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

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ABSTRACT

This report summarises changes in worldwide legislation and regulations governing motor vehicle emissions, fuel specifications and fuel consumption. Specifically it details current and proposed legislation on emissions limits and emissions testing, vehicle inspection and maintenance programmes plus legislation aimed at controlling in-service emissions performance, fuel consumption and carbon dioxide emissions. It also includes information on fuel specifications and characteristics.

The report should be read in conjunction with the Appendix to Part 1 and Part 2, which was originally issued as a separate volume in 1997 (Report No. 6/97). There are now two editions of Part 2:

- Report No. 6/97, detailing the development of worldwide legislation and regulations governing motor vehicle emissions, fuel specifications and fuel consumption from 1970 to 1996.

- Report No 6/06, providing the same material for the period from 1996 to 2005.

These two editions of Part 2 provide similar information on an historical basis. It is intended that Part 1 will be updated regularly, whereas Part 2 - a comprehensive reference document - will be revised at appropriate, longer term intervals. The Appendix to Part 1 and Part 2 (Report 6/06) replace an earlier edition of Part 2 (Report No 2/01).

KEYWORDS

Vehicle emissions, legislation, automotive fuels, specifications

CONTENTS

INTRODUCTION - HOW TO USE THIS REPORT

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 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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SUMMARY

Europe

Light duty emission limits for 2000 and 2005 were published in December 1998 as EU Directive 98/69/EC and are generally referred to as “Euro 3” and “Euro 4” limits respectively. The Directive also included a revised light duty cycle (eliminating the initial 40 second idle period with no emissions measurements) and a cold start (-7°C) emissions test. The regulations were updated by Directive 2002/80/EC, which included new specifications for reference fuels for light duty vehicles. Euro 5 light duty proposals were published on 18 November 2005. New heavy duty emissions limits and test cycles were introduced in EU Directive 1999/96/EC and this was further refined for gas powered engines in 2001/27/EC.

Tighter limit values for mopeds applied from 17 June 2002 and were published in Directive 97/24/EC of 17 June 1997. New regulations for motorcycles, tricycles and quadricycles came into effect in 2003, with a further tightening of emission limits for two-wheeled motorcycles in 2006. Details will be found in Directives 2002/51/EC and 2003/77/EC. EU Directive 97/68/EC sets out emission limits for internal combustion engines installed in non-road mobile machinery. Directive 2004/ 26/EC of 21 April 2004 amended this Directive, introducing two further stages of limit values to be implemented between 2005 and 2014. Directive 2005/13/EC of 21 February 2005 confirmed the same emission limits for tractors.

EU Directive 98/70/EC, dated 13 October 1998, 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 maximum 10 mg/kg sulphur content. Sufficient quantities of gasoline and diesel fuels with a maximum sulphur content of 10 mg/kg must be available from 1 January 2005 on an appropriate geographic basis. The complete penetration of gasoline and diesel fuels with a maximum sulphur content of 10 mg/kg should be provided for from 1 January 2009. This date has yet to be confirmed for diesel fuels.

Specifications for alternative fuels exist at both the European level (e.g. EN 14214:2001 for biodiesel) and on a national basis (e.g. French and Italian specifications for water/diesel emulsions). The Biofuels Directive 2003/30/EC was published on 8 May 2003 and aims at promoting the use of biofuels for transport purposes in each Member State by providing “indicative national targets”.

The EU Commission has published its “Thematic Strategy on Air Pollution”, resulting from the Clean Air for Europe (CAFE) programme. The Commission state that, despite significant improvements, serious air pollution impacts persist. Their strategy establishes interim objectives for air pollution in the EU and proposes appropriate measures for achieving them. It recommends that current legislation be modernised, be better focused on the most serious pollutants and that more is done to integrate environmental concerns into other policies and programmes.

The EU Commission and the European automotive industry have a voluntary agreement regarding reductions in CO_2 emissions from passenger cars. The fleet average target for new cars is set at 140g CO_2/km by 2008.

EU Directive 92/55/EEC (June 1992, amending Directive 77/143/EEC), legislates in-service emissions limits in vehicle roadworthiness tests. The EU introduced OBD systems on gasoline powered passenger cars and light duty vehicles from 2000, their diesel counterparts followed in 2003. These regulations were updated by Directive 2002/80/EC. OBD systems for heavy duty vehicles are still under discussion.

US Federal Regulations

Tier 2 emissions limits were introduced from 2004. These phase-in a single average exhaust emission standard that covers both passenger cars and all light trucks, irrespective of the fuel employed. Tier 2 evaporative emissions standards have also been published. Tighter heavy duty vehicle emissions limits were introduced from 1998 and new heavy duty standards (including gasoline powered vehicles) have been proposed for 2007.

Current US Federal motorcycle emission limits became effective in 2005. 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 motorcycles beginning in 2008.

The EPA set three phases of emission limits for non-road diesel engines (rated at 37 kW and above) to be implemented between 1988 and 2008. An important consideration was harmonization with standards for non-road engines adopted or under debate elsewhere in the world. On 29 June, 2004 the EPA published its final rule on Tier 4 emission and fuel standards for non-road diesel engines. New standards will begin to take effect in the 2008 model year, phasing in over a number of years. The EPA also adopted on 8 November, 2002 emission standards for several groups of non-road engines that had not, till then, been subject to EPA emission limits. The legislation involved large spark-ignition engines and recreational vehicles. Tank permeability will be controlled in this legislation and new emissions test cycles have been introduced.

Phase II of the reformulated gasoline (RFG) programme began on 1 January 2000. The EPA also established substantial reductions in gasoline sulphur levels to 30 ppm in 2004. In June 2006 the EPA will introduce a phased-in sulphur limit for diesel fuel of 15 ppm, scheduled for completion by 2010. The Energy Policy Act of August 2005 removed the requirement to include oxygenates in reformulated gasoline. However, it also called for a tripling of the use of ethanol by 2012. There is no federal ban on MTBE but some twenty-three States have partially or completely banned its use.

Deposit control additives are required by the Clean Air Act.

The Federal Test Procedure has been supplemented by two additional cycles. These are the US06, representing aggressive and micro-transient driving, and the SC03 cycle, simulating driving immediately after start up with the air-conditioning in operation.

The Clean Air Act amendments required enhanced I&M programmes to be introduced from 1992. However, many states considered the IM 240 test proposed by the EPA to be too expensive and have proposed their own programmes, some of which have still to be introduced. OBD systems have been required on light duty vehicles and trucks since the 1994 model-year.

California

California has introduced more stringent standards for light duty vehicles and trucks than those in place in the Federal States. These involve the progressive introduction of Low, Ultra Low and Zero Emissions Vehicles. The introduction of the latter has been delayed and new regulations have been introduced. There are also proposals for hybrid electric vehicles with suitably low emissions to be classified as Equivalent Zero Emissions Vehicles (EZEVs). Exhaust emission standards for 2001 and subsequent model year passenger cars, light duty trucks, and medium duty vehicles have been published.

The California motor cycle exhaust emission standards are similar to the Federal requirements but were introduced earlier. On 28 January 2001 CARB adopted identical non-road heavy duty diesel standards to those published for the Federal States. Legislation adopted on 1 September 1999 applied to new 2001 and later non-road large spark-ignition (LSI) engines of 25 and greater horsepower. On the same date the regulations for off-highway recreational vehicles and engines used in such vehicles produced on or after 1 January 1997 were updated.

On 25 March 1999, California announced a three year, eight month phase-out of MTBE from Californian gasoline. 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 regulation delayed the ban on MTBE and other specified oxygenates until 31 December 2003. Earlier compliance with the standard was permitted.

Generally California employs Federal test procedures, but a number of specific cycles and protocols are in place for ZEVs, hybrid electric vehicles and off-highway spark ignition engines.

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. 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. California has introduced truck idling rules and the EPA are considering a federal regulation.

Japan

In November 1997 the Japanese Environment Agency embarked on a revision of the existing regulations for motor vehicles to take effect between 2000 and 2002. Further changes to diesel vehicle emissions limits came into effect between 2003 and 2005. The proposals are particularly stringent for heavy duty buses and trucks with regard to PM and NOx emissions. New non-road regulations were introduced from 2004 applying to all diesel non-road vehicles with a rated power between 19 and 560 kW. NOx, HC, CO and PM will all be controlled, with particular emphasis being placed on nitrogen oxides and particulates. The target values for reduction are very similar to the second phase of limits introduced in the US and EU.

Other amendments include an extension of durability requirements, the introduction of OBD and the adoption of a SHED procedure for evaporative emissions control.

In addition to the emissions legislation, the Central Environment Council (CEC) recommended new long-term regulations for fuels. The proposed fuel quality

requirements included a reduction in sulphur for both gasoline and diesel to less than 50 mg/kg by the end of 2004. The sulphur content of diesel fuel was reduced to 50 mg/kg in April 2003, ahead of the deadline. In addition, the Council requested that the vapour pressure of gasoline be set to below 65 kPa, commencing summer 2005 and the industry has adopted this voluntary limit.

The CEC issued proposed new 2009/2010 emission limits for diesel and gasoline cars and trucks in early 2005. In parallel with these tighter standards, gasoline and diesel sulphur levels must be reduced to 10 mg/kg maximum by 2007. The oil industry announced that all gasoline and diesel fuel would meet this limit by 1 April 2005.

The Japanese Auto/Oil Programme (JCAP1), launched in 1996 to identify vehicle and fuel technologies required to meet Year 2000+ air quality objectives, has been completed. JCAP II was launched in 2002 as a five year project.

Other Countries

Emissions legislation in other countries tends to follow US, European or Japanese standards and test methods. For example, Canada has established emission limits and test procedures that are aligned with US Tier 2 limit values, HD standards and motorcycle regulations. New Zealand's 2006 fuel specifications are similar to those introduced in Europe in 2005. China is adopting EU emission standards and India is planning to implement emissions limits equivalent to Euro 3 and Euro 4 between 2005 and 2010.

Gasolines are totally unleaded in many countries and the world-wide trend to lead phase-out is accelerating. Diesel fuel sulphur contents are tending to decrease. Interest in alternative fuels is increasing.

World-wide harmonization of emissions certification test procedures is progressing. The UN-ECE Groupe de Rapporteurs sur la Pollution et l'Energie have published draft global technical regulations for both heavy-duty engines and motor-cycles.

1. EUROPEAN UNION

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 **Part 2**, **Section B.1.3**.

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

The limit values are summarised in **Table 1.1**, below. Full descriptions of the vehicle classifications will be found in **Section 12** but, for ease of reference, Category M vehicles are essentially passenger cars, whereas Category N_1 refers to commercial vehicles with a maximum mass of 3500 kg.

Table 1.1 Year 2005 EU Emissions Limits for Passenger Cars and Light Commercial Vehicles

Category		Class	Reference Mass "RW" (kg)	Fuel	Limit Values (g/km)				
					CO	HC	NOx	HC+NOx	PM (1)
Euro 4 B (2005) (3)	M (2)	-	All (2)	Gasoline	1.0	0.10	0.08	-	-
				Diesel	0.50	-	0.25	0.30	0.025
	N_1 (4)	I	RW ≤1305	Gasoline	1.0	0.10	0.08	-	-
				Diesel	0.50	-	0.25	0.30	0.025
		II	1305 <RW ≤1760	Gasoline	1.81	0.13	0.10	-	-
				Diesel	0.63	-	0.33	0.39	0.040
		III	RW >1760	Gasoline	2.27	0.16	0.11	-	-
				Diesel	0.74	-	0.39	0.46	0.06

(1) For compression ignition engines only.

(2) Category M vehicles in excess of 2500 kg are treated as Category N_1, Class 1 vehicles. Until 01/01/03, M_1 diesel vehicles weighing more than 2000 kg, designed to carry more than 6 occupants (including the driver) or classed as off-road vehicles were considered as Category N_1 vehicles.

(3) Dates for "Year 2005" implementation are as follows:

Category/Class	Date
M (3); N_1 Class I - New types	01/01/05
N_1 Classes II & III - New types	01/01/06
M (3); N_1 Class I - All models	01/01/06
N_1 Classes II & III - All models	01/01/07

(4) Plus those Category M vehicles specified in Note (2), above.

Evaporative Emissions

The evaporative emissions test (Type IV Test) has been increased in severity and details will be found in the **Appendix to Part 1**, **Section A.1.3.6.** The limit value for evaporative emissions remains at 2.0 g of HC per test.

On-Board Diagnostics (OBD)

EU Directive 98/69/EC also requires the fitting of OBD systems, according to the schedule shown in **Table 1.2**, below:

Table 1.2 EU Implementation Schedule for OBD

Category/Class of Vehicle	Date
Gasoline powered M_1 and N_1 - All classes	01/01/00
Diesel powered M_1 (1) - New types	01/01/03
Diesel powered M_1 (1) - All models	01/01/04
Diesel powered M_1 exempted by note (1)	01/01/05
Diesel powered N_1 Class I - New Types	01/01/05
Diesel powered N_1 Classes II & III - New Types	01/01/06

(1) Excludes vehicles designed to carry more than six occupants, including the driver and vehicles exceeding 2500 kg in mass.

