.10/0.05 (1)

(1) Lower limits for urban buses

The Environment Ministry (SEMARNAT) proposed revisions to a number of emissions standards in 2004. The first draft was NOM-042, which established more stringent standards for new light duty vehicles. This set limit values similar to the

US Federal Tier 1 standards, including durability. It will apply to all spark ignition vehicles manufactured in Mexico from 2006. The NOM will also phase-in US Federal Tier 2 standards, but the implementation schedule was not known at the time of publication of this report.

A.6.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.6.2.1. Argentina Gasoline Specifications

Table A.6.8 Gasoline Specifications – Argentina

Characteristic	Unit	Current specifications: Year 2004 (1)		Future specifications						Test Method
		Común, Normal or Regular	Super, Extra or Especial	2006 (1)		2008 (1)		2009 (1)		
		Regular	Medium	Regular	Medium	Regular	Medium	Regular	Medium	
RON		83	93	83	93	83	93	83	93	ASTM D 2699 IRAM IAP A 6521
MON		75	84	75	84	75	84	75	84	
Lead Content (max)	mg Pb/l	13	13	13	13	13	13	12	0,013 max	ASTM D 3237 ASTM D 3116 IRAM IAP 6521-2
Sulphur Content max.	mg/kg	600	350	600 500 (2)	350 300 (2)	600 500 (2)	350 300 (2)	50	50	ASTM D 2622
RVP max. @ 37.8°C	kPa	See following table								
Final Boiling Point (max)	°C	225	225	225	225	225	225	225	225	
Oxygen Content (max)	%m/m	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	
Benzene Content max.	%v/v	2.5	2.7	1.5	1.5	1.0	1.0	1.0	1.0	ASTM D 3606 IRAM-IAP A 6560
Aromatics Content max.	%v/v	45	45	40	40	35	35	35	35	ASTM D 1319 IRAM 41093
MTBE (max)	%v/v	15	15							ASTM D 4815
Ethanol (1)	%v/v	5	5							
Isopropyl Alcohol (1)	%v/v	5	5							
Tertiary Butyl Alcohol (1)	%v/v	7	7							
Isobutyl Alcohol (1)	%v/v	7	7							

(1) Resolution 222/01 (Modif. 394/02, 398/03 and 824/03)

(2) Applicable to Buenos Aires and the Gran Buenos Aires (except La Plata)

Table A.6.9 Gasoline Vapour Pressure – Argentina (Resolution 222/01)

Zone	Volatility Class	Period	RVP (kPa)
North	A	01/Nov to 31/March	35-70
	B	01/04 to 31/10	45-80
Centre	A	01/Dec to 29/Feb	35-70
	B	01/March to 30/Apr and	
		01/Oct to 30/Nov	45-80
	C	01/May to 30/Sep	55-90
South	B	01/Nov to 31/March	45-80
	C	01/Apr to 30/Oct	55-90
North	Provinces north to Neuquén and Río Negro Provinces, except Bahía Blanca, Coronel Rosales, Coronel Dorrego, Monte Hermosos, Patagones and Villarino Part of Buenos Aires Province and Caleu Caleu, Curacó, Guatraché, Hucal, Liuel Calel, Limay Mahuida, Puelén y Utracán (La Pampa Province)		
Centre	Includes Neuquén and Río Negro Provinces, Buenos Aires and La Pampa Parts excluded from the North Zone and the following departments of Chubut Province: Cushamen, Gastre and Telsen		
South	Territories south to the limits of Río Negro Province, exept for the Parts of Chubut Province belonging to Centre Zone		

A.6.2.2. Bolivia Gasoline Specifications

Table A.6.10 Gasoline Specifications – Bolivia

Property		Especial (Regular)	Premium	Test Method
RON	min	85	95	ASTM D 2699
MON		Report	Report	ASTM D-2700
Density @ 15°C (kg/m^3)		Report	Report	ASTM D 1298
Colour		Colourless to light yellow	Violet	Visual
Lead Content (mg Pb/l)	max	13	13	ASTM D 3237
Manganese Content (mg Mn/l)	max	18	18	ASTM D 3831
Sulphur Content (mg/kg)	max	500	500	ASTM D 1266
Existent Gum (Unwashed) (mg/100 ml)	max	5	5	ASTM D 381
Copper Corrosion Strip (3 hours, 50°C)	max	1	1	ASTM D 130
RVP @ 37.8°C (psi)		7 to 9.5 (2)	7 to 9.5 (2)	ASTM D 323
T10 (°C)	max	60 (3)	60 (3)	ASTM D 86
T50 (°C) (4)		77-118	77-118	ASTM D 86
T90 (°C) (4)	max	190	190	ASTM D 86
FBP (°C)	max	225	225	ASTM D 86
Residue (%v/v)	max	2	2	ASTM D 86
(A) Vapour/Liquid Ratio (B) Temperature ((°C))	(B) min	(A)20 (B)51	(A)20 (B)51	ASTM D 2533
Oxygen (%m/m)	max	2.7	2.7	ASTM D 2504
Benzene Content (%v/v)	max	3.0	3.0	ASTM D 4053
Aromatics Content (%v/v)	max	42.0	48.0	ASTM D 1319
Olefins Content (%v/v)	max	18	18	ASTM D 1319
Appearance		Crystalline	Crystalline	Visual
Calorific Value (BTU/lb)		Report	Report	ASTM D 240

(1) Approximate value, constitutes specification. @ 15.6°C. Original unit: Specific Gravity @ 15.6/15.6°C.
(2) 9.0 psia max during summer
(3) 56°C min during summer; 65°C max during summer.
(4) Summer limits.
(5) 190°C max during summer.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.3. Brazil Ethanol and Gasoline Specifications

Under the terms of ANP Act Nº 204, “Gasoline A” grades are produced by oil refineries and the petrochemical industry and these are blended with 20 to 25% anhydrous ethanol [Method ABNT NBR. 13992]. Blending is carried out by refiners, the petrochemical industry and distributors to provide “Gasoline C” blends for sale in the retail network.

Table A.6.11 Gasoline Specifications Brazil

Characteristic		2004 Specifications				2007 and 2009 Specifications (15)		
		Comun Tipo A (1), (2)	**Comun Tipo C** (1)	**Premium Type A** (1), (2)	**Premium Tipo C** (1)	**Regular Type C**	**Premium Type C**	**Test Methods**
MON			82 (9)			82		ASTM D 2700 ABNT MB 457
(R+M)/2			87 (9)		91 (9)	87	91	ASTM D 2699 ASTM D 2700 ABNT MB 457
Density @ 15°C (kg/m^3)		Report (14)	Report (14)	Report (14)	Report (14)			ASTM D 1298 ASTM D 4052 ABNT NBR 7148
Colour		(3)	(4)	(3)	(4)			Visual (5)
Lead Content (mg Pb/l)	max	5 (11)	5 (11)	5 (11)	5 (11)			ASTM D 3237
Sulphur Content (mg/kg)	max	1200 (12)	1000	1200 (12)	1000	80	80	ASTM D 1266 ASTM D 3120 ASTM D 4294 ABNT NBR 6563
Oxidation Stability (minutes)	min	(2) (13)	360 (13)	(2) (13)	360 (13)			ASTM D 525 ABNT MB 288
Washed Gum (mg/100 ml)	max	5	5	5	5			ASTM D 381 ABNT MB 289
Copper Corrosion Strip (3 hours, 50°C)	max	1	1	1	1			ASTM D 130 ABNT MB 287
RVP @ 37.8°C (psi)	max	6.5-9.0 (10)	10.0 (10)	6.5-9.0 (10)	10.0 (10)			ASTM D 4953/ ASTM D 5190/ ASTM D 5191/ ASTM D 5482
T10 (°C)	max	65.0	65.0	65.0	65.0			ASTM D 86 ABNT NBR 9616
T50 (°C)	max	120.0	120.0	120.0	120.0			
T90 (°C)	max	190.0 (8)	190.0 (8)	190.0 (8)	190.0 (8)			
FBP (°C)	max	220.0	220.0	220.0	220.0			
Residue (%v/v)	max	2.0	2.0	2.0	2.0			
Benzene (%v/v)	max	1.2 (12)	1.0	1.9 (12)	1.5			ASTM D 3606 ASTM D 5443 ASTM D 6277
Aromatics (%v/v)	max	57 (12)	45	57 (12)	45			
Olefins (%v/v)	max	38 (12)	30	38 (12)	30			
Appearance			(6)	(6)	(6)			
Additives			(11)	(11)	(11)			

(1) Every specified limit is an absolute value according to rule ASTM E 29.

(2) Gasoline produced in the country or imported without oxygenated compounds.

(3) Colourless to yellowish, without colouring.

(4) Colourless to yellowish if without colouring. Colouring addition is permitted except for blue and pink, which are restricted to aviation gasoline and the mixture Methanol/Ethanol/Gasoline respectively.

(5) The visualization takes place in a glass receiver according to method NBR 7148 or ASTM D 1298.

(6) Limpid and with no impurities.

(7) Anhydrous ethanol addition is mandatory by law. The fixed amount of ethanol added to gasoline must be within 20% to 25% and actual value is determined according ethanol availability.

(8) While trying to inhibit contamination, the value of T90 must not be less than 155°C for Gasoline Type A, and 145°C for Gasoline Type C.

(9) The producer must report the octane number of the mixture with 1% lower volume of anhydrous ethanol than the established value.

(10) For the states of R.G Do Sul, Sta. Catarina, Paraná, Sao Paulo, R. de Janeiro, Espírito Santo, Minas Gerais, Mato Grosso, Mato Grosso do Sul, Goiás e Tocantins, and the Federal District, from april to november, the RVP max is allowed to increase up to 11,0 psi. Original unit: Kpa

(11) Permitted according to legislation. The use of heavy metals based additives is prohibited.

(12) Aromatics, olefins, benzene and sulphur content in gasoline type A in this table is related to a mixture with 22% ethanol, and it will be reduced or increased as ethanol content in mixture is increased or reduced.

(13) @ 100°C. Test must be performed with a mixture with 1% higher volume of ethanol anhydrous than the established value.

(14) Relative density @ 20/4°C.

(15) 2007 limits not defined at present time. Limited information on the 2009 proposals presented at a conference in 2003.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON > 95

Table A.6.12 Specifications Anhydrous Ethanol (AEAC) and Hydrated Ethanol (AEHC) [16 March 2001, ANP Act N°.45]: Brazil

Property		AEAC (1)	AEHC (2)	Method	
				ABNT/NBR	ASTM
Total acidity (as acetic acid), mg/l	max	30	30	9866	D 1613
Electrical conductivity, μS/m	max	500	500	10547	D 1125
Density @ 20°C, kg/m³ (3)	max	791.5	809.3 ± 1.7	5992	D4052
Alcohol content °INPM (4)	min	99.3	93.2 ± 0.6	5592	-
Density @ 20°C, kg/m³ (5)	max	-	808.0 ± 3.0	5992	D4052
Alcohol content (with allowable hydrocarbons of 30 ml/l) °INPM		-	92.6 - 94.7	5992	-
pH		-	7.0 ± 1.0	10891	-
Residue on evaporation, mg/l	max	-	5.0	8644	-
Hydrocarbon content, % v/v	max	-	3.0	13993	-
Ethanol content, % v/v (6)	min	99.3	92.6	-	D 5501
Chloride, mg/kg	max		1	10894/ 10895	D 512
Sulphate, mg/kg	max		4	10894/ 12120	-
Iron, mg/kg	max	-	5	11331	-
Sodium, mg/kg	max	-	2	10422	-
Copper, mg/kg	max	0.07		10893	-

(1) Anhydrous ethanol, “gasolina” blend stock.
(2) Hydrated ethanol “Alcool” fuel.
(3) Production specification, excluding hydrocarbons.
(4) ºINPM is a measure of ethanol content, based on temperature corrected relative density.
(5) Distribution specification, including 3% v/v hydrocarbons.
(6) Requirement when ethanol is not produced from sugar cane fermentation.

Background

Since 1979 the use of ethanol has been mandatory in Brazil through their government "*Proalcool*" programme. Two grades of gasoline and one alcohol fuel are available:

"*Alcool*" is hydrated ethanol, as produced by conventional distillation containing 93% ethanol and 7% water, often referred to as E93.

"*Gasolina*" is a blend of anhydrous ethanol and hydrocarbon streams containing 22% (± 1%) ethanol.

Specially designed vehicles are produced in Brazil to operate on one or the other of these fuels. The market for alcool (E93) vehicles has varied enormously over the last few years, depending upon tax incentives. In 2001, for example, alcool vehicles were only available by direct order from the car plants. Problems with crude supplies, imbalances in petroleum fuel demand and uncertainties over sugar subsidies leading to sugar shortages resulted in the proportion of alcohol in ‘gasolina’ being reduced from its original level of 22% to 12%. However, this led to an increase in emissions and the recent law setting revised emissions standards for Brazil also restored the composition of Brazil's gasohol mixture. [28 December 1999 ANP Act Nº 197 (republished on 18 August 2000 as ANP Act Nº 204)].

A.6.2.4. The Caribbean

Unleaded gasoline is widely available in most Caribbean Island markets, and also Bermuda, which is totally unleaded. Some Caribbean specifications will be found in the following pages.

A.6.2.5. Chile Gasoline Specifications

Leaded grades have been withdrawn – see **Part 2**, **Section B.6.2.2**.

Table A.6.13 Unleaded Gasoline Specifications: Chile

Characteristic		**Early 2004**				**May 2004**	**July 2004**	**January 2005**	**January 2007**	**Test Methods**
		Región Metropolitana		**Rest of the country [2]**		**Metropolitan Region**		**Rest of the country**		
		RON 93	**RON 97**	**RON 93**	**RON 97**	**All grades**		**All grades**		
RON		93	97	93	97					ASTM D 2699
MON		Report	Report	Report	Report					ASTM D 2700
Lead Content (mg Pb/l)	max	13	13	13	13					NCh2329 [3] or NCh1897 [4] ASTM D 3237 or D 5059 [15]
Phosphorous Content (mg P/l)	max	Report [7]	Report [7]	Report [7]	Report [7]					NCh2327
Sulphur Content (mg/kg)	max	400	400	1000	1000	150 [10]	30 [10]	100 [10]	30 [10]	D 1294, D 2622 or ASTM D 54538 [12]
Oxidation Stability (minutes)	min	240	240	240	240					NCh1853 ASTM D 525 [15]
Washed Gum (mg/100 ml)	max	5.0	5.0	5.0	5.0					ASTM D 381
Copper Corrosion Strip max (3 hours, 50°C)		1	1	1	1					NCh70 ASTM D 130 [15]
RVP @ 37.8°C (psi)	max	8.0 & 10.0 [16]	8.0 & 10.0 [16]	10.0 & 12.5 [17]	10.0 & 12.5 [17]	8.0 & 10.0 [16]	8.0 & 10.0 [16]	10.0 & 12.5 [17]	10.0 & 12.5 [17]	NCh1845 or NCh2328 ASTM D 323, 5191 or 1953 [15]
T10 (°C)	max	70	70	70	70					NCh66 ASTM D 86 [15]
T50 (°C)	max	121	121	121	121	121	121			
T90 max (°C)	max	190	190	190	190	177	177			
Final Boiling Point (°C)	max	225	225	225	225					
Residue (%v/v)	max	2.0	2.0	2.0	2.0					
A) Vapour/Liquid Ratio B) Temperature (°C)	max	A) 29 B) 47	A) 29 B) 47	Report	Report					NCh1846 (8)
Oxygen Content (%m/m)	max	2.0	2.0	Report	Report	2.0	2.0	Report	Report	n/r
Benzene Content (%v/v)	max	2.0	2.0	5.0	5.0	1.0	1.0	1.0	1.0	NCh2195 or NCh2246 ASTM D 1053 or D 3606 [15]
Aromatics Content max (%v/v)	max	35.0	Report	Report	Report	40.0	38.0	50.0	38.0	
Olefins Content max (%v/v)	max	35	20	Report	Report	20.0	12.0	40.0	20.0	
MTBE and other oxygenated compounds		Report [6]	Report [6]	Report	Report					

(1) National specifications NCh64-Of95 & NCh62-Of95 in force for all zones with no special environmental requirements.
(2) Regulations for urban zones with environmental restrictions established by the Decree D-16: General Secretariat of the Presidency.
(3) Use NCh2329 for both leaded and unleaded gasoline. NCh1843 & NCh2350 can be used as alternative methods.
(4) Use NCh1897 for both leaded and unleaded gasoline. NCh2351 can be used as alternative method for unleaded gasoline, and NCh2352 can be used for in-land determinations.
(5) NCh71/1 & NCh2325 can be used as alternative methods.
(6) For gasolines with these products, its type and percentage content must be declared.
(7) Phosphorus compounds cannot be added to gasoline, method NCh2327 must be used in case of arbitration.
(8) V/L can be calculated from the RVP and the distillation temperatures.
(9) This item is invalid for gasoline produced and used in Zones XI & XII of the country.
(10) Original unit: ppm.
(11) For Class I gasoline. For Class II gasoline corresponds 10 psi.
(12) Original unit: °F.
(13) For gasoline 93 & 97 Octane.
(14) 8.0 Type I (Sep. - March) for R.M.
(15) 9.5 Type II (April - August) for R.M.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.6. Colombia Gasoline Specification

Table A.6.14 Gasoline Specifications: Colombia

Characteristic		2004 [6]		2005 [4]		2008		Test Methods
		Regular	Extra	Regular Oxygenated	Extra Oxygenated	Regular	Extra	
(RON + MON)/2		81	87	84	89	81	87	ASTM D 2699 ASTM D 2700 [2]
Lead (mg Pb/l)	max	13	13	13	13	13	13	ASTM D 3237 ASTM D 5059
Sulphur (mg/kg)	max	1000	1000	1000	1000	300	300	ASTM D 4294 ASTM D 2622
Oxidation Stability (minutes)	min	240	240	240	240	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100ml)	max	5	5	5	5	5	5	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	1	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	8.5	8.5	9.3	9.3	8.0	8.0	ASTM D 323 ASTM D 5191 ASTM D 4953
T10 (°C)	max	70	70	70	70	70	70	ASTM D 86
T50 (°C)	max	77-121	77-121	77-121	77-121	77-121	77-121	
T90 (°C)	max	190	190	190	190	190	190	
FBP (°C)	max	225	225	225	225	225	225	
Residue (%v/v)	max			2	2	n/r	n/r	
Oxygen (%m/m)	max			3.5 [3]	3.5 [3]			ASTM D 5845 ASTM D 4815
Benzene (%v/v)	max	1	2.0	1.0 [5]	2.0 [5]	1.0	1.5	ASTM D 5580 ASTM D 3606 or PIANO
Aromatics (%v/v)	max	28	35	25	30	25	30	ASTM D 5580 ASTM D 1319 or PIANO
Vapour Lock Index	max	98	98	124	124	98	98	[1]
Ethanol (%v/v) [5]	max			10.0 ± 0.5	10.0 ± 0.5			
Water (%v/v)	max			0.04	0.04			ASTM D 6422

(1) VLI = RVP (Kpa) + 1.13 x E70
(2) Alternative method: IR.
(3) Refers to anhydrous ethanol addition and for oxygenated gasolines to be distributed in cities larger than 500,000 inhabitants.
(4) Resolution 0447 indicates the specifications of anhydrous ethanol to be added to oxygenated gasolines.
(5) Dilution effect for ethanol, not included.

- Specifications derived from Resolution 0447 (April 14, 2003).

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.7. Costa Rica Gasoline Specifications

Table A.6.15 Gasoline Specifications – Costa Rica

Characteristic		Regular Bio Plus	Super Eco	Test Methods
RON	min	88	94	ASTM D 2699
Density @ 15°C (kg/m^3)		Report	Report	ASTM D 1298
Colour		Orange	Green	Visual
Lead (mg Pb/l)	max	13	13	ASTM D 3227
Sulphur (mg/kg)	max	1500	1000	ASTM D 1266 ASTM D 2622
Oxidation Stability (minutes)	min	240	240	ASTM D 525
Existent Gums (Unwashed) (mg/100 ml)	max	5.0	5.0	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	ASTM D 130
RVP @ 378°C (psi)	max	10	10	ASTM D 323 ASTM D 4953
T10 (°C)	max	70	70	ASTM D 86
T50 (°C)	max	77-140	77-140	
T90 (°C)	max	190	190	
FBP (°C)	max	225	225	
Residue (%v/v)	max	2.0	2.0	
Oxygen (%m/m)	max	2.8	2.8	
Water & Sediment (%v/v)		None	None	Visual

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.8. Ecuador Gasoline Specifications

Table A.6.16 Gasoline Specifications: Ecuador

Characteristic		2004		Future (Date not known)		Test Methods
		Medium	**Regular**	**Medium**	**Regular**	
RON		89 min	80 min	90 min	85 min	ASTM D 2699
Lead (mg Pb/l) (1)	max	13	13	13	13	NTEINEN931
Sulphur (mg/kg)	max	2000	2000	1000	1000	NTEINEN929
RVP @ 378°C (psi)	max	8.0 – 12.0	8.0 – 12.0	8.0 – 12.0	8.0 – 12.0	NTEINEN928
T10 (°C)	max	70	70	70	70	NTEINEN926
T50 (°C)	max	77-121	77-121			NTEINEN926
T90 (°C)	max	190	189			NTEINEN926
FBP (°C)	max	220	215	220	215	NTEINEN926
Benzene (%v/v)	max	2.0	1.0	1.0	1.0	ASTM D 3606
Aromatics (%v/v)	max	30.0	20.0	35.0	30.0	ASTM D 1319
Olefins (%v/v)	max	25.025	20.0	25.025	20.0	ASTM D 1319

(1) No intentional addition.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.9. El Salvador Gasoline Specifications

Table A.6.17 Gasoline Specifications – El Salvador

Characteristic		2003		Test Methods
		Special	Regular	
RON	min	95 (2)	87 (2)	ASTM D 2699-94
MON	min	85 (2), (3)	77 (2), (3)	ASTM D 2700-94
(RON + MON)/2	min	90 (2)	82 (2)	
Density @ 15°C		Report (5)	Report (5)	ASTM D 1298-85 (1990)
Colour		Red (1)	Orange (1)	Visual
Lead (mg Pb/l)	max	13	13	ASTM D 3237-90 ASTM D 3341-92
Sulphur (mg/kg)	max	1500	1500	ASTM D 1266-91 ASTM D 4045-92
Oxidation Stability (minutes)	min	240	240	ASTM D 525-94
Washed Gums (mg/100 ml)	max	3	3	ASTM D 381-94
Copper Corrosion Strip (3 hours, 50°C)	max	1	1	ASTM D 130-94
RVP @ 378°C (psi)	max	10.0	10.0	ASTM D 323-94
FBP (°C)	max	225	225	ASTM D 86-93
Residue (%v/v)	max	1.1	1.1	ASTM D 86-93
Additives		Report	Report	
Odour		Satisfactory	Satisfactory	
Doctor Test (6)		Negative	Negative	ASTM D 4952-94
Mercaptan Sulphur (6)	max	0.003	0.003	ASTM D 3227-92
Fluorescence Test		Report	Report	(4)

(1) If gasoline has to be imported with a colour different to the specified one (in order to ensure supply) this must be notified to the Economy Ministry at least 20 days in advance and the public must be notified.

(2) These values can be modified, if necessary, by request of the Economy Ministry, in order to match with the most common specifications of the International Market.

(3) Verified over a period of at least six months.

(4) This test will be included once a method is determined.

(5) °API @ 15.56°C.

(6) One specification or the other.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.10. Guadeloupe Gasoline Specifications

Table A.6.18 Gasoline Specifications – Guadeloupe

Characteristic		**2003**		**Test Methods**
		Super Leaded	**Eurosuper Unleaded**	
RON		96.2 - 98	95.0	ASTM D 2699 AFNOR NFM 07-026
MON			85.0	
Density @ 15°C (kg/m^3)		770	730 - 780	ASTM D 1298 AFNOR NFT 60-101
Colour		Red	Yellow	Visual
Lead (mg Pb/l)	max	640	13	ASTM D 3341 AFNOR NFM 07-043
Phosphorous (mg P/l)	max		0	
Sulphur (mg/kg)	max	2000	1000	ASTM D 2785 AFNOR NFT 60-142
Oxidation Stability (minutes)	min	240	240	ASTM D 525 AFNOR NFM 07-012
Existent Gums (Unwashed) (mg/100 ml)	max	8.0	5.0	ASTM D 381 AFNOR NFM 07-004
Copper Strip Corrosion (3 hours, 50°C)	max	1b	1	ASTM D 130 AFNOR NFM 07-015
RVP @ 37.8°C (psi)	max	10 – 15	10 – 12.5	ASTM D 323 AFNOR NFM 07-007
T10 (°C)	max	70		ASTM D 86 AFNOR NFM 07-002
T50 (°C)	max	140		
T95 (°C)	max	195		
FBP (°C)	max	215	215	
Temperature range between 5% and 90% (°C)		60	60	
Residue (%v/v)	max	3.0	2.0	
Benzene (%v/v)	max		5.0	AFNOR NFM 07-062
Volatility Index: RVP + 7xE70	max	1000	1000	

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.11. Guatemala Gasoline Specifications

Table A.6.19 Gasoline Specifications – Guatemala (2003)

Characteristic		Superior	Regular	Gasohol 90/10 (3)	Test Methods
RON	min	95.0	87.0	91.0	ASTM D 2699
MON	min			83.0	ASTM D 2700
(RON + MON)/2	min			87.0	
Density @ 15°C (kg/m^3)	min	758 (2)	758 (2)	768.5 (2)	ASTM D 1298 ASTM D 287
Colour		Red	Orange	Orange	Visual
Lead (mg Pb/l)	max	13	13	790	ASTM D 3116 ASTM D 3229 ASTM D 3237 (4)
Sulphur (mg/kg)	max	1500	1500	1500	ASTM D 126 ASTM D 2622
Oxidation Stability (minutes)	min	240	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100 ml)	max	4.0	4.0	4.0	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)		1	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	10.0	10.0	11.0	ASTM D 323
T10 (°C)		50.0 – 66.67	50.0 – 66.67	50.0 – 66.67	ASTM D 86
T50 (°C)	max	76.67 – 121.0	76.67 – 121.0	76.67 – 121.0	
T90 (°C)	max	190	190	190	
FBP (°C)	max	225	225	225	
Residue (%v/v)	max	2.0	2.0	2.0	
Oxygen (%m/m)	max	2.7 (1)	2.7 (1)		ASTM D 5845
Benzene (%v/v)	max	3.0	3.0		ASTM D 5845
Aromatics (%v/v)	max	45.0	45.0		ASTM D 1319 ASTM D 236
Olefins (%v/v)	max	25.0	25.0	.	ASTM D 1319
Doctor Test		Negative	Negative		ASTM D 484
Mercaptan Sulphur (%m/m)	max	0.005	0.005		ASTM D 3227
Water		None	None	None	Visual
Sediment		None	None	None	Visual
Suspended matter		None	None	None	Visual
Ethanol (%v/v)				9.5 – 10.5	n/r
Water Content (%m/m)	max	n/r	n/r	0.4	ASTM E 203 ASTM D 1744

(1) Corresponds to a maximum MTBE content of 15% v/v.
(2) @ 15.56°C. Original unit: °API @ 15.56°C.
(3) Mixture of 90% v/v of Regular gasoline and 10% v/v of anhydrous denatured ethanol.
(4) To be used if the total lead content is between 0.01 and 0.1 g/gal USA (3.0 to 30.0 gPb/l).