Details of the threshold values for the operation of OBD malfunction indicators and the faults to be detected will be found in **Section 1.6.3**. Directive 2002/80/EC includes further guidance on the required infrastructure for OBD equipment

Cold Start (-7°C) Requirements

EU Directive 98/69/EC also stipulated that, from 1 January 2002, all new types of gasoline powered M_1 and N_1 Class I vehicles had to meet the following emissions limits when tested at -7°C:

Table 1.3 Cold Start (-7°C) Emission Limits

Emissions (g/km)	
CO	**HC**
15.0	1.8

The test (designated the Type VI test) is conducted over the four urban elements of the Type I test cycle and further details will be found in **Section 1.3.2**.

Directive 2001/100/EC, published on 7 December 2001, extended the requirements to include category N_1 class II and III with positive-ignition engines. It also included category M_1 with positive-ignition engines designed to carry more than six occupants and vehicles of category M_1 with positive-ignition engines whose maximum mass exceeds 2500 kg. These latter vehicles were also previously excluded. The limits are as follows and applied to all new types of vehicle from 1 January 2003:

Table 1.4 Cold Start (-7°C) Emission Limits for Heavier Passenger Cars and Light Commercial Vehicles

Category	Class	Emissions (g/km)	
		CO	HC
M_1 (1)		15	1.8
N_1 (2)	II	24	2.7
	III	30	3.2

(1) Except vehicles designed to carry more than six occupants and vehicles the maximum mass of which exceeds 2500 kg.

(2) And those category M_1 vehicles which are specified in note 1.

Reference Fuels

The Directive also specifies the reference fuels to be employed for emissions testing. This was subsequently updated by Directive 2002/80/EC and full details will be found in **Section 1.4**.

Conformity of Production and In-Service Conformity Checks

EU Directive 98/69/EC introduced two new statistical methods for checking conformity of production and revised criteria for in-service conformity checks. Details of the in-service checks are summarised in **Section 1.6**.

Tax Incentives

Article 5 of the Directive allows Member States to make provision for tax incentives only in respect of motor vehicles in series production complying with EU Directive 70/220/EEC, as amended by 98/69/EC. These incentives had to be terminated once the emission limits become mandatory.

Other Provisions

The EU Commission must submit proposals for:

- Improved roadworthiness testing.
- Examination of Type V testing (ageing testing to verify the durability of “anti-pollution” devices), including the possibility of abolishing the procedure.

1.1.2. Passenger Cars and Light Commercial Vehicles - “Euro 5” Emissions Proposals

On 18 November 2005, the Enterprise and Industry Directorate-General (Consumer Goods - Automotive Industry Unit) published its draft COM(2005) 683 final proposals. This proposal has been developed in the context of the "Clean Air For Europe" (CAFE) programme that provided the technical basis for the preparation of the Thematic Strategy on Air Pollution. Euro 5 is one among several measures to reduce emissions of ozone precursors (such as NOx and HC) and particulate matter.

The main aspect of this Regulation is that it requires a further tightening of vehicle emission limits for particulate matter and nitrogen oxides (NOx). A large reduction (80%) in the mass of particulate emissions from diesel vehicles will be required.

While this lower emission limit does not prescribe a particular technology, it will de facto require the introduction of diesel particulate filters (DPFs).

At present, the emission limit selected can only be met by closed filters, which have the benefit of reducing the ultra fine particles that are considered more harmful to health. To prevent the possibility that open filters are developed that meet the new particulate mass limit but enable a high number of ultra fine particles to pass, it is foreseen that a new standard limiting the number of particles that can be emitted may be introduced at a later stage.

It is not yet appropriate to define a number standard as research is being conducted at the UN/ECE under the Particulate Measurement Programme (PMP). Once the results of the PMP programme are available, a number standard will be implemented. The PMP programme is also testing a new protocol for measuring particulate emissions. A key benefit of the new approach is that it provides for greater repeatability in measuring emissions in the laboratory. Once the programme is complete, consideration will be given to replacing the current measurement procedure with the new approach. When the new measurement procedure is implemented, the Commission will have to recalibrate the PM mass emission limits set out in this proposal, as the new technique records a lower level of mass than the current method.

For diesel vehicles, only a small reduction (20%) in NOx is planned. This emission limit has been set so that reductions can be achieved by further internal engine measures. As the proposal will lead to the installation of particulate filters in the exhaust stream, the Commission wished to avoid an obligation for installing an additional NOx after-treatment system at this stage. As the technology for further NOx reduction is not yet mature, it is therefore proposed not to reduce NOx emissions beyond the 200 mg/km limit value.

The proposal includes further reductions in emissions from gasoline cars. The Commission proposes a 25% reduction in NOx and a 25% reduction in hydrocarbons (HC). Many gasoline vehicles currently sold in the EU are comfortably beneath this limit, others can be made to respect it at relatively low cost. Emission limits on the mass of particulate emissions from gasoline engines are also proposed. These limits apply only to direct injection vehicles operating in lean burn mode.

A further change is the proposal that the durability period over which manufacturers must ensure the functioning of pollution control devices has been extended from 80,000 km to 160,000 km. This change will more realistically reflect the actual life of vehicles and ensure that emission control systems continue to function throughout the life of the vehicle.

The proposal includes a requirement that vehicle repair information be made available through websites in the standardised format developed by a technical committee of stakeholders (the so-called “OASIS standard”).

A final aspect is the removal of the exception in previous legislation which enabled heavy passenger vehicles (Class M_1, over 2500 kg) to be type approved as light commercial vehicles. There is no longer seen to be any justification for this exemption.

Table 1.5 Proposed Euro 5 Vehicle Tailpipe Emission Limits [(1)]

Category	Class	Reference Mass RM (kg)	Limit Values (mg/kg) [(2)]									
			CO		HC		NOx		HC + NOx		PM [(3)]	
			L_1		L_2		L_3		$L_2 + L_3$		L_4	
			SI	CI	SI	CI	SI	CI	SI	CI	SI [(4)]	CI
M	-	All	1000	500	75	-	60	200	-	250	5.0	5.0
N_1	I	RM 1305	1000	500	75	-	60	200	-	250	5.0	5.0
	II	1305 < RM 1760	1810	630	100	-	75	260	-	320	5.0	5.0
	III	1760 < RM	2270	740	120	-	82	310	-	380	5.0	5.0

(1) By [6 months after entry into force] the Commission shall examine the need to redefine the emission limit value of hydrocarbons, to consider emissions of non-methane hydrocarbons and methane separately. Consideration shall also be given to including methane emissions in the calculation of carbon dioxide emissions.

(2) SI = Spark ignition (or positive ignition); CI = Compression ignition (diesel).

(3) A number standard is to be defined at a later stage.

(4) Spark Ignition (SI) or positive ignition (PI) particulate mass standards apply only to vehicles with direct injection engines that operate either partially or wholly in lean burn mode.

Evaporative Emissions

No change is proposed to the evaporative emissions limit, i.e. it remains at 2.0 g/test.

Table 1.6 Cold Start (- 7 C) Emission Limits

Category	Class	CO (g/km)	HC (g/km)
		L_1	L_2
M		15	1.8
N_1	I	15	1.8
	II	24	2.7
	III	30	3.2

Financial Incentives

Member States may make provision for financial incentives in respect of motor vehicles in series production which comply with this Regulation. Those incentives shall be valid for all new vehicles offered for sale on the market of a Member State in advance of the following dates:

- With effect from [36 months from the date of entry into force], and from [48 months from the date of entry into force] in the case of category N_1 class II and III. The incentives must cease on those dates.

Member States may make provision for financial incentives for the retrofitting of in-use vehicles to meet the emission limits laid down in this Regulation and for scrapping vehicles which do not comply.

The financial incentives shall for each type of motor vehicle be for an amount lower than the additional cost of the technical devices introduced to ensure compliance with the emission limits specified in **Table 1.5**, including the cost of installation on the vehicle.

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

EU Directive 1999/96/EC sets out stringent limits which are shown in **Tables 1.7** and **1.8**, below.

Table 1.7 HD Emission Limits - Diesel Engines over the ESC/ELR Test Cycles (Steady-state & Dynamic Load Response Smoke Tests)

Implementation Date [1]		Gaseous and PM Emissions (g/kWh)				Smoke (m^{-1}) [3]
		CO	HC	NOx [2]	PM	
B1 - 2005	(Euro 4)	1.5	0.46	3.5	0.02	0.50
B2 - 2008 [4]	(Euro 5)	1.5	0.46	2.0	0.02	0.50
C (EEV) - 1999 [5]		1.5	0.25	2.0	0.02	0.15

(1) All implementation dates are 1 October in the designated year.

(2) The specific mass of the oxides of nitrogen measured at the random check points within the control area of the ESC test must not exceed by more than 10% the values interpolated from the adjacent test modes.

(3) The smoke value on the random test speed of the ELR must not exceed the highest smoke value of the two adjacent test speeds by more than 20%, or by more than 5% of the limit value, whichever is greater.

(4) The EU Commission shall consider the available technology with a view to confirming the mandatory NOx standard

(5) EEV = “Enhanced Environmental Vehicle”

Table 1.8 HD Emission Limits - Diesel and Gas Engines over the ETC (Transient) Test Cycle [1]

Implementation Date [1]		Gaseous and PM Emissions (g/kWh)				
		CO	NMHC [2]	CH_4 [3]	NOx	PM [5]
B1 - 2005	(Euro 4)	4.0	0.55	1.1	3.5	0.03
B2 - 2008 [4]	(Euro 5)	4.0	0.55	1.1	2.0 [6]	0.03
C (EEV) - 1999		3.0	0.40	0.65	2.0	0.02

(1) All implementation dates are 1 October in the designated year.

(2) A manufacturer may choose to measure the mass of total hydrocarbons (THC) on the ETC test instead of measuring the mass of non-methane hydrocarbons. In this case, the limit for the mass of total hydrocarbons is the same as that shown above for the mass of non-methane hydrocarbons.

(3) Natural gas engines only.

(4) Not applicable to gas fuelled engines under Stages B1 and B2.

(5) The EU Commission shall consider the available technology with a view to confirming the 2008 NOx standard

Test cycles for type approval

Emissions are determined over the ESC and ELR tests with conventional diesel engines including those fitted with electronic fuel injection equipment, exhaust gas

recirculation (EGR), and/or oxidation catalysts. The ESC cycle is a steady-state test, whilst the ELR cycle is essentially a free acceleration smoke test. Diesel engines fitted with advanced exhaust after-treatment systems including DeNOx catalysts and/or particulate traps, shall additionally be tested over a heavy duty transient cycle, referred to as the ETC. These procedures and their development are fully described in the **Appendix to Part 1**, **Section A.1.1.3**.

Defeat Devices

The use of a defeat device and/or irrational emissions control strategy is forbidden.

On-Board Diagnostics

OBD are not fully developed for heavy duty vehicles but were to be introduced from 2005 with a view to permitting rapid detection of failure of emission critical components and systems on vehicles. Further details of the action to be taken by the EU Commission will be found in **Section 1.6.4**.

Tax Incentives

Member States are allowed, by means of tax incentives, to speed the introduction of vehicles which satisfy the limit values. However, such incentives have to satisfy certain conditions to avoid distortions of the internal market. They have to be terminated with effect from the dates of mandatory application of the emission limit values.

Type Approval

From 1 October 2005, for new types, and from 1 October 2006, for all models, type-approvals granted to vehicles and engines shall also confirm the correct operation of the emission control devices during the normal life of the vehicle or engine under normal conditions of use (conformity of in-service vehicles properly maintained and used). The EU Commission is to examine differences in normal life of various categories of heavy duty vehicles and consider proposing appropriate durability requirements specific to each category.

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**.

Reference fuels

The Directive describes diesel, natural gas and LPG reference fuels - these were subsequently modified by Directive 2001/27/EC of 10 April 2001. Full details will be found in **Section 1.4**.

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.

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. Further information will be found in the **Part 1 Appendix**, **Section A.1.1.3**.

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.

Table 1.9 Future EU Motorcycle Emission Limits

Effective Date	Class	Emission Limits (g/km) (1)		
		CO	HC	NOx
Motorcycles (2 wheels)				
A (2003)	I (< 150 cm^2)	5.5	1.2	0.3
	II (≥150 cm^2)	5.5	1.0	0.3
B (2006)	I (< 150 cm^2) [UDC cold] (2)	2.0	0.8	0.15
	II (≥150 cm^2) [UDC + EUDC cold] (3)	2.0	0.3	0.15
Tricycles and Quadricycles (positive ignition)				
A (2003)	All	7.0	1.5	0.4
Tricycles and Quadricycles (compression ignition)				
A (2003)	All	2.0	1.0	0.65

(1) The emissions test must be repeated three times - for each pollutant or combination of pollutants, one of the three resulting masses obtained may exceed, by not more than 10%, the limit prescribed, provided the arithmetical mean of the three results is below the prescribed limit. Where the prescribed limits are exceeded for more than one pollutant, it is immaterial whether this occurs in the same test or in different tests.