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.12. Honduras Gasoline Specifications

Table A.6.20 Gasoline Specifications – Honduras (2003)

Characteristic		Regular	Superior	Test Methods
RON	min	87.0	95.0	ASTM D 2699
Density @ 15°C (kg/m^3)	min	Report [(1)]	Report [(1)]	ASTM D 287
Colour		Orange [(2)]	Red [(2)]	Visual
Lead (mg Pb/l)	max	13	13	ASTM D 3348
Sulphur (mg/kg)	max	1500	1500	ASTM D 1266
Oxidation Stability (minutes)	min	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100 ml)	max	4.0	4.0	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)		1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	10.0	10.0	ASTM D 323
T10 (°C)	max	65	65	ASTM D 86
T50 (°C)		77 - 121	77 - 121	
T90 (°C)	max	190	190	
FBP (°C)	max	225	225	
Doctor Test [(3)]		Negative	Negative	ASTM D 4952
Mercaptan Sulphur (%m/m) [(3)]	max	0.003	0.003	ASTM D 3227
Water & Sediment		Report	Report	ASTM D 2709
Additives		Report	Report	

(1) °API @ 15.6°C.

(2) If it is necessary to import gasoline of a different colour to that specified, it must be notified to the Economy Ministry at least 20 days before and the public must be advised.

(3) One specification or the other.

A.6.2.13. Jamaica Gasoline Specifications

Table A.6.21 Gasoline Specifications – Jamaica

Characteristic		Medium	Test Methods
(RON + MON)/2	min	87.0 (5)	ASTM D 2699 ASTM D 2700
Lead (mg Pb/l)	max	13 (1), (9)	ASTM D 2599 ASTM D 3237
Manganese (mg Mn/l)	max	18 (9)	ASTM D 3831
Phosphorous (mg P/l)		(9)	
Sulphur (mg/kg)	max	1500	ASTM D 1266 ASTM D 5453 ASTM D 6428-99
Oxidation Stability (minutes)	min	240	ASTM D 525
Washed Gum (mg/100 ml)	max	5	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)		1	ASTM D 130
RVP @ 378°C (psi)	max	10 (8)	ASTM D 323 ASTM D 5191 ASTM D 5188
T10 (°C)	max	70	ASTM D 86 as per ASTM D 4814 Class A
T50 (°C)		77 - 121	
T90 (°C)	max	190	
FBP (°C)	max	225	
Distillation Recovered (%v/v)	min	98.0	
Oxygen (%m/m)	max	2.7 (4)	ASTM D4815-99
Benzene Content max.	max	5.0	ASTM D 4053 ASTM D 4815
Aromatics (%v/v)	max	45.0 (3)	ASTM D 6730
Olefins (%v/v)	max	Report	ASTM D 6730
Ethanol (%m/m) (7)	max	10.0	ASTM D 4806
All gasoline additives (6)	Brand names to be reported		

(1) Applies to unleaded gasoline. All unleaded gasoline must contain sufficient detergent additive to pass the BMW 318i unlimited mileage test (ASTM D 5500) using the LAC for additives certified by the US EPA.

(2) On and after April 1, 2002.

(3) To be reviewed on a yearly basis.

(4) For ethers with 5 or more carbon atoms.

(5) Or higher; value to be indicated as (R + M)/2 to consumers.

(6) All gasoline must be described and must have current approval by US EPA, European Union or other government jurisdictions approved by the Minister on advice from the Petroleum Corporation of Jamaica.

(7) Alternative to Oxygen Content.

(8) Original unit: KPa.

(9) Not added.

A.6.2.14. Mexico Gasoline Specifications

Table A.6.22 Gasoline Specifications – Mexico Premium Grades

Characteristics		Pemex Premium ZM	Pemex Premium	Pemex Premium ZM	Pemex Premium ZM	Test Methods
		Valle México	Rest of the country	Guadalajara	Monterrey	
		Premium Reformulated unleaded	Premium unleaded	Premium unleaded	Premium unleaded	
RON	min	95.0	95.0	95.0	95.0	D-2699-99
MON	min	Report	Report	Report	Report	D-2700-99
(RON + MON)/2	min	92.0	92.0	92.0	92.0	D-2699-99 and D-2700-99
Density @ 15°C	max	Report (1)	Report (1)	Report (1)	Report (1)	D-1298-99
Colour		Natural	Natural	Natural	Natural	Visual
Lead (mg Pb/l)	max					D-3237-97
Phosphorous (mg P/l)	max	1 (11)	1 (11)	1 (11)	1 (11)	D-3231-99
Sulphur (mg/kg)	max	250 -300 (9)	250 -300 (9)	250 -300 (9)	250 -300 (9)	D-4294-98
Existent gum (Unwashed) (mg/100 ml)	max	4.0 (12)	4.0 (12)	4.0 (12)	4.0 (12)	D-381-00
Washed Gum (mg/100 ml)	max	70 (12)	70 (12)	70 (12)	70 (12)	D-381-00
Copper strip corrosion (3Hrs. 50 °C)		1	1	1	1	D-130-94
RVP @ 37.8 °C (psi)	max	6.5 - 7.8 (13)	6.5 - 7.8 (13)	6.5 - 7.8 (13)	(4), (13)	D-4953-99 a
T10 (°C)	max	70	(2)	70	(4)	D-86-00
T50 (°C)		77 - 121	(2)	77 - 121	(4)	
T90 (°C)	max	190	(2)	190	(4)	
FBP (°C)	max	225	(2)	225	(4)	
Residue (%m/m)	max	2	(2)	2	(4)	
A) Vapour/Liquid ratio B) Temperature (°C)		(3)	(2)	(3)	(4)	D-5188-99
Oxygen (%m/m)		1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	1.0 - 2.0	D-4815-99
Benzene (%v/v)	max	1.0	2.0	2.0	2.0	D-3606-99
Aromatics (%v/v)	max	25.0	32.0	32.0	32.0	D-1319-99
Olefins (%v/v)	max	10.0	15.0	15.0	15.0	D-1319-99
Doctor Test		negative	negative	negative	negative	D-4952-97
Mercaptan Sulphur	max	20.0	20.0	20.0	20.0	D-3227-00
Dispersant Detergent Additive		165.0	165.0	165.0	165.0	
Induction Period (minutes)	min	300.0	300.0	300.0	300.0	D-525-00

(1) Specific weight @ 20/4°C in kg/l.
(2) The values of these parameters are in tables 1, 2 and 6 of the specification No. 105/2002.
(3) The values of these parameters are in the tables 1,2 and 3 of the specification Nº 104/2002.
(4) The values of these parameters are in tables 1, 2 and 4 of the specification Nº 115/2002.
(5) The values of these parameters are in the tables 1,2 and 3 of the specification N° 106/2002.
(6) The values of these parameters are in tables 1, 2 and 6 of the specification N° 107/2002.
(7) The values of these parameters are in the tables 1and 2 of the specification N° 109/2002.
(8) The values of these parameters are in the tables 1,2 and 4 of the specification N° 108/2002.
(9) Minimum value.
(10)Original units: g/Gal and mg/l.
(11)Original units: g/Gal and kg/m^3.
(12)Original units: mg/100ml and kg/m^3.
(13)Original units: psia and kPa.

- Grade Structure: See notes after following table.

Table A.6.23 Gasoline Specifications – Mexico Regular Grades

Characteristics		Pemex Magna ZM	Pemex Magna	Pemex Magna ZM	Pemex Magna ZM	Test Methods
		Valle México	Rest of the country	Guadalajara	Monterrey	
		Regular Reformulated unleaded	Regular unleaded	Regular unleaded	Regular unleaded	
RON	min	Report	Report	Report	Report	D-2699-99
MON	min	82.0	82.0	82.0	82.0	D-2700-99
(RON + MON)/2	min	87.0	87.0	87.0	87.0	D-2699-99 and D-2700-99
Density @ 15°C	max	Report (1)	Report (1)	Report (1)	Report (1)	D-1298-99
Colour		Red	Red	Red	Red	Visual
Lead (mg Pb/l)	max	26	26	26	26	D-3237-97
Phosphorous (mg P/l)	max	1 (11)	1 (11)	1 (11)	1 (11)	D-3231-99
Sulphur (mg/kg)	max	500	1000	1000	1000	D-4294-98
Existent gum (Unwashed) (mg/100 ml)	max	4.0 (12)	4.0 (12)	4.0 (12)	4.0 (12)	D-381-00
Washed Gum (mg/100 ml)	max					D-381-00
Copper strip corrosion (3Hrs. 50 °C)		1	1	1	1	D-130-94
RVP @ 37.8 °C (psi)	max	6.5 - 7.8 (13)	(6), (13)	6.5 - 7.8 (13)	(8), (13)	D-4953-99 a
T10 (°C)	max	70	(6)	70	(8)	D-86-00
T50 (°C)		77 - 121	(6)	77 - 121	(8)	
T90 (°C)	max	190	(6)	190	(8)	
FBP (°C)	max	225	(6)	225	(8)	
Residue (%m/m)	max	2	(6)	2	(8)	
A) Vapour/Liquid ratio B) Temperature (°C)		(5)	(6)	(7)	(8)	D-5188-99
Oxygen (%m/m)		1.0 - 2.0		1.0 - 2.0	1.0 - 2.0	D-4815-99
Benzene (%v/v)	max	1.0	4.9	2.0	2.0	D-3606-99
Aromatics (%v/v)	max	25.0	Report	30.0	30.0	D-1319-99
Olefins (%v/v)	max	10.0	Report	12.5	12.5	D-1319-99
Doctor Test		negative	negative	negative	negative	D-4952-97
Mercaptan Sulphur	max	20.0	20.0	20.0	20.0	D-3227-00
Dispersant Detergent Additive		165.0	165.0	165.0	165.0	
Induction Period (minutes)	min	300.0	300.0	300.0	300.0	D-525-00

(1) Specific weight @ 20/4°C in kg/l.
(2) The values of these parameters are in tables 1, 2 and 6 of the specification No. 105/2002.
(3) The values of these parameters are in the tables 1,2 and 3 of the specification Nº 104/2002.
(4) The values of these parameters are in tables 1, 2 and 4 of the specification Nº 115/2002.
(5) The values of these parameters are in the tables 1,2 and 3 of the specification N° 106/2002.

(6) The values of these parameters are in tables 1, 2 and 6 of the specification N° 107/2002.
(7) The values of these parameters are in the tables 1and 2 of the specification N° 109/2002.
(8) The values of these parameters are in the tables 1,2 and 4 of the specification N° 108/2002.
(9) Minimum value.
(10)Original units: g/Gal and mg/l.
(11)Original units: g/Gal and kg/m^3.
(12)Original units: mg/100ml and kg/m^3.
(13)Original units: psia and kPa.

Grade Structure - Mexico

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.15. Martinique Gasoline Specifications

Table A.6.24 Gasoline Specifications – Martinique (2003)

Characteristic		Super	Eurosuper	Test Methods
RON	min	96.0	95.0	NF EN 25164
MON	min	86.0	85.0	NF EN 25163
Density @ 15°C (kg/m^3)	max	775	720 - 775	NF EN ISO 12185
Colour		Red	Yellow	Visual
Lead (mg Pb/l)	max	150	5	NF EN ISO 3830 EN 237
Phosphorous (mg P/l)		0	0	
Sulphur (mg/kg)	max	150	150	NF EN ISO 8754
Oxidation Stability (minutes)	min	360	360	NF EN ISO 7536
Existent Gum (Unwashed) (mg/100 ml)	max	5	5	NF EN ISO 6246
Copper Strip Corrosion (3 hours, 50°C)		1	1	NF EN ISO 2160
RVP @ 37.8°C (psi)	max	6.5 – 8.7	6.5 – 8.7	NF EN 12 or EN 13016-1
T10 (°C)	°C	70		ASTM D 86 AFNOR NFM 07-002
T50 (°C)	°C	140		
T95 (°C)	°C	195		
FBP (°C)	°C	210	210	
Distillation Residue max.	%vol	2.0	2.0	
Temperature range between 5% and 90% (°C)	min	60	60	
Volatility Index: RVP + 7xE70	max	1000	1000	Decree
Oxygen (%m/m)	max	2.7	2.7	NF EN 13132
Benzene (%v/v)	max	6.5	3.5	NF EN 12177 or NF EN 238
Aromatics (%v/v)	max		report	ASTM D 1319
Olefins (%v/v)	max		report	ASTM D 1319

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.16. Nicaragua Gasoline Specifications

Table A.6.25 Gasoline Specifications – Nicaragua

Characteristic		Premium Unleaded	Regular Unleaded	Test Methods
RON	min	95.0	87.0	ASTM D 2699 ASTM D 2885
MON	min	83.0	77.0	
Density @ 15°C (kg/m^3)		Report	Report	ASTM D 287 ASTM D 1298 ASTM D 4052
Colour		Red	Orange	Visual
Lead (mg Pb/l)	max	20.0	20.0	ASTM D 3237 ASTM D 5059
Manganese (mg Mn/l)	max	18.0	18.0	
Sulphur (mg/kg)	max	1000	1000	ASTM D 1266 ASTM D 2622 ASTM D 3120
Oxidation Stability (minutes)	min	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100 ml)	max	4	4	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	10.0	10.0	ASTM D 323 ASTM D 2551
IBP (°C)	max	Report	Report	ASTM D 86
T10 (°C)	max	65	65	
T50 (°C)	max	115	115	
T90 (°C)	max	180	180	
FBP (°C)	max	225	225	
Residue (%v/v)	max	2.0	2.0	
Benzene (%v/v)	max	5.0	5.0	
Odour		Satisfactory	Satisfactory	
Doctor Test		Negative	Negative	ASTM D 4952 P-30
Mercaptan Sulphur (%m/m)	max	0.0015	0.0015	ASTM D 3227
Additives		Report	Report	

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.17. Panama Gasoline Specifications

Table A.6.26 Gasoline Specifications – Panama

Characteristic		Regular Unleaded	Medium Unleaded	Premium Unleaded	Test Methods
RON	min	87.0	91.0	95.0	ASTM D 2699
MON	min	78.0	82.0	85.0	
Lead (mg Pb/l)	max	13	13	13	
Sulphur (mg/kg)	max	1000	1000	1000	ASTM D 1266
Oxidation Stability (minutes)	min	240	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100 ml)	max	3.0	3.0	3.0	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	10.0	9.8	10.0	ASTM D 323
IBP (°C)	max				ASTM D 86
T10 (°C)	max	70	50-70	70	
T50 (°C)	max	77 - 120	77 - 120	77 - 120	
T90 (°C)	max	190	190	190	
FBP (°C)	max	225	225	225	
Residue (%v/v)	max	2.0	2.0	2.0	
Olefins (%v/v)	max	20.0	20.0	20.0	
Odour		Characteristic	Characteristic	Characteristic	
Doctor Test		Negative	Negative	Negative	ASTM ST 26
Mercaptan Sulphur (%m/m)	max	0.003	0.003	0.003	ASTM D 3227
Additives		0.0	0.0	0.0	ASTM D4815

A.6.2.18. Paraguay Gasoline Specifications

Table A.6.27 Gasoline Specifications - Paraguay

Characteristic		Regular Unleaded	Premium Unleaded	Plus-95 Unleaded	Regular Leaded (1)	Test Method
RON	min	85.0	97.0	95.0	83.0 – 85.0	ASTM D 2699
Colour		Yellow	Light yellow	Green	Red	Visual
Lead (mg Pb/l)	max	13	13	13	150 – 1100	ASTM D 3237
Sulphur (mg/kg)	max	1000	1000	1000	1500	ASTM D 1266
Oxidation Stability (minutes)	min	240	240	240	240	ASTM D 525
Existent Gum (Unwashed) (mg/100 ml)	max	5	5	5	5	ASTM D 381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	7.8 – 11.0	7.8 – 11.0	7.8 – 11.0	7.8 – 11.0	ASTM D 323
T10 (°C)	max	70	70	70	70	ASTM D 86
T50 (°C)	max	77 - 118	77 - 118	77 - 118	77 - 118	
T90 (°C)	max	190	190	190	190	
FBP (°C)	max	225	225	225	225	
Residue (%v/v)	max				2.0	
Oxygen (%m/m)	min	4.2 (2)		4.2 (2)		

(1) Lead was phased out during 2003.
(2) Equivalent to 12% v/v ethanol. The use of 20% is under study.

A.6.2.19. Peru Gasoline Specifications

Table A.6.28 Gasoline Specifications: Peru

Characteristic		1993 Specifications					2005 Specifications	Test Methods
		Regular Unleaded	84 RON Plomada (2)	Super Unleaded	Premium Unleaded	Super extra Unleaded	Unleaded All Grades	
RON	min	84.0	84.0	90.0	95.0	97.0		
Lead (mg Pb/l)	max		140 (2)				13	
Sulphur (mg/kg)	max	2000	2000	2000	2000	2000	1000	ASTM D 4294-98
Oxidation Stability (minutes)	min	240	240	240	240	240	240	ASTM D 525-95
Existent Gum (Unwashed) (mg/100 ml)	max	5	5	5	5	5	5	ASTM D 381-94
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	1	1	1	ASTM D 4814-97b NTP 321.021
RVP @ 37.8°C (psi)	max	12	10	12	12	12	10	ASTM D 323-94 NTP 321.088
T10 (°C)	max	70	70	70	70	70	70	ASTM D 86-96 NTP 321.023
T50 (°C)	max	140	77 - 121	140	140	140	77 - 121	
T90 (°C)	max	200	190	200	200	200	190	
FBP (°C)	max	221	225	221	221	221	225	
Volume Recovered (%v/v)	min	96	96	96	96	96		
Residue (%v/v)	max	2	2	2	2	2	2	
A) Vapour/Liquid Ratio B) Temperature (°C)	max	A)20 B) 56	A)20 B) 56	A)20 B) 56	A)20 B) 56	A)20 B) 56	A)20 B) 56	ASTM D 4814-97b ASTM D 2533-96
Oxygen (%m/m)	min						2.7	
Benzene (%v/v)	max		2.5				2.5	
Aromatics (%v/v)	max		45.0				45.0	
Olefins (%v/v)	max		25.0				25.0	
Odour		Clear	Clear	Clear	Clear	Clear	Clear	

A.6.2.20. Trinidad & Tobago Gasoline Specifications

Table A.6.29 Gasoline Specifications: Trinidad & Tobago

Characteristic		Regular Unleaded	Premium Unleaded	Super Unleaded	Test Methods
RON	min	83.0	95.0	92.0	ASTM D 2699-88a
MON	min	80.0	85.0	82.0	ASTM D 2700-88a
Density @ 15°C (kg/m^3)		710 - 780	710 - 780	710 - 780	ASTM D 1298-85
Colour		Orange (3)	Undyed (3)	Pink (3)	
Lead (mg Pb/l)	max	13 (4)	13 (4)	13 (4)	ISO 3880-1981 ASTM D 3341-88
Phosphorous (mg P/l)	max	1.10	1.10	1.10	ASTM D 3231-89
Sulphur (mg/kg)	max	1500	1500	1500	ASTM D 1266-87 ASTM D 4294-83
Oxidation Stability (minutes)	min	240	240	240	ASTM D 525-88
Existent Gum (Unwashed) (mg/100 ml)	max	5	5	5	ASTM D 381-86
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	ASTM D 130-88
RVP @ 37.8°C (psi)	max	9.0 (2)	9.0 (2)	9.0 (2)	ASTM D 323-89
T10 (°C)	max	(5)	(5)	(5)	ASTM D 86-82
T50 (°C)	max	(6)	(6)	(6)	
T90 (°C)	max	(7)	(7)	(7)	
FBP (°C)	max	205	205	205	
Residue (%v/v)	max	2	2	2	
A) Vapour/Liquid Ratio B) Temperature (°C)	max	A) 20 B) 60	A) 20 B) 60	A) 20 B) 60	ASTM D 4814-89
Benzene (%v/v)	max	5.0	5.0	5.0	ASTM D 3606-87 ASTM D 4420-89
Olefins (%v/v)	max	20.0	20.0	20.0	ASTM D 1319-89
Water & Suspended Matter (%v/v)	max	0.05	0.05	0.05	ASTM D 95-83
Mercaptan Sulphur (%m/m) (1)	max	0.0020	0.0020	0.0020	ASTM D 3227-89
Doctor Test (1)	max	Negative	Negative	Negative	ASTM D 235-87 IP 30/91 (1986)

(1) One specification or the other.

(2) Original unit: KPa.

(3) Great precision in colour matching is not required, as the colour has no effect on the performance of the gasoline. The gasoline is simply coloured to aid identification by the customer.

(4) The intentional addition of lead is not permitted.

(5) Original Report: % evap @70°C: 10 min and 25 max for all types of gasolines.

(6) Original Report: % evap @100°C: 36 min and 65 max for all types of gasoline.

(7) Original Report: % evap @180°C: 90 min for all types of gasoline.

A.6.2.21. Uruguay Gasoline Specifications

Table A.6.30 Gasoline Specifications – Uruguay (Effective 30/03/2004)

Characteristic		**Especial 87 SP**	**Super 95 SP**	**Premium 97 SP**	**Test Methods**
RON	min	87.0	95.0	97.0	ASTM D 2699
MON	min	75.0	81.0	83.0	ASTM D 2700
(RON + MON)/2	min	81.0	88.0	90.0	
Colour		Blue	Amarillo	Clear Red	Visual
Lead (mg Pb/l)	max	13	13	13	ASTM D 3237
Manganese (mg Mn/l)	max	(5)	(5)	(5)	
Phosphorous (mg P/l)	max	(5)	(5)	(5)	
Sulphur (mg/kg)	max	1000 (6)	1000 (6)	700 (6)	ASTM D 4045
Oxidation Stability (minutes)	min	240	240	360	ASTM D 525
Washed Gum (mg/100 ml)		5	5	5	
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	1	ASTM D 130
RVP @ 37.8°C (psi)	max	12.0 (1), (7) 10.5 (2), (7)	12.0 (1), (7) 10.5 (2), (7)	12.0 (1), (7) 10.5 (2), (7)	ASTM D-323
T10 (°C)	max	67	67	70	ASTM D-86
T50 (°C)	max	75 - 120	75 - 120	75 - 120	
T90 (°C)	max	200	200	200	
FBP (°C)	max	225	225	225	
Residue (%v/v)	max	2	2	2	
Oxygen (%m/m)	max	2.7 (3)	2.7 (3)	2.7 (3)	ASTM D 4815
MTBE (%v/v)	max	15.0	15.0	15.0	
Benzene (%v/v)	max	2.5	2.5	2.5	ASTM D 4420
Aromatics (%v/v)	max	40.0	45.0	45.0	ASTM D 1319
Olefins (%v/v)	max	25.0	25.0	25.0	ASTM D 1319
Multifunctional Additive (4)		Present	Present	Present	

(1) April-October.

(2) November-March.

(3) The type of oxygenated compound will be indicated.

(4) Keep clean dose - for carburettors, injectors, inlet valves and combustion chambers.

(5) Not present.

(6) Original Units: ppm.

(7) Original units: psia and kPa.

A.6.2.22. Venezuela Gasoline Specifications

Table A.6.31 Gasoline Specifications: Venezuela

Characteristic		RON 95 Unleaded	RON 91 Unleaded	Test Methods
MON	min	87.0	82.0	COVENIN 893
(RON + MON)/2	min	91.0	87.0	COVENIN 893
Colour		Pale yellow (1)	Orange	
Lead (mg Pb/l)	max	13	13	COVENIN 2048 ASTM D 5059
Sulphur (mg/kg)	max	600	1500	COVENIN 1826 ASTM D-2622
Oxidation Stability (minutes)	min	240	240	COVENIN 873 ASTM D-525
Existent Gum (Unwashed) (mg/100 ml)	max	5.0	5.0	COVENIN 874 ASTM D-381
Copper Strip Corrosion (3 hours, 50°C)	max	1	1	COVENIN 872 ASTM D-130
RVP @ 37.8°C (psi)	max	9.5	9.5	COVENIN 875 ASTM D 5191
IBP (°C)	max	30	30	
T10 (°C)	max	70	70	
T50 (°C)		77 - 121	77 - 121	
T90 (°C)	max	195	195	COVENIN 850
FBP (°C)	max	225	225	
Residue (%v/v)	max	2	2	
E70		Report	Report	
Vapour Lock Index	max	14.5	14.5	(3)
Red Colouring (mg/l) (2)	max	(1)	2.52	

(1) The pale yellow colour of the Premium Unleaded gasoline is due to components colour.
(2) Metallized derivatives of the 4-azobenzene 2 naftol.
(3) The value of VLI is calculated from the following formula: VLI = RVP + 0.13 x E70.

Grade Structure

- Regular: RON < 86
- Medium: 86 ≤RON < 95
- Premium: RON ≥95

A.6.2.23. Argentina Diesel Fuel Specifications

Table A.6.32 Diesel Fuel Specifications: Argentina

Characteristic		**2004**		**2008**	**Test Methods**
		Gas Oil Grade 2D	**Diesel Grade 4D**	**Grade 2D**	
Flash Point (°C)	min	45	55	45	ASTM D 93 IRAM IAP 6539
Viscosity @ 40°C (mm^2/s)		2.0 – 5.5	7.4 max	2.0 – 5.5	ASTM D 445 IRAM 6544
Cetane Number	min	50		50	ASTM D 613
Cetane Index	min	48	30	48	ASTM D 976 IRAM IAP 6682
T90 (°C)	max	360		360	ASTM D 86 IRAM-IAP 6600
E360 (%v/v)	min	90		90	
Sulphur (mg/kg)	max	2500 (1) – 1500 (2)		500 (3) – 50 (4)	ASTM D 3120 ASTM D 4294 ASTM D 129 IRAM IAP A 6598 IRAM IAP A 6516

(1) Applicable to all the country except for Buenos Aires City, parts of the Gran Buenos Aires (except La Plata), Rosario City, Córdoba city, Mendoza City and the following parts of Mendoza province: Godoy Cruz, Guaymallén, Las Heras and Luján de Cuyo.

(2) Applicable to Buenos Aires City, parts of the Gran Buenos Aires (except La Plata), Rosario City, Córdoba city, Mendoza City and the following parts of Mendoza province: Godoy Cruz, Guaymallén, Las Heras and Luján de Cuyo.

(3) Applicable to all the country except for Buenos Aires City, Buenos Aires province, Córdoba province, Mendoza province and Santa Fe province.

(4) Applicable to Buenos Aires City, Buenos Aires province, Córdoba province, Mendoza province and Santa Fe province.

- Resolution 222/01 (Modif. 145/02, 394/02, 398/03 y 824/03).

A.6.2.24. Bolivia Diesel Fuel Specifications

Table A.6.33 Diesel Fuel Specifications – Bolivia

Characteristic		Grade 1D Low Sulphur	Test Methods
Density @ 15°C (kg/m^3)		800-860	ASTM D 1298 ASTM D 4052
Flash Point (°C)	min	38	ASTM D 93
Viscosity @ 40°C (mm^2/s)		1.7 - 4.1	ASTM D 445
Cetane Number	min	48	ASTM D 613
Cetane Index	min	50	ASTM D 976 ASTM D 4737
Colour	max	4.0	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	3	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 1796
T90 (°C)	max	282 - 382	ASTM D 86
Sulphur (mg/kg)	max	2000	ASTM D 1266 ASTM D 2622
Total Aromatics (%v/v)	max	25.0	ASTM D 1319
Ramsbottom Carbon Residue (%m/m)	max	0.20	ASTM D 524
Ash Content (%m/m)	max	0.01	ASTM D 482
Pour Point (ºC)	max	-1.1	ASTM D 97
Appearance		Crystalline	Visual
Calorific Value (btu/lb)		Report	ASTM D 240

A.6.2.25. Brazil Diesel Fuel Specifications

Brazil formerly had four grades of diesel fuel (A, B, C and D) as specified by DNC ACT Nº 32 of 4 August, 1997. Only two grades, B and D, are now supplied, plus a marine diesel fuel. The specifications are set out in the following table:

Table A.6.34 Diesel Fuel Specifications - Brazil

Characteristic		2004 (1), (9)		2006 (1), (8)		2009 (1), (8)		Test Methods
		B (3)	D (6)	Metropolitan Zones	Non Metropolitan Zones	Low Sulphur	High Sulphur	
Density @ 15°C (kg/m^3)		820-880 (2)	820-865 (2)	820-860 (2)				ASTM D 1298 ASTM D 4052 ABNT NBR 7148
Flash Point (°C)	min	38	38					
Viscosity @ 40°C (mm^2/s)		2.5 – 5.5	2.5 – 5.5					ASTM D 445 ABNT NBR 10441
Cetane Number	min	42.0 (5)	42.0 (5)					ASTM D 613
Colour		3 (7)	3					ASTM D 1500 ABNT MB 351
Copper Strip Corrosion (3 hours, 50°C)	min	1	1					ASTM D 130 ABNT MB
Water & Sediment (%v/v)	max	0.05	0.05					ASTM D 1796
T50 (°C)		245 - 310	245 - 310					ASTM D 86 ABNT NBR 9619
T85 (°C)	max	370	360					
T90 (°C)	max			360				
Sulphur (mg/kg)	max	3500	2000	500	2000	50	500	ASTM D 1552 ASTM D 2622 ASTM D 4294 ABNT MB 902
Ramsbottom Carbon Residue (%m/m)	max	0.25	0.25					ASTM D 524 ABNT MB 290
Ash Content (%m/m)	max	0.020	0.020					ASTM D 482 ABNT NBR 9842
CFPP (ºC)	max	(4)	(4)					IP 309
Appearance		Clear and without visual impurities						

(1) Every specified limit is an absolute value according to ASTM E 29.

(2) @ 20°C. Original unit: Density @ 20/4°C.

(3) Diesel Oil available countrywide, except for Metropolitan Zones. It must be red dyed.

(4) In accordance with Table II.

(5) Alternative specification: Cetane Index 45,0 min (Method: ASTM D4737). In case of disagreement prevails Cetane Number.

(6) Available in Metropolitan Zones, according to the Diesel Oil Quality Enhancing Programme.

(7) Limit before dye addition.

(8) Not defined yet.

(9) Specifications derived from Resolution ANP Nº 310 enacted 27 December, 2001.

CFPP limits (°C, max):

State	Dec-Mar	Apr, Oct, Nov	May-Sept
DF - GO - MG - BS - RJ	13	11	7
SP - MT - MS	12	9	5
Pr - SC - RS	11	8	2

A.6.2.26. Chile Diesel Fuel Specifications

Table A.6.35 Diesel Fuel Specifications – Chile

Characteristic	Early 2004		July 2004			January 2005	July 2006	Test Methods
	Grade B (6) Grade N°2D	**Diesel A1(7) Grade N°2D Low Sulphur**	**Diesel A1(7) Grade N°2D Low Sulphur**		**Grade B (6) Grade N°2D**	**Grade B (6) Grade N°2D**	**Grade B (6) Grade N°2D**	
Density @ 15°C (kg/m^3)		830-870 (3), (5)	830-850 (3)	830-850 (3)	830-870 (3), (5)	830-860 (3)	830-860 (3)	NCh822 ASTM D 1052 ASTM D 1298
Flash Point (°C)	min	52	52	52				NCh69 ASTM D 93 ASTM D 3828
Viscosity @ 40°C (mm^2/s)		1.9-5.5	1.9-4.1 (8)	1,9-4,1 (8)				NCh1950 ASTM D 445
Cetane Number	min	45 (4)	50 (4)	50 (4)	46 (4)	46 (4)	46 (4)	NCh1987
Cetane Index	min		50	50				ASTM D 976
Copper Strip Corrosion (3 hours, 50°C)	min	2	2	2				NCh70 ASTM D 130
Water & Sediment (%v/v)	max	0.10	0.10	0.10				NCh1982 ASTM D 1796 ASTM D 2709
T90 (°C)	max	366	338	338	350	350	350	NCh66/ASTM D 86
Sulphur (mg/kg)	max	3000	300	50	2000	500-1000 (9)	350-1000 (10)	NCh1947 ASTM D 1294 ASTM D 5453
Total Aromatics (%v/v)	max	Report	35	35	35	35	35	IP 391
Ramsbottom Carbon Residue (%m/m)	max	0.35 (2)	0.21 (2)	0.21 (2)				NCh1985 ASTM D524
Ash Content (%m/m)	max	0.01	0.01	0.01				NCh1984 ASTM D182
CFPP (ºC)	max	Report	Report	Report	Report	Report	Report	
Pour Point (ºC)	max	-1 (1)	-1	-1				NCh1983 ASTM D 93 ASTM D 5950 ASTM D 5949
API Gravity (°API)			38.9-34.9	38.9-34.9				ASTM D 1052 ASTM D 1298
Polycyclic Aromatics (%v/v)		Report	10	5	25	20	20	IP 391 ASTM D 1176
Nitrogen Content (ppm)		Report	170	170	300	300	300	ASTM D 1629
Conradson Carbon Residue max (%m/m) (2)		0.34 (2)	0.2 (2)	0.2 (2)				NCh1986 ASTM D 189

(1) In Zones XI & XII, the minimum value must be -9°C from April 15 to September 15 each year.

(2) In case of disagreement Ramsbottom Carbon Residue must be used.

(3) Original unit: kg/l.

(4) The calculated Cetane Index (NCh1988) can be used as a practical method, but in case of disagreement the reference method is the Cetane Number (NCh1987).

(5) In Zones XI & XII the minimum density value can be 815 kg/m3.

(6) National specifications in force for all zones with no special environmental requirements.

(7) Regulations for urban zones with environmental restrictions established by the decree D-16: General Secretariat of the Presidency.

(8) Original unit: mm2/s.

(9) IV to X Region - I to III and XI to XII Region.

(10)IV to X Region and I to III - XI to XII Region.

A.6.2.27. Colombia Diesel Fuel Specification

Table A.6.36 Diesel Fuel Specifications: Colombia

Characteristic		2004 (7)		2008 (7)		Test Methods
		Diesel Regular	**Diesel Extra-Low Sulphur (4) Grade N°2D**	**Diesel Regular Grade N°2D Low Sulphur**	**Diesel Extra-Low Sulphur (4) Grade N°2D Low Sulphur**	
Density @ 15°C (kg/m^3)		Report minimum (2)	Report minimum (2)	Report minimum (2)	Report minimum (2)	ASTM D 4052 ASTM D 1298 ASTM D 287
Flash Point (°C)	min	52	52	52	52	ASTM D 93
Viscosity @ 40°C (mm^2/s)		1.9-5.0 (3)	1.9-4.1 (3)	1.9-5.0 (3)	1.9-4.1 (3)	ASTM D 445
Cetane Number	min	43 (6)	45	43 (6)	45	ASTM D613
Cetane Index	min	45 (5)	45 (5)	45 (5)	45 (5)	ASTM D 976 ASTM D 4737
Colour	max	3.0	2.0	3.0	2.0	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	2	2	2	2	ASTM D 130
Water & Sediment (%v/v)	max	0.05	0.05	0.05	0.05	ASTM D 1796 ASTM D 2709
IBP (°C)		Report	Report	Report	Report	ASTM D 86
T50 (°C)		Report		Report		
T90 (°C)	max	360	282-338	360	282-338	
FBP (°C)	max	390	360	390	360	
Sulphur (mg/kg)	max	4500	1200	500	500	ASTM D 4294 (1)
Total Aromatics (%v/v)	max	35	35	35	35	ASTM D 5186
Ramsbottom Carbon Residue (%m/m)	max	0.02	0.20	0.20	0.20	ASTM D 4530
Ash Content (%m/m)	max	0.01	0.01	0.01	0.01	ASTM D 482
Pour Point (ºC)	max	4	4	4	4	ASTM D 97 ASTM D 5949

(1) Alternative methods: ASTM D 2622/ ASTM D 1552/ ASTM D 1266.
(2) °API.
(3) Original unit: mm^2/s
(4) Only valid for Bogotá D.C.
(5) Valid for diesel produced in the atmospheric distillation of crude oil, without blending with other refinery components.
(6) For diesel with components derived of catalytic or thermal cracking processes and/or cetane improver additives.
(7) Specifications derived from Resolution 0447 (April 14, 2003).

A.6.2.28. Costa Rica Diesel Fuel Specifications

Table A.6.37 Diesel Fuel Specifications – Costa Rica

Characteristic		2004 Aceite Combustible Diesel N°2D Low Sulphur	2005	2007	2008	Test Methods
Density @ 15°C (kg/m^3)		Report [(1)]				ASTM D 1298
Flash Point (°C)	min	52				ASTM D 93
Viscosity @ 40°C (mm^2/s)		1.9 – 5.0				ASTM D 445
Cetane Index	min	45				ASTM D 976
Colour	max	3				ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	2				ASTM D 130
Water & Sediment (%v/v)	max	0.05				ASTM D 2709
T90 (°C)	max	360				ASTM D 86
Sulphur (mg/kg)	max	4500	4000	3500	500	ASTM D 1266 ASTM D 2622
Conradson Carbon Residue (%m/m)	max	0.2				ASTM D 189
Ash Content (%m/m)	max	0.01				ASTM D 482
Pour Point (ºC)	max	5				ASTM D 97

(1) Alternative specification: API Gravity @ 15.6°C.

A.6.2.29. Ecuador Diesel Fuel Specifications

Table A.6.38 Diesel Fuel Specifications – Ecuador

Characteristic		Diesel Premium Grade N°1D	Diesel No. 2 Grade N°1D
Flash Point (°C)	min	51	51
Viscosity @ 37.8°C (mm^2/s)		2.5 – 7.0	2.5 – 6.0
Cetane Index	min	46	45
T90 (°C)	max	360 max	360 max
Sulphur (mg/kg)	max	500	7000
Ramsbottom Carbon Residue (%m/m)	max	0.15	0.15

A.6.2.30. El Salvador Diesel Fuel Specifications

Table A.6.39 Diesel Fuel Specifications – El Salvador (2003)

Characteristic		Fuel Oil Light Diesel Grade N°1D	Test Methods
Density @ 15°C (kg/m^3)		Report (1)	ASTM D 1298
Flash Point (°C)	min	51.7	ASTM D 93
Viscosity @ 37.8°C (mm^2/s)		1.9 – 4.1	ASTM D 445
Cetane Index	min	45	ASTM D 976
Colour		Report	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	1	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 1796 ASTM D 2709
T10 (°C)		Report	ASTM D 86
T50 (°C)		Report	
T90 (°C)	max	282 - 363	
FBP (°C)	max	Report	
Sulphur (mg/kg)	max	5000	ASTM D 129 (2) ASTM D 1552 ASTM D 4294
Ash Content (%m/m)	max	0.01	ASTM D 482
Pour Point (ºC)	max	Report	ASTM D 97
Cloud Point (ºC)	max	9.0	ASTM D 2500
Conradson Carbon Residue (%m/m)		0.1	ASTM D 189
Additives		Report	

(1) °API @ 15,56°C.

(2) Unsafe method.

A.6.2.31. Guadeloupe Diesel Fuel Specifications

Table A.6.40 Diesel Fuel Specifications – Guadeloupe (2003)

Characteristic		Gas Oil Grade No. 4D	Test Methods
Density @ 15°C (kg/m^3)		810 - 865 [(1)]	ASTM D 1298 AFNOR NFT 60-101
Viscosity @ 37.8°C (mm^2/s)	max	5.9	ASTM D 445 AFNOR NFT 60-100
Cetane Index	min	47	ASTM D 976
Colour	max	5	ASTM D 1500 AFNOR NFT 60-104
Water & Sediment (%v/v)	max	0.1	ASTM D 1796 AFNOR NFM 07-020
T65 (ºC)	min	250	ASTM D 86 AFNOR NFM 07-002
T85 (ºC)	max	360	
T95 (°C)	max	390	
Sulphur (mg/kg)	max	8000	ASTM D 2785 AFNOR NFT 60-142
Conradson Carbon Residue (%m/m)	max	0.20	ASTM D 189 AFNOR NFT 60-116
Ash Content (%m/m)	max	0.01	ASTM D 482 AFNOR NFM 07-045
Pour Point (ºC)	max	5	ASTM D 2500 AFNOR NFT 60-105
Cloud Point (ºC)	max	10	ASTM D 2500 AFNOR NFT 60-105
Appearance		Clear	
Vanadium Content (mg/l)	max	0.5	ASTM D 3605
Sodium & Potassium (mg/l)	max	1.0	ASTM D 3605
Lead (mg/l)	max	1.0	ASTM D 3605
Calcium (mg/l)	max	2.0	ASTM D 3605
Neutralization Value (mg KOH/g)	min	0	ASTM D 974 AFNOR NFT 60-112

(1) Original unit: kg/l.

A.6.2.32. Guatemala Diesel Fuel Specifications

Table A.6.41 Diesel Fuel Specifications – Guatemala (2003)

Characteristic		Aceite Combustible Grade No 2D	Test Methods
Density @ 15°C (kg/m^3)	min	875.3 [(1)]	ASTM D 287 ASTM D 1298
Flash Point (°C)	min	51.67	ASTM D 93
Viscosity @ 37.78°C (SSU)		32.6 – 40.1	ASTM D 88 ASTM D 445
Cetane Number	min	45 [(2)]	ASTM D 613
Cetane Index	min	45 [(3)]	ASTM D 976
Copper Strip Corrosion (3 hours, 50°C)	min	3	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 2709
T90 (°C)	max	282.22-350.00	ASTM D 86
Sulphur (mg/kg)	max	5000 [(3)]	ASTM D 2622 ASTM D 1266 ASTM D 129
Total Aromatics (%v/v)	max	30	ASTM D 2709
Ramsbottom Carbon Residue (%m/m)	max	0.25	ASTM D 524
Ash Content (%m/m)	max	0.01	ASTM D 482
Pour Point (ºC)	max	-6.67	ASTM D 97
Cloud Point (ºC)	max	-3	ASTM D 2500 ASTM D 3117

(1) Density @ 15.56°C. Original unit: API Gravity @ 15.56°C.

(2) Cetane Number and Index Number are alternative specifications, but in case of disagreement prevails the first one.

(3) In special cases, this value could be greater than 5000 mg/kg, with the previous authorization of the General Hydrocarbons Directorate of the Ministry of Energy and Mines.

A.6.2.33. Honduras Diesel Fuel Specifications

Table A.6.42 Diesel Fuel Specifications – Honduras (2003)

Characteristic		Diesel Automotriz Grade N°2D	Test Methods
Density @ 15°C (kg/m^3)	min	875.3 [(1)]	ASTM D 287
Flash Point (°C)	min	52	ASTM D 93
Viscosity @ 40°C (mm^2/s)		1.90 – 5.80	ASTM D 445
Cetane Index	min	45	ASTM D 976
Copper Strip Corrosion (3 hours, 50°C)	min	3	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 2709
T10 (°C)	max	Report	ASTM D 86
T50 (°C)	max	290.3	
T90 (°C)	max	Report	
FBP (°C)	max	376.7	
Distillation Residue (%v/v)	max	Report	
Sulphur (mg/kg)	max	5000	ASTM D 1266 ASTM D 1551
Ash Content (%m/m)	max	0.010	ASTM D 482
Pour Point (ºC)	max	0	ASTM D 97
Neutralization Index -SAN and TAN (mg KOH/g)	max	0.50	ASTM D 974

(1) @ 15.6°C. Original unit: API Gravity @ 15.6°C.

A.6.2.34. Jamaica Diesel Fuel Specifications

Table A.6.43 Diesel Fuel Specifications – Jamaica

Characteristic		2004 Grade N°2D	2008 Grade N°2D	Test Methods
Density @ 15°C (kg/m^3)		829 - 870 (2)		ASTM D 1298
Flash Point (°C)	min	60		ASTM D 93
Viscosity @ 38°C (mm^2/s)		2.3 – 4.2		ASTM D 445
Cetane Index	min	45 (1)		ASTM D976
Colour	max	2.0		ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	1 (3)		ASTM D 130
T50 (°C)	max	288 (4)	n/r	ASTM D 86
T90 (°C)	max	352		ASTM D 86
Sulphur (mg/kg)	max	5000	500	ASTM D 2622
Conradson Carbon Residue (%m/m)	max	0.10		ASTM D 189
Ash Content (%m/m)	max	0.01		ASTM D 482
Pour Point (ºC)	max	-7		ASTM D 97
Neutralization Number – TAN (mg KOH/g)		Report	Report	ASTM D 974
Sediment, suspended (mg/100ml)	max	0.70		AM-S,77-060 ASTM D 473
Water by distillation (%v/v)	max	0.05		ASTM D 95

(1) Cetane Index (D-976) is calculated from the gravity and the distillation temperature at which 50% is recovered. Alternatively, a Cetane Number of 45 minimum acceptable.

(2) Gravity shall be as low as practicable, but abrupt changes should be avoided.

(3) Note test temperature is 100°C.

(4) To be abandoned.

A.6.2.35. Martinique Diesel Fuel Specifications

Table A.6.44 Diesel Fuel Specifications – Martinique (2003)

Characteristic		Gas Oil Grade No 4D	Test Methods
Density @ 15°C (kg/m^3)		820 - 845 (1)	NF EN ISO 12185
Flash Point (°C)	min	55	ISO 2719
Viscosity @ 37.8°C (mm^2/s)	max	4.5	NF EN ISO 3104
Cetane Index	min	46	NF EN ISO 4264
Colour	max	5	ASTM D 1500 AFNOR NFT 60-104
Oxidation Stability (minutes)	min	25 max (2)	NF EN ISO 12205
Copper Strip Corrosion (3 hours, 50°C)	min	1	NF EN ISO 2160
Water & Sediment (%v/v)	max	200 (3)	NF EN ISO 6296
T65 (ºC)	min	250	ASTM D 86 AFNOR NFM 07-002
T85 (ºC)	max	360	
T95 (°C)	max	360	
Sulphur (mg/kg)	max	350	NF EN ISO 8754
Polycyclic Aromatics (%v/v)	max	11	IP 391
Conradson Carbon Residue (%m/m)	max	0.30	NF EN ISO 10370
Ash Content (%m/m)	max	0.01	ASTM D 482 AFNOR NFM 07-045
Pour Point (ºC)	max	5	ASTM D 2500 AFNOR NFT 60-105
Cloud Point (ºC)	max	10	NF EN 23105
Lubricity (wsd in microns)	microns	460	NF EN ISO 12156-1
Appearance		Clear	
T65 (ºC)	min	250	ASTM D 86/ AFNOR NFM 07-002
T85 (ºC)	max	360	ASTM D 86/ AFNOR NFM 07-002
Conradson Carbon Residue (%m/m)	max	0,30	NF EN ISO 10370
Vanadium Content (mg/l)	max	0.5	ASTM D 3605
Sodium & Potassium (mg/l)	max	1.0	ASTM D 3605
Lead (mg/l)	max	1.0	ASTM D 3605
Calcium (mg/l)	max	2.0	ASTM D 3605
Neutralization Value (mg KOH/g)	min	0	ASTM D 974 AFNOR NFT 60-112

(1) Original unit: kg/l.
(2) Reported in g/m^3.
(3) Reported in mg/kg.

A.6.2.36. Mexico Diesel Fuel Specifications

Table A.6.45 Diesel Fuel Specifications: Mexico (2003)

Characteristic		Pemex Diesel 1-D Low Sulphur	Diesel Desulphurized 1-D	Diesel Marino Especial 1-D Low Sulphur	Diesel Industrial Bajo Azufre 1-D Low Sulphur	Test Methods
Density @ 15°C (kg/m^3)		Report (2)		Report (2)	Report (2)	D-1298-99
Flash Point (°C)	min	45	41	60	52	D-93-00
Viscosity @ 40°C (mm^2/s)		1.9 - 4.1	1.9 - 4.1	1.9 - 4.1	1.9 - 5.8	D-445-97
Cetane Number	min	48				D-613-95
Cetane Index	min	48	45	40		D-976-91 (2000)
Colour	max	2.5	2.5	purple	5	D-1500-98
Copper Strip Corrosion (3 hours, 50°C)	min	1	2	2		D-130-94 (2000)
Water & Sediment (%v/v)	max	0.05	0.05	0.05	0.05	D-2709-96
T90 (°C)	max	345	350	350		D-86-00
T95 (°C)	max	Report				
FBP (°C)	max	Report				
Sulphur (mg/kg)	max	5000	500	500	500	D-4294-98
Ramsbottom Carbon Residue (%m/m)	max	0.25	0.25	0.25		D-524-00
Ash Content (%m/m)	max	0.01	0.01	0.01		D-482-00 a
Pour Point (ºC)	max	(1)	(1)	(1)	10	D-97-96a
Cloud Point (ºC)	max	Report	Report	Report		D-2500-99

(1) Between March and October: 0°C maximum.
Between November and February: 5°C maximum.

(2) Specific weight 20/4°C.

A.6.2.37. Nicaragua Diesel Fuel Specifications

Table A.6.46 Diesel Fuel Specifications – Nicaragua

Characteristic		**Combustible Diesel Liviano Grade No 2D**	**Test Methods**
Density @ 15°C (kg/m^3)		Report (1)	ASTM D 1052
Flash Point (°C)	min	60	ASTM D 93
Viscosity @ 40°C (mm^2/s)		2.0 – 4.5	ASTM D 88 ASTM D 445
Cetane Number	min	45	ASTM D 613
Cetane Index	min	45	
Colour		2.0 (3)	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	1	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 1796
IBP (°C)		Report	ASTM D 86
T10 (°C)	min	Report	
T50 (°C)	max	292 max.	
T90 (°C)	max	282-363	
T95 (°C)	max	Report	
FBP (°C)	max	Report (2)	
Sulphur (mg/kg)	max	5000	ASTM D 1552 ASTM D 129 ASTM D 2622 ASTM D 4294
Total Aromatics (%v/v)	max	Report (4)	
Ramsbottom Carbon Residue (%m/m)	max	0.10	
Conradson Carbon Residue (%m/m)	max	0.35	ASTM D 189
Ash Content (%m/m)	max	0.01	ASTM D 482
Pour Point (ºC)	max	4.0 (2)	ASTM D 97
Cloud Point (ºC)	max	10 (2)	ASTM D 2500

(1) @ 15,56°C. Original unit: API Gravity = 30 @ 15,56 °C.

(2) Original unit: °F.

(3) Colour must be measured before adding any additive.

(4) Report to EIA Quality Advisor if this value is less than 20% vol.

A.6.2.38. Panama Diesel Fuel Specifications

Table A.6.47 Diesel Fuel Specifications – Panama

Characteristic		Diesel Liviano Grado N°2D	Test Methods
Density @ 15°C (kg/m^3)		820.3 – 860.2 [(2)]	ASTM D 267
Flash Point (°C)	min	60	ASTM D 93
Viscosity @ 40°C (mm^2/s)		1.9 – 4.1	ASTM D 445
Viscosity @ 40°C (SSU)		33.5 – 40.0	ASTM D 2161
Cetane Number	min	45 [(1)]	ASTM D 613
Cetane Index	min	48 [(1)]	ASTM D 976
Colour		2.0	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	2.0	ASTM D 130
Water & Sediment (%v/v)	max	0.05	ASTM D 1796
T50 (ºC)	max	288	ASTM D 86
T90 (°C)	max	338	
FBP (°C)	max	371	
Residue	max	2.0	
Loss	max	2.0	
Sulphur (mg/kg)	max	5000	ASTM D 1552
Conradson Carbon Residue (%m/m)	max	0.25	ASTM D 189
Ash Content (%m/m)	max	0.01	ASTM D 482

(1) Cetane Number or Cetane Index are accepted.

(2) Original Unit: API Degrees.

A.6.2.39. Paraguay Diesel Fuel Specifications

Table A.6.48 Diesel Fuel Specifications – Paraguay (2001)

Characteristic		Gas Oil Sale Grade No 2D	Test Methods
Flash Point (°C)	min	52	ASTM D 93
Viscosity @ 37.8°C (mm^2/s)		33 - 46	ASTM D 2161
Cetane Index	min	45	ASTM D 976
Colour	max	2.5	ASTM D 1500
Copper Strip Corrosion (3 hours, 50°C)	min	3	ASTM D 130
Water & Sediment (%v/v)	max	0.1	ASTM D 1796
T90 (°C)	max	370	ASTM D 86
Sulphur (mg/kg)	max	5000	ASTM D 129
Ramsbottom Carbon Residue (%m/m)	max	0.35	ASTM D 524
Conradson Carbon Residue (%m/m)	max	0.32	ASTM D 189
Ash Content (%m/m)	max	0.02	ASTM D 482
Pour Point (ºC)	max	(1)	ASTM D 97

(1) During summer: 8°C max. During winter: -5°C min.

A.6.2.40. Peru Diesel Fuel Specifications

Table A.6.49 Diesel Fuel Specifications - Peru

Characteristic		2003		Year – See Note (1)				Test Methods
		Grade N°1D	Grade N°2D	Grade N°1D	Grade N°2D	Diesel N°2 Especial Grade N°2D	Diesel N°2 Superior Low Sulphur	
Density @ 15°C (kg/m^3)							820-845	
Flash Point (°C)	min	38	52	38	52	52	55	ASTM D 93 NTP 321.024
Viscosity @ 40°C (mm^2/s)		1.3-2.4	1.8-5.8	1.3-2.4	1.9-4.1	1.9-4.1	2.0-4.5	ASTM D 445
Cetane Number	min	40 (2)	45 (2)	40 (2)	45 (2)	50 (2)	51 (2)	ASTM D 613
Cetane Index	min			40	40	45	46	
Colour	max		3					ASTM D 1500
Oxidation Stability (minutes)	min		2 (3)				2.5 (3)	ASTM D2274
Copper Strip Corrosion (3 hours, 100°C)	min	3	3	3	3	3	3	ASTM D 130 NTP 321.021
Water & Sediment (%v/v)	max	0.05	0.05	0.05	0.05	0.05	0.02	ASTM D 1796 NTP 321.029
T90 (°C)	max	288	357	288	282-360	282-360		ASTM D 86 NTP 319.177
T95 (°C)	max						360	
FBP (°C)	max		385					
Recovered @ 250°C (%v/v)	max	n/r	n/r	n/r	n/r	n/r	65	
Recovered @ 350°C (%v/v)	min	n/r	385	n/r	n/r	n/r	80	
Sulphur (mg/kg)	max	5000	7000	5000	5000	1500	350	ASTM D 1552 ASTM D 4294
Ramsbottom Carbon Residue (%m/m)	max			0.15	0.35	0.35		ASTM D 524
Conradson Carbon Residue (%m/m)	max	0.15	0.35				0.30	ASTM D 189/ NTP 321.041
Ash Content (%m/m)	max	0.01	0.01	0.01	0.01	0.01	0.01	ASTM D 482 NTP 321.020
Pour Point (ºC)	max	-12	4	-12	4	4		ASTM D 97 NTP 321.037
Cloud Point (ºC)	max						-4	
Acidity, (mg KOH/g)	max		2.0				0.08	ASTM D974
Particulate Contaminant (mg/l)	max						24	ASTM D2276

(1) New Technical Normative of Peru that should become valid once the General Hydrocarbons Directorate approves - probably in 2004.