(2) Test Cycle: ECE R40 (with emissions measured for all six modes - sampling starts at T = 0)

(3) Test Cycle: ECE R40 + EUDC (with emissions measured from all modes - sampling starts at T = 0). When testing for compliance with the limit values in rows B for 2006 for motorcycles with a permitted maximum speed of 110 km/h, the maximum speed for the extra-urban driving cycle will be restricted to 90 km/h.

- The use of a defeat device and/or irrational emissions control strategy is forbidden.
- An engine control device, function, system or measure may be installed to a vehicle provided that:
  - it is activated only for such purposes as engine protection, cold starting or warming up, or
  - it is activated only for such purposes as operational security or safety and limp-home strategies.
- The use of an engine control device, function, system or measure which results in the use of a different or modified engine control strategy to that normally employed during the applicable emission test cycles will be permitted if it is fully demonstrated that the measure does not reduce the effectiveness of the emission control system. In all other cases, such devices shall be considered to be a defeat device.

Further background information and additional details will be found in the **Part 1 Appendix**, **Section A.1.1.4**.

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.1.1.4**.

Directive 2004/ 26/EC of 21 April 2004 amended Directive 97/68/EC and the new limits for non-road mobile machinery are shown below. The legislation also includes limit values for locomotives, railcars and inland waterway vessels, which are beyond the scope of this report.

Table 1.10 Emission Limits for Non-Road Mobile Machinery Stage IIIA, IIIB and IV Limit Values

Stage	Category	Net Power [P] (kW)	Emissions (g/kWh)			
			CO	**HC**	**HC + NOx**	**PM**
IIIA	H	130 ≤ P ≤ 560	3.5	-	4.0	0.2
	I	75 ≤ P < 130	5.0	-	4.0	0.3
	J	37 ≤ P < 75	5.0	-	4.7	0.4
	K	19 ≤ P < 37	5.5	-	7.5	0.6
			CO	**HC**	**NOx**	**PM**
IIIB (1)	L	130 ≤ P ≤ 560	3.5	0.19	2.0	0.025
	M	75 ≤ P < 130	5.0	0.19	3.3	0.025
	N	56 ≤ P < 75	5.0	0.19	3.3	0.025
	P	37 ≤ P < 56	5.0	-	**(HC + NOx)** 4.7	0.025
IV (1)	Q	130 ≤ P ≤ 560	3.5	0.19	0.4	0.025
	R	56 ≤ P < 130	5.0	0.19	0.4	0.025

(1) A further review shall be carried out by the EU Commission, to be completed not later than 31 December 2007, with a view to confirming the Stage IIIB and IV emissions limit values.

Table 1.11 Implementation Dates for Non-Road Mobile Machinery Stage IIIA, IIIB and IV Limit Values

Stage	Category	Net power P (kW)	Entry into force dates (1) by Engine Type	
			Variable Speed	**Constant Speed**
IIIA	H	130 ≤ P ≤ 560	31 December 2005	31 December 2010
	I	75 ≤ P < 130	31 December 2006	31 December 2010
	J	37 ≤ P < 75	31 December 2007	31 December 2011
	K	19 ≤ P < 37	31 December 2006	31 December 2010
IIIB	L	130 ≤ P ≤ 560	31 December 2010	
	M	75 ≤ P < 130	31 December 2011	
	N	56 ≤ P < 75	31 December 2011	
	P	37 ≤ P < 56	31 December 2012	
IV	Q	130 ≤ P ≤ 560	31 December 2013	
	R	56 ≤ P < 130	31 December 2014	

(1) Entry into force dates (placing on the market dates).

Background information and additional details will be found in the **Appendix to Part 1**, **Section A.1.1.5**.

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 **Section 1.1.4**.

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

Introduction

On 21 September 2005, the Commission published COM(2005) 446 final, detailing their future strategy on air pollution. In this Communication the Commission state that, despite significant improvements, serious air pollution impacts persist. Against this backdrop, the Community's Sixth Environmental Action Programme (6^{th} EAP) called for the development of a thematic strategy on air pollution with the objective to attain "levels of air quality that do not give rise to significant negative impacts on, and risks to human health and the environment".

The Commission has examined whether current legislation is sufficient to achieve the 6^{th} EAP objectives by 2020. This analysis looked at future emissions and impacts on health and the environment and has used the best available scientific and health information. It showed that significant negative impacts will persist even with effective implementation of current legislation.

Accordingly, this strategy establishes interim objectives for air pollution in the EU and proposes appropriate measures for achieving them. It recommends that current legislation be modernised, be better focused on the most serious pollutants and that more is done to integrate environmental concerns into other policies and programmes.

Strategy Objectives

The chosen strategy sets health and environmental objectives and emission reduction targets for the main pollutants. These objectives will be delivered in stages. To achieve these objectives, SO_2 emissions will need to decrease by 82%, NOx emissions by 60%, VOCs by 51%, ammonia by 27% and primary $PM_{2.5}$ by 59% relative to emissions in 2000. A large part of these emissions reductions will be delivered by measures already adopted and implemented in the Member States.

Part of the strategy will be implemented through a revision of the current ambient air quality legislation comprising two main elements:

1. streamlining of existing provisions and merging five legal instruments into a single directive;

2. the introduction of new air quality standards for fine particulate matter ($PM_{2.5}$).

Actions and Means

In order to attain these strategic objectives, current air quality legislation will be simplified and other legislation revised where appropriate. Further initiatives will be taken on new vehicles.

- **Simplification of Air Quality Legislation:** A legislative proposal combines the Framework Directive, the First, Second and Third Daughter Directives and the Exchange of Information Decision. The recently adopted Fourth Daughter Directive will be merged later.
- **Control of Human Exposure to $PM_{2.5}$:** Evidence shows that fine particles ($PM_{2.5}$) are more hazardous than larger ones. A cap of 25 $\mu g/m^3$ is proposed which is unlikely to impose additional burdens except in the most polluted areas of the EU. The level chosen for the cap takes account of the inherent uncertainties in our current knowledge about the risks of $PM_{2.5}$. A uniform interim reduction target of 20% is proposed for all Member States to be attained between 2010 and 2020. It is foreseen that this target will be reviewed when more air quality monitoring information is available.
- **Revision of the NECD:** The Commission will review the national emissions ceilings directive in 2006 and propose revised emission ceilings. Any revision will ensure that reduced emissions of NOx, SO_2, VOCs, NH_3 and primary PM are consistent with the interim objectives proposed for 2020.
- **VOC Emissions at Filling Stations:** Given the role of volatile organic compounds in the formation of ground level ozone, the Commission will examine the scope to further reduce VOC emissions at filling stations.
- **Transport:** The Commission will further encourage shifts towards less polluting modes of transport, alternative fuels and reduced congestion. A proposal to reduce emissions of new passenger cars and vans was put forward in 2005 (Euro V). The Commission will also come forward with a proposal to tighten further the emissions from heavy duty vehicles. In the longer term, the Commission will also investigate the feasibility of improving the type approval process so that test-cycle emissions better reflect real world driving. Older road vehicles cause disproportionate levels of pollution. Therefore, Member States should consider targeted retrofitting and scrapping schemes when drawing up plans to meet air quality objectives.

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.1.2.8**.

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 **Sections 1.2.2** and **1.2.3**).

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

Table 1.12 EU Directive 2003/17/EC: Year 2005 Limits for Gasoline

Parameter [1]	Unit	Limits [2]	
		Minimum	Maximum
Research octane number		95 [3]	-
Motor octane number		85	-
Vapour pressure, summer period [4]	kPa	-	60.0 [5]
Distillation:			-
Evaporated @ 100°C	%v/v	46.0	
Evaporated @ 150°C	%v/v	75.0	-
Hydrocarbon analysis:			
olefins	%v/v	-	18.0
aromatics	%v/v	-	35.0
benzene	%v/v	-	1.0
Oxygen content	%m/m	-	2.7
Oxygenates			
Methanol (stabilising agents must be added)	%v/v	-	3
Ethanol (stabilising agents may be necessary)	%v/v	-	5
Iso-propyl alcohol	%v/v	-	10
Tertiary-butyl alcohol	%v/v	-	7
Iso-butyl alcohol	%v/v	-	10
Ethers containing 5 or more carbon atoms per molecule	%v/v	-	15
Other oxygenates [6]	%v/v	-	10
Sulphur content	mg/kg	-	50
	mg/kg	-	10 [7]
Lead content	g/l	-	0.005

(1) Test methods shall be those specified in EN 228:1999. Member States may adopt the analytical method specified in replacement EN 228:1999 standard if it can be shown to give at least the same accuracy and at least the same level of precision as the analytical method it replaces.

(2) The values quoted in the specification are “true values”. In the establishment of their limit values the terms of ISO 4259 “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259 (published in 1995).

(3) Member States may decide to continue to permit the marketing of unleaded regular grade petrol with a minimum motor octane number (MON) of 81 and a minimum research octane number (RON) of 91.

(4) The summer period shall begin no later than 1 May and shall not end before 30 September. For Member States with arctic or severe winter conditions, the summer period shall begin no later than 1 June and shall not end before 31 August.

(5) For Member States with arctic or severe winter conditions, the vapour pressure shall not exceed 70 kPa during the summer period.

(6) Other mono-alcohols and ethers with a final boiling point no higher than that stated in EN 228:1999.

(7) By no later than 1 January 2005 unleaded petrol with a maximum sulphur content of 10 mg/kg must be marketed and be available on an appropriately balanced geographical basis within the territory of a Member State. By 1 January 2009 all unleaded petrol marketed in the territory of a Member State must have a maximum sulphur content of 10 mg/kg.

Table 1.13 EU Directive 2003/17/EC: Year 2005 Limits for Diesel Fuel

Parameter [1]	Unit	Limits [2]	
		Minimum	Maximum
Cetane Number		51.0	-
Density at 15 °C	kg/m^3	-	845
Distillation:			
95%v/v recovered at	°C	-	360
Polycyclic Aromatic Hydrocarbons	%m/m	-	11
Sulphur content	mg/kg	-	50
	mg/kg	-	10 [3]

(1) Test methods shall be those specified in EN 590. Any change to a test method in EN 590 shall only be binding on the Member States if the new method gives at least the same accuracy and at least the same level of precision as the test method it replaces.

(2) The values quoted in the specification are 'true values´. In the establishment of their limit values the terms of ISO 4259 'Petroleum products - Determination and application of precision data in relation to methods of test´ have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account (R = reproducibility). The results of individual measurements shall be interpreted on the basis of the criteria described in ISO 4259 (published in 1995).

(3) By no later than 1 January 2005 diesel fuel with a maximum sulphur content of 10 mg/kg must be marketed and be available on a broad geographic basis within the territory of a Member State. Subject to the Commission's review, all diesel fuel marketed in the territory of a Member State must have a sulphur content of less than 10 mg/kg by 1 January 2009.

1.2.2.1. Additional Provisions of EU Directive 2003/17/EC

The Directive confirmed that, with the exception of sulphur, there are no other changes to the 2005 fuel specifications set out in Directive 98/70/EC. However, the Commission is to review the fuel specifications (with the exception of sulphur content) and propose amendments, if appropriate. The outcome of the review was not known at the time of publication of this report. Dates for the introduction of 10 mg/kg sulphur content fuels have been confirmed and the specification for non-road diesel fuel is also discussed.

Sulphur Content

Sufficient quantities of gasoline and diesel fuels with a maximum sulphur content of 10 mg/kg must be available from 1 January 2005 on an appropriate geographic basis. The complete penetration of gasoline and diesel fuels with a maximum sulphur content of 10 mg/kg should be provided for from 1 January 2009 in order to allow the fuel manufacturing industry enough time to make the necessary investments. It will be necessary to confirm this date in the case of diesel fuels.

Member States may, for the "Outermost Regions" [1], make specific provisions for the introduction of gasoline of a maximum sulphur content of 10 mg/kg.

Gasoline and diesel fuel containing a maximum of 10 mg/kg sulphur is now becoming available in EU markets and readers should refer to the DG Environment Fuel Quality Monitoring reports for the latest information: (http://europa.eu.int/comm/environment/air/fuel_quality_monitoring.htm)

1 "Outermost Regions" means France with regard to the French Overseas Departments, Portugal with regard to the Azores and Madeira and Spain with regard to the Canary Islands

Specification Review

By 31 December 2005 the Commission was to review the fuel specifications with the exception of sulphur content and propose amendments, if appropriate, in keeping with current and future requirements of Community vehicle emission and air quality legislation and related objectives. The review, now expected in late 2006, encompasses not just conventional fuels and is therefore summarized in **Section 1.2.6**.

1.2.2.2. 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. Details of the Standard will be found in the **Appendix to Part 1**, **Section A.1.2.4**.

1.2.2.3. Fuels for Non-Road Mobile Machinery

The exhaust emissions from engines installed in non-road mobile machinery and agricultural tractors are regulated by Directive 97/68/EC and Directive 74/150/EEC respectively. Heating oil has been widely used by these vehicles in the past. The wording of Article 2 of Directive 98/70/EC can be interpreted so as to permit (but not mandate) alternatives for the maximum sulphur content of fuels used by non-road mobile machinery and agricultural tractors. This can be either the sulphur content of diesel fuels stated in Directive 98/70/EC or the previous sulphur content of diesel fuel stated in Directive 93/12/EC. As Directive 93/12/EC has largely been repealed there is in fact further uncertainty regarding the meaning of this reference.