(2) In case the equipment required for this method is not available, the Cetane Index will be calculated as per the ASTM D4737-01 method.

(3) Reported in mg/100ml.

A.6.2.41. Puerto Rico Diesel Fuel Specifications

Table A.6.50 Diesel Fuel Specifications: Puerto Rico

Property		Puerto Rico
Cetane Number	min	45
or Cetane Index	min	45
Sulphur (% m/m)	max	0.05 (1)
Aromatics (% v/v)	max	
Distillation (°C)		
IBP		
10% v/v rec.	max	
50% v/v rec.	max	
90% v/v rec.	max	
End point	max	
Cold Flow Properties		
Pour Point (°C)	max	
Cloud Point (°C)	max	
Other Parameters		
Density @ 20°C		820-870
Viscosity @ 40°C (mm^2/s)		
Flash Point PM (°C)	min	
Conradson CR 10% (% m/m)	max	
Ramsbottom CR 10% (% m/m)	max	
Water & sediment (% v/v)		
Ash (% m/m)	max	
Copper corrosion 3h/100°C	max	
Colour ASTM	max	
Test Methods		

0.5% m/m sulphur grade available for off-highway and marine applications.

A.6.2.42. Venezuela Diesel Fuel Specifications

Table A.6.51 Diesel Fuel Specifications: Venezuela

Property		Venezuela
Cetane Number	min	43
or Cetane Index	min	
Sulphur (% m/m)	max	1.0
Aromatics (% v/v)	max	
Distillation (°C)		
IBP		
10% v/v rec.	max	
50% v/v rec.	max	
90% v/v rec.	max	360
End point	max	
Cold Flow Properties		
Pour Point (°C)	max	0
Cloud Point (°C)	max	
Other Parameters		
Density @ 20°C		report
Viscosity @ 40°C (mm^2/s)		1.6-5.2
Flash Point PM (°C)	min	60
Conradson CR 10% (% m/m)	max	0.15
Ramsbottom CR 10% (% m/m)	max	
Water & sediment (% v/v)		0.10
Ash (% m/m)	max	0.01
Copper corrosion 3h/100°C	max	2
Colour ASTM	max	2.5
Test Methods		COVENIN

A.6.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

CONCAWE have no information on emissions and fuel economy test procedures for the region.

A.6.4. REFERENCE FUELS

A.6.4.1. Argentine Reference Gasoline

Characteristic		Limits	ASTM Method
RON	min	93.0	D 2899
Sensitivity	min	7.5	
Lead	g/l (max)	0.013	D 3237
Distillation:	°C		D 86
IBP		23.0 - 35.0	
10% v/v rec.		48.9 - 57.2	
50% v/v rec.		93.3 - 110.0	
90% v/v rec.		148.9 - 162.8	
FBP	max	212.8	
Sulphur	% mass (max)	0.10	D 1265
Phosphorous	g/l (max)	0.0013	
Vapour pressure	kPa	60.8 - 63.4	D 323
Composition	% v/v (max)		D 1310
Olefins		10.0	
Aromatics		35.0	
Saturates		Balance	

A.6.4.2. Argentine Reference Diesel Fuel

Characteristic		Limits	ASTM Method
Density @ 15°C	kg/l	0.835 - 0.845	D 1298
Cetane index		51.0 - 57.0	D 976
Distillation:	°C		D 86
50% v/v rec.	max	245	
90% v/v rec.		320 - 340	
FBP	max	370	
Viscosity @ 40°C	mm^2/s	2.5 - 3.5	D 445
Sulphur	% mass	0.20 - 0.50	D 1265 D 2622 D 2785
Flash point	°C (min)	55.0	D 93
CFPP	°C (max)	- 5.0	EN 116 (1)
CCR (10%)	% m/m (max)	0.20	D 189
Ash	% m/m (max)	0.01	D 482
Water	% m/m (max)	0.05	D 95 D 1744
Copper corrosion @ 100°C	max	1.0	D 130
Neutralisation value	mg KOH/g (max)	0.20	D 974

(1) European method, equivalent to IP 309.

A.6.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

CONCAWE are unaware of any current fuel consumption and CO_2 regulations in the region.

A.6.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

A.6.6.1. Argentina

In-service emissions limits were published in Official Bulletin No. 27.919, dated 27 June 1994:

Table A.6.52 Argentina In-Service Emission Limits

Date of Vehicle Registration	Gasoline Idle Emissions		Diesel Free Acceleration Smoke	
	CO (% v/v)	HC (ppm)	Bacharach Index	Coefficient of Absorption (m^{-1})
Gasoline				
01/01/83 - 31/12/91	4.5	900	-	-
01/01/92 - 31/12/94	3.0	600	-	-
From 01/01/95	2.5	400	-	-
Diesel				
From 01/07/94	-	-	5	2.62

A.6.6.2. Colombia

Table A.6.53 In-use Emission Limits for New or Used Gasoline Vehicles - Resolucion Numero 005 de 09 ene 1996

Model Year	CO (% v/v at idle)		HC (ppm at idle)	
	Altitude 0-1500m	Altitude 1501-3000m	Altitude 0-1500m	Altitude 1501-3000m
2001 and later	1.0	1.0	200	200
1998 – 2000	2.5	2.5	300	300
1996 – 1997	3.0	3.5	400	450
1991 – 1995	3.5	4.5	550	750
1981 – 1990	4.5	5.5	750	900
1975 - 1980	5.5	6.5	900	1000
Pre – 1975	6.5	7.5	1000	1200

Table A.6.54 In-Use Free Acceleration Smoke Limits for Diesel Vehicles - Resolucion Numero 005 de 09 ene 1996

All Weight Classes Model Year	Opacity (%)
2001 and later	40
1996 – 2000	50
1991 – 1995	55
1986 – 1990	60
1981 – 1985	65
Pre-1981	70

A.6.6.3. Mexico

Mexico City - Inspection and Maintenance

An I&M programme was introduced by the Mexico City Metropolitan Area (MCMA) in 1989. By June 1990 about 750 repair shops and 32 government stations were licensed by the government of the City (Departamento Del Distrito Federal or DDF) or the State of Mexico to carry out the inspections covering about 2.7 million vehicles.

Inspections are currently performed twice a year and consist of a brief visual inspection of emission control components, a visual check of exhaust smoke and an analysis of exhaust gas emissions for gasoline-powered vehicles. CO and HC emissions are measured at idle and at 2500 rpm in neutral. The analysers are manually operated units built to the specifications issued by the California Bureau of Automotive Repair (BAR) in 1974 and 1980 (BAR74 or BAR80). An inspector is responsible for issuing pass/fail certificates. Enforcement is by a visual sticker system. A dated window sticker is issued by the inspection station at the completion of the test. Display of an expired sticker results in a fine and impoundment of the vehicle for 24 h.

The programme was reviewed at the end of 1995 as it was increasingly clear that many independent stations were not applying the tests impartially. In view of the importance that I/M testing had in achieving air quality standards in Mexico City, the DDF decided to close down private garage inspection stations and switch to a completely centralised system. In addition it was agreed that the State of Mexico would proceed along similar lines but with a delayed schedule. The upgraded programme will be implemented in three stages and will include the following improvements;

- inspections only at stations which do not have responsibility to repair vehicles (test only or large centralised centres)
- tighter standards for all vehicle categories
- improved, loaded mode testing of CO, HC and NOx emissions
- independent auditors at each station to monitor the quality and integrity of each inspection

The Official Diary of 12 January 1996 specified CO and HC idle limits applicable to gasoline vehicles effective from the 1 January 1996 (see **Table A.6.55**).

Table A.6.55 Mexican Idle CO and HC limits effective from 1 January 1996

passenger cars light duty <2727 kg		
Model Year	**CO (% v/v)**	**HC (ppm)**
before 1980	4.0	450
1980-1986	3.5	350
1987-1993	2.5	300
after 1993	1.0	100

Vehicles >2727 kg		
Model Year	**CO (% v/v)**	**HC (ppm)**
before 1980	5.0	600
1980-1985	4.0	500
1986-1991	3.5	400
1992-1993	3.0	350
after 1993	2.0	200

Vehicles operating in the Mexico City area		
Model Year	**CO (% v/v)**	**HC (ppm)**
before 1987	2.00	200
1987-1993	1.00	150
after 1993	0.75	100

A.7. JAPAN

A.7.1. VEHICLE EMISSIONS LIMITS

On 21 November 1997, the Central Environment Council issued a report entitled "Future policy for motor vehicle exhaust emissions reduction (Second Report)". Following publication, the Environment Agency embarked on a partial revision of the existing regulations. This resulted in the current limits for gasoline and LPG fuelled vehicles, including two wheeled models and these are described in **Part 1**, **Section 7.1.2**. The diesel emission limits published at that time have been superseded and the details of more recent developments are described below and in **Part 1**, **Section 7.1.3**.

In December 1998 the Central Environment Council (CEC) published its third report on "Future policy for motor vehicle exhaust emission reduction". This called for a further tightening of NOx and PM limits for diesel engines in two stages and these are described in **Part 1**, **Section 7.1.3**.

New regulations was introduced from 2004 applying to all diesel non-road vehicles with a rated power between 19 and 560 kW and further details will be found in **Part 1**, **Section 7.1.5**.

At the end of 1996, an Auto/Oil Programme was launched. The "Japan Clean Air Programme" (JCAP) was a tripartite activity between the government (mainly represented by MITI), the auto industry (JAMA) and the oil industry (PAJ). The Petroleum Energy Centre (PEC), in collaboration with automobile and oil industries in Japan, conducted the programme.

A.7.1.1. Short-Term Diesel Emissions Target (2002/2004)

In December 1998 the Central Environment Council (CEC) published its third report on "Future policy for motor vehicle exhaust emission reduction". This called for a further tightening of NOx and PM limits for diesel engines in two stages. The long term targets are described in **Part 1.**

NOx was reduced by 25 - 30% and PM by 28 - 35% over the years 2002 to 2004, depending on vehicle category. HC and CO emissions were reduced by 70%. These short term measures were implemented without any change in diesel fuel quality (i.e. sulphur content = 500 mg/kg max.). In order to maintain in-use emissions performance, the durability distance has been "drastically" increased and OBD became obligatory.

The short term targets are shown in Table **A.7.1**:

Table A.7.1 Short term Japanese vehicle exhaust emission limits

Fuel	Vehicle	Emission Limits (g/km for LD, g/kWh for HD) (1)				Test Cycle
		CO	HC	NOx	PM	
Diesel	Passenger Vehicles (< 1265 kg)	0.63	0.12	0.28	0.052	10·15 mode
	Passenger Vehicles (> 1265 kg)	0.63	0.12	0.30	0.052	
	Commercial Vehicles (< 1.7t)	0.63	0.12	0.28	0.052	
	Commercial Vehicles (1.7 - 3.5t)	0.63	0.12	0.49	0.060	
		g/kWh				
	Commercial Vehicles (> 3.5t))	2.22	0.87	3.38	0.180	13 mode

(1) Both maximum and mean limits are stipulated - the mean limits shown here apply to production ≥2000 units/y and are to be met as a type approval limit and as a production average. The maximum limits apply for production of <2000 units/y and generally as an individual limit in series production.

The proposed durability requirements for diesel vehicles are compared with the current limits in **Table A.7.2**:

Table A.7.2 Amendments to Diesel Durability Requirements

	Durability Distance (km))					
	Passenger cars	Trucks & buses (GVW t)				
		≤2.5	>2.5 - 3.5	>3.5 - 8.0	>8.0 - 12.0	>12.0
Current	30 000	20 000	30 000	30 000	30 000	30 000
Future	80 000	80 000	80 000	250 000	450 000	650 000

Diesel Particulate Filter Regulations for Tokyo

The Tokyo Metropolitan Government published draft regulations on 18 February 2000, mandating the installation of diesel particulate filters (DPF) for all diesel vehicles that operate in the Tokyo area. The regulations were enforced from April 2003 for older vehicles. Any diesel vehicle not fitted with a DPF will be banned from Tokyo after April 2006. Concerns have been expressed by operators regarding the cost of DPFs.

Non-road Vehicles

New regulations were introduced from 2004 applying to all diesel non-road vehicles with a rated power between 19 and 560 kW. Certification of the engines was scheduled to be established “around the year 2001”. NOx, HC, CO and PM are controlled, with particular emphasis being placed on nitrogen oxides and particulates. The C1 mode of the ISO draft test method is used and the target values for reduction are very similar to the second phase of limits being introduced in the US and EU. The third report on “Future policy for motor vehicle exhaust emission reduction” has proposed that the scope of the legislation should be studied. The study would include both smaller and larger engines and would be extended to include gasoline and LPG powered off-road vehicles.

A.7.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

The regulations are described in **Part 1**, **Section 7.2**.

A.7.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

A.7.3.1. Current Test Procedures

The test procedures detailed in **Part 2**, **Section B.7.3.1** were augmented in the early 1990s. The replacement test cycles are illustrated in **Figure A.7.1** and **A.7.3**. These procedures have been modified to include a high speed cycle and measurements will be made in terms of g/km or g/kWh, instead of ppm. Details of the changes in cycle type, measurement mode, vehicles affected and implementation dates are given below:

10-Mode Replaced by 10·15-Mode (**Figure A.7.1*****)***
- Gasoline/LPG passenger cars, light and medium duty commercial vehicles, mini trucks and diesel passenger cars/light duty commercial vehicles.
- Implementation Date: 1991.

The 10.15-mode test is also used to measure fuel economy.

Gasoline/LPG 6-Mode Replaced by Gasoline/LPG 13-Mode (**Figure A.7.3*****)***
- Measurement Mode: ppm changed to g/kWh
- Gasoline/LPG heavy duty commercial vehicles.
- Implementation Date: 1992

Diesel 6-Mode Replaced by 10·15 Mode (**Figure A.7.1*****)***
- Measurement Mode: ppm changed to g/km
- Diesel medium duty commercial vehicles.
- Implementation Date: 1993

Diesel 6-Mode Replaced by Diesel 13-Mode (Figure **A.7.3*****)***
- Measurement Mode: ppm changed to g/kWh
- Diesel heavy duty commercial vehicles.
- Implementation Date: 1994

Because of the differences in test procedures, a direct comparison of Japanese emission standards with those applied in the US and Europe cannot be made.

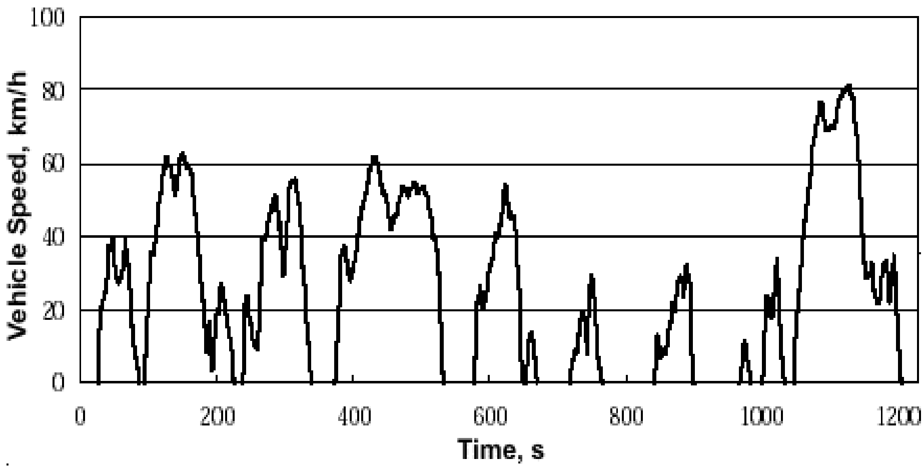
In the spring of 2002, the CEC recommended new long-term regulations for vehicles and fuels (Future Policy For Motor Vehicle Exhaust Emission Reduction, Fifth Report, April 16, 2002). These recommendations included changes to the test modes to better reflect “real” world driving conditions in light duty and heavy duty vehicles. Japanese 2005 emission standards will therefore introduce two new transient emission test cycles:

- New test mode for light vehicles of GVW < 3500 kg. Note that this test mode has yet to be formally adopted by the Ministry of Environment.
- JE05—new test mode for heavy vehicles of GVW above 3500 kg

For light duty vehicles, the new test cycle will be fully phased-in by 2011. Between the years 2005 and 2011 emissions will be determined using weighted averages from the new test mode, 10·15 mode, and 11 mode cycles. For heavy duty vehicles, the new test mode JE05 becomes effective in 2005.

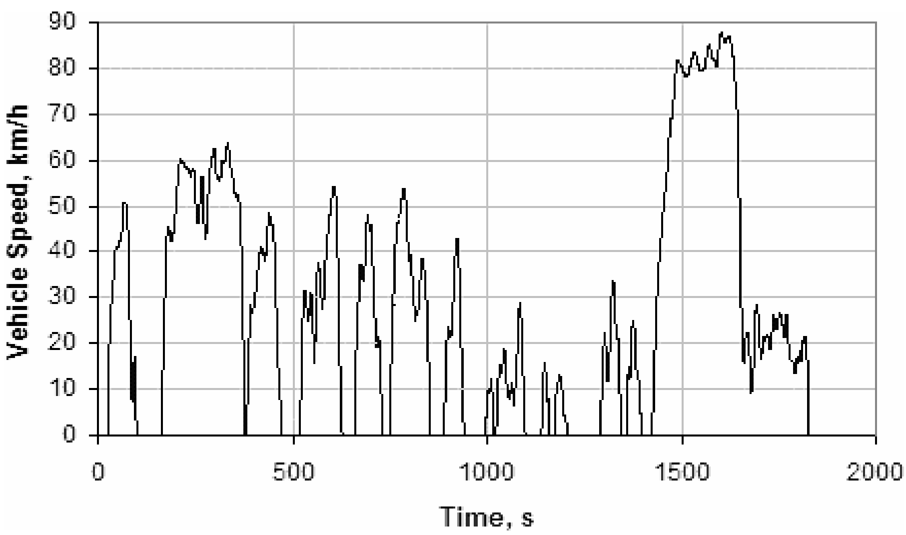
The cycles are intended for emissions testing of both diesel and gasoline vehicles. They can be run as either cold- or warm-start tests, depending on the application. The current hot start test modes (modes 10 - 15) and cold start mode (mode 1) for LD vehicles, and mode 13 for HD vehicles will be replaced with those shown in **Figures A.7.1** and **A.7.2** respectively.

Figure A.7.1 Japan - Proposed New LD Vehicle Test Mode



The JE05 cycle (also known as the ED12) is a heavy duty transient driving schedule with a total duration of approximately 1800 seconds. The JE05 test is defined through vehicle speed vs. time points, as shown in **Figure 7.2**. For engine dynamometer testing, engine torque-speed-time data must be generated based on the vehicle speed points. Computer programs to generate the torque-speed data for both gasoline and diesel engines have been provided by the Japanese Ministry of Environment.

Figure A.7.2 Japan - JE05 Heavy Duty Transient Driving Cycle



A.7.3.2. Illustration of Current Japanese Test Cycles

Figure A.7.3 Japanese 10.15 light duty test cycle

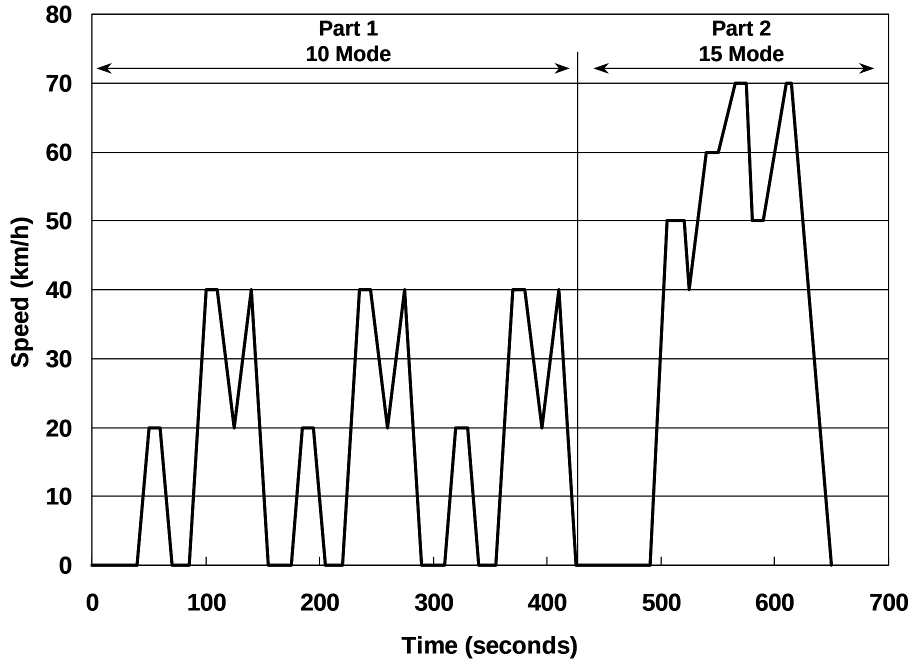
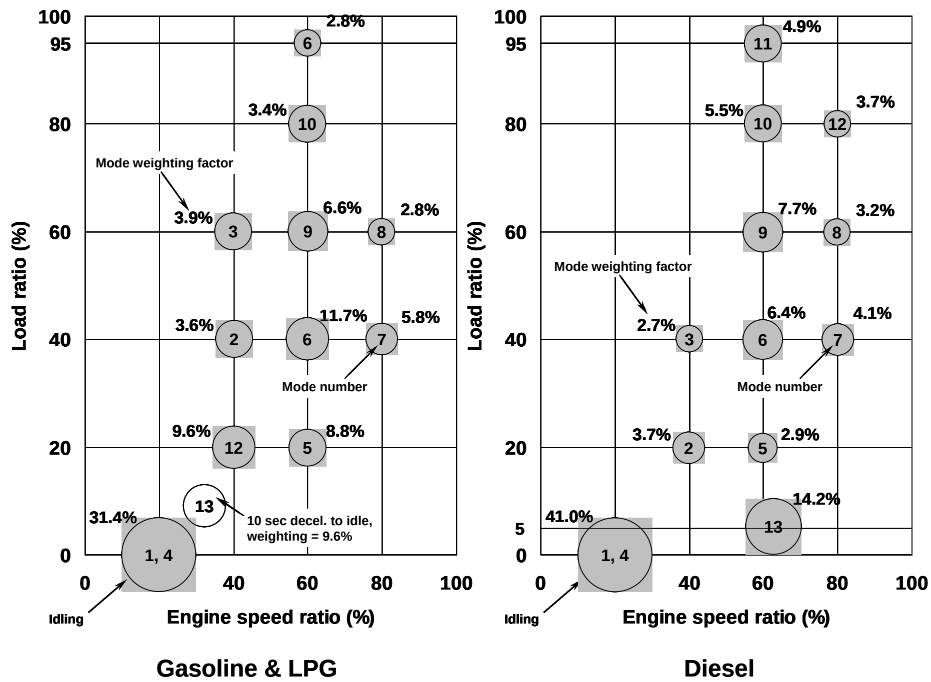


Figure A.7.4 Japanese 13 mode HD test cycles



A.7.4. FUEL ECONOMY AND CO_2 REGULATIONS

In January 1993 fuel economy targets for passenger cars in the year 2000 were officially published. The current targets apply only to gasoline passenger cars and commercial vehicles. Details of the existing targets are given in **Part 2**, **Section B.7.5**.

In October 1998 the vehicle standardisation subcommittee of the Vehicle Transport Technology Council proposed new target values to tighten the standards for gasoline vehicles and to incorporate limits for their diesel counterparts, that is, all vehicles below 2.5 t. Each vehicle manufacturer must meet the target values for each category (or segment) on a weighted average of the vehicles produced. For passenger cars, the fuel economy targets are based on vehicles fitted with automatic transmissions, on the basis that the bulk of the Japanese car population are so equipped. Fuel economy targets for vehicles between 2.5 and 3.5 t will be discussed “sometime after the year 2000”. The target values are shown in **Part 1**, **Section 7.4**.

A.7.5. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

Emissions testing forms an integral part of the Japanese roadworthiness test (“Shaken”). Vehicles must be submitted for testing once they are 3 years old and thereafter every 2 years. The limits applied are:

Table A.7.3 Japanese In-Service Limits

Species	Limit
CO	4.5% v/v max.
HC	1200 ppm max. (4-stroke engines) 7800 ppm max. (2-stroke engines)

The measurements are made by NDIR at idle. If the emissions exceed the prescribed limits then some re-tuning is permitted.

A.8. AUSTRALASIA

A.8.1. VEHICLE EMISSIONS LIMITS

A.8.1.1. Australia - Introduction

In 1989 a Federal Act of Parliament, the “Motor Vehicle Standards Act 1989” brought new vehicle standards under the jurisdiction of the Federal Government. The regulations, encoded as the Australian Design Rules (ADRs), are administered by the Federal Office of Road Safety. Standards are developed cooperatively by transport and environment agencies of both State and Federal Governments, in consultation with the automotive industry, oil companies and consumer organisations. Standards prior to 2000 are described in **Part 2, Section B.8.1.1**.

The new standards implement the Australian Government’s commitments under the Tax Package Agreement for European standards to be implemented from 2002 to 2006 for diesel vehicles, and from 2003 to 2005 for petrol vehicles. These are described in **Part 1**, **Section 8.1**.

A.8.1.2. Proposed Future Emissions Legislation

The Government’s Motor Vehicle and Environment Committee (MVEC) has issued draft proposals for emissions requirements beyond 2006. Again, these are briefly described in **Part 1**, **Section 8.1.2**.

A.8.1.3. New Zealand Draft Land Transport Rule - Vehicle Exhaust Emissions 2003 (Rule 33001) - 6 December 2002: Objective and Scope

Details will be found in **Part 1**, **Section 8.1.3**.

A.8.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.8.2.1. Australia Fuel Quality Standards Act 2000 - Act No. 153 of 2000 (as amended)

The *Fuel Quality Standards Act 2000* (the Act) and the *Fuel Quality Standards Regulations 2001* create national standards for fuels and provides a framework for enforcing these standards. These are described in **Part 1**, **Section 8.2.1**.

Approved variations of theses standards are tabulated below.

Table A.8.1 Australia - Approved Variations on the Fuel Standards

Name of Approval Holder	Period of Operation	Approved Variation of Fuel Standard	Commonwealth Gazette Number and Date
BP Australia Bulwer Island	27 March 2003 - 31 December 2003	Permits the supply of diesel with a minimum density of 810 kg/m^3	GN14, 9 April 2003
BP Australia Pty Ltd The Shell Company of Australia Caltex Australia Petroleum Pty Ltd Mobil Oil Australia Pty Ltd	21 March 2003 - 31 December 2004	Permits the supply of (winter mix) diesel with the following parameters: viscosity 1.2 cSt @ 40°C density 800 kg/m^3 lubricity 0.700 mm sulphur 1000 mg/kg Conditions attached	GN14, 9 April 2003
IOR Energy Pty Ltd Moama Refinery Pty Ltd Central Oil Refineries Pty Ltd	31 December 2003 - 31 December 2005	Permits the supply of diesel with a minimum density of 790 kg/m^3.	GN3,22 January 2003
Mobil Oil Australia Pty Ltd	31 December 2002 - 30 June 2004	Permits the supply of diesel produced at the Altona refinery with a sulphur content of up to 1300 mg/kg with the fuel additive Cleanerburn™.	GN10, 13 March 2002

Record Keeping and Reporting Obligations

Fuel suppliers at each point along the supply-chain from importers and producers, through distributors, and to service station outlets must provide documentation relating to the fuel. At each stage, before supply to the consumer, these documents must include a statement about whether or not the fuel complies with the relevant fuel quality standard, and if not, how and why the standard has not been complied with.

Industry's documentation, and related production and distribution processes, are likely to be investigated if "off-specification" fuel is detected through the random sampling programme undertaken by Environment Australia. All fuel documentation must be kept for each calendar year for two years. Failure to provide accurate information about compliance with national fuel quality standards and other prescribed matters is an offence attracting significant penalties under the Act. From 2003, fuel producers and importers are also required to report annually to Environment Australia, about the fuel they produced and supplied in 2002. The statement must be provided on or before:

1. 14 February in the following year; or
2. any later day allowed by the Secretary.

Some of this information will be included in Environment Australia's annual report and tabled in Federal Parliament.

Exceptions to Compliance

The Act prohibits the supply of fuels, which do not meet the standards set out in the Determinations, for use in motor vehicles. In the case of fuels supplied for gasoline fuelled vehicles, supply of aviation gasoline is also prohibited unless an approval is held. The Act also makes it an offence to alter fuel to take it outside the specifications of a standard, in specified circumstances. There are four main exceptions to the general prohibitions of the Act:

1. The gasoline standard does not apply to fuel supplied for use solely at a racing event or on a race track approved or recognised by:

    - The Confederation of Australian Motor Sport,
    - National Association of Speedway Racing,
    - Australian National Drag Racing Association,
    - Australian Karting Association, or
    - Motorcycling Australia.

2. An approval varying the standard for specified fuel supplies for a limited time can be granted under the Act by the Minister for the Environment and the Heritage.

3. It is not an offence to supply "off-specification" fuel if the supplier believes, on reasonable grounds, that the fuel will be further processed for the purpose of bringing it into compliance with the standard or an approval.

4. The supply of "off-specification" fuel may be permitted under a direction or order made under an emergency law.

Monitoring Compliance

Random fuel sampling at refineries, terminals, distribution terminals and service stations has been undertaken by Commonwealth inspectors from early 2002. Samples will be tested at selected laboratories accredited by the National Association of Testing Authorities Australia. The Act sets out inspectors' obligations when exercising their powers under the Act. Inspectors will be properly qualified and trained to exercise their powers safely in circumstances where fuels are being supplied.

Application for an Approval to Vary the Fuel Standard

An application for an approval to supply fuel that differs from the standard can be made to the Minister for the Environment and Heritage (the Minister). Under the Act the Minister can grant an approval that varies a fuel quality standard with respect to specified supplies of fuel for a specified time.

The Minister is required by the Act to have regard to the recommendations of the Fuel Standards Consultative Committee (FSCC) before granting an approval to vary a standard. The FSCC comprises Commonwealth, State and Territory government representatives, and representatives of industry and consumer organisations. The Minister may appoint one or more persons (expert advisers) to give expert advice to the Fuel Standards Consultative Committee to assist the Committee in commenting on matters about which the Minister is required to consult the Committee. Expert advisers are not members of the Committee.

Applicants who unsuccessfully seek an approval have a right to appeal to the Administrative Appeals Tribunal. An application for approval should be made in accordance with the *Fuel Quality Standards Regulations 2001*.

A.8.2.2. Ethanol Regulations

Please refer to **Part 1**, **Section 8.2.4**.

A.8.2.3. Proposed Future Fuel Standards

These are described in **Part 1**, **Section 8.2.5**.

A.8.2.4. New Zealand Petroleum Products Specification Regulations 2002

These regulations came into force on 1 September 2002, revoking the Petroleum Product Regulations 1998 (SR 1998/267). Date of notification in the *Gazette* was: 25 July 2002 and the regulations are described in **Part 1**, **Section 8.2.6**. Earlier specifications will be found in **Part 2**, **Section B.8.2.4**.

Calculating pool average

If a pool average is specified, it must be determined as set out below. Pool averages must be calculated separately by each producer of fuel in New Zealand and by each fuel importer for imported product. Monthly pool averages must be calculated based on:

- batch fuel quality, as indicated on the certificate of quality, and quantity and date of completion of loading, as indicated on the bill of lading, for fuel produced in New Zealand; and
- batch fuel quality, as indicated on the certificate of quality, and supplied quantity and date of completion of discharge into the first port storage at a New Zealand port, as indicated on the bill of lading or other appropriate documentation, for imported fuel.

Each producer of fuel in New Zealand and each fuel importer must keep for a period of not less than 3 years the following records with regard to properties that are regulated by pool averaging:

a) relevant fuel quality, for each individual batch; and
b) quantity of each individual batch, on a mass or volume basis as appropriate; and
c) date of the batch; and
d) monthly average; and
e) monthly journal entry.

Each producer of fuel and each fuel importer must supply access in New Zealand to the records required to be kept when requested, in writing, to do so by the responsible Minister of the Crown.

For diesel fuel sulphur content, for each calendar month during the period this regulation is in effect, each producer of fuel in New Zealand and each fuel importer must separately calculate for each region the average sulphur content of diesel produced or imported in that month as follows:

a) for each batch of diesel respectively produced or imported in the month, the average sulphur content of the batch (in mg/kg) is multiplied by the mass of the batch (in kg) to obtain the mass of sulphur (in mg) contained in the batch; and
b) the mass of sulphur calculated from all diesel batches produced or imported in a month is added together and the total divided by the total mass of all the month's batches to produce the monthly average sulphur content (in mg/kg) as follows:

where:

- S_i is the average sulphur content for batch i in mg/kg
- M_i is the mass of batch i in kg
- n is the total number of batches in the month; and

the monthly average sulphur content is subtracted from the pool average maximum and the difference multiplied by the total mass of all the month's batches to produce the monthly journal entry as follows:

where:

- M_i is the mass of batch i in kg
- n is the total number of batches in the month.

For total aromatic compounds in gasoline, for each calendar month during the period that this regulation is in effect, each producer of fuel in New Zealand and each fuel importer must separately calculate the average percentage total aromatic compounds for each relevant grade of gasoline produced or imported in that month as follows:

a) for each batch of regular grade gasoline and each batch of premium grade gasoline respectively produced or imported in the month, the average total aromatic compounds content of the batch (in l/l) is multiplied by the volume of the batch (in l) to obtain the volume of total aromatic compounds (in l) contained in the batch; and
b) the volume of total aromatic compounds calculated from all gasoline batches of the relevant grade produced or imported in a month is added together and the total divided by the total volume of all the month's batches to produce the monthly average total aromatic compounds content (in l/l) as follows:

where:

- A_i is the average total aromatic compounds content for batch i in litres
- V_i is the volume of batch i in litres
- n is the total number of batches in the month; and

the monthly average total aromatics compounds content is subtracted from the pool average maximum expressed in l/l, and the difference multiplied by the total volume of all the month's batches of the relevant grade to produce the monthly journal entry as follows:

where:

- Vi is the volume of batch i in litres
- n is the total number of batches in the month.

If the monthly journal entry is negative, it is considered a debit. If the monthly journal entry is positive, it is considered a credit. Debits must be offset with an equal number of credits within 5 months following the end of the month in which the debits were accumulated. Credits may be used within 5 months following the end of the month in which the credits were accumulated to offset future debits. Credits expire and may not be used after this time period.

For diesel sulphur content, all debits must be offset with an equal number of credits by 31 December 2005.

A.8.2.5. Ethanol Regulations

In August 2003, the Environmental Risk Management Authority approved the use of up to 10% v/v ethanol in gasoline blends. Such blends are to be excise duty free for a minimum period of two years. The new measure was prompted by the availability of 6 - 11 million litres per of renewable ethanol produced annually by the dairy industry.

A.8.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

Test procedures commensurate with the adopted emissions standards have been adopted.

A.8.4. REFERENCE FUELS

CONCAWE have no information available.

A.8.5. FUEL ECONOMY AND CO_2 REGULATIONS

A.8.5.1. Australia

The FCAI proposed reductions of the national average fuel consumption of the new car fleet with a target of 5% from 1989 levels by 1995 and further reductions thereafter as follows:

Table A.8.2 Australian fuel economy regulations

Year	Fuel consumption (1/100km)
1995	8.7
2000	8.2
2005	8.0

A.8.6. INSPECTION AND MAINTENANCE

A.8.6.1. Australia

A pilot scheme was introduced in the Greater Sydney area in July 1998 and was to be extended to all light duty vehicles in the year 2000. See **Part 2, Section B.8.6.1**.

National In-Service Emissions (NISE2) Study

NISE 2 will consist of two phases: a Preliminary Phase to establish an Australian drive cycle for light duty petrol vehicles; and a Main Phase testing vehicles to establish the current emissions performance of light duty petrol vehicles. Further details will be found in **Part 1**, **Section 8.6.1**.

A.8.6.2. New Zealand

The Department of Motor Industry and the oil industry are developing standards for vehicle emissions. The new system is expected to be in place by the latter half of 2006. See **Part 2**, **Section B.8.6.2**.

A.9. OTHER ASIAN COUNTRIES

A.9.1. VEHICLE EMISSIONS LIMITS

Current exhaust emissions legislation for Asian countries other than Japan are detailed below. Earlier legislation is covered in greater detail in **Part 2**, **Section B.9.1**.

A.9.1.1. Cambodia

The "Sub-decree on Air Pollution Control and Noise Disturbance" under the 1996 law on environmental protection and natural resources management sets the vehicle emissions requirements as well as standards for sulphur and lead in fuel and ambient air quality. The emission regulation was created by the Ministry of Environment in 1991, which is aimed at safeguarding and improving air quality in Cambodia.

Table A.9.1 Cambodia Idle Emissions Standards

Fuel	Vehicle	Idle Emission Levels (1)				
		CO (%)		HC (mg/kg)		Black Smoke (%)
		A	B	A	B	
Gasoline	2-stroke motorcycle	4.5	4	10000	3000	-
	4-stroke motorcycle	4.5	4	10000	2400	-
	All four wheeled vehicles	4.5	4	10000	800	-
Diesel	All four wheeled vehicles	-	-	-	-	50

(1) A – all vehicles used over five years from year of production. B – all newly imported vehicles in the first five years from year of production

A.9.1.2. China

The Chinese State Environment Protection Agency (SEPA) proposed the adoption of EU Directive 91/441/EEC in 2000. However, Beijing and Shanghai implemented the new emissions regulations in 1999. Beijing proposed that three-way catalysts be installed from 1999 and promulgated its own legislation accordingly. The first tranche of standards went into effect on 1 January 1999 and are given in **Part 2**, **Section B.9.1.1**. More recent standards are reported in **Part 1**, **Section 9.1.1**.

A.9.1.3. Hong Kong

Light Duty Vehicles

Revised limits became effective from 13 July 1996, replacing 70/220/EEC with 94/12/EEC.

Heavy Duty Vehicles

Revised limits, effective from 13 July 1996, replaced 88/77/EEC by 91/542/EEC.

A.9.1.4. India - Proposed Emissions Legislation

India is proposing to introduce light duty emissions legislation equivalent to Euro II, III and IV between 2005 and 2010. Bharat Stage II (Euro II equivalent) was introduced in 2000 & 2001 in Delhi, Mumbai, Kolkata and Chennai. Bangalore, Hyderabad Ahmedabad, Pune, Surat, Kanpur and Agra followed on 1 April 2003.

Table A.9.2 Proposed Timetable for More Stringent Emission Limits for New Vehicles (excluding 2 & 3 Wheelers)

Location	Emission Limits	Effective Date
Entire Country	Bharat Stage II [(1)]	1 April 2005
	Euro III equivalent	1 April 2010
Delhi, Mumbai, Kolkata & Chennai	Bharat Stage II	Introduced in 2000 & 2001
Bangalore, Hyderabad Ahmedabad, Pune, Surat, Kanpur and Agra	Bharat Stage II	1 April 2003
Delhi, Mumbai, Kolkata & Chennai, Bangalore, Hyderabad Ahmedabad, Pune, Surat, Kanpur and Agra	Euro III equivalent - all private vehicles, city public service vehicles and city commercial vehicles	1 April 2005
	Euro IV equivalent - all private vehicles, city public service vehicles and city commercial vehicles	1 April 2010

(1) Equivalent to Euro II

Table A.9.3 Proposed Timetable for More Stringent Emission Limits for New 2 and 3 Wheeled Vehicles [(1)]

Emission Limits	Effective Date
Bharat Stage II	1 April 2005
Bharat Stage III	Preferably from 1 April 2008 but not later than 1 April 2010

(1) Emission Limits for 2/3 Wheelers are to be applied across the entire country.

Proposed Emission Limit Values for New 2 and 3 Wheeled Vehicles

In respect of 2 and 3 wheeler limits, India considers that it is already ahead of most of the advanced world as far as the emission norms are concerned. However, there is a need for more stringent control of 2 and 3 wheel vehicle emissions on account of their large population. New India specific limits are to be implemented from the year 2005 and are called the *Bharat Stage II* norms for 2 and 3 wheelers. The next stage of limit values beyond 2005 has been finalized. It has been recommended that these norms preferably be adopted by 2008 but not later than 2010. These are referred to as the *Bharat Stage III* norms.

Table A.9.4 Proposed Emission Limit Values for New 2 and 3 Wheeled Vehicles (1)

Vehicle	Pollutant	Limit Values (g/km) (2)			
		2005		Preferably 2008	
		Bharat Stage II		Bharat Stage III	
		Norms	DF (3)	Norms	DF (3)
2 Wheelers	CO	1.50	1.2	1.0	1.2
	HC + NOx	1.50	1.2	1.0	1.2
3 Wheelers (Gasoline)	CO	2.25	1.2	1.25	1.2
	HC + NOx	2.00	1.2	1.25	1.2
3 Wheelers (Diesel)	CO	1.00	1.1	0.50	1.1
	HC + NOx	0.85	1.0	0.50	1.0
	PM	0.10	1.2	0.05	1.2

(1) Emission Limits for 2/3 Wheelers are to be applied across the entire country.
(2) The emission norms for new 2 and 3 wheelers should be identical for 2 stroke and 4 stroke vehicles.
(3) Deterioration factors to account for deterioration of devices such as catalytic converters. In view of "an element of arbitrariness" of Deterioration Factor (DF) and the fact that meeting ambient air quality is dependent on actual emissions from on-road vehicles, the prescribed values of DF may be reviewed in the year 2005. This review will be made after the results of field trials conducted by the manufacturers are available.
(4) It is recommended that the progress in terms of meeting the proposed 2008 emission norms be reviewed in the year 2005.
(5) The 2 and 3 wheeler vehicle manufacturers may be asked to give mandatory on-road emission warranty for 30 000 km in respect of components which may have impact on emissions including that of any catalytic converter.
(6) In order to reflect the actual conditions on the road, the following Reference Vehicle Mass for Chassis Dynamometer Tests have been recommended:
    (i) 2 wheelers - current reference masses
    (ii) 3 wheelers - two persons + driver
    (iii) 3 wheelers (Diesel) - GVW as declared by the manufacturers

A.9.1.5. Indonesia

The only current emissions control regulation in Indonesia (Minister of Communications No. KM 8/1989) controls idle CO and HC emissions from gasoline engines and free acceleration exhaust emissions from diesel engines, as shown in **Table A.9.5**.

Table A.9.5 Indonesian exhaust emission regulations

Vehicle Category	Engine Type	Gasoline Idle Emissions		Diesel Smoke
		CO (% v/v)	HC (ppm)	(opacity)
4-wheeled		4.5	1200	50%
2-wheeled	4-stroke	4.5	2400	
	2-stroke	4.5	3000	

A.9.1.6. Malaysia

Malaysia introduced ECE 15.04 regulations in September 1992. In 1995 the ECE R 24.03 and 93/59/EEC regulations were adopted. The Department of the Environment recommended to Parliament that all new passenger cars be fitted with catalytic converters.

From 1 January 2000 light duty vehicles had to meet the limits found in EU Directive 94/12/EEC. From 1 January 1997, heavy duty diesels (above 3.5 t) were not to exceed the limit values of ECE R 49.02 and light duty diesel vehicles had to comply with EU Directive 93/59/EEC. The above limits apply to both new vehicles and to vehicles fitted with replacement engines. Malaysia has also introduced in-service regulations and these are described in **Part 2, Section B.9.6.3**.

A.9.1.7. Nepal

The government announced that, with effect from 11 July 1999, imported light duty vehicles meeting Euro 1 standards (or higher) enjoy a 10% rebate on import duties.

A.9.1.8. Philippines

Pursuant to Section 7 of Presidential Decree No. 1181, the Department of Environment and Natural Resources issued revised rules and regulations regarding motor vehicle pollution which contain more stringent standards for new and used motor vehicles. These required that, after 1 January 1997, all newly manufactured gasoline fuelled vehicles (including motorcycles and mopeds) must be designed to operate on unleaded gasoline.

From 1 January 1997, all new light duty vehicles had to comply with ECE regulation R15-04 standards. Fuel evaporative emissions for spark ignition engines were not to exceed 2.0 grams per test and crankcase emissions were eliminated. For motorcycles, CO emissions at idle should not exceed 6.0%. New medium and heavy duty engines sold after 1 January 1997 had to comply with ECE Regulation 49-01.

The new Philippine Clean Air Act was signed in late June 1999. It required that, by 2003, cars and light commercial vehicles met Euro 1 limits, as laid down in Directives 91/441/EEC and 93/59/EEC. For heavy duty vehicles the gaseous emissions limits of EU Directive 91/542/EEC (Euro 1) apply.

Prior to first registration, any imported used or any rebuilt motor vehicles registered for the first time prior to 31 December 1999 had to meet limits of 3.5% CO and 500 ppm HC (spark ignition engines) or 1.65 m^{-1} opacity for diesels. Vehicles registered for the first time on or after 1 January 2000 must comply with limits of 1.2% CO and 200 ppm HC (spark ignition) or 1.2 m^{-1} smoke opacity (compression ignition). If the in use emission standard of the country of origin is more stringent than these maximum limits, it will supersede them.

A.9.1.9. Singapore

Singapore adopted intermediate gasoline emissions limits from January 1992, i.e. European ECE 83 or Japanese 1978 limits and from July 1993 introduced EU "*Consolidated Emissions Directive*" limits. The government was planning to implement EU Directive 96/69/EC in March 2000 for gasoline powered vehicles. New diesel vehicles have had to comply with the ECE R24 smoke emission standard since 1 January 1991 and from 1 January 1992 this requirement was extended to include used vehicles imported for registration. "Euro 2" limits were introduced in March 2000 and Euro 4 will be implemented in 2006. Motorcycles have been required to comply with US EPA Standards since 1 October 1991.

A.9.1.10. South Korea

Until July 1987, exhaust emission regulations in South Korea were based on Japanese test procedures. New regulations were introduced for spark ignition vehicles and diesel vehicles based on US and ECE R 49 procedures respectively, as shown in **Table A.9.6**.

Table A.9.6 South Korean passenger and commercial vehicle emission standards

Type of Vehicle		Date	CO g/km	HC g/km	NOx g/km	Evap HC g/test	PM (Smoke) g/km	Test
Passenger mini-cars (gasoline and LPG)	≤800 cc	July 1987	8.0	1.5	1.5	4.0 [1]	-	FTP 75
		Dec 1996	4.5 [2]	0.5 [2]	1.25 [2]	4.0 [1]	-	
		Jan 1998	2.11/4.0 [3]	0.25/0.5 [3]	0.62/1.0 [3]	2.0	-	
		Jan 2000	2.11	0.16	0.25	2.0	-	
Passenger cars (gasoline and LPG)	>800 cc <3.0 t	July 1987	2.11	0.25	0.62	2.0	-	FTP 75
		Jan 1998	2.11	0.25	0.42	2.0	-	
		Jan 2000	2.11	0.16	0.25	2.0	-	
Passenger cars (diesel)	≥800 cc <3.0 t	Jan 1993	2.11	0.25	1.25	-	0.25	FTP 75
		Jan 1996	2.11	0.25	0.62 [6]	-	0.08	
		Jan 2000	2.11	0.25	0.62 [6]	-	0.05	
Light duty trucks	≤1.7 t	July 1987	6.21	0.50	1.43	2.0	-	FTP 75
		Jan 1998	6.21	0.5	0.75	2.0	-	
		Jan 2000	2.11	0.25	0.62	2.0	-	
		Jan 2004	1.27	0.18	0.16	2.0	-	
Light duty trucks (gasoline and LPG)	1.7 - 3.0 t	July 1987	6.21	0.50	1.43	2.0	-	FTP 75
		Jan 1998	6.21	0.5	1.06	2.0	-	
		Jan 2000	2.74	0.29	0.43	2.0	-	
		Jan 2004	1.65	0.24	0.30	2.0	-	
Light duty trucks (diesel) ≤2.7 ton			**ppm**	**ppm**	**ppm**		**(%)**	Jap 6-mode
	DI	Jan 1993	980	670	750	-	(40)	
	IDI	Jan 1993	980	670	350	-	(40)	
Light duty trucks (diesel) ≤1.7 t			**g/km**	**g/km**	**g/km**		**g/km**	FTP 75
	DI & IDI	Jan 1996	6.21	0.5	1.43	-	0.31	
		Jan 1998	2.11	0.25	1.40	-	0.14	
		Jan 2000	2.11	0.25	1.02	-	0.11	
		Jan 2004	1.27	0.21	0.64	-	0.06	
Light duty trucks (diesel) 1.7-3.0 t	DI & IDI	Jan 1996	6.21	0.50	1.43	-	0.31	FTP 75
		Jan 1998	2.11	0.50	1.40	-	0.25	
		Jan 2000	2.11	0.50	1.40	-	0.14	
		Jan 2004	1.52	0.33	0.71	-	0.08	
Heavy duty vehicles (gasoline and LPG)			**g/KWh**	**g/KWh**	**g/KWh**			Jap gasoline 13-mode
	>2.7 t	July 1987	33.5	1.3	11.4	-		
	>3.0 t	Jan 2000	33.5	1.3	5.5	-		
Heavy duty vehicles (diesel) >2.7t			**ppm**	**ppm**	**ppm**		**(%)**	Jap 6-mode
	DI	Jan 1993	980	670	450	-	(40)	
	IDI	Jan 1993	980	670	450	-	(40)	
Heavy duty vehicles (diesel) >3.0t	DI & IDI		**g/KWh**	**g/KWh**	**g/KWh**		**g/KWh (%)**	13-mode (ECE R 49)
		Jan 1996	4.9	1.2	11.0	-	0.9 (40)	
		Jan 1998	4.9	1.2	6.0/9.0 [5]	-	0.25 [4] (25)	
		Jan 2000	4.9	1.2	6.0		0.25 [4] (25)	
		Jan 2002	4.9	1.2	6.0		0.15 [4] (25)	

(1) Reduced to 2.0 g/test WEF 01/01/96.

(2) For new registrations for mini-cars previously certified.

(3) Commercial mini-cars.

(4) Buses PM 0.5 g/kWh in 1996 and 0.10 g/kWh 2000/2002

- Emissions warranties; 5 yr or 80 000 km for passenger cars and for light duty vehicles after January 2000, 40 000 km and 60 000 km for light duty vehicles before January 1998 (except diesels) and January 2000 respectively, no requirement for diesel light duty vehicles before January 1998. Other requirements for LPG vehicles

Legislation was also introduced for 2-stroke and 4-stroke motorcycles which require the use of catalysts. The limits are given in **Table A.9.7**, but the test procedure is not known.

Table A.9.7 South Korean Motorcycle Emission Standards (CO and HC emissions at idle)

Effective Date	Engine Size (cc)	2-stroke		4-stroke	
		CO (% v)	HC (% v/v)	CO (% v)	HC (% v/v)
Jan 1996	≤125	4.0	0.70	4.0	0.40
	126 to 500	3.6	0.45	3.6	0.25
	>500	3.0	0.30	2.5	0.10
Jan 2000	ECE R 40.01				

A.9.1.11. Taiwan

Legislation in Taiwan required gasoline passenger vehicles to be certified to 1984 US Federal limits from July 1990. From July 1995 gasoline goods vehicles and buses with engine capacity greater than 1200 cc were certified against the 1984 US Federal standard for light duty trucks and this was extended to all such vehicles in July 1998. It was required to certify light duty diesel vehicles against the US 1984 light duty truck limits including particulates from July 1993 and it was planned to certify these vehicles to the US 1994 LDT limits from 1998. Heavy duty truck particulate limits, based on the US transient test cycle, have also been adopted. Details are given in **Table A.9.8**. Taiwan has also introduced limits for motorcycles which required catalysts be fitted from 1991 and 3-way catalysts from 1998. Fuel economy standards are also required for passenger cars and motorcycles (see **Section A.9.5.2)**.

Table A.9.8 Taiwan Vehicle Exhaust Emission Limits

Vehicle		Effective date	CO g/km	HC g/km	NOx g/km	HC+ NOx (g/km)	PM g/km	Idle CO (% v/v)	Idle HC (ppm)
Gasoline passenger vehicles (1) (2)	gvw ≤3.5t	1/7/90	2.11	0.255	0.62			3.5	600
Gasoline goods vehicles & buses (1) (2)	≤1200 cc	1/7/95	11.06	1.06	1.43			1.0	200
	≤1200 cc	1/7/98	6.20	0.50	1.43			0.5	100
	>1200 cc	1/7/95	6.20	0.50	1.43			1.0	200
	>1200 cc	1/7/99	3.11	0.242	0.68			0.5	100
Motorcycles (3)	All	1991						4.5	7000
	All	1/1/98	3.5			2.0		4.5	6000
	2-Stroke	31/12/2003	7.0			1.0		3.5	2000
	4-Stroke		7.0			2.0		3.5	2000
Light duty Diesel	gvw ≤2.5t	1/7/93	6.20	0.5	1.43		0.38		
		1998 plan	2.125	0.156	0.25		0.05		
Heavy duty Diesel (4)			**g/bhp.h**	**g/bhp.h**	**g/bhp.h**		**g/bhp.h**		
	gvw >3.5t	current	10	1.3	6.0		0.7(3)		

(1) Diesel engined passenger vehicles are not allowed.