Under Directive 2003/17/EC, Member States shall ensure that gas oils intended for use by non-road mobile machinery, agricultural and forestry tractors contain less than 2000 mg/kg of sulphur. By 1 January 2008 at the latest the maximum permissible sulphur content of gas oils intended for use by these machines shall be 1000 mg/kg. However, Member States may require a lower limit or the same sulphur content for diesel fuels stipulated in this Directive.

When considering its proposal for the next stage of emission standards for compression ignition non-road engines, the Commission shall establish in parallel the required fuel quality. The Commission shall then align appropriate fuel quality

requirements for non-road applications with the on-road sector by a certain date, currently expected to be 1 January 2009. This was to be confirmed or amended by the Commission in its review in 2005, now expected in late 2006.

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

Introduction

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.

As of 1 May 2004, ten new Member States enlarged the EU:

- Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

Four other countries have applied to become members:

- Bulgaria, Croatia, Turkey and Romania.

The European Council has expressed its support for Bulgaria and Romania in their efforts to achieve membership in 2007. The December 2004 European Council requested the Council to agree on a negotiating framework with a view to opening accession negotiations with Croatia on 17 March 2005, provided that there is full cooperation with the International Criminal Tribunal for the former Yugoslavia. Turkey must sign a customs accord extending to all EU members, including Cyprus, and this accord must be signed by the start of entry talks, proposed for October 2005.

The tables showing gasoline volatility classes and diesel cold properties have been revised to show the grades selected by all the member states and accession countries. No information was available for Cyprus but it is known that the Energy Service has adopted Directives 98/70/EC and 99/32/EC in the framework of new legislation that regulates the specification of petroleum products and fuels. Based on the provisions of the law, specifications of various oil products have been set by Ministerial order.

Unleaded Gasoline - EN 228:2004

This European Standard was approved by CEN on 24 December 2003 and replaced EN 228:1999. **Table 1.14** detail the generally applicable standards and appropriate test methods for premium unleaded gasoline. Ten volatility classes are defined to meet hot and cold vehicle driveability requirements - these are given in **Table 1.15** and illustrated in **Figure 1.1**. Each country shall, in a national annex to this European Standard, specify which of these ten classes apply during which period of the year for defined regions of the country. The footnotes to **Table 1.15** stipulate the criteria to be applied in selecting the volatility classes and **Table 1.16** details the volatility classes selected by individual European countries.

Table 1.14 EN 228:2004 Premium Grade Unleaded Gasoline

Property	Units	Limits		Test Method (1)
		Min	Max	
RON (2)		95.0	-	prEN ISO 5164 (2)
MON (2)		85.0	-	prEN ISO 5163 (2)
Lead content	mg/l	-	5	prEN 237
Density @ 15°C (3)	kg/m^3	720	775	EN ISO 3675 EN ISO 12185
Sulphur content (3)	mg/kg	-	150 (Until 31.12.04) or 50.0	EN ISO 20846 EN ISO 20847 EN ISO 20884
		-	10.0	EN ISO 20846 EN ISO 20884
Oxidation stability	minutes	360	-	EN ISO 7536
Gum content (solvent washed)	mg/100 ml	-	5	EN ISO 6246
Copper strip corrosion (3 h @ 50°C)	rating		Class 1	EN ISO 2160
Appearance		clear and bright		visual inspection
Hydrocarbon type content (3, 4, 5 and 6)				
- olefins	%v/v	-	18.0	ASTM D 1319 prEN 14517
- aromatics	%v/v	-	42.0 (Until 31.12.04) or 35.0	
Benzene content (3)	%v/v	-	1.0	EN 12177 EN 238 prEN 14517
Oxygen content (3)	%m/m	-	2.7	EN 1601 EN 13132
Oxygenates content (3)	%v/v			
- methanol (7)		-	3	
- ethanol (8)		-	5	
- iso-propyl alcohol		-	10	EN 1601 EN 13132
- iso-butyl alcohol		-	10	
- tertiary-butyl alcohol		-	7	
- ethers (5 or more C atoms)		-	15	
- other oxygenates (9)		-	8	

(1) All test methods referred to in this European Standard include a precision statement. In cases of dispute, the procedures for resolving the dispute and interpretation of the results based on test method precision, described in EN ISO 4259, shall be used.

(2) A correction factor of 0.2 for MON and RON shall be subtracted for the calculation of the final result, before reporting according to the requirements of the European Directive 98/70/EC, including Amendment 2003/17/EC.

(3) In cases of dispute concerning sulphur EN ISO 20847 is unsuitable as an arbitration method. In cases of dispute concerning benzene, oxygen and oxygenates, hydrocarbon type content and density, the following test methods shall be used:

Property	Procedure
benzene	EN 12177
oxygen and oxygenates	EN 1601
hydrocarbon type	ASTM D 1319
density	EN ISO 3675

(4) The content of oxygenate compounds shall be determined as prescribed in the above Table in order to make the corrections when necessary according to clause 13.2 of ASTM D 1319.

(5) When Ethyl-tertiary-butyl ether (ETBE) is present in the sample, the aromatic zone shall be determined from the pink brown ring downstream of the red ring normally used in the absence of ETBE. The presence or absence of ETBE can be concluded from the analysis as required in footnote d.

(6) For the purpose of this standard ASTM D 1319 shall be applied without the optional depentanisation step. Therefore clauses 6.1, 10.1 and 14.1.1 shall not be applied.

(7) Stabilising agents shall be added.

(8) Stabilising agents may be necessary.

(9) Other mono-alcohols and ethers with a final boiling point no higher than prescribed in Table **1.15**.

- Given the known potential for some motor gasolines to absorb water, suppliers shall ensure that no water segregation occurs under the range of climatic conditions experienced in the country concerned. When there is a risk of water separation, anti-corrosion additives shall be incorporated.

As from 1 January 2005 regular grade gasoline is not longer included in EN 228. From that date, regular grade unleaded gasoline may be specified in a National Annex to this standard. Details will be found in **Part 2**, **Section B.1.2.2**.

To meet hot and cold vehicle driveability requirements under the European seasonal and geographical conditions, ten volatility classes are defined in **Table 1.15** and illustrated in **Figure 1.1**. Each country shall, in a national annex to this European Standard, specify which of these ten volatility classes apply during which period of the year for defined regions of the country.

Table 1.15 EN 228:2004 Unleaded Gasoline Volatility Classes

Property	Units		Limits						Test Method (1)
			Class A (2)	Class B (3)	Class C/C1 (4)	Class D/D1 (4)	Class E/E1 (4)	Class F/F1 (4)	
Vapour pressure (VP)	kPa	min	45.0	45.0	50.0	60.0	65.0	70.0	EN 13016-1 (DVPE) (5)
		max	60.0	70.0	80.0	90.0	95.0	100.0	
% evaporated @ 70°C, E70	%v/v	min	20.0	20.0	22.0	22.0	22.0	22.0	EN ISO 3405
		max	48.0	48.0	50.0	50.0	50.0	50.0	
% evaporated @ 100°C. E100	%v/v	min	46.0	46.0	46.0	46.0	46.0	46.0	
		max	71.0	71.0	71.0	71.0	71.0	71.0	
% evaporated @ 150°C, E150	%v/v	min	75.0	75.0	75.0	75.0	75.0	75.0	
Final Boiling Point, FBP	°C	max	210	210	210	210	210	210	
Distillation residue	%v/v	max	2	2	2	2	2	2	
VLI (10 VP + 7E70)	index	max	-	-	C -	D -	E -	F -	
		max	-	-	C1 1050	D1 1150	E1 1200	F1 1250	

(1) All the test methods include a precision statement. In cases of dispute, the procedures described in EN ISO 4259:1995 shall be used.

(2) Class A shall apply during summer, starting not later than 1 May and ending not before 30 September (see also Note 3).

(3) In countries with arctic or severe winter conditions, class B shall apply during the summer, starting not later than 1 June and ending not before 31 August.

(4) Each country shall apply one or more volatility classes with VLI (class C1, D1, E1 or F1) for the transition periods on either side of summer. Each transition period shall be a minimum of 4 weeks. When transition periods are deemed critical, they shall be a minimum of 8 weeks. During the remaining period one or more winter classes shall apply with or without VLI (class C, C1, D, D1, E, E1, F or F1).

(5) Dry Vapour Pressure Equivalent (DVPE) shall be reported

Figure 1.1 EN 228:2004 - Relationship between Vapour pressure, E70 and VLI for the Ten Volatility Classes

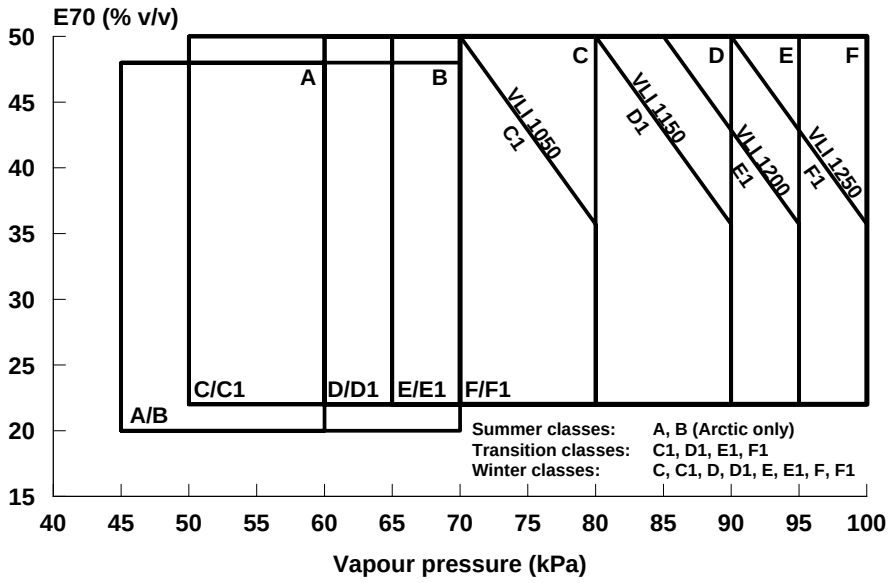


Table 1.16 EN 228:2004 Unleaded Gasoline Volatility Classes adopted by individual countries (including accession countries)

Country	Winter Class	Transition (1)		Summer		Transition (1)	
		Class	Period	Class	Period	Class	Period
Austria	D	D1	01/03 - 30/04	A	01/05 - 30/09	D1	01/10 - 31/10
Belgium	E	E1	01/04 - 30/04	A	01/05 - 30/09	E1	01/10 - 31/10
Czech Republic	D	- (2)	-	A	01/05 - 30/09	-	-
Denmark	E	E1	01/05 - 31/05	A	01/06 - 31/08	E1	01/09 - 30/09
Estonia	E, E1	B, E, E1	01/03 - 30/04	B	01/05 - 30/09	B, E, E1	01/10 - 30/11
Finland	F (3)	F1 (3)	01/04 - 31/05	B	01/06 - 31/08	F1 (3)	01/09 - 31/10
France	D	D1/A	16/03 - 30/04	A	01/05 - 30/09	D1/A D1	01/10 – 31/10 01/11 – 15/11
Germany	D	D1	16/03 - 30/04	A	01/05 - 30/09	D1	01/10 - 15/11
Greece	C	-	-	A	01/04 - 31/10	-	-
Hungary	D	C1	01/03 – 30/04	A	01/05 – 30/09	C1	01/10 - 14/11
Italy	D	C1	16/03 - 30/04	A	01/05 - 30/09	C1	01/10 - 15/11
Ireland	F	F1	16/04 - 31/05	B	01/06 - 31/08	F1	01/09 - 15/10
Latvia	E, E1			B	01/05 - 30/09	C1	01/10 – 30/11
Lithuania	D	C1	01/03 – 30/04	B	01/05 – 30/09	C1	01/11 – 28(29)/03
Luxembourg	E	E1	01/04 - 30/04	A	01/05 - 30/09	E1	01/10 - 31/10
Malta	C, C1	-	-	A	01/05 - 30/09	-	-
Netherlands	E	E1	01/04 - 30/04	A	01/05 - 30/09	E1	01/10 - 31/10
Norway	F	F1	01/05 - 31/05	B	01/06 - 31/08	F1	01/09 - 30/09
Poland	D	-	01/03 – 30/04	A	01/05 – 30/09	-	01/10 – 30/10
Portugal	D	D1	01/04 - 30/04	A	01/05 - 30/09	D1	01/10 - 31/10
Slovakia	D	C1	01/03 – 14/04	A	15/04 – 30/09	C1	01/10 – 15/11
Slovenia	D	C1	16/03 – 30/04	A	01/05 – 30/09	D1	01/10 – 15/11
Spain	C	C1	01/04 - 30/04	A	01/05 - 30/09	C1	01/10 - 31/10
Sweden North (5)	E	E1 (6)	16/04 - 15/05	B	16/05 - 31/08	E1 (6)	01/09 - 30/09
Sweden South (5)	E	E1 (6)	01/04 - 30/04	B	01/05 - 15/09	E1 (6)	16/09 - 15/10
UK	F	F1 (max) B (min)	16/04 - 31/05	B	01/06 - 31/08	F1 (max) B (min)	01/09 - 15/10
Bulgaria	D			A	16/04 – 15/10		
Croatia	D	D1	01/04 – 30/04	A	01/05 – 30/09	D1	01/10 – 30/10
Turkey	EN 228:2004 volatility classes are not applied						
Romania	D			A	01/05 – 30/09		

(1) During the transition period any mixture is accepted of the applicable transition grade and the summer grade. For France, different rules apply - see Note (4).

(2) Winter period: 01/10 – 30/03. No transition period.

(3) Finland class D 01/09-31/05 to meet tax incentive.

(4) In France the mixture described in footnote (1) is only allowed during the last two weeks of the transition period in spring and the first two weeks of the transition period in autumn.

(5) Requirements for the Swedish “Environmental” EN 228 gasoline are more stringent than standard EN 228 grades.

(6) Swedish legislation has set transition periods of six weeks. No VLI max applies during winter (E) or summer (B) periods. For Class E1; a VLI limit of 1200 max applies during the four week periods indicated in the table. Legal transition periods apply 01/04 - 15/05 and 01/09-15/10 for Sweden North and 16/03 - 30/04 and 16/09 - 31/10 for Sweden South.

Diesel Fuel - EN 590:2004

The requirements of EU Directives 98/70/EC and 2003/17/EC superseded the diesel fuel specifications set out in previous European (EN) standards and these were revised accordingly. This European Standard was approved by CEN on 24 December 2003 and replaced EN 590:1999. Generally applicable standards and test methods are shown in **Table 1.17** and climate dependent requirements are detailed in **Table 1.18**. The climatic grades selected by individual European countries are shown in **Table 1.19**.

Table 1.17 EN 590:2004 Diesel Fuel

Property	Units	Limits		Test Method (1)
		Min	Max	
Cetane Number (2)		51.0	-	EN ISO 5165
Cetane index		46.0	-	EN ISO 4264
Density @ 15°C (3)	kg/m^3	820	845	EN ISO 3675 EN ISO 12185
Polycyclic aromatic hydrocarbons (4, 5)	%m/m	-	11	EN 12916
Sulphur content (6)	mg/kg	-	350 (Until 31.12.04) or 50.0	EN ISO 20846 EN ISO 20847 EN ISO 20884
		-	10.0	EN ISO 20846 EN ISO 20884
Flash point	°C	> 55	-	EN 22719
Carbon residue (7) (on 10% distillation residue)	%m/m	-	0.30	EN ISO 10370
Ash content	%m/m	-	0.01	EN ISO 6245
Water content	mg/kg	-	200	EN ISO 12937
Total contamination	mg/kg	-	24	EN 12662
Copper strip corrosion (3 h @ 50°C)	rating	-	Class 1	EN ISO 2160
Oxidation stability	g/m^3	-	25	EN ISO 12205
Lubricity, corrected wear scar diameter (wsd 1,4) @ 60°C	µm	-	460	ISO 12156-1
Viscosity @ 40°C	mm^2/s	2.00	4.50	EN ISO 3104
Distillation (8, 9)				EN ISO 3405
% recovered @ 250°C	%v/v		<65	
% recovered @ 350°C	%v/v	85		
95%v/v recovered	°C		360	
FAME content (10)	%v/v	-	5	EN 14078

(1) All the test methods include a precision statement. In cases of dispute, the procedures described in EN ISO 4259 shall be used.

(2) For the determination of cetane number alternative methods may also be used in cases of dispute, provided that these methods originate from a recognised method series, and have a valid precision statement, derived in accordance with EN ISO 4259, which demonstrates precision at least equal to that of the referenced method. The test result, when using an alternative method, shall also have a demonstrable relationship to the result obtained when using the referenced method.

(3) In cases of dispute concerning density, EN ISO 3675 shall be used.

(4) For the purposes of this standard, polycyclic aromatic hydrocarbons are defined as the total aromatic hydrocarbon content less the mono-aromatic hydrocarbon content, both determined by EN 12196 "Petroleum products - Determination of aromatic hydrocarbon types by high performance liquid chromatography with refractive index detection".

(5) EN 12196 is not able to distinguish between polycyclic aromatic hydrocarbons and fatty acid methyl esters (FAME). FAME, if present in diesel fuels, will give a bias which will increase the value for polycyclic aromatic hydrocarbons. An improved method for the determination of polycyclic aromatic hydrocarbons is under development by CEN/TC 19.

(6) In cases of dispute concerning sulfur content, EN ISO 20847 is unsuitable as an arbitration method.

(7) The limiting value for carbon residue given above is based on product prior to the addition of ignition improver, if used. If a value exceeding the limit is obtained on finished fuel in the market, EN ISO 13759 shall be used as an indicator of the presence of a nitrate-containing compound. If an ignition improver is thus proved present, the limit value for the carbon residue of the product under test cannot be applied. The use of additives does not exempt the manufacturer from meeting the requirement of maximum 0.30%m/m of carbon residue prior to the inclusion of additives.

(8) For the calculation of cetane index the 10%, 50% and 90%v/v recovery points are also needed.

(9) The limits for distillation at 250°C and 350°C are included for diesel fuel in line with the EU Common Customs Tariff.

(10) Any FAME must meet the specification requirements of EN 14214.

For climate-dependent requirements options are given to allow for seasonal grades to be set nationally. The options in temperate climates are for six cold filter plugging point (CFPP) grades, whilst arctic climates are provided with five different classes (see **Table 1.18**, **parts A** and **B**). When tested by the methods given in the table, automotive diesel fuel shall be in accordance with the limits specified.

The cetane number limits for the arctic or severe winter grades are lower than for the temperate grade (**Table 1.18**), reflecting the correlation between ignition quality and density, and the low density of arctic or severe winter grades. The values for cetane number in **Table 1.18**, **part B** do not meet the requirements of EU Directive 98/70/EC, and are included for use in countries where the Directive does not apply or for countries where exceptions for arctic or severe winter grades have been granted.

In a national annexe to this European Standard each country shall detail requirements for a summer and winter grade and may include an intermediate grade and/or regional grade(s) which shall be justified by national meteorological data.

Table 1.18 EN 590:2004 Diesel Fuel - Climate-Related Requirements and Test Methods

Part A - Temperate Climates

Property	Units	Limits for Grade						Test Method (1)
		A	B	C	D	E	F	
CFPP	°C (max)	+ 5	0	- 5	- 10	- 15	- 20	EN 116

Part B - Arctic Climates

Property	Units		Limits for Class					Test Method (1)
			0	1	2	3	4	
CFPP	°C	(max)	- 20	- 26	- 32	- 38	- 44	EN 116
Cloud point	°C	(max)	- 10	- 16	- 22	- 28	- 34	EN 23015
Density @ 15°C (2)	kg/m^3	(min)	800	800	800	800	800	EN ISO 3675
	kg/m^3	(max)	845	845	840	840	840	EN ISO 12185
Viscosity @ 40°C	mm^2/s	(min)	1.50	1.50	1.50	1.40	1.20	EN ISO 3104
	mm^2/s	(max)	4.00	4.00	4.00	4.00	4.00	
Cetane Number (3)		(min)	49.0	49.0	48.0	47.0	47.0	EN ISO 5165
Cetane index		(min)	46.0	46.0	46.0	43.0	43.0	EN ISO 4264
Distillation (4, 5)								EN ISO 3405
% recovered @ 180°C	%v/v	(max)	10	10	10	10	10	
% recovered @ 340°C	%v/v	(max)	95	95	95	95	95	

(1) All the test methods include a precision statement. In cases of dispute, the procedures described in EN ISO 4259 shall be used.

(2) In cases of dispute concerning density, EN ISO 3675 shall be used.

(3) For the determination of cetane number alternative methods may also be used in cases of dispute, provided that these methods originate from a recognised method series, and have a valid precision statement, derived in accordance with EN ISO 4259, which demonstrates precision at least equal to that of the referenced method. The test result, when using an alternative method, shall also have a demonstrable relationship to the result obtained when using the referenced method.

(4) EU Common Customs Tariff definition of gas oil may not apply to the grades defined for use in arctic climates.

(5) For the calculation of cetane index the 10%, 50% and 90%v/v recovery points are also needed.

Table 1.19 EN 590:2004 Diesel Fuel - Climate Grades adopted by individual countries (including accession countries)

Country	Winter Grade	Transition		Summer		Transition	
		Grade	Period	Grade	Period	Grade	Period
Austria	F	E	01/03 - 31/03	A	01/04 - 30/09	-	-
Belgium	E	-	-	B	01/03 - 30/11	-	-
Cyprus							
Czech Republic	F	D	01/03 – 14/04	B	15/04 – 30/09	D	01/10 – 15/11
Denmark	F	-	-	D	16/03 - 30/09 (1)	E	01/10 - 31/11 (1)
Estonia	Arctic 1	Arctic 1 / C	01/03 - 30/04	C	01/05 - 30/09	Arctic 1 / C	01/10 - 30/11
Finland	Arctic 1 (2)	-	-	C	01/04 - 31/10	-	-
France	E (3)	-	-	B	01/04 - 31/10	-	-
Germany	F	D	01/03 - 14/04	B	15/04 - 30/09	D	01/10 - 15/11
Greece	C	-	-	A	16/03 - 30/09	-	-
Hungary	F	-	01/03 – 30/04	A	01/05 – 30/09	-	01/10 – 30/11
Iceland	Arctic 0	-	-	D	16/03 - 15/09	F	16/09 - 31/10
Italy	D	-	-	B	16/03 - 14/11	-	-
Ireland	E	-	-	C	16/03 - 21/10	-	-
Latvia	Arctic 0 - 3	-	-	C	-	-	
Lithuania	Arctic 2	E	01/03 - 30/04	C	01/05 - 30/09	E	01/10 - 30/11
Luxembourg	E	-	-	B	01/03 - 30/11	-	-
Malta	B	-	-	A	01/05 - -30/09	-	-
Netherlands	E	C	01/03 - 30/04	B	01/05 - 30/09	C	01/10 - 30/11
Norway	F & Arctic 2 (4)	F (4)	01/03 - 31/03	D (5)	01/04 - 15/09	F (4)	16/09 - 31/10 (6)
Poland	F	D	01/03 – 15/04	B	16/04 – 30/09	D	01/10 – 15/11
Portugal	D	C	01/03 - 31/03	B	01/04 - 14/10	C	15/10 - 30/11
Slovakia	F	D	01/03 – 15/04	B	16/04 – 30/09	D	01/10 – 15/11
Slovenia	F	D	01/03 – 15/04	B	16/04 – 30/09	D	01/10 – 15/11
Spain	D	-	-	B	01/04 - 30/09	-	-
Sweden	Environmental Class 1 (one quality all year) meets the EN 590 Arctic Class 2 limits, but overall requirements are more severe.						
Sweden North				D	01/05 – 15/09		
Sweden South				D	01/04 – 15/10		
Switzerland	Arctic 0 (7)	-	-	D (8)	01/05 - 30/09	-	-
UK	E	-	-	C (9)	16/03 – 15/11	-	-
Bulgaria	E			A	16/04 – 15/10		
Croatia	E	D	01/03 – 15/04	B	16/04 – 30/09	D	01/10 – 15/11
Turkey	D	-	-	A	01/04 – 30/09	-	-
Romania	E	-	-	A	01/05 – 30/09	-	-

(1) In Denmark the periods refer to “out of depot” dates as “ex-pump” dates are not set in the national annex.

(2) For severe cold areas during the winter season: Arctic 3.
For extreme cold areas during the winter season: Arctic 4.

(3) For extra cold winter conditions, a special “grand froid” grade, Class F, is used.

(4) F or Arctic Class 2, depending on region. Requirements for both grades are more severe than those specified in EN 590:
Norwegian Class F: Cloud point - 15°C (max); CFPP - 24°C (max); Cetane Number 51 (min).
Norwegian Arctic Class 2: Cetane Number 51 (min).

(5) For Norway, CFPP is - 11°C (max) compared with - 10°C (max) for EN 590 Grade D.

(6) In Norway the periods refer to “out of depot” dates as “ex-pump” dates are not set in the national annex.

(7) If used during the summer, minimum density and viscosity must satisfy the summer specification for Class D.

(8) Although Class D is accepted, most suppliers have Arctic Grade 0 available throughout the year.

(9) Deliveries ex refineries and import terminals to commence one month earlier. The date for the change-over from summer to winter grades will be reviewed “in the light of experience”.

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. The EN system is described in more detail in the **Appendix to Part 1**, **Section A.1.2.4**.

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 below.

1.2.5.1. Other European Gasolines

Finland

In Finland an interim reformulated gasoline “City gasoline” was introduced commercially from January 1993, supported with a tax incentive. In April 1994 a reformulated gasoline with 1% benzene was introduced commercially and the specification was updated with effect from 1 April 1999 (see **Part 2**, **Section B.1.2.5**). The specification was further modified in September 2004 (see the following table).