(2) Evaporative emissions 2.0 g/test for gasoline vehicles.

(3) 2 & 3 wheeled vehicles with a curb weight <400 kg and a maximum speed >50 km/h or engine displacement >50 cc. Test Cycles – 1998: ECE40; 2003: ECE 15 (Cold Start). A 15 000 km durability requirement became effective from 1/1/98.

(4) Test cycle: Federal HD Transient Cycle.

- Smoke limit 40% opacity under acceleration and full load.
- Crankcase emissions are not allowed.

A.9.1.12. Thailand

ECE test cycles and limits have been proposed or adopted by Thailand for its emission regulations (**Tables A.9.9** and **A..9.10**):

Table A.9.9 Thai Emission Standards in 1995/96

Vehicle	Effective Date	Thai Standard	Equivalent Limits
Passenger cars (gasoline)	01/04/96	1280-2538	ECE R 83.01
Light duty (diesel ≤3.5 t)	01/01/96	1285-2538	ECE R 83.01 C
Heavy duty (diesel >3.5 t)	01/01/96		91/542/EEC A
Motorcycles	15/03/95	1185-2536	ECE R 40.01

Table A.9.10 Thai Emission Standards in 1997/99

Vehicle Type	Effective Date	Emissions (g/km)				Reference
		HC	NOx	CO	PM	
Passenger Cars & LDVs - Gasoline	01/01/99	0.5		2.2	-	94/12/EEC
Passenger Cars & LDVs - Diesel	01/01/99	0.7		1.0	0.08	94/12/EEC
Motorcycles/Mopeds	01/07/97	5.0		13.0	-	-
	01/07/99	3.0		4.5	-	-
		Emissions (g/kWh)				
HD >3.5t - Diesel	01/01/97	1.1	8.0	4.5	0.36	91/542/EEC
	01/01/99	1.1	7.0	4.0	0.15	96/1/EEC

A.9.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.9.2.1. Bangladesh and Brunei Gasoline Specifications

Bangladesh

Leaded 96 RON Premium and 80 RON Regular grades are marketed in Bangladesh. Unleaded grades were introduced in 1999 – see **Table A.9.11**.

Table A.9.11 Gasoline Specifications: Bangladesh

Property			Regular	Premium	Test Method ASTM
Density @ 15°C	kg/l	max	To be reported	To be reported	D1298
RON		min	80	95	D2699
Lead content	g/l	max	0.013	0.013	
Distillation:					D86
IBP	°C		To be reported	To be reported	
10% v/v recovered @ °C		max	75	75	
50% v/v recovered @ °C		min	80	80	
50% v/v recovered @ °C		max	125	125	
90% v/v recovered @ °C		max	180	180	
FBP	°C	max	215	215	
Residue	% m/m	max	2	2	
RVP @ 38°C	psi	max	10	10	D323
Sulphur	% m/m	max	0.1	0.1	D1266
Copper Corrosion 3 h @ 50°C		max	1	1	D130
Mercaptan sulphur	% m/m	max	0.001	0.001	D1219
Oxidation stability		min	240	240	D525
Doctor test			Negative	Negative	D235

Brunei

Table A.9.12 Grade Structure: Brunei

Property	Industry Limit	Test Method
RON, min	85/92/97	ASTM D2699-94
MON, min	report	ASTM D2700-94
Lead, mg/l, max	13	ASTM D3237-89
Sulphur, mg/kg, max	1 000	ASTM D4294-90
Benzene, % v/v, max	5.0	ASTM D5443-93
RVP @ 37.8 °C, kPa, max	report	ASTM D5191-93a
Density @ 15 °C, kg/m^3, min - max	report	ASTM D1298-90
Distillation:		ASTM D86-93
IBP, °C, max	report	
E70, %, min-max	15 – 40	
E100, %, min-max	40 – 65	
E180, %, min	90	
EP, °C, max	210	
Residue, vol%, max	2	
Oxygenates, vol%, max Ethers (5 or more C atoms)	15	Calculated
Existent Gum (solvent washed), mg/100 ml, max	4	ASTM D381-94
Copper Corrosion, 3 hr @ 50 °C, max	Class 1	ASTM D130-94
Colour	yellow/p. orange/green	Visual
Other	(1)	-

(1) FVI, calculated: max: 90; Doctor test: negative; Water content, mg/kg, max: 750. Source: Petroleum Unit, Prime Minister's Department, 2001

A.9.2.2. Cambodia

Fuel quality control is managed by the CamControl (under the Ministry of Commerce) and the Department of Custom and Excise (under the Ministry of Economic and Finance (MEF). The Ministry of Commerce also facilitates fuel import and export and quality control whereas MEF is responsible for fuel taxation and curbs smuggling. In the future, the Cambodian National Petroleum Authority (CNPA) is planning to take over some of these roles.

Table A.9.13 Cambodia Gasoline Specifications (Source: CamControl, March 2005)

Property	**Current Grades**		**Test Method (ASTM)**
	Leaded Regular/Premium	**Unleaded Regular/Premium**	
RON, min	87/95	92/97	D 2699
MON, min	79/84	83.6/85.6	D 2700
Lead, mg/l, max	150	13	D 3384
Sulphur, mg/kg, max	1500	1000	D 4292

A.9.2.3. China Euro 3 and Euro 4 Gasoline and Diesel Fuel Specifications

See **Part 1**, **Section 9.2.3** for brief details.

A.9.2.4. Hong Kong Gasoline Specifications

Leaded premium, intermediate and regular grades were marketed but were banned (along with lead containing additives) from 1 April 1999. Lead replacement gasolines, containing valve seat protection additives were made available (see **Table A.9.14**). Unleaded gasolines, with a similar grade structure to the now defunct leaded grades, have been established for some years, with benzene limited to 5% v/v and with the option of adding oxygenates according to EU Directive 85/536/EEC. The sulphur content of unleaded gasoline is limited to 0.05% m/m. From 1 April 2000 the country moved partially to the Euro 3 specification, with a 1% v/v limit on benzene and a voluntary 350 ppm limit on sulphur content.

Table A.9.14 Hong Kong Gasoline Specifications

Property		01/04/01	Proposed 01/01/01
Octane Number			
Research	min		95 (1)
Motor	min		85
(R+M)/2	min		(1)
Volatility			
distillation			
10% (°C)	max	70	
50% (°C)	max	120	
90% (°C)	max	190	
FBP (°C)	max	205	
residue	max	2.0	
E100 (% v/v)	min		46
E150 (% v/v)	min		75
RVP @ 37.8°C kPa	max	W 88 S 74	S 60
Composition			
sulphur ppm)	max	350 (voluntary)	150
lead (g/l) (2)	max		
aromatics (% v/v)	max		42.0
benzene (% v/v)	max	1.0	1.0
olefins (% v/v)	max		18.0
oxygenates (3)	max		
ethers (% v/v)	max	0 -10	0 -15
Other Parameters			
copper corrosion (3h/50°C)	max		
mercaptan S (% m/m)	max		
doctor test			
acidity (mgKOH/100ml)	max		
oxidation stability (min)	min		
existent gum (mg/100ml)	max		

(1) Regular and Super grades are also available:
Regular RON: 90; (R+M)/2: 85
Super RON: 97; (R+M)/2: 92

(2) Hong Kong banned the sale of leaded gasolines and lead containing fuel additives from 1 April 1999. Valve seat protection additives are incorporated.

(3) Oxygenates as per EU Directive 85/536/EEC.

A.9.2.5. India Gasoline Specifications

Unleaded regular was introduced in Delhi, Madras, Bombay and Calcutta from 1 April 1995 and pan-India availability was planned for 1999. An unleaded premium grade was introduced in 2000 and the specification included tighter volatility limits. The Supreme Court ordered a complete ban on the sale of leaded gasoline in Delhi with effect from 1 September 1998. The change to unleaded gasoline was scheduled to be extended to the entire country by the turn of the century.

Table A.9.15 Leaded Gasoline Specifications: India

Property		Regular 2005 (1)	Premium (1)
Octane			
Research or	min	89	93
(R+M)/2	min	84	88
Volatility			
distillation			
IBP (°C)	max	report	report
E70 (% v/v)		10-45	10-45
E100 (% v/v)		40-70	40-70
E180 (% v/v)	min	90	90
FBP (°C)	max	215	215
residue % v/v	max	2.0	2.0
Vapour Pressure @ 37.8°C kPa (S-W)	max	35-60	35-70
VLI (2)		-	950
Composition			
sulphur (% m/m)	max	0.20	0.20
lead (g/l)	max	0.15	0.15
benzene (% v/v)	max		
oxygenates (% v/v) (3)	max		
Other Parameters			
density @ 15 °C	min max	report	report
copper corrosion (3h/50°C)	max	No.1	No. 1
mercaptan S (% m/m)	max		
doctor test			
water tolerance (4) (°C)	max	S 10 W 0 (5)	S 10 W 0 (5)
oxidation stability (min)	min		
potential gum (mg/100ml)	max	5	5
existent gum (mg/100ml)	max	4	4
colour		orange	red

(1) Leaded premium was banned by the year 2000, leaded regular will follow in 2005.
(2) VLI 750 May-July central and northern plains. VLI for new grades not known.
(3) Oxygenates permitted as per EU Directive 85/536/EEC (column A limits).
(4) For fuels containing oxygenates.
(5) Water tolerance –10°C in winter for the northern hilly region.

Table A.9.16 Year 2000 BIS Unleaded Gasoline Specification: India (Applicable from 1 April 2000)

Property		Regular	Premium [1]
Octane			
Research or	min	88	93
(R+M)/2	min	84	88
Volatility			
Distillation:			
E70 (% v/v)		10 - 45	10 - 45
E100 (% v/v)		40 - 70	40 - 70
E180 (% v/v)	min	90	90
FBP (°C)	max	215	215
Residue	max	2.0	2.0
Vapour pressure @ 37.8°C kPa		35 - 60	35 - 60
VLI (10 VP + 7 E70)	max	(S) 750/ (W) 950	(S) 750/ (W) 950
Composition			
Sulphur mg/kg [2]	max	1000	1000
Lead (g/l)	max	0.013	0.013
Benzene (% v/v) [3]	max	5.0	5.0
Oxygenates (% v/v) [4]	max		
Other parameters			
Density @ 15 °C (kg/m^3)		710 - 770	710 - 770
Copper corrosion (3h/50°C)	max	No. 1	No. 1
Water tolerance [5] (°C)	max	S 10 W 0 [6]	S 10 W 0 [6]
Potential gum (g/m^3)	max	50	50
Existent gum (g/m^3)	max	40	40
Colour		orange	red
Intake system cleanliness [7]		report	report
Specification		BIS 2796:2000	
Test methods		BIS 1448	

(1) Premium grade specification introduced in 1998/99. This grade is marketed on demand in major cities.

(2) Gasoline with a sulphur content of 500 mg/kg (max) was made available in the National Capital Region of Delhi from 31 May, 2000 (Supreme Court of India Order; 10 May 2000). In Mumbai, the oil industry commenced supply of gasoline with the same sulphur content with effect from 1 January 2001.

(3) Gasoline with a benzene content of 1% v/v (max) was made available in the National Capital Territory of Delhi from 1 October, 2000 and in the National Capital Region of Delhi from 31 March 2001 (Supreme Court of India Order; 10 May, 2000). In Mumbai city, the oil industry commenced supply of gasoline with the same benzene content with effect from 1 January, 2001. In other metropolitan areas a 3% v/v maximum limit has applied from 1 April 2000.

(4) Oxygenates permitted as per EU Directive 98/70/EC.

(5) For fuels containing oxygenates - temperature for phase separation.

(6) Water Tolerance -10°C winter northern hilly region.

(7) Multi-functional additives to be employed.

Table A.9.17 Proposed Gasoline Specifications for Bharat Stage II, Euro 3 and Euro 4 emission norms: India

Property		Bharat Stage II Norms		Euro 3 & 4 Norms [(1)]	
		Regular	**Premium**	**Regular**	**Premium**
Octane					
Research	min	88	93	91	95
Motor	min	-	-	81	86
(R+M)/2	min	84	88	-	-
Volatility					
Distillation					
E70 (% v/v)		10 - 45	10 - 45	10 - 45	10 - 45
E100 (% v/v)		40 - 70	40 - 70	40 - 70	40 - 70
E150 (% v/v)	min	-	-	75	75
E180 (% v/v)	min	90	90	-	-
FBP (°C)	max	215	215	210	210
Residue	max	2.0	2.0	2.0	2.0
Vapour pressure @ 37.8°C kPa		35 - 60	35 - 60	-	-
	max	-	-	60	60
VLI (10 VP + 7 E70)	max	(S) 750/ (W) 950	(S) 750/ (W) 950	(S) 750/ (W) 950	(S) 750/ (W) 950
Composition					
Sulphur mg/kg [(2)]	max	1000	1000	150	150
Lead (g/l)	max	0.013	0.013	0.005	0.005
Benzene (% v/v) [(3)]	max	5.0	5.0	1.0	1.0
Olefins % v/v	max	-	-	21	18
Aromatics % v/v [(4)]	max	-	-	42	42
Oxygenates (% v/v)	max	[(5)]	[(5)]	-	-
Oxygenates (% m/m) [(6)]	max	-	-	2.7	2.7
Other Parameters					
Density @ 15 °C (kg/m^3)		710 - 770	710 - 770	720 - 775	720 - 775
Oxidation stability (minutes)	min	-	-	360	360
Copper corrosion (3h/50°C)	max	No. 1	No. 1	No. 1	No. 1
Water tolerance [(7)] (°C)	max	S 10 W 0 [(8)]	S 10 W 0 [(8)]	-	-
Potential gum (g/m^3)	max	50	50	-	-
Existent gum (g/m^3)	max	40	40	-	-
Gum (solvent washed) mg/100 ml	max	-	-	5	5
Colour		orange	red	orange	red
Intake system cleanliness [(9)]		report	report	report	report

(1) Gasoline of 89 RON and 79 MON and having all other properties as the unleaded regular grade indicated above shall also be available for meeting requirements of the older vehicles which will be conforming to *pre-Euro III* equivalent emission norms.

(2) Sulphur content reducing to 50 mg/kg maximum to meet Euro 4 norms.

(3) Benzene content in gasoline shall be reduced from the existing limit of 3% v/v max. for the four metros (Delhi, Mumbai, Kolkata & Chennai) and 5% v/v max. in the rest of the country independent of implementation of *Bharat Stage II* emission norms. The benzene content shall be reduced progressively to 1% v/v max. in the mega cities (Delhi National Capital Territory and Region, Greater Mumbai, Kolkata, Chennai, Bangalore, Hyderabad and Ahmedabad) by April 2005. For the rest of the country, the maximum benzene content shall be 3% v/v max. from April 2005.

(4) Aromatics content reducing to 35% v/v maximum to meet Euro 4 norms.

(5) Oxygenates permitted as per EU Directive 98/70/EC.

(6) Oxygenate type and content as per EN 228:1999 Unleaded Gasolines.

(7) For fuels containing oxygenates - temperature for phase separation.

(8) Water Tolerance -10°C winter northern hilly region.

(9) Multi-functional additives to be employed.

A.9.2.6. Indonesia

A leaded 88 octane "premium" is the only grade available but 10% v/v MTBE can be added at service stations to produce a 91.5 RON "Premix" (**Table A.9.18**).

Table A.9.18 Indonesia Gasoline Specifications

Property		**Prem. 88**	**Premix**[1)]
Octane			
Research	min	88.0	91.5 [(1)]
Volatility			
Distillation			
10% (°C)	max	74	74
50% (°C)	max	88-125	88-125
90% (°C)	max	180	180
FBP (°C)	max	205	205
Residue % v/v	max	2.0	2.0
Vapour Pressure @ 37.8°C kPa [(4)]	max	62	62
Composition			
Sulphur (% m/m)	max	0.20	0.20
Lead (g/l)	max	0.42	0.42
MTBE (% v/v)	max		10
Mercaptan S (% m/m)	max	0.002	0.002
Doctor test		neg.	neg.
Other Parameters			
Copper corrosion (3h/50°C)	max	No.1	No.1
Oxidation stability (min)	min	240	240
Existent gum (mg/100ml)	max	4	4
Colour		yellow	yellow

(1) Premix is Premium 88 mixed with 10% v/v MTBE

A.9.2.7. Malaysia Gasoline Specifications

From 1st January 1995, the number of specified grades was reduced from three to two, a leaded regular (0.15 g Pb/l) and an unleaded premium. Malaysia banned leaded gasoline from 1 January 1999 and two unleaded grades (92 and 97 RON) are currently marketed, see **Table A.9.19**.

Malaysia is planning to implement its future gasoline specifications in two phases, Stage 1 took place in the first quarter of 2005 and Stage 2 is scheduled for 2010. For gasoline, sulphur limits will be reduced to 500 mg/kg and 50 mg/kg respectively in Stage 1 and Stage 2, as compared to the current (MS118) limit of 1000 mg/kg. Also, the benzene limit will be reduced to 1.0% v/v in Stage 2.

Table A.9.19 Gasoline Specifications: Malaysia

Property	Stage 1	Stage 2
Retail Implementation Date	Quarter 1, 2005	2010
RON, min	92/97	92/97
Lead, mg/l, max	13	13
Sulphur, mg/kg, max	500	50
Benzene, % v/v, max	5	1
RVP @ 37.8 °C, kPa, max	65	60
Density @ 15°C, kg/m^3, max	725 - 780	To report
Distillation:		
IBP, °C, max	40	40
T10, °C, max	74	74
T50, °C, min-max	75 – 115	75 – 115
T90, °C, max	180	180
FBP, °C, max	215	215
Residue, % v/v, max	2	2
Oxidation Stability, minutes, min	240	240
Existent gum, mg/100ml, max	4	4

A.9.2.8. Pakistan

Table A.9.20 Gasoline Specifications: Pakistan [(1)]

Property		Unleaded			Leaded		
		Super	**Prem.**	**Regular**	**HOBC**	**Prem.**	**Reg.**
Octane							
Research	min	97	87	80	97	87	80
Volatility							
Distillation							
10% (°C)	max				70	70	100
50% (°C)	max				125	125	150
90% (°C)	max				180	180	180
FBP (°C)	max				205	205	205
Residue	max				2.0	2.0	2.0
RVP @ 37.8°C kPa [(2)]	max	W 69 S 62	W 69 S 62	W 69 S 62	W 69 S 62	W 69 S 62	W 69 S 62
Composition							
Sulphur (% m/m)	max	0.2	0.2	0.2	0.2	0.2	0.2
Lead (g/l)	max				0.84	0.42	0.42
Other parameters							
Density @ 15.4° C					0.74- 0.79	0.72- 0.76	0.69- 0.74
Mercaptan S (% m/m)	max						0.001
Copper corrosion (3h/50°C)	max				1	1	1
Oxidation stability (min)	min						240
Existent gum (mg/100ml)	max				4	4	4
Colour					Red	Orange	Yellow
Test Methods		ASTM					

(1) Pakistani Standards Institute specification

(2) Winter: November - February; Summer: March - October.

A.9.2.9. Philippines

An unleaded 93 RON premium grade was introduced in 1994 alongside the standard 93 RON/0.15 gPb/l grade. The unleaded specification also introduced limits on aromatics and benzene and allowed the use of ethers (**Table A.9.21**). On 26 September 1997, President Ramos signed Executive Order 446 mandating the phase out of leaded gasoline no later than 1 January 2000 in Metro Manila and no later than 1 January 2001 throughout the remainder of the country.

The Philippines Clean Air Act has undergone a number of changes since it was first enacted and the following summarises the latest intentions as at the time of publication of this report:

December 1999 Gasoline: aromatics 45% vv (max); benzene 4% v/v (max)

December 2000 Gasoline: AKI 87.5 (min); RVP 9 psi (max)

Table A.9.21 Philippines Gasoline Specifications

Property		**Limits** (2)	
		Prem.	**UL Prem.**
Octane Number			
Research	min	93	93
Volatility			
Distillation			
IBP	max		
10% (°C)	max	70	70
50% (°C)		77-121	77-121
90% (°C)	max	185	185
FBP (°C)	max	221	221
Residue % v/v	max	2.0	2.0
RVP @ 37.8°C kPa	max	85	70
Composition			
Sulphur (% m/m)	max	0.2	0.1
Lead (g/l)	max	0.15	0.013
Aromatics (% v/v)	max		55.0 (3)
Benzene (% v/v)	max		5.0
Oxygenates			allowed
Other Parameters			
Copper corrosion (3h/50°C) (1)	max	1	1
Existent gum (mg/100ml)	max	4	4

(1) ISO 2160-1985.

(2) ULG market share of 61% in July 1994; estimated at 82% in July 1997 and scheduled to be 100% by January 2000

(3) Aromatics may increase to 65% v/v max if no MTBE added.

A.9.2.10. Singapore Gasoline Specifications

Singapore banned leaded premium, (with a lead content of 0.15 g/l max) with effect 1 July 1998. Unleaded Superplus and regular grades are marketed. The government has a “guideline” of 5% v/v max for benzene which is not legislated. However, the oil companies have to submit quarterly reports on benzene content and it is possible that the limit will be reduced to below 3% v/v (**Table A.9.22**). The government is also monitoring aromatics content with a view to issuing legislation in the future.

Table A.9.22 Gasoline Specifications: Singapore

Property		**ULSuper Prem.**	**UL Reg.**
Octane Number			
Research	min	98.0	92.0
Lead (g/l)	max	unleaded	unleaded

A.9.2.11. South Korea Gasoline Specifications

South Korea has marketed unleaded grades since 1986/7 and became totally unleaded in 1993. The premium and regular unleaded grades had specified limits in 1998 of 45.0% v/v aromatics, 4.0% v/v benzene and a requirement for the addition of a minimum of 0.75% m/m oxygen as oxygenates. These limits changed in 1999, 2000 and again in 2003 or 2004. Details will be found in **Table A.9.23**.

Table A.9.23 Gasoline Specifications: South Korea

Property		UL Prem. (1998)	UL Reg. (1999)	UL Prem. (2000)	UL Reg. (2000)	UL Prem. (Post 2000)	UL Reg. (Post 2000)
Octane Number							
Research	min	91	95.0	91.0	87.0	> 94.0	91.0 – 94.0
Motor	min	83	84.0	80.0	76.0		
Volatility							
Distillation							
10% (°C)	max	70	70	70	70	70	70
50% (°C)	max	125	70-110	70-110	70-110	125	125
90% (°C)	max	175	170	170	170	175	175
FBP (°C)	max	225	200	200	200	225	225
Residue % v/v	max	2.0				2.0	2.0
RVP @ 37.8°C kPa	max	45-82 (1)	W 62 S 48	W 62 S 48	W 62 S 48	44 – 70 (S) 44 – 96 (W)	44 – 70 (S) 44 – 96 (W)
Composition							
Sulphur (mg/kg)	max	500	500	200	200	130	130
Lead (mg/l)	max	13	13	13	13	13	13
Aromatics (% v/v)	max	45.0	45.0	35.0	35.0	35.0	35.0
Benzene (% v/v)	max	4.0	4.0	2.0	2.0	1.5	1.5
Olefins (% v/v)		-	-	23.0	23.0	18.0	23.0
Oxygen (% m/m)	min	0.75 (2)	0.75 (2)	1.3 – 2.3	1.3 – 2.3	0.5 - 2.3 (S) 1.0 – 2.3 (W)	0.5 - 2.3 (S) 1.0 – 2.3 (W)
Methanol (% m/m)	max					0.1	0.1
Phosphorus (g/l)	max	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013
Other Parameters							
Copper corrosion (3h/50°C)	max	1	1	1	1	1	1
Water (% v/v)	max	0.01	0.01	0.01	0.01	0.01	0.01
Oxidation stability (min)	min	480	480	480	480	480	480
Existent gum (mg/100ml)	max	5	5	5	5	5	5
Colour		Green	Yellow	Green	Yellow	Green	Yellow

(1) RVP 98 kPa max available for cold weather operation.
(2) For 1999, oxygen content increased to 1.0% m/m.

A.9.2.12. Sri Lanka Gasoline Specification

Table A.9.24 Emissions Related Gasoline Specification - Sri Lanka (Effective 1 January 2003)

Parameter	Unit	Limits	Test Method
RON		90 - 95	ASTM D 2699
Reid vapour pressure	kPa	35 - 60	ASTM D 5191
Total aromatics	% v/v (max)	45	UOP 273
Benzene content	% v/v (max)	4.0	ASTM D 3606
Lead content	g/l (max)	0.013	ASTM D 3341 ASTM D 5055
Sulphur content	mg/kg (max)	1000	ASTM D 1266
Gum (solvent washed)	g/m^3 (max)	40	ASTM D 381
Oxygenates content	% v/v (max)	15	ASTM D 4815
Oxygen content	% m/m (max)	2.7	by calculation

A.9.2.13. Taiwan

Taiwan has had a premium leaded, plus unleaded premium and regular grades, available since June 1990 and May 1986 respectively. The government reduced the lead content of the leaded grade from 0.08 to 0.026 g/l by July 1997 and became totally unleaded in January 2000. It was proposed to introduce a 30% v/v aromatics limit by July 1996. It was also proposed that the benzene contents of all grades would be reduced from 3.5% v/v to 3.0% v/v by July 1997 and to 1.0% v/v by January 2000 (see **Table A.9.25**).

Table A.9.25 Gasoline Specifications: Taiwan

Characteristics	Current	Proposed	
	(Jan 2002)	(Jan 2007)	(Jan 2011)
RON	98/95/92	98/95/92	98/95/92
Benzene, % v/v max,	1.0	1.0	1.0
Volatility			
Distillation:			
10% (°C)	74	74	74
50% (°C)	127	127	127
90% (°C)	190	190	190
FBP (°C)	225	225	225
Residue % v/v	2.0	2.0	2.0
RVP, psi, max	8.5/8.5/8.9	8.7	8.5
Oxygen, wt%, max	2	2.7	2.7
Sulphur, mg/kg, max	80/120/180	50	30
VOCs + NOx, mg/km, max	1500/1570/1700	-	-
Toxics, mg/km, max	41/45/48	-	-
Aromatics, % v/v max,	37	37	35
Olefin, % v/v max,	18	18	18

A.9.2.14. Thailand

Thailand introduced unleaded reformulated gasoline specifications on the 1 January 1993, incorporating a number of changes, including two types of premium leaded and unleaded grades:

- Type II for Bangkok and other cities (Premium)
- Type I for rural areas (Intermediate)

The Type II specifications contain a number of compositional constraints including maximum limits for benzene (3.5% v/v), aromatics (50% v/v) and a minimum oxygenate addition of 5.5% v/v. The aromatics limit was reduced to 35% v/v from 1 January 2000. Additives to control injector and inlet valve deposits are also required (see **Table A.9.26**). The Type II specifications in addition require a minimum concentration of MTBE. The specification for the regular grade also required detergent additives from 1 January 1995 at the time when it became unleaded.

The following specifications appear to have been overtaken by recent government decisions. CONCAWE understand that, from 01/01/2007, all gasolines must contain 10% v/v ethanol. It is not clear if any concessions have been made on vapour pressure or distillation characteristics.