Table 1.20 “Sulphur-free” Reformulated Gasoline (1 September, 2004) - Act 394/2004

Characteristic		Limits	
		Min	Max
Sulphur content	mg/kg		10
Oxygen content	%m/m	2.0	2.7
Vapour Pressure (01/06 – 31/08)	kPa		70
Vapour Pressure (01/09 – 31/05)	kPa		90

This grade enjoys a tax incentive and has a market penetration of practically 100%. Other requirements comply with Directive 2003/17/EC. EN 228 is not required by legislation but is followed voluntarily.

Sweden

During 1993 Sweden developed a classification for gasolines, comprising four different classes. Class 4 was equivalent to CEN standard, and Class 3 to the then current Swedish standard. Specifications for Class 2 gasolines were drawn up and the product was introduced on 1 December 1994, this was later followed by Environmental Class 1. The specifications are optional and use is encouraged by tax relief. The environmental classifications were first amended with effect from 1 January 2000 and amended again with effect from 1 January 2005.

Table 1.21 Swedish Environmental Gasolines - Classifications

Classification	Application
MK1	New specification
MK2a	Catalyst cars
MK2b	Non-catalyst cars, used for super premium with a lead replacement additive
MK2c	Equipment such as chain-saws etc., commonly called Alkylate-gasoline
MK3	EN228

Table 1.22 gives details of the grades in use from 1 January 2000:

Table 1.22 Swedish Environmental Gasolines (wef 1 January 2000)

Property	Units	Classification		
		MK1	MK1 Alkylate Gasoline (1)	MK2
RON (min)	-	95		95
MON (min)	-	85		85
Density (min/max)	kg/m^3	-	680-720	720-775
RVP (S/W) (max)	kPa @ 37.8°C	(2)	65	70/95
RVP (S/W) (min)	kPa @ 37.8°C	(2)	50	45/65
E70 (S/W) (min)	%v/v	(2)	15/42	20/22
E100 (S/W) (min)	%v/v	(2)	46/72	46
E150 (min)	%v/v	(2)	-	75
E180 (min)	%v/v	-	95	
FBP (max)	°C	205	200	210
Olefins (max)	%v/v	13	0.5	18.0
Benzene (max)	%v/v	1.0	0.1	1.0
Aromatics (max)	%v/v	42.0	0.5	42.0
Oxygen (max)	%m/m	2.7		2.7
Sulphur (max)	mg/kg	50	50	150
Lead (max)	mg/l	5.0	2.0	5.0
Tax	SEK/litre	4.47	4.47	4.50

(1) Notwithstanding the tax incentive, this grade is much higher in price than MK1.

(2) The following seasonal controls on vapour pressure and distillation apply to MK1:

Property	Unit	Summer	Transitional	Winter
RVP	kPa @ 37.8°C	45-70	45-95	65-95
VLI (max		1200	1200	1200
E70	%v/v	20-48	20-50	22-50
E100	%v/v	47-71	47-71	50-71
E150 (min)	%v/v	75	75	75
FBP (max)	°C	205	205	205
Residue (max)	%v/v	2	2	2

The seasonal dates vary between the North and South of the country – see below:

	South	North
Summer	01/5-15/9	16/5-31/8
Winter	01/11-15/3	16/10-31/3
Transition	16/9-31/10	1/9-13/10

UK

The UK introduced tax incentives for “Ultra-low sulphur gasoline”. This is based on the outline specification for 2005, published in Directive 98/70/EC, i.e. 35%v/v max. aromatics content and 50 mg/kg max. sulphur content.

1.2.5.2. Other European Diesel Fuels

France

Table 1.23 France – Gazole Grand Froid (NF EN 590, January 2000) (1)

Property	Units		Specification	Test Method
Density @ 15°C (2)	kg/m^3		820 – 845	NF EN ISO 3675 NF EN ISO 12185
Distillation:				pr NF EN ISO 3405:1998
% recovered @ 250°C	%v/v	max	65	
% recovered @ 350°C	%v/v	min	85	
95%v/v recovered	°C	max	380	
Viscosity @ 40°C	mm^2/s		2.0 – 4.5	NF EN ISO 3104
Sulphur content (2)	mg/kg	max	350	NF EN ISO 14596:1998 NF EN ISO 8754:1995 NF EN 24260:1994
Water content (2)	mg/kg	max	200	NF T 60-154 pr EN ISO 12937:1996
Total contamination	mg/kg	max	24	NF EN 12662
Ash content	%m/m	max	0.01	NF EN ISO 6245
Cetane Number		min	51.0	NF EN ISO 5165:1998
Cetane Index		min	46.0	NF EN ISO 4264
Carbon residue (6) (on 10% distillation residue)	%m/m	max	0.30	NF EN ISO 10370
Copper strip corrosion (3 h @ 50°C)	rating		Class 1	NF EN ISO 2160
Oxidation Stability	g/m^3	max	25	NF EN ISO 12205
Flash Point	°C	min	55	NF EN 22719
Lubricity, HFRR method, corrected wear scar diameter (wsd 1,4) @ 60°C (3)	μm	max	460	ISO 12156-1
CFPP	°C	min	20	NF EN 116
Polycyclic aromatic hydrocarbons (4)	%m/m	max	11	IP 391: 1995

(1) Replaces CSR 09 bis – G of 1 November 1999.

(2) In cases of dispute concerning density, sulphur or water content, the following procedures shall be used:

Property	Procedure
density	NF EN ISO 3675
sulphur content	NF EN ISO 14596: 1998
water content	pr EN ISO 12937: 1998

(3) Transfer by pipeline for gas oils containing approved lubricity additives authorised from 1 July 1999.

(4) IP 391 is not able to distinguish between polycyclic aromatic hydrocarbons and fatty acid methyl esters (FAME). FAME, if present in diesel fuels, will give a bias which will increase the value for polycyclic aromatic hydrocarbons. An improved method for the determination of polycyclic aromatic hydrocarbons is under development by CEN/TC 19.

Finland

In Finland a “reformulated” diesel fuel was introduced commercially on 1 July 1993. Compared with the standard specification, its characteristics included a reduced sulphur content and an aromatics limit (see **Part 2**, **Table A.1.51**). This grade was replaced in September 2004 and details will be found in the following table:

Table 1.24 “Sulphur-free” Diesel Fuel (1 September, 2004) - Act 394/2004

Characteristic		Limits	
		Min	Max
Sulphur content	mg/kg		10

This grade enjoys a tax incentive and enjoys a market penetration of practically 100%. Other requirements are as in Directive 2003/17/EC. EN 590 is not required by legislation but is followed voluntarily. Note that the previous limit for a maximum total aromatics content of 20 %v/v to qualify for a tax incentive has been cancelled.

The oil companies’ cold operability criteria are very flexible and are based on seasonal and regional needs:

Table 1.25 Finland Diesel Cold Flow Requirements

Region	Cloud Point (C)	CFPP (C)
Mainland	0	-10
	-5	-15
	-15	-25
	-29	-34
Lapland	-40	-44

Table 1.26 Non-road Diesel Fuel (1 January 1, 2005) - Regulation 767/2003

Characteristic		Limits	
		Min	Max
Sulphur content	mg/kg		50

This grade is taxed as light heating fuel oil. Red colour and solvent yellow "euro marker" are mandatory under tax legislation allowed for heating, agricultural, non-road mobile machinery, and marine. However this is only a definition for "non-road diesel fuel", the use of it is not mandatory. Currently, the predominant grade is based on road diesel fuel by adding colour and marker at supply terminals.

Sweden

In Sweden two “Environmental Classifications”, EC1 and EC2, were introduced on 1 January 1991 for diesel fuels specifying compositional constraints and sulphur contents of 10 and 50 mg/kg respectively. The EC2 grade was discontinued in 1996. The EC1 grade is supported by a tax incentive and its market penetration is almost 100%.

Table 1.27 Sweden EC1 Diesel Fuel Specification

Characteristic	Limit
Cetane No. (Index) (min)	51 (50)
Cloud Point °C, S (W) (max)	0 (-16)
CFPP °C, S (W) max	-10 (-26)
Density @ 15°C kg/m^3	800 - 820
Viscosity @40°C mm^2/s	1.2 – 4.0
IBP°C (max)	180
T95E°C (max)	285
Sulphur mg/kg (max)	10
Aromatics %v/v (max)	5
PAH %v/v (max)	Not detectable

UK

In the UK, a city diesel was specified by the Department of Transport, Environment and the Regions in 1997 (now the Department for Transport) and this specification was subsequently amended in 1998. The grade is defined in HM Customs and Excise Tariff Notice No. 6/98 (issued in March 1998) as "Ultra Low Sulphur Diesel" or "ULSD".

ULSD must meet EN 590, plus the following requirements:

Sulphur: 50 mg/kg (max)
Density: 820 - 835 kg/m^3 at 15°C.
T95: 345°C (max)

ULSD benefits from a tax incentive and all diesel fuel in the UK now meets ULSD requirements. The UK differential taxation scheme was approved by Council Decision 2000/434/EC of 29 June 2000, [published in the Official Journal L172, p. 23 on 12 July 2000].

1.2.6. Alternative Fuels

1.2.6.1. European Standard LPG Specification

The European Union has adopted the CEN LPG Specification EN 589:2004 (see **Table 1.28**), which was approved by CEN on 24 December 2003. This specification supersedes EN 589:2000. For the minimum vapour pressure, five grades, A, B, C, D and E are given to allow for seasonal limits to be set nationally for each period of the year. In a national annex to this European Standard, each country shall indicate which grade(s) it adopts to achieve a minimum vapour pressure of 150 kPa (gauge) throughout the entire year and shall detail the date range in which the selected grade applies.

Table 1.28 CEN Automotive LPG Specification EN 589:2004

Property	Units	Specification Limits		Test Method [1]
		Min	Max	
MON		89.0		Annex B, EN 589
Total dienes content	% mole/mole		0.5	EN 27941
Hydrogen sulphide		Negative		ISO 8819
Total Sulphur content (after stenching) [2]	mg/kg		100	EN 24260 ASTM D 3246 ASTM D 6667
Copper strip corrosion 1h at 40ºC	rating	Class 1		EN ISO 6251
Evaporative residue	mg/kg		100	EN ISO 13757
Vapour pressure, gauge at 10°C [3]	kPa		1550	EN ISO 4256 EN ISO 8973 and Annex C, EN 589
Vapour pressure, gauge, min 150 kPa at a temperature of [4, 5]				
- for Grade A	°C		- 10	EN ISO 8973 and Annex C, EN 589
- for Grade B	°C		- 5	
- for Grade C	°C		0	
- for Grade D	°C		+ 10	
- for Grade E	°C		+ 20	
Water content		No free water at 0° C		Visual inspection
Methanol content [7]	mg/kg		2000	ISO 8174
Odour		Unpleasant and distinctive at 20% LEL		Annex A, EN 589

(1) All the test methods include a precision statement. In cases of dispute the procedures described in EN ISO 4259 shall be used.

(2) In cases of dispute concerning the total sulphur content, ASTM D 6667 shall be used.

(3) In cases of dispute, EN ISO 4256 shall be used.

(4) For the purpose of this standard EN ISO 8973 together with Annex C, EN 589 shall be applied at the indicated temperatures. For internal routine quality control purposes the values as given in the informative Annex D, EN 589 may also be used.

(5) For the purpose of this standard EN ISO 8973 together with Annex 3, EN 589 shall be applied at the indicated temperatures. For routine quality control, the values given in Informative Annex D, EN 589 may be used.

(6) For the minimum vapour pressure, five grades, A, B, C, D and E are given to allow for seasonal limits to be set nationally for each period of the year. In a national annex to this European Standard, each

country shall indicate which grade(s) it adopts to achieve a minimum vapour pressure of 150 kPa (gauge) throughout the entire year and shall detail the date range in which the selected grade applies. The following seasonal grades were selected for the previous version of this standard:

Country	Grade	Season	Country	Grade	Season
Belgium	C	01/12 - 31/03	Netherlands	A	01/01 - 29/02
Denmark	A	01/09 - 31/03	Netherlands	B	01/12 - 31/12
Finland	A	01/09 - 31/05	Netherlands	B	01/03 - 31/03
France	A	01/11 - 15/03	Norway	A	All year
Germany	B	01/12 - 31/03	Spain	B	01/11 - 31/03
Italy	C	15/11 - 15/03	Sweden	A	01/10 - 14/04
			UK	A	01/09 - 31/03

No summer minimum vapour pressure is specified.

7) For operational purposes the addition of up to 2 000 mg/kg methanol is allowed. No other antifreeze agents shall be added.

1.2.6.2. Automotive fuels — Ethanol as a blending component for gasoline - (Draft Specification: pr EN 15376)

Introduction

CEN/TC 19 issued their first draft for requirements and test methods in August 2005. This document gives all relevant characteristics, requirements and test methods for (bio)ethanol, which are currently known to be necessary when defining the product up to a maximum of 5%(v/v) in gasoline. If the percentage or use is expanded the requirements need to be restudied. Biological characterization is under investigation, and suitable limits and test methods may be incorporated into an amended version of this standard upon successful conclusion of this investigation, or an alternative, administrative method may be regulated.