Table A.9.26 Gasoline Specifications: Thailand

Property	Past	Current	Proposed	Test Method (ASTM)
Retail Implementation Date	May 1998	January 26, 2004	2010	
RON, min:				D 2699
Refinery/Importer	87 / 91 / 95	91 / 95	-	
Retailer	86.6 / 90.6 / 94.6	90.6 / 94.6	-	
MON, min:				D 2700
Refinery/Importer	76 / 80 / 84	80 / 84	85	
Retailer	75.6 / 79.6 / 83.6	79.6 / 83.6	-	
Lead, mg/l, max	13	13	13	D 5059
Sulphur, mg/kg, max	1000	500 (1)	50	D 4294
Phosphorus, mg/l, max	1.3	1.3	-	D 3231 (2)
Benzene, % v/v, max	3.5	3.5	1.0	D 5580
Aromatics, % v/v, max	35 (3)	35	35	D 5580
Olefins, % v/v, max	-	-	18	-
Oxygen content, % m/m, max	2 max/2 max/ 1 min - 2 max	-	1 min - 2 max	-
RVP @ 37.8 °C, kPa, max	48(S)/62(W)	62	8 psi	D 4953
Distillation:				D 86
T10, °C, max	70	70	-	
T50, °C, min-max	70-110	70-110	102 max	
T90, °C, max	170	170	154	
FBP, °C, max	200	200	200	
Residue, % v/v max	2.0	2.0	-	
Oxygenates, % v/v:				D 4815
Min	-/-/5.5	-/5.5	-	
Max	-/11/11	11/11	-	
Methanol, max	-	3.0	-	
Oxidation stability, minutes, min	360	360	-	D 525
Existent gum, mg/100ml, max	4	4	-	D 381
Cu Corrosion, 3 hr @ 50°C, max	Class 1	Class 1	-	D 130
Colour Hue	Green (4)/Red (5)/ Pale Yellow (6)	Red (5)/ Pale Yellow (6)	-	(a) Visual or (b) D 2392 or (c) D 1500
Dye Content, mg/l, min	4.0/10.0/-	7.0/-	-	
Colour Intensity	-/-/0.5-1.0	-/0.5-1.5	-	
Appearance	Bright, clear and no separation	Bright, clear and homogeneous	-	Visual
Water, % m/m, max				Visual E 203
Non-oxygenated blends	-/Nil/Nil	Nil/-	-	
Oxygenated blends	0.7 (7)	0.7	-	
Detergent Additives:				
Port Fuel Injector/Intake Valve	-/X/X (8) (9)	X/X (10)	-	
Other Additives (if used)	(10)	(10)	-	

(1) Effective October 21, 2002.

(2) Conduct the test when having phosphorus in the additive.

(3) Before 1 January, 2000 - aromatics, %, v/v max: 50 for all grades.

(4) Use 1,4 dialkylamino anthraquinone compounds and 1,3-benzenediol 2,4-BISI(Alkylpheny) Azo-1 Compounds in the ratio 9:4 and use test method (a) or (b).

(5) Use 2-Naphthalenol ((phenulazo)Phenyl) azo alkyl derivatives compounds and 1,3 Benzenedio 1,2,4-bis (alkyl phenyl)azo compounds in the ratio 57:8 by weight and use test method (a) or (b).

(6) Use test method (c).

(7) Methanol and ethanol blends only.

(8) Mandated for gasoline designated "X".

(9) Additives which have properties to clean up port fuel injection/intake valve deposit control shall comply with the standard engine Chrysler 2.2 L test at "Keep clean" and "Clean up" level, and the standard engine BMW 318i test at a distance of 10,000 miles respectively. If other additives are used, they shall be approved by the Department of Commercial Registration.

(10) Must be in accordance with Department of Energy Business's (DOEB) requirements.

- Source: Pollution Control Department, 2004

The aim is to implement Euro IV equivalent fuel requirements around 2010. Various aspects of the fuel specifications still need to be researched and studied, i.e. the possibility of reducing sulphur levels to 10 mg/kg instead of 50 mg/kg in 2010 and the consequent financial implications for the refinery industry.

A.9.2.15. Vietnam Gasoline Specifications

Table A.9.27 2000 Gasoline Specification - Vietnam [(1)]

Characteristic	Unit	Limits	Test Method
RON	(min)	90/ 92/95	ASTM D2699
Lead content	mg/l (max)	13	TCVN 6704:2000 (ASTM D5059/ ASTM D3237)
Distillation			
IBP	ºC	Report	ASTM D86
10% v/v	ºC (max)	70	
50% v/v	ºC (max)	120	
90% v/v	ºC (max)	190	
FBP	ºC (max)	215	
Residue	% v/v (max)	2	
Copper corrosion 50 ºC/3hr	(max)	1	TCVN 2694:2000 (ASTM D130)
Existent gum	mg/100ml (max)	5	TCVN 6593:2000 (ASTM D381)
Oxidation stability	minutes (min)	240	TCVN 6778:2000 (ASTM D525)
Sulphur content	mg/kg (max)	1500	ASTM D1266
Vapour pressure (Reid) @ 37.8ºC	kPa	43-80	TCVN 5731:2000 (ASTM D323/ ASTM D4953)
Benzene content	% v/v (max)	5	TCVN 6703:2000 (ASTM D3606)
Density at 15ºC	(kg/m^3)	Report	TCVN 6594: 2000 (ASTM D1298)
Appearance		Clear, no suspended matter	Visual control

(1) Vietnamese Standard Number TCVN 6776:2000

Table A.9.28 2006 Proposed Gasoline Specification - Vietnam (1)

Property	PROPOSED TCVN 6776 : 2005
Implementation date	July 2006
RON, min	90/92/95
MON, min (1)	79/81/84
Lead, mg/l, max	13
Sulphur, mg/kg, max	500
Benzene, % v/v, max	2.5
Aromatics, % v/v, max	10
Olefins, % v/v, max	38
Oxygen content, % v/v, max	2.7
RVP @ 37.8°C, kPa, max	43 - 75
Density @ 15°C, kg/m3, min-max	Report
Distillation:	
IBP, °C, min	Report
T10, °C, max	70
T50, °C, max	120
T90, °C, max	190
FBP, °C, max	215
Residue, % v/v, max	2.0
Oxidation stability, minutes, min	480
Existent gum, mg/100ml, max	5
Cu Corrosion, 3 hr @ 50°C, max	Class 1
Appearance	Clear, non-suspended matter
Metal content (Fe, Mn)	5

(1) Apply when required. Source: Vietnam Standards Centre, Directorate for Standards and Quality, July 2005

A.9.2.16. Brunei Diesel Fuel Specification

Table A.9.29 Brunei - Diesel Fuel Specification

Property	Limit	Test Method
Cetane Index, min	47	ASTM D4737-90
Sulphur, mg/kg, max	1 000 (1)	ASTM D4294-90
Density @ 15 °C, kg/m^3, min-max	870	ASTM D1298-90
Viscosity @ 37.8°C, cSt, min-max	1.6 - 4.8	ASTM D445-94
Distillation T50, °C, max FBP, °C, max	(2) report report	ASTM D86-93
Flash Point, °C, min	68	ASTM D93-94
Cloud Point (CP), °C, max	14	ASTM D2500-91
Water, mg/kg, max	500	ASTM D1744-92
Copper corrosion, 3hr @100°C, max	Class 1b	ASTM D130-94
Colour, ASTM, max	2	ASTM D1500-91
Particulates, g/l	0.01	ASTM D2276-94

(1) Sulphur by XRF, % m/m, max: 0.3

(2) Distillation, E300, % v/v, min 60; E350, % v/v, min: 85.

- Source: Petroleum Unit, Prime Minister's Department, 2001

A.9.2.17. Cambodia Diesel Fuel Specifications

Fuel quality control is managed by CamControl (under the Ministry of Commerce) and the Department of Custom and Excise (under the Ministry of Economic and Finance - MEF). The Ministry of Commerce also facilitates fuel import and export and quality control whereas MEF is responsible for fuel taxation and curbs smuggling. In the future, the Cambodian National Petroleum Authority (CNPA) is planning to take over some of these roles.

Table A.9.30 Cambodia - Diesel Fuel Specification

Property	Current Grades (1)		
	HSD-Type I	HSD-Type II	LSD
Cetane Index, min	47	47	45
Sulphur, mg/kg, max	2,500	5,000	15,000
Water and sediment, % v/v, max	0.05	0.05	0.3
Ash, % m/m, max	0.01	0.01	0.02

(1) HSD – high speed diesel, LSD – low speed diesel.

- Source: CamControl, March 2005

A.9.2.18. China Diesel Fuel Specifications

Table A.9.31 China - Diesel Fuel Specification BG/T 19147-2003

Property		No 10	No 5	No 0	No - 10	No - 20	No - 35	No - 50	Method
Cetane number	min	49	49	49	49	46	45	45	GB/T 386
or Cetane index	min	46	46	46	46	46	45	45	GB/T 11139 GB/T 261
Distillation									GB/T 6536
50% v/v	ºC max	300	300	300	300	300	300	300	
90% v/v	ºC max	355	355	355	355	355	355	355	
95% v/v	ºC max	365	365	365	365	365	365	365	
Density at 20ºC	kg/m^3	820 - 860					800 - 840		BG/T 1884
Oxidation stability:									
Total insoluble	mg/100ml max	2.5	2.5	2.5	2.5	2.5	2.5	2.5	SH/T 0175
Sulphur content	mg/kg max	500	500	500	500	500	500	500	GB/T 380
Carbon residue (on 10% residue)	% m/m max	0.3	0.3	0.3	0.3	0.3	0.3	0.3	GB/T 268
Ash content	% m/m max	0.01	0.01	0.01	0.01	0.01	0.01	0.01	GB/T 508
Copper strip corrosion (50ºC, 3h)	Class max	1	1	1	1	1	1	1	GB/T 5096
Water content	% v/v max	nil	nil	nil	nil	nil	nil	nil	GB/T 260
Mechanical contaminants		nil	nil	nil	nil	nil	nil	nil	GB/T 511
Lubricity, wear scar diameter at 60ºC	µm max	460	460	460	460	460	460	460	ISO 12156
Viscosity at 20ºC	mm^2/s	3.0 - 8.0				2.5 - 8.0	1.8 - 7.0		GB/T 265
Pour point	ºC max	10	5	0	- 10	- 20	- 35	- 50	GB/T 510
CFPP	ºC max	12	8	4	- 5	- 14	- 29	- 44	SH/T 0248
Flash point (closed cup)	ºC min	55	55	55	55	50	45	45	GB/T 261

A.9.2.19. Hong Kong Diesel Fuel Specifications

Hong Kong reduced the sulphur content of its diesel fuel from 0.2 to 0.05% m/m from 1 April 1997 and has specifications covering most standard properties (e.g. cetane, density and viscosity).

Table A.9.32 Diesel Fuel Specifications: Hong Kong

Property		Before April 2000	01/04/00	Proposed 01/01/01
Density (kg/m^3)		820 – 860	820 – 860	<845
Cetane Number	min	50	50	51
Sulphur (% m/m)	max	0.05	350 (1)	350
Distillation				
95% v/v rec. (°C)	max	370	370	360
Polyaromatics (% m/m)	max			11.0
Other Parameters				
Specific Gravity @ 15.6/15.6 °C		0.82-0.86		
Viscosity @ 40°C (mm^2/s)		2.0-4.5		
Flash Point PM (°C)	min	66		

A.9.2.20. India Diesel Fuel Specifications

Table A.9.33 Year 2000 BIS Diesel Fuel Specification: India (Applicable from 1 April 2000)

Property		Limits
Acidity, inorganic		nil
Acidity, total (mg KOH/g)	max	0.2
Ash (% m/m)	max	0.01
Sediments (% m/m)	max	0.05
Total sediment (mg/100 ml) (1)	max	1.6
Carbon residue (Ramsbottom) on 10% residue (% m/m)	max	0.3
Cetane number (2)	min	48.0
or Cetane index (2)	min	46.0
Distillation °C		
T 85	max	350
T 95	max	370
Sulphur mg/kg (3)	max	2500
Density @ 15 °C (kg/m^3)		820 - 860 (2)
Copper corrosion (3h/50°C)	max	No. 1
Water content	max	0.05
Flash point - Abel (°C)	min	35
Viscosity (mm^2/s @ 40°C)		2.0 - 5.0
CFPP (°C)	max	(S) 18.0 (W) 6.0
Pour point (°C)	max	(S) 15.0 (W) 3.0
Specification		BIS 1460
Test Methods		BIS 1448

(1) Total sediment at the refinery before the addition of multi-functional additives.

(2) For diesel fuel processed from Assam crude, either CN of 45 min. or CI 43 min. and a density of 820 - 870 kg/m^3 shall be applicable.

(3) Fuel with 500 mg/kg sulphur content was made available in the National Capital Territory of Delhi from 31 December 2000 (Supreme Court of India Order; 10 May, 2000). Fuel with the same sulphur content was made available in the National Capital Region of Delhi from 30 June 2001 (Supreme Court of India Order; 10 May, 2000). In Mumbai city, the oil industry commenced supply of diesel fuel with the same sulphur content with effect from 1 January, 2001.

Table A.9.34 Proposed diesel fuel specifications for Bharat Stage II, Euro 3 and Euro 4 Emission Norms: India

Property		**Bharat Stage II Norms**	**Euro 3 & 4 Norms (1)**
		Limits	
Acidity, inorganic		nil	-
Acidity, total (mg KOH/g)	max	0.2	-
Ash (% m/m)	max	0.01	0.01
Sediments (% m/m)	max	0.05	-
Total sediment (mg/100 ml) (1)	max	1.6	-
Total contaminants (mg/kg)	max	-	24
Oxidation stability (g/m^3)	max	-	25
Carbon residue (Ramsbottom) on 10% residue (% m/m)	max	0.3	0.3
Cetane number	min	48.0 (2)	51
or Cetane index	min	46.0 (2)	46
Distillation °C			
T 85	max	350	-
T 95	max	370	360
Sulphur (mg/kg)	max	500	350 (3)
Density @ 15 °C (kg/m^3)		820 - 860 (2)	820 - 845 (2)
Polycyclic aromatic hydrocarbons (% m/m)	max	-	11
Copper corrosion (3h/50°C)	max	Class 1	Class 1
Water content (% v/v)	max	0.05	-
Water content (mg/kg)	max	-	200
Flash point - Abel (°C)	min	35	35
KV (mm^2/s @ 40°C)		2.0 - 5.0	2.0 - 4.5
Lubricity, corrected wear scar diameter (wsd 1.4) @ 60ºC (µm)	max	460	
CFPP (°C)	max	(S) 18.0 (W) 6.0	(S) 18.0 (W) 6.0
Pour point (°C)	max	(S) 15.0 (W) 3.0	-

(1) Total sediment at the refinery before the addition of multi-functional additives.

(2) For diesel fuel processed from Assam crude, relaxation of CN or CI by three units. and a density of 820 - 870 kg/m^3 shall be applicable.

(3) Sulphur content reducing to 50 mg/kg maximum to meet Euro 4 norms.

A.9.2.21. Indonesia Diesel Fuel Specification

Table A.9.35 Diesel Fuel Specification: Indonesia

Property		Limits
Density (kg/m^3)		
Cetane Number	min	45
or Cetane Index	min	48
Sulphur (% m/m)	max	0.5
Distillation		
40% v/v rec. (°C)	max	300
Cold Flow Properties		
Pour Point (°C)	max	18.3
Other Parameters		
Specific Gravity @ 15.6/15.6 °C		0.82-0.87
Viscosity @ 37.8°C (mm^2/s)		1.6-5.8
Flash Point PM (°C)	min	65.6
CCR 10% (% m/m)	max	0.1
Water (% v/v)	max	0.05
Sediment (% m/m)	max	0.01
Ash (% m/m)	max	0.01
Copper corrosion 3h/100°C	max	1
Colour ASTM	max	3.0
TAN mg KOH/g	max	0.6
SAN mg KOH/g	max	nil

A.9.2.22. Malaysia Diesel Fuel Specification

In Malaysia, the sulphur content was scheduled to be reduced from 0.5% m/m to 0.3% m/m by 1997. Malaysia is planning to implement its future diesel specifications over two phases, Stage 1 in the first quarter of 2005 and Stage 2 from 2010, similarly to gasoline. For diesel, sulphur limits will be reduced to 500 mg/kg and 50 mg/kg respectively in Stage 1 and Stage 2, as compared to the current (MS123) cap of 3000 mg/kg. The cetane number requirement is planned to be increased from the current minimum of 45 to a minimum of 49 in Stage 1 and 51 in Stage 2, respectively. The current T90 specification is planned to be replaced by T95, which remains at 370°C in Stage 1 and decreases to 360°C in Stage 2. New density and electrical conductivity limits are also planned to be introduced in Stage 1.

Table A.9.36 Malaysia Diesel Fuel Specifications

Property	Limit Values	
	Stage 1	**Stage 2**
Retail Implementation Date	Quarter 1, 2005	2010
Cetane Number, min	49	51
Sulphur, mg/kg max	500	50
Density @ 15 °C, kg/m^3, min-max	810 - 870	-
Viscosity @ 40°C, mm^2/s	1.6 – 5.8	1.6 – 5.8
Distillation T95, °C, max	370	360
Flash Point, °C min	60	60
Pour Point, °C max	15	15
Ash, wt%, max	0.01	0.01
Total acid number, mg KOH/g, max	0.25	0.25
Electrical Conductivity, pSm	50	-

A.9.2.23. Pakistan Diesel Fuel Specification

Table A.9.37 Diesel Fuel Specification: Pakistan [(1)]

Property		**Limits**
Cetane Index	min	45
Sulphur (% m/m)	max	1.0 [(2)]
Distillation		
50% v/v rec. (°C)		report
90% v/v rec. (°C)	max	365
Cold Flow Properties		
Pour Point (°C)	max	(W) 3 (S) 6 [(3)]
Cloud Point (°C)	max	(W) 6 (S) 9 [(3)]
Other Parameters		
Specific Gravity @ 15.6/15.6 °C		report
Viscosity @ 37.8 (38)°C (mm^2/s)	max	1.5-6.5
Flash Point PM (°C)	min	66 max
CCR 10% (% m/m)	max	0.2
Water (% v/v)	max	0.05
Sediment (% m/m)	max	0.01
Ash (% m/m)	max	0.01
Copper corrosion 3h/100°C	max	1
Colour ASTM	max	3.0
TAN (SAN) mg KOH/g	max	0.05 (nil)

(1) Pakistan Standards Institute Specification, ASTM test methods apply.
(2) 0.5% m/m max proposed from 2000.
(3) Winter period November to February.

A.9.2.24. Philippines Diesel Fuel Specifications

In December 2000 the sulphur content of diesel fuel was reduced to 0.2% m/m.

Table A.9.38 Philippines Diesel Fuel Specification

Property		Philippines
Cetane Number	min	
or Cetane Index	min	47
Sulphur (% m/m)	max	0.5
Distillation		
90% v/v rec. (°C)	max	report
Other Parameters		
Density @ 15°C, g/ml	max	0.870
Viscosity @ 40°C (mm^2/s)		1.7-5.5
Flash Point PM (°C)	min	52
CCR 10% (% m/m)	max	0.35
Water and sediment (% m/m)	max	0.10

A.9.2.25. Singapore Diesel Fuel Specification

In Singapore the maximum sulphur content of diesel fuel was limited to 500 ppm from 1 April 1999 and the government has expressed interest in developing a more comprehensive diesel fuel specification.

A.9.2.26. South Korea Diesel Fuel Specification

Table A.9.39 Diesel Fuel Specification - South Korea (1993 or 1994)

Property		Limit Value
Cetane number	(min)	45.0
Density @ 15ºC	kg/m^3	815 - 855
Distillation, 90% v/v	ºC (max)	360
Viscosity @ 40ºC	mm^2/s	1.9 - 5.5
Sulphur content	mg/kg (max)	430
Flash point	ºC (min)	40.0
Conradson carbon (10% distillation residue)	% m/m (max)	0.15
Pour point	ºC min	0.0 (S) - 17.5 (W)
CFPP	ºC min	- 16.0 (W)
Ash	% m/m (max)	0.02
Copper corrosion (3 hours, 50ºC)	max	1.0
Lubricity (HFRR wear scar diameter @ 60ºC)	µm (max)	460

A.9.2.27. Diesel Fuel - Sri Lanka

Table A.9.40 Emissions Related Diesel Fuel Standard: Sri Lanka (Effective 1 January 2003)

Parameter	Unit	Limits	Test Method
Cetane number	(min)	48	ASTM D 613 IP 21
Cetane index	(min)	46	ASTM D 1266
Density at 15ºC	kg/m^3	820 - 860	ASTM D 1298
Distillation - T90	ºC (max)	370	ASTM D 86
Sulphur content	mg/kg (max)	3000	ASTM D 1266

A.9.2.28. Taiwan Diesel Fuel Specifications

Taiwan reduced the sulphur content of diesel fuel from 0.5% m/m to 0.3% m/m in July 1993 and reduced it further in 2002 (see below).

Table A.9.41 Diesel Fuel Specifications: Taiwan

Property		Current	Proposed	
		01/2002	**01/2007**	**01/2011**
Cetane Index	min	48	-	-
Sulphur (mg/kg)	max	350	50	30
Aromatics (% v/v)	max	-	25	35
Distillation				
90% v/v rec. (°C)	max	338	338	338
End point (°C)	max	385	385	385
Pour Point (°C)	max	-4	-4	-4
Viscosity@ 37.8 (38)°C (mm^2/s)	max	1.7-4.3	1.7-4.3	1.7-4.3
Flash Point PM (°C)	min	50	50	50
CCR 10% (% m/m)	max	0.10	0.10	0.10
Water & sediment (% v/v)		0.05	0.05	0.05
Ash (% m/m)	max	0.01	0.01	0.01
Copper corrosion 3h/100°C	max	1	1	1

A.9.2.29. Thailand Diesel Fuel Specification

The Ministry of Commerce of Thailand issued a specification for diesel fuels on the 1 January 1993, giving a phased reduction of sulphur for diesel fuel used in cities from a level of ASTM 0.5% m/m max to 0.25% m/m from 1 January 1996 and 0.05% m/m from 1 January 2000. The sulphur content of diesel fuel used in country areas was reduced from 1.0% m/m to 0.5% m/m max from 1 September 1993.

Table A.9.42 Diesel Fuel Specifications: Thailand

Property	Limit Values			Test Method (ASTM)
	Past	Current	Proposed	
Retail Implementation Date	Jan 1999	Jan 26, 2004	2010	
Cetane Number, min	47 (1)	47 (1)	51	D 613
Cetane Index, min	47 (1)	47 (1)	-	D 976
Sulphur, mg/kg, max	500	350	50	D 2622
Density @ 15.6°C, kg/m^3, min-max	810 - 870	810 - 870	810 - 870	D 1298
Viscosity @ 40°C, mm^2/s, min-max	1.8 – 4.1	1.8 – 4.1	-	D 445
Distillation T50, °C, max T90, °C, max	report 357	- 357	- 357	D 86
Polyaromatics (PAH), % m/m, max	-	-	11	-
Flash Point, °C, min	52	52	-	D 93
Carbon Residue, % m/m, max	0.01	0.05	-	D 189
Pour Point, °C, max	10	10	-	D 97
Water and sediment, % v/v, max	0.02	0.05	-	D 2709
Ash, % m/m, max	0.01	0.01	-	D 482
Lubricity, HFRR, micron, max	460 (2)	460	-	CEC F-06-A-96
Cu strip Corrosion, 3hr/100 °C, max	Class 1	Class 1	-	D 130
Total acid number, mg KOH/g, max	0.5 (3)	-	-	-
Colour, max	4.0	4.0	-	D 1500
Appearance	Bright & Clear	-	-	Visual
Detergent Additive (if used)	(4)	(5)	-	-

(1) Either cetane number or calculated cetane index.

(2) Must incorporate a lubricity additive without heavy metal ash and phosphorus containing compounds. A test certificate indicating that the additive does not cause problems concerning compatibility with lubricant and plunger sticking in in-line injector system must be submitted. Effective January 1, 1999.

(3) Strong acid number, mgKOH/g, max: Nil.

(4) Must incorporate a detergent additive which has passed superior level in the Cummins L-10 test, using Caterpillar 1-K diesel oil or equivalent.

(5) Department of Energy Business's (DOEB) requirements.

- Source: Pollution Control Department, 2004

A.9.2.30. Vietnam Diesel Fuel Specifications

Table A.9.43 Past and Current Diesel Fuel Specification: Vietnam

Property	Past TCVN 5689:1997	Current TCVN 5689 : 2002	Test Method	
Grade	**DO 0.5S/DO 1.0S**	**DO 0.05S/ DO0.25S /DO 0.5S**	**ASTM**	**TCVN**
Year	1997	January 2002		
Cetane Index, min	50/45	45	D 976-91	-
Sulphur, mg/kg, max	5000/10000	500/2500/5000	D 129-91/ D 2622-87	-
Density @ 15.6°C, kg/m^3, min-max	N/A	Report	-	-
Viscosity @ 40°C, mm^2/s, min-max	1.8 - 5.0	1.6 - 5.5	D 445-88	-
Distillation: T90, °C, max	370	370	-	2698-1995
Flash Point, °C, min	60 / 50	50	D 93-90	2693-1995
Carbon residue 10%, wt%, max (CCR)	0.3	0.3	D 189-91	6324-1997
Pour Point, °C, max	5 (north); 9 (south)	9	D 97-87	2690-1995
Water, % m/m, max	0.05	0.05	D 2709-88	-
Ash, % m/m, max	0.01	0.01	D 482-91	2690-1995
Cu strip Corrosion, 3 hr/100 °C, max	Class 1	Class 1	D 130-88	2694-1995
Existent Gum, mg/100ml, max	Report	Report	-	3178-79

Table A.9.44 Proposed 2006 Diesel Fuel Specification: Vietnam

Property	**Proposed TCVN 5689: 2005**
Grade	DO 0.05S/DO 0.25S
Year	July 2006
Cetane Index, min	46
Sulphur, mg/kg, max	500/2500
Density @ 15.6°C, kg/m^3, min-max	820 - 860
Viscosity @ 40°C, mm^2/s, min-max	2 - 4.5
Distillation T90, °C, max	370
Flash Point, °C, min	55
Carbon residue 10%, % m/m, max (CCR)	0.3
Pour Point, °C, max	6
Water, % m/m, max	0.02
Ash, wt%, max	0.01
Lubricity, HFRR, micron, max	460
Cu strip Corrosion, 3 hr/100°C, max	Class 1
Appearance	Clear, bright
Particulates, mg/l, max	10

- Source: Vietnam Standards Centre, Directorate for Standards and Quality, July 2005.

A.9.3. TEST PROCEDURES

Individual countries have adopted test procedures appropriate to the emissions legislation standards adopted.

A.9.4. REFERENCE FUELS

CONCAWE have no data on reference fuels for Asian countries other than Japan.

A.9.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

A.9.5.1. South Korea

The Korean Ministry of Energy and Resources issued a notice based on the Rationalisation of Energy Consumption Act on 17 August 1992. It required manufacturers (excluding importers) to meet new fuel efficiency standards from 1 January 1996. More restrictive standards were introduced from 1 January 2000. From 1 September 1992 all manufacturers, including importers, have been required to display the level of fuel efficiency on their cars according to five classifications for each engine displacement class. Non-compliance results in severe fines.