Many of the test methods included in this document are the subject of inter-laboratory testing to determine the applicability of the method and its precision in relation to different sources of ethanol. Some precision statements are as yet unknown and identified test methods and limits may change.

Denaturing

Where denaturing of the automotive ethanol is required, the only denaturants permitted are:

- Automotive gasoline conforming to EN 228,
- Ethyl tert butyl ether (ETBE),
- Methyl tert butyl ether (MTBE),
- Tertiary Butyl Alcohol (TBA),
- Isobutanol, and
- Isopropanol.

Any or all of these denaturants may be used alone or together, except isobutanol and isopropanol which are easily removed. It is therefore advisable to use them in combination with another denaturant. The concentration of denaturant(s) is to be decided by national authorities and shall meet requirements of EN 228.

Table 1.29 Ethanol – Draft EN Standard for generally applicable requirements and test methods (pr EN 15376)

Property	Unit	Limits		Test method (1)
		min	max	
Ethanol content + higher saturated alcohols	% (m/m)	98.7		EC/2870/2000 - Appendix 2, method B
Higher saturated (C_3 - C_5) mono-alcohols content (2)	% (m/m)		2.0	EC/2870/2000 - method III, or EN 13132 or EN 1601
Methanol content	% (m/m)		1.0	EC/2870/2000 - method III, or EN 13132, or EN 1601
Water content	% (m/m)		0.3	WI 00019307 (3)
Inorganic chloride content	mg/l		20	WI 00019298 (4)
Copper content	mg/kg		0.1	WI 00019306 (5)
Total acidity (expressed as acetic acid) (6)	% (m/m)		0.007	WI 00019309
pHe		6.5	9.0	WI 00019308
Appearance		Clear and bright		Visual inspection
Phosphorus	mg/l		0.5	WI 00019305 (7)
Involatile material	mg/100ml		10	EC/2870/2000 – method II
Sulphur	mg/kg		10.0	WI 00019301, or WI 00019303 (8)

(1) When tested by the methods indicated above, ethanol shall be in accordance with these limits. The test methods listed have been shown to be applicable to ethanol in an inter-laboratory test programme. However, precision data from this programme have been found to be different from the precision data given in the test methods for petroleum products.

(2) Problems occur in measuring higher alcohols when gasoline is used as a denaturant.

(3) A cross check validation may show that a Karl Fischer volumetric method is also applicable, but in cases of dispute the indicated method shall be used.

(4) WI 00019298 is an adaptation of ISO 6227.

(5) WI 00019306 is an adaptation of IP 478.

(6) To adequately limit the acidity of the gasoline, the acidity of fuel ethanol used as a blend stock is limited.

(7) WI 00019305 is an adaptation of EN ISO 6878.

(8) WI 00019301 is an adaptation of EN ISO 20846 and WI 00019303 is an adaptation of EN ISO 20884.

- In case of a need for identification of the biological origin of ethanol, a traceable record of biological origin is the recommended method. An alternative is age determination, which is based on the beta(minus) decay of the radioactive carbon isotope C-14. This method is under study.
- Given the known potential for ethanol to absorb water, suppliers shall ensure that no water segregation occurs under the range of climatic and fuel distribution conditions experienced in the country concerned.
- All test methods referred to in this European Standard include a precision statement according to EN ISO 4259. In cases of dispute, the procedures described in EN ISO 4259 shall be used for resolving the dispute, and interpretation of the results based on the test method precision shall be used.

1.2.6.3. CEN Fatty Acid Methyl Ester (Biodiesel) Standard

Table 1.30 EN Specification for Fatty Acid Methyl Ester (FAME) Diesel Fuel (EN 14214:2001)

Property	Units	Limits		Test Method
		Min.	Max.	
Methyl ester content	%m/m	96.5		prEN 14103 (1)
Density @ 15ºC	kg/m^3	860	900	UNI EN ISO 3675 UNI EN ISO 12185
Viscosity at 40ºC (2)	mm^2/s	3.5	5.0	UNI EN ISO 3104
Flash point	ºC	120		ISO/CD 3679 (3)
Sulphur content	mg/kg		10	ASTM D1552/ISO 8754
Carbon Residue, Conradson (CCR) (4)	%m/m		0.3	UNI EN ISO 10370
Cetane Number		51.0		EN ISO 5165
Sulphated ash content	%m/m		0.02	ISO 3987
Water content	mg/kg		500	prEN ISO 12937:1999
Total contamination (5)	mg/kg		24	EN 12662
Copper strip corrosion	3 h. at 50°C		Class 1	UNI EN ISO 2160
Thermal stability (6)				
Oxidation stability at 110°C	hours	6		prEN 14112 (7)
Acid value	mg/KOH/g		0.50	prEN 14104
Iodine value	g I_2/100g		120	prEN 14111
Linolenic acid methyl ester	%m/m		12.0	prEN 14103 (1)
Polyunsaturated (≥4 double bonds) methyl esters (8)	%m/m		1	
Methanol content	%m/m		0.2	prEN 14110 (8)
Monoglycerides	%m/m		0.8	prEN 14105 (10)
Diglycerides	%m/m		0.2	prEN 14105 (10)
Triglycerides	%m/m		0.2	prEN 14105 (10)
Free glycerine	%m/m		0.02	prEN 14105 (10) prEN 14106
Total glycerine content	%m/m		0.25	prEN 14105 (10)
Alkali metals (Na + K) content	mg/kg		5	prEN 14108 (Na) prEN 14109 (K) (11)
Phosphorus content	mg/kg		10.0	prEN 14107 (12)

(1) See CEN/TC 307, publication of NF T 60-703:1997

(2) For CFPP of -20°C or lower, the viscosity measured at 20°C must not exceed 48 mm^2/s. In this case, EN ISO 3104 is applicable without the precision data.

(3) Apparatus with a thermal detection device shall be used.

(4) ASTM D 1160 shall be used to obtain the 10% distillation residue.

(5) Extension of this limit to cover additional elements, e.g. Ca and Mg to be considered.

(6) Suitable test method and limit to be proposed by CEN/TC19.

(7) CEN/TC 307 publication of ISO 6886 modified.

(8) Suitable test method to be proposed by CEN/TC 307.

(9) CEN/TC 307 publication of NF T 60-701 (procedure A) and DIN 51608 (procedure B).

(10) See CEN/TC 307, publication of NF T 60-704:1997

(11) Extension of this limit to cover additional elements, e.g. Ca and Mg to be considered.

(12) See CEN/TC 307, publication of NF T 60-705:1997

Table 1.31 EN Specification for FAME Diesel Fuel - Climate Dependent Requirements

Property	Unit	Proposed Limits Temperate Climate Grades						Test Method
		A	B	C	D	E	F	
CFPP	°C, max	+ 5	0	- 5	- 10	- 15	- 20	EN116

Property	Unit	Proposed Limits Arctic Climate Classes					Test Method
		0	1	2	3	4	
CFPP	°C, max	- 20	- 26	- 32	- 38	- 44	EN116

See the **Appendix to Part 1**, **Sections A.1.2.6** for further background information and details of national specifications.

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

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. Additional information will be found in the **Part 1 Appendix**, **Section A.1.2.6**.

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.

Table 1.32 Biofuel National Indicative Targets

Target Reference Value (%) (1)	Date
2	31 December 2005
5.75	31 December 2010

(1) Calculated on the basis of energy content, of all gasoline and diesel fuel for transport purposes placed on the market.

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. 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.

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 Council on the progress made in the use of biofuels and other renewable fuels in the Member States. On the basis of this report, the Commission shall submit, where appropriate, proposals 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

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. The CEN should establish appropriate standards for other transport biofuel products in the European Union.

1.2.6.5. Water/Diesel Emulsions - France and Italy

Specification details will be found in the **Appendix to Part 1**, **Section A.1.2.6**.

1.2.7. Fuels Legislation - Future EU Review

EU Directive 2003/17/EC also requires the EU Commission to review various provisions of the Directives no later than 31 December 2005. These review items are summarised below:

Table 1.33 Fuels - Post 2005 Legislative Considerations

Subject	Post 2005 Considerations
Gasoline and Diesel Fuel Specifications	By 31 December 2005 at the latest(1) the Commission shall review the fuel specifications of Annex III and IV with the exception of sulphur content and propose amendments, if appropriate, in keeping with current and future requirements of Community vehicle emission and air quality legislation and related objectives. In particular, the Commission shall consider: The necessity of any change to the end date for the full introduction of diesel fuel, with a maximum sulphur content of 10 mg/kg, in order to ensure that there is no overall increase in greenhouse gas emissions. This analysis shall consider developments in refinery processing technologies, expected fuel economy improvements of vehicles and the rate at which new fuel-efficient technologies are introduced into the vehicle fleet. The implications of new Community legislation setting air quality standards for substances such as polycyclic aromatic hydrocarbons. The outcome of the review of limit values for SO_2, NO_2 and NOx, PM and Pb in ambient air The outcome of the review of measures to be taken against the emission of gaseous and particulate pollutants from automotive CI engines, and the emission of gaseous pollutants from automotive SI engines fuelled with natural gas or LPG, plus confirmation of the mandatory NOx emission standard for HD engines. The effective functioning of new pollution abatement technologies and the impact of metallic additives and other relevant issues on their performance, plus developments affecting international fuel markets. The need to encourage the introduction of alternative fuels, including biofuels, as well as the need to introduce modifications to other parameters in the fuel specifications, both for conventional and alternative fuels.
The next stage of Emission Standards for Non-Road CI Engines	The establishment of required fuel quality. The Commission shall take into account the importance of emissions from this sector, the overall environmental and health benefits, the implications in the Member States regarding fuel distribution, plus the costs and benefits of a more restrictive sulphur level. The Commission shall then align appropriate fuel quality requirements for non-road applications with the on-road sector by a certain date, currently expected to be 1 January 2009, to be confirmed or amended by the Commission in its review in 2005.(1)
Captive Fleets	Proposals setting levels of specifications for any special fuels they use.
LPG, natural gas and biofuels	Proposals setting levels of specifications.

(1) Postponed; the review is now expected to be published in late 2006.

1.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

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. Thereafter modified or new cycles have been employed and these are briefly described below. Details are given in the **Appendix to Part 1**, **Section A.1.3**.

1.3.2. Light Duty Testing

The ECE15+EUDC cycle was modified by EU Directive 98/69/EC to eliminate the initial 40 s "idle stabilisation" period. 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. A cold temperature (-7ºC) emissions test was incorporated in EU Directive 98/69/EC.

A new evaporative emissions test was introduced in 2000. Details will be found in the **Appendix to Part 1**, **Section A.1.3.6**.

The light duty emissions tests employed in the EU are summarised in **Table 1.34**, below:

Table 1.34 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. Details will be found in the **Appendix to Part 1**. **Section A.1.3.2**.

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. Details will be found in the **Appendix to Part 1**, **Section A.1.3.2**.

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. The characteristics of these tests are described more fully in the **Appendix to Part 1**, **Section A.1.3.3**.

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.

1.3.5. Illustration of Current European Test Cycles

Figures will be found in the **Appendix to Part 1**, **Section A.1.3.5**.

1.4. REFERENCE FUELS

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.

The following sections tabulate current EU reference fuels. Details of superseded grades will be found in **Part 2**. **Section B.1.4**.

1.4.2. Reference Gasoline, Directive 2002/80/EC - Type I Emissions Certification Test (Euro 4 Limits)

Characteristics		Limits (1)		Test Method
		Min	Max	
Research octane number		95.0	-	EN 25164
Motor octane number		85.0	-	EN 25163
Density 15°C	kg/m^3	740	754	ISO 3675
Vapour pressure	kPa	56.0	60.0	prEN ISO 13016-1 (DVPE)
Distillation:				
Evaporated @ 70ºC	%v/v	24.0	40.0	EN-ISO 3405
Evaporated @ 100°C	%v/v	50.0	58.0	
Evaporated @ 150°C	%v/v	83.0	89.0	
FBP	°C	190	210	
Residue	%v/v.	-	2	
Hydrocarbon analysis:				
Olefins	%v/v	-	10	ASTM D 1319
Aromatics	%v/v	29.0	35.0	ASTM D 1319
Benzene	%v/v	-	1.0	pr. EN 12177
Saturates	%v/v	report	report	ASTM D 1319
Carbon/Hydrogen ratio		report	report	
Induction period (2)	minutes	480	-	EN-ISO 7536
Oxygen content	%m/m	-	1.0	EN 1601
Existent gum	mg/ml	-	0.04	EN-ISO 6246
Sulphur content (3)	mg/kg	-	10	pr. EN-ISO/DIS 14596
Copper corrosion @ 50°C		-	Class 1	EN-ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D3231

(1) The values quoted in the specification are “true values”. In establishment of their limit values the terms of ISO 4259, “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (where R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the fuel manufacturer should nevertheless aim at a zero value where the stipulated maximum value is 2R and the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersant additives and solvent oils must not be used.

(3) The actual sulphur content of the fuel used for the Type I test shall be reported.