Table A.9.45 South Korean Fuel Efficiency Requirements

Engine Displacement (cc)	From 01/01/96 km/l	From 01/01/00 km/l
<800	23.4	24.6
800-1100	20.3	21.3
1100-1400	17.3	18.1
1400-1700	15.4	16.1
1700-2000	11.4	12.0
2000-2500	9.9	10.4
2500-3000	8.5	8.9

South Korea also has fuel economy standards for motor cycles as follows:

Table A.9.46 South Korean motorcycle fuel economy standards

Effective Date	Engine Size (cc)	Fuel Economy (km/l)
	≤50	41.0
1991	51 - 100	33.5
	>100	32.5
	≤50	49.0
01/01/98	51 - 100	48.0
	>100	44.5

A.9.5.2. Taiwan

Taiwan has fuel economy regulations for passenger cars based on the combined US urban and highway cycles. It also has limits for motorcycles (2- and 3-wheeled vehicles with a curb weight of less than 400 kg and maximum speed greater than 50 km/h) which were due to be made more severe from January 1998.

Table A.9.47 Taiwanese Fuel Economy Regulations

Passenger cars	
Mass Class (kg)	**Fuel Economy (km/l)**
≤1046	14.7
1047-1276	12.0
1277-1496	10.1
1497-1726	8.7
1727-1956	7.7
1957-2176	6.9
>2176	5.3
Motorcycles	
Engine Displacement (cc)	**Fuel Economy (km/l)**
From 1991	
≤50	41.0
51-100	33.5
>100	32.5
from 01/01/98	
≤50	49.0
51-100	48.0
>100	44.5

A.9.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTICS SYSTEMS

A wide range of in service emissions programmes are in place in the region. CONCAWE's information is dated and the legislation is therefore reported in **Part 2**, **Section B.9.6.1**.

To CONCAWE's knowledge, there is currently no on-board diagnostic system legislation in place.

A.10. MIDDLE EAST & AFRICA

A.10.1. VEHICLE EMISSION LIMITS

A.10.1.1. Israel

In January 2003, the Ministry of Transportation Motor Vehicle Division issued new mandatory requirements for Model Year 2004 Category M vehicles. These categories are shown below:

Table A.10.1 Israel - Vehicle Categories (Model Year 2004)

Category (1)	Description
M1	Vehicles used for the carriage of passengers and comprising not more than 8 seats in addition to the driver's seat, and having a maximum mass not exceeding 3.5 tonnes.
M2	Vehicles used for the carriage of passengers and comprising more than 8 seats in addition to the driver's seat, and having a maximum mass not exceeding 5 tonnes.
M3	Vehicles used for the carriage of passengers and comprising more than 8 seats in addition to the driver's seat, and having a maximum mass exceeding 5 tonnes.

(1) For buses there are additional requirements, which were published in "Mandatory requirements for buses", 5th edition, January 2000.

The following emission standards apply:

Table A.10.2 Israel Emission Standards (Model Year 2004)

Vehicle Category	Emission Type	Emission Standard
M1 (gasoline or diesel)	Gaseous	Base: 72/306/EEC Amendment:98/69/EC 1999/102/EC Amendment 2001/1A/EC up to 98/69/EC (1) 2001/100A/EC (1)
M2 and M3 (gasoline or diesel)	Gaseous	Base: 88/77/EEC Amendment 1999/96A/EC up to 2001/27A/EC
All vehicles produced in NAFTA countries		EPA 40 CFR Part 86
All types of diesel vehicle	Smoke	Base: 72/306/EEC Amendment 89/491/EEC up to 97/20/EC or ECE 24

(1) 98/69/EC with 2001/100A/EC will be effective according to the schedule noted in Directive 98/69/EC.

A.10.1.2. Saudi Arabia

Saudi Arabia has adopted standards equivalent to ECE R 15.03.

A.10.1.3. South Africa

In February 2005 South Africa introduced Euro 1 tail pipe emissions for newly homologated vehicles only. This will be followed by the introduction of "Euro 2" emission standards for newly homologated vehicles in 2006. However, there is no emission legislation or requirement for the current vehicle parc or new car sales.

The government has launched the "National Vehicle Emissions Programme" (NVEP). The programme has the objective of formulating and implementing a meaningful vehicle emissions policy for South Africa. The partners in the programme include the government departments of environment, minerals and energy, the oil industry, vehicle manufacturers and others.

The NVEP is equally funded by the five major partners and comprises five phases:

1. Gathering and evaluation of ambient air quality data and developing a motor vehicle inventory (completed).
2. Establishment of exhaust emissions levels from local car fleets and an understanding of the combinations of fuel, engine and altitude influences on South African vehicle emissions (completed).
3. Development of an urban atmosphere air quality model (under development).
4. Formation of policy.
5. Development of an action plan to ensure conformity with new requirements.

The South African government has indicated that it wishes to align South African fuel specifications with those of the EU over the next decade. The major challenges will be:

Total lead phase-out.

Lowering of sulphur in diesel fuel to 500 mg/kg.

Optimisation of the South African octane structure.

A.10.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

A.10.2.1. Gasoline Specifications - Israel

Israel has adopted EN 228:1999, see **Part 1**, **Section 1.2.3**. A 50 mg/kg sulphur content grade was introduced in 2003 and a 10 mg/kg limit was imposed towards the end of 2004.

A.10.2.2. Gasoline Specifications - South Africa

In South African coastal areas, leaded 97 octane has been retained but leaded 93 octane gasoline has been phased out and replaced by 95 octane unleaded. Inland 87 octane has been replaced by 91 octane unleaded, while leaded 93 octane has been retained. Before 1994 mixed alcohols were used in the gasolines manufactured in the SASOL oil-from-coal process. This practice ceased when alternative export markets were found but, following the end of Brazilian supply contracts, alcohol has been reintroduced in the South African market. The specification of the alcohol and the permissible concentrations varies by both gasoline grade and location. Full details will be found in **Table A.10.3** and **A.10.4**.

The South African government has indicated that it wishes to align South African fuel specifications with those of the EU over the next decade. The major challenges will be the total phase-out of lead and optimisation of the octane structure. The South African Cabinet has formally approved lead phase-out from 2006.

Table A.10.3 Gasoline Specifications: South Africa

Property		Leaded		Unleaded	
		SABS 299:1995		SABS 1598:1993	
		Coastal Grade 97	**Inland Grade 93**	**Coastal Grade 95**	**Inland Grade 91**
RON	min	97	93	95	91
MON	min	87	83	85	81
MON (blends with >0.2% v/v alcohol)	min	89	85	87	83
Density at 20ºC	(kg/m^3)	705 - 785	705 - 785	710-785	710-785
Distillation:	ºC				
10%	max	65			
50%		77-115			
90%	max	185			
FBP		215			
Residue, % v/v	max	2.0			
Vapour pressure	kPa (max)	75			
VLI summer	max	950	890	950	890
winter	max	1000	940	1000	940
Lead content	g Pb/l (max)	0.4		0.013	
Induction period	mins/min	240		360	
Existent gum, mg/100 ml	max	4		4	
Potential gum, mg/100 ml	max	4		4	
Sulphur content	mg/kg (max)	1500		1000	
Copper strip corrosion 3h at 50ºC	max	1		1	
Total acidity (1)	mg KOH/g max	0.03	0.03	0.03	0.03
Alcohol content (2)	% v/v, (max)	8	8	2.8	3.7

(1) Applicable only to fuels derived from coal and to blends containing alcohol(s) or other oxygenated compounds or both.

(2) The maximum oxygen content of blends that contain alcohol(s) of other oxygenated compounds or both shall be 4.6% m/m. This shall be determined as a summation of the oxygen contents for the different alcohols and oxygenates as determined by ASTM D4815, until such time as a suitable standard test for oxygen content is developed. The addition of methanol is not permitted except for either its presence as a by-product of other oxygenates, or as an additive component, up to a maximum concentration of 0.5 % v/v of the blend as determined by ASTM D4815. The alcohol mixture shall contain at least 55% m/m of C_2 alcohols as determined by ASTM D4815. Ethers that contain five or more carbon atoms per molecule may be included up to a maximum concentration of 20% v/v of the blend as determined by ASTM D4815 and such other methods that could be developed for other C_5 ethers.

Table A.10.4 Bureau of Standards Oxygen Content Regulations: South Africa

Gasoline Grade	Delivery Area	Maximum Oxygen Content (% m/m)	Permitted equivalent volume of oxygenate (% v/v)	
			"Alcohol"	**MTBE**
Leaded	Inland	4.6	12.0 (1)	20
Unleaded	Inland	3.7	9.5 (2)	20
Unleaded	Coastal	2.8	7.5 (2)	15

(1) Ethanol content greater than 55% m/m. Balance must be propanols, butanols and trace heavier alcohols.

(2) Ethanol content greater than 85% m/m. Balance made up of propanols and trace heavier alcohols.

- Alcohol with 65 - 80% ethanol was added on the Highveld (inland area) from the early 1980's to 1994, when unleaded gasoline was introduced.

A.10.2.3. Diesel Fuel Specification - Israel

Israel has adopted EN 590:1999 but the sulphur content is limited to 50 mg/kg. See **Part 1**, **Section 1.2.3**.

A.10.2.4. Diesel Fuel Specification - South Africa

The South African National Specification for Automotive Diesel Fuel is given below. The South African government has indicated that it wishes to align South African fuel specifications with those of the EU over the next decade. The major challenge will be lowering sulphur to 500 mg/kg, which the South African Cabinet has formally approved.

Table A.10.5 National Specifications for Automotive Diesel Fuel: South Africa (SABS 342:1998)

Property	**Limits**		**Test Method**	
	Low Sulphur Grade	**Standard Grade**	**ASTM**	**IP or ISO**
Distillation 90% recovery (max)	362		D 86	IP 123
Flash point, PM °C (min)	55		D 93	IP 34
Sulphur content, mg/kg (max)	500	3000	D 2622/D 5453	IP 336
Cetane number (1) (min)	45		D 613	IP 41
Copper strip corrosion (3 h. @ 100°C), (max)	1		D 130	IP 154
CFPP °C (max)	- 4 or 3 (2)		-	IP 309
Carbon residue on 10% distillation residue, % m/m (max)	0.2		D 524	IP 14
Ash content, % m/m (max)	0.01		D 482	IP 4
Water content, % v/v (max)	0.05		D 95 or D 1744	IP 74
Sediment content, % m/m (max)	0.01		D 473	IP 53
Viscosity @ 40°C (mm^2/s)	2.2 - 5.3		D 445	IP 71
Density @ 20°C (kg/l) (3)	0.800		D 4052	IP 365 or ISO 3575
Oxidation stability, mg/100 ml (max)	2.0		D 2274	IP 388

(1) Provided a proven correlation between Cetane Number and Cetane index (ASTM D 976/ASTM D 4737) has been established (for the crude being refined), the Cetane Number specification may be replaced by a Cetane index specification with a minimum value of 48. The basic need is that the product shall have a minimum Cetane Number of 45. The reference method is ASTM D 613/IP 41

(2) Unless otherwise acceptable, a product with a maximum CFPP of:
(a) -4°C and supplied between 1 April and 30 September (inclusive (WINTER), and
(b) 3°C and supplied between 1 October and 31 March (inclusive) (SUMMER), may be considered acceptable.

(3) Test method ASTM D 1298/IP 160 may be used to determine density at 15°C and the result converted to values at 20°C (using standard calibrations) with the proviso that this is NOT a reference method.

A.10.2.5. Alternative Fuels

There are a limited number of retail automotive LPG stations in Israel and the fuel, specified to EN 589:2004 (see **Part 1, Section 1.2.6**), attracts a tax incentive.

A.10.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

CONCAWE have no information available.

A.10.4. REFERENCE FUELS

CONCAWE have no information available.

A.10.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

CONCAWE are not aware of any regulations in the region.

A.10.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

A.10.6.1. Egypt

In-service control of diesel engined vehicle emissions are in place and the authorities are considering introducing EU limit values.

A.10.6.2. Israel

The following regulations are in place:

Table A.10.6 Israel In-Service Emission Limits

Vehicle Description			**Idle CO (% v/v)**
Gasoline	Manufactured up to and including 1986		4.5
	Manufactured between 1987 and 1992		3.5
	Manufactured after:	Engine capacity (cm^3)	
	1992	2000	1.0
	1993	1600	
	1994	All	
	1995	All	0.5
Diesel			**Smoke Hartridge**
	Manufactured after 1974 and with maximum net power exceeding 200 HP		50
	All other vehicles		60

A.10.6.3. Saudi Arabia

Annual inspections of vehicle emission control systems are required in Jeddah, Riyadh and Dammam.

A.11. WORLDWIDE HARMONISATION OF TEST CYCLES

A.11.1. PROPOSED WORLD-WIDE HEAVY-DUTY EMISSIONS CERTIFICATION PROCEDURE

Full details will be found in **Part 1**, **Section 11.1**.

A.11.2. PROPOSED WORLD-WIDE EMISSIONS TEST CYCLE FOR TWO-WHEELED MOTORCYCLES

Full details will be found in **Part 1**, **Section 11.2**.

A.12. GLOSSARY AND VEHICLE CLASSIFICATIONS

Commonly Used Abbreviations

AAM	(US) Alliance of Automobile Manufacturers (formerly AAMA)
AAMA	American Automobile Manufacturers Association (formerly MVMA)
ABT	Averaging, banking, and trading (US Federal regulations)
ACEA	Association des Constructeurs Europeans d'Automobiles (formerly CCMC see below)
ACEM	Association of European Motorcycle Manufacturers
ADR	Australian Design Rules - legal regulations
AEAC	Anhydrous ethanol (Brazilian terminology)
AECD	Auxiliary Emission Control Device (device which modifies the action of any part of an emission control system - US EPA definition)
AEHC	Hydrated ethanol (Brazilian terminology)
AGO	Automotive Gas Oil (diesel fuel)
AKI	Anti-knock Index
ALVW	Adjusted Loaded Vehicle Weight (average of vehicle curb weight and gross vehicle weight rating (GVWR)
ANPRM	Advanced notice of proposed rule-making (US Federal regulations)
API	American Petroleum Institute
AQIRP	US Auto/Oil Air Quality Improvement Research Programme
ASM	Acceleration Simulation Model (US I/M tests)
ASTM	American Society for Testing and Materials
ATA	American Trucking Association
BAR	Bureau of Automobile Repair (California)
BS	British Standards
CAA	US Clean Air Act
CAAA	1990 US Clean Air Act Amendments
CAAAC	Clean Air Act Advisory Committee (US)
CAFE	Corporate Average Fuel Economy (US fuel economy standard)
CARB	Californian Air Resources Board
CCEPC	Japanese Central Council for Environmental Pollution
CCMC	Comité des Constructeurs Européens d'Automobiles du Marché Commun (now ACEA)
CCR	California Code of Regulations.
CEC	California Energy Commission or Coordinating European Council
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CFFP	Clean Fuel Fleet Programme (US Clean Air Act requirement)
CFFV	Clean Fuel Fleet Vehicle
CFPP	Cold Filter Plugging Point
CFR	Code of Federal Regulations or Cooperative Fuels Research
CFV	Clean Fuel Vehicle (US Federal vehicle classification)
CI	Cetane index
CN	Cetane Number
CNG	Compressed Natural Gas
CP	Cloud point
CRC	Coordinating Research Council
CO	Carbon monoxide
CO_2	Carbon dioxide
CONAMA	Brazilian National Environmental Council

CONCAWE	Conservation of Clean Air and Water in Europe (the oil companies' European organization for environment, health and safety)
CVS	Constant Volume Sampling System (FTP)
DDC	Detroit Diesel Corporation
DGF	Deutsche Gesellschaft für Fettchemie - Einheitsmethoden Abteilung-Fette
DI	Direct Injection
DIN	Deutsches Institut für Normung (German Standards Institute)
DOE	US Department of Energy
DPF	Diesel Particulate Filter
E70	% gasoline evaporated at 70°C
El00	% gasoline evaporated at 100°C
E180	% gasoline evaporated at 180°C
EA	Japanese Environmental Agency
EC	European Community (now EU)
ECE	United Nations Economic Commission for Europe
EDV	Emission Data Vehicle (vehicle used in EPA certification procedures)
EEC	European Economic Community (now EU)
ECOS	Environmental Council of the States - US organization of environmental commissioners with members from 50 states and territories
EFEG	European Fuel Experts Group of the Commission of European Communities
EGR	Exhaust Gas Recirculation (to control NOx)
ELR	European Load Response Test - a dynamic load response test (part of the European steady-state cycle for HD type approval from 2000)
EMA	Engine Manufacturers Association (US)
EPEFE	European Programme on Emissions, Fuels and Engine Technologies
EP	Distillation End Point
EPA	US Environmental Protection Agency
ESC	European Steady-state Cycle for HD type approval from 2000
ETBE	Ethyl Tertiary Butyl Ether
ETC	European Transient Cycle for HD type approval from 2000
EtOH	Ethyl alcohol (ethanol)
EU	European Union (formerly EC)
EUDC	Extra-Urban Driving Cycle
EUROPIA	European Petroleum Industries' Association
EZEV	Equivalent Zero Emission Vehicle (CARB)
FAME	Fatty Acid Methyl Ester
FBP	Distillation Final Boiling Point
FCAI	Australian Federal Chamber of Automotive Industries.
FIA	Fluorescence Indicator Absorption test (for gasoline composition)
FiGE	Forschungsinstitut Geräusche und Erschütterungen (German research institute for noise and vibration testing)
FFV	Flexible Fuelled Vehicle (oxygenates and/or gasoline)
FR	Federal Register (US legislation register)
FRM	Final Rulemaking (US Federal Regulations)
FTP	Federal Test Procedure (US exhaust emissions test)
FVI	Flexible Volatility Index
GM	General Motors
GRPE	Groupe des Rapporteurs pour Pollution et Energie (UN ECE group)
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating (maximum gross laden weight)
HC	Hydrocarbons
HCHO	Formaldehyde

HDDEs	Heavy Duty Diesel Engines
HDDTC	Heavy Duty Diesel Transient Cycle (US Federal)
HDDV	Heavy Duty Diesel Vehicle
HDEs	Heavy Duty Engines
HDGTC	Heavy Duty Gasoline Transient Cycle (US Federal)
HDS	Hydrodesulphurisation
HDV	Heavy Duty Vehicle
HEV	Hybrid Electric Vehicle
HFRR	High Frequency Reciprocating Rig - Test equipment used to evaluate diesel fuel lubricity
HHDDEs	Heavy Heavy Duty Diesel engines
HHDVs	Heavy Heavy Duty Vehicles
HLDT	Heavy, light duty truck (US classification)
HOV	High Occupancy Vehicle (US highway lane restrictions)
HSDI	High Speed Direct Injection (diesel engine)
HSU	Hartridge Smoke Units
HWFET	Highway Fuel Economy Test (part of US FTP)
HWY	Highway
ICR	Information Collection Request (US Federal Regulations)
IDI	Indirect Injection (diesel engine)
IFP	Institut Français du Pétrole
IGO	Industrial Gas Oil
ILEV	Inherently Low Emission Vehicle (EPA definition)
I&M or I/M	Inspection and Maintenance
IP	Institute of Petroleum (UK)
ISO	International Standards Organization
IVD	Intake Valve Deposits (also BMW IVD test)
JAMA	Japanese Motor Manufacturers Association
JCAP	Japan Clean Air Programme
JPI	Japanese Petroleum Institute
kPa	kiloPascals (unit of pressure)
KSLA	Knock Limited Spark Advance
LCV	Lower Calorific Value
LDT	Light Duty Truck
LDT1	A light duty truck with a loaded vehicle weight of 0-3750 lb.
LDT2	An “LEV II” light duty truck with a loaded vehicle weight of 3751 to a gross vehicle weight of 8500 lb or a “LEV I” light duty truck with a loaded vehicle weight of 3751-5750 lb.
LDV	Light Duty Vehicle
LEV	Low Emission Vehicle (CARB emission standard)
LHDDEs	Light Heavy Duty Diesel engines
LHDVs	Light Heavy Duty Vehicles
LLDT	Light, Light Duty Truck (US vehicle classification)
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LVW	Loaded Vehicle Weight (curb weight plus 300 lb)
MeOH	Methyl alcohol (methanol)
M10	Gasoline containing 10% methanol
M85	Gasoline containing 85% methanol
MDV	Medium Duty Vehicle
MHDDEs	Medium Heavy Duty Diesel engines
MI or MIL	Malfunction Indicator or Malfunction Indicator Lamp (for OBD systems)
MIRA	Motor Industry Research Association (UK)
MITI	Japanese Ministry of International Trade and Industry

MMT	Methylcyclopentadienyl Manganese Tricarbonyl
MON	Motor Octane Number
MOU	Memorandum of Understanding (US Federal Regulations)
MTBE	Methyl tertiary butyl ether
MVEG	Motor Vehicles Emissions Experts Group of the Commission of the European Communities
MVMA	Motor Vehicle Manufacturers' Association of North America (now AAMA)
MY	Model Year (vehicle)
NA	Naturally Aspirated
NAAQS	National Ambient Air Quality Standard (US)
NDIR	Non-Dispersive Infra-Red
NESCAUM	Northeast States (of USA) for Coordinated Air Use Management
NLEV	National Low Emissions Vehicle (US Federal Regulations)
NMHC	Non-Methane Hydrocarbons
NMOG	Non-Methane Organic Gases, the total mass of oxygenated and non-oxygenated hydrocarbon emissions
NOx	Nitrogen Oxides
NPAH	Nitrated Polycyclic Aromatic Hydrocarbons
NPRM	US Notice of Proposed Rule Making
NRDC	US Natural Resources Defence Council
NYCC	New York City Cycle (element of some EPA requirements)
OBD	On-board diagnostic system.
OBM	On-board measurement system (i.e. a system that directly measures exhaust pollutants)
OE	Organic Equivalent
OEM	Original Equipment Manufacturer
OICA	Organisation Internationale des Constructeurs d'Automobiles
OMB	US Office of Management and Budget
OMHCE	Organic Material Hydrocarbon Equivalent (mass equivalent of organic emissions defined in EPA methanol vehicle emission standards)
OMNMHCE	Organic Material Non-Methane Hydrocarbon Equivalent
ON	Octane Number
OTAG	The Ozone Transport Assessment Group - a partnership between the US EPA, the Environmental Council of the States (ECOS) and various industry and environmental groups
OTC	Northeast Ozone Transport Region Commission (US)
OTR	Northeast Ozone Transport Region (comprising the District of Columbia, plus Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and Virginia)
PADD	US Petroleum Administration for Defense Districts
PAH	Polycyclic Aromatic Hydrocarbon
PAJ	Petroleum Industry Association of Japan
PC	Passenger car.
PM (Pm)	Particulate Matter
POM	Polycyclic Organic Matter
PNGV	"Partnership for a New Generation of Vehicles" - a ten year joint R&D project between the US EPA, GM, Ford and DaimlerChrysler.
PP	Pour point
ppb	Parts per billion (thousand million)
ppm	Parts per million
RAF	Reactivity Adjustment Factor
RCHO	Aldehydes
RFG	Reformulated Gasoline

RFP	Reasonable Further Progress (US CAAA requirement)
RIA	US Regulatory Impact Analysis
RIC	Reciprocating Internal Combustion (ISO definition)
(R+M)/2	Average of RON and MON (US pump posting of octane)
RM	Reference Mass (EU legislation)
RME	Rapeseed Methyl Ester
ROM	US Regional Oxidant Model
RON	Research Octane Number
ROS	Renewable Oxygenate Standard (US EPA)
RVP	Reid Vapour pressure
RW	Reference (vehicle) Weight
SAE	US Society of Automotive Engineers
SC03	US Federal Driving cycle, representing driving immediately following vehicle start-up, air conditioning operation and micro-transient driving (part of the SFTP)
SCAQMD	South Coast Air Quality Management District (of California)
SEA	US Selective Enforcement Audit
SFTP	Supplemental Federal Test Procedure (US EPA, introduced 22 October 1997)
SHED	Sealed Housing for Evaporative Determination (evaporative emissions test for vehicles)
SI	Spark ignition
SIP	State Implementation Plan (non-Federal emissions requirement)
SOP	Statement of Principles (US EPA)
Stage I	Control of VOC emissions at depots and service stations during gasoline delivery
Stage II	Control of vehicle refuelling VOC emissions at service stations
SULEV	Super Ultra Low Emission Vehicle (proposed natural gas fuelled vehicle category) (CARB)
SULG	Super Unleaded Gasoline
T10E	Temperature at which 10%v/v gasoline has evaporated
T50E	Temperature at which 50%v/v gasoline has evaporated
T90E	Temperature at which 90%v/v gasoline has evaporated
TAME	Tertiary Amyl Methyl Ether
TBA	Tertiary Butyl Alcohol
TC or T/C	Turbocharged
THC	Total Hydrocarbons
TLEV	Transitional Low Emission Vehicle (CARB emission standard)
toe	tonnes oil equivalent
TOG	Total Organic Gas emissions (hydrocarbon and oxygenate)
$TP_{(cold)}$ $TP_{(hot)}$	Transition Period (cold and hot) (part of Federal city cycle)
UAM	US Urban Airshed Model
UDDS	Urban Dynamometer Driving Schedule (FTP)
ULEV	Ultra Low Emission Vehicle (CARB emission standard)
ULG	Unleaded Gasoline
US06	US Federal Driving cycle, representing aggressive and micro-transient driving (Part of the SFTP)
US FTP	United States Federal Test Procedure
UTAC	French Transport Ministry Technical Advisory Committee
VLI	Vapour Lock Index
VOC	Volatile Organic Compounds
VP	Vapour pressure
ZEV	Zero Emission Vehicle (CARB emission standard)

Vehicle Categories according to EU Council Directive 92/53/EEC of 18.6.92, amending Directive 70/156/EEC of 6.2.1970

CATEGORY M	Motor vehicles with at least 4 wheels, used for the carriage of passengers
Category M_1	Vehicles used for the carriage of passengers and comprising no more than 8 seats in addition to the driver's seat
Category M_2	Vehicles used for the carriage of passengers, comprising more than 8 seats in addition to the driver's seat, and having a maximum mass not exceeding 5 t
Category M_3	Vehicles used for the carriage of passengers, comprising more than 8 seats in addition to the driver's seat, and having a maximum mass exceeding 5 t
CATEGORY N	Motor vehicles with at least 4 wheels, used for the carriage of goods
Category N_1	Vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 t
Category N_2	Vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 t but not exceeding 12 t
Category N_3	Vehicles used for the carriage of goods and having a maximum mass exceeding 12 t

US Federal Vehicle Classifications

Light Duty Vehicles	Passenger cars and passenger car derivatives capable of seating no more than 12 passengers
Light Duty Trucks	Vehicles with GVWR ≤8500 lb, curb weight ≤6000 lb and frontal area ≤45 ft^2 designed for the transportation of goods or the carriage of more than 12 passengers
Light Light Duty Trucks	Light duty trucks with GVWR ≤6000 lb
Heavy Light Duty Trucks	Light duty trucks with GVWR ≥6000 lb
Heavy Duty Vehicles	Vehicle with GVWR >8500 lb or curb weight >6000 lb or frontal area >45 ft^2

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