1.4.3. Reference Gasoline, Directive 2002/80/EC - Type VI Low Temperature Emissions Certification Test

Property	Units	Limits (1)		Test Method
		Min	Max	
Research octane number		95.0	-	EN 25164
Motor octane number		85.0	-	EN 25163
Density 15°C	kg/m^3	740	754	ISO 3675
Vapour pressure	kPa	56.0	95.0	prEN ISO 13016-1 (DVPE)
Distillation:				
Evaporated @ 70ºC	%v/v	24.0	40.0	EN-ISO 3405
Evaporated @ 100°C	%v/v	50.0	58.0	
Evaporated @ 150°C	%v/v	83.0	89.0	
FBP	°C	190	210	
Residue	%v/v.	-	2	
Hydrocarbon analysis:				
Olefins	%v/v	-	10	ASTM D 1319
Aromatics	%v/v	29.0	35.0	ASTM D 1319
Benzene	%v/v	-	1.0	pr. EN 12177
Saturates	%v/v	report	report	ASTM D 1319
Carbon/Hydrogen ratio		report	report	
Induction period (2)	minutes	480	-	EN-ISO 7536
Oxygen content	%m/m	-	1.0	EN 1601
Existent gum	mg/ml	-	0.04	EN-ISO 6246
Sulphur content (3)	mg/kg	-	10	pr. EN-ISO/DIS 14596
Copper corrosion @ 50°C		-	Class 1	EN-ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D3231

(1) The values quoted in the specification are “true values”. In establishment of their limit values the terms of ISO 4259, “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (where R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the fuel manufacturer should nevertheless aim at a zero value where the stipulated maximum value is 2R and the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersant additives and solvent oils must not be used.

(3) The actual sulphur content of the fuel used for the Type VI test shall be reported.

1.4.4. Reference Diesel Fuel, Directive 2002/80/EC - Type I Emissions Certification Test (Euro 4 Limits)

Property	Units	Limits (1)		Test Method
		Min.	Max.	
Cetane number (2)		52.0	54.0	EN-ISO 5165
Density at 15°C	kg/m^3	833	837	EN-ISO 3675
Distillation				EN-ISO 3405
50%v/v point	°C	245	-	
95%v/v point	°C	345	350	
FBP	°C		370	
Flash point	°C	55	-	EN 22719
CFPP	°C	-	-5	EN 116
Viscosity at 40°C	mm^2/s	2.3	3.3	EN-ISO 3104
Polycyclic Aromatic Hydrocarbons	%m/m	3.0	6.0	IP 391
Sulphur content (3)	mg/kg	-	10	ASTM D 5453
Copper corrosion		-	Class 1	EN-ISO 2160
Conradson Carbon Residue on 10% Dist. Residue	%m/m	-	0.2	EN-ISO 10370
Ash content	%m/m	-	0.01	EN-ISO 6245
Water content	%m/m	-	0.02	EN-ISO 12937
Neutralisation (strong acid) number	mg KOH/g	-	0.02	ASTM D974
Oxidation stability (4)	mg/ml	-	0.025	EN-ISO 12205
Lubricity (HFRR wear scar diameter at 60ºC)	µm	-	400	CEC F-06-A-96
FAME	Prohibited			

(1) The values quoted in the specification are “true values”. In establishment of their limit values the terms of ISO 4259, “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (where R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the fuel manufacturer should nevertheless aim at a zero value where the stipulated maximum value is 2R and the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The range for cetane number is not in accordance with the 4R requirement. However, in the case of a dispute with a fuel supplier, the terms of ISO 4259 may be used - provided replicate measurements of sufficient number to archive the necessary precision are made in preference to a single determination.

(3) The actual sulphur content of the fuel used for the Type I test shall be reported.

(4) Even though the oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

1.4.5. Reference LPG, Directive 2002/80/EC - Type I Emissions Certification Test (Euro 3 and Euro 4 Limits)

Property	Unit	Fuel A	Fuel B	Test Method
Composition				
C_3 content		30 ± 2	85 ± 2	
C_4 content	%v/v	balance	balance	ISO 7941
< C_3, > C_4		2 (max)	2 (max)	
Olefin content		12 (max)	15 (max)	
Evaporation residue	mg/kg	50 (max)	50 (max)	ISO 13757
Water at 0°C		free	free	Visual inspection
Total sulphur content	mg/kg	50 (max)	50 (max)	EN 24260
Hydrogen sulphide	-	none	none	ISO 8819
Copper strip corrosion	rating	class 1	class 1	ISO 6251 (1)
Odour		characteristic		
Motor octane number		89 (min)	89 (min)	EN 589 Annex B

(1) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

1.4.6. Reference Natural Gas, Directive 2002/80/EC - Type I Emissions Certification Test (Euro 3 and Euro 4 Limits)

Property	Unit	Basis	Limits		Test Method
			Min.	Max.	
Reference Fuel G_{20}					
Composition					
Methane	% mole	100	99	100	ISO 6794
Balance (1)		-	-	1	
N_2					
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326-5
Wobbe index (net)	MJ/m^3 (3)	48.2	47.2	49.2	
Reference Fuel G_{20}					
Composition					
Methane	% mole	86	84	88	ISO 6794
Balance (1)		-	-	1	
N_2		14	12	16	
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326-5
Wobbe index (net)	MJ/m^3 (3)	39.4	38.2	40.6	

(1) Inerts (different from N_2) + C_2 + C_{2+}.

(2) Value to be determined at 293.2 K (20ºC) and 101.3 kPa.

(3) Value to be determined at 273.2 K (0ºC) and 101.3 kPa.

1.4.7. Heavy Duty Reference Diesel Fuel - Directive 1999/96/EC

Property [1]	Units	Limits [2]		Test	
		Min.	Max.	Method	Date
Cetane number [3]		52	54	EN-ISO 5165	1998
Density at 15°C	kg/m^3	833	837	EN-ISO 3675	1995
Distillation				EN-ISO 3405	1988
50%v/v point	°C	245	-		
95%v/v point	°C	345	350		
FBP	°C		370		
Flash point	°C	55	-	EN 22719	1993
CFPP	°C	-	-5	EN 116	1981
Viscosity at 40°C	mm^2/s	2.5	3.5	EN-ISO 3104	1996
Polycyclic aromatic hydrocarbons	%m/m	3.0	6.0	IP 391 (*)	1995
Sulphur content [4]	mg/kg	-	300	pr. EN-ISO/ DIS 14596	1998
Copper corrosion		-	1	EN-ISO 2160	1995
Conradson carbon residue on 10% Dist. Residue	%m/m	-	0.2	EN-ISO 10370	1995
Ash content	%m/m	-	0.01	EN-ISO 6245	1995
Water content	%m/m	-	0.05	EN-ISO 12937	1998
Neutralisation (strong acid) number	mg KOH/g	-	0.02	ASTM D974-95	1998
Oxidation stability [5]	mg/ml	-	0.025	EN-ISO 12205	1996
(*) New and better method for polycyclic aromatics under development	%m/m	-	-	EN 12916	

(1) If it is required to calculate the thermal efficiency of an engine or vehicle, the calorific value of the fuel can be calculated from:
Specific energy (calorific value) (net) in MJ/kg =
$(46.423 - 8.792d^2 + 3.170d)(1 - (x + y + s)) + 9.420s - 2.499x$
where,
d = the density @ 15ºC
x = the proportion by mass by water (% divided by 100)
y = the proportion by mass of ash (% divided by 100)
s = the proportion by mass of sulphur (% divided by 100)

(2) The values quoted in the specification are “true values”. In establishment of their limit values the terms of ISO 4259, “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (where R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the fuel manufacturer should nevertheless aim at a zero value where the stipulated maximum value is 2R and the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(3) The range for cetane number is not in accordance with the 4R requirement. However, in the case of a dispute with a fuel supplier, the terms of ISO 4259 may be used - provided replicate measurements of sufficient number to archive the necessary precision are made in preference to a single determination.

(4) The actual sulphur content of the fuel used for the test shall be reported. In addition, the sulphur content of the reference fuel used to approve a vehicle against the limit values set out in Row B of the Directive (see **Section 1.1.1**) shall have a max. sulphur content of 50mg/kg. The EU Commission will, by 31/12/99, forward a modification to this specification reflecting the market average sulphur content.

(5) Even though the oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

1.4.8. Non-Road Mobile Machinery Reference Diesel Fuel - Stages IIIA, IIIB and IV Type Approval

Parameter	Unit	Limits (1)				Test Method
		III A Approval		III B & IV Approval		
		Min	Max	Min	Max	
Cetane number (2)	-	52.0	54.0	-	54.0	EN-ISO 5165
Density at 15°C	kg/m^3	833	837	833	837	EN-ISO 3675
Distillation:						
50% point	°C	245	-	245	-	EN-ISO 3405
95% point	°C	345	350	345	350	
FBP	°C	-	370	-	370	
Flash point	°C	55	-	55	-	EN 22719
CFPP	°C	-	- 5	-	- 5	EN 116
Viscosity @ 40°C	mm^2/s	2.5	3.5	2.3	3.3	EN-ISO 3104
Polycyclic aromatic hydrocarbons	%m/m	3.0	6.0	3.0	6.0	IP 391
Sulphur content (3)	mg/kg	-	300	-	10	ASTM D 5453
Copper corrosion	-	-	class 1	-	class 1	EN-ISO 2160
Conradson carbon residue (10% dist. residue)	%m/m	-	0.2	-	0.2	EN-ISO 10370
Ash content	%m/m	-	0.01	-	0.01	EN-ISO 6245
Water content	%m/m	-	0.05	-	0.02	EN-ISO 12937
Neutralization (strong acid) number	mg KOH/g	-	0.02	-	0.02	ASTM D 974
Oxidation stability (4)	mg/ml	-	0.025	-	0.025	EN-ISO 12205
Lubricity (HFRR wear scar diameter at 60°C)	µm	-	-	-	400	CEC F-06-A-96
FAME		-	-	Prohibited		

(1) The values quoted in the specifications are “true values”. In establishment of their limit values the terms of ISO 4259 “Petroleum products - Determination and application of precision data in relation to methods of test” have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the questions as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

(3) The actual sulphur content of the fuel used for the Type I test shall be reported.

(4) Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

1.4.9. Heavy Duty Engine Reference Fuels: Gases and Ethanol (Directive 2001/27/EC)

The following reference natural gases, LPGs and ethanol for diesel engines were stipulated in EU Directive 2001/27/EC. The gaseous fuels are specified with varying compositions to reflect the European market**.**

1.4.9.1. Natural Gas

European market fuel are available in two ranges:

- The H range, whose two extreme reference fuels are G_R and G_{23}
- The L range, whose two extreme reference fuels are G_{23} and G_{25}

The characteristics of these fuels are summarised below:

Reference Fuel G_R					
Property	**Units**	**Basis**	**Limits**		**Test Method**
			Min	**Max**	
Composition:					
Methane		87.0	84.0	89.0	
Ethane	% mole	13.0	11.0	15.0	ISO 6794
Balance		-	-	1.0	
[Inerts + C_{2+}]					
Sulphur content	mg/m^3 (1)			10	ISO 6326-5
Reference Fuel G_{23}					
Property	**Units**	**Basis**	**Limits**		**Test Method**
			Min	**Max**	
Composition:					
Methane	% mole	92.5	91.5	93.5	ISO 6794
Balance		-	-	1.0	
N_2		7.5	6.5	8.5	
Sulphur content	mg/m^3 (1)			10	ISO 6326-5
Reference Fuel G_{25}					
Property	**Units**	**Basis**	**Limits**		**Test Method**
			Min	**Max**	
Composition:					
Methane	% mole	86.0	84.0	88.0	ISO 6794
Balance		-	-	1.0	
N_2		14.0	12.0	16.0	
Sulphur content	mg/m^3 (1)			10	ISO 6326-5

(1) Value to be determined at standard conditions (293,2 K (20°C) and 101,3 kPa).

1.4.9.2. LPG

Property	Unit	Limits Fuel A		Limits Fuel B		Test Method
		Minimum	Maximum	Minimum	Maximum	
Motor octane number		92.5 (1)		92.5		EN 589 Annex B
Composition						
C_3 content	%v/v	48	52	83	87	ISO 7941
C_4 content		48	52	13	17	
Olefin content		0	12	0	14	
Evaporation residue	mg/kg		50		50	NFM 41-015
Total sulphur content	mg/kg (1)		50		50	EN 24260
Hydrogen sulphide	-		None		None	ISO 8819
Copper strip corrosion	rating		Class 1		Class 1	ISO 6251 (2)
Water @ 0°C			Free		Free	Visual inspection

(1) Value to be determined at standard conditions 293,2 K (20°C) and 101,3 kPa.

(2) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

1.4.9.3. Ethanol for Diesel Engines (1)

Parameter	Units	Limit (2)		Test Method (3)
		Min	Max	
Alcohol, mass	%m/m	92.4	-	ASTM D 5501
Alcohol other than ethanol contained in total alcohol, mass	%m/m	-	2.0	ASTM D 5501
Density at 15°C	kg/m^3	795	815	ASTM D 4052
Ash content	%m/m	-	0.001	ISO 6245
Flash point	°C	10		ISO 2719
Acidity, calculated as acetic acid	%m/m	-	0.0025	ISO 1388-2
Neutralization (strong acid) number	KOH mg/l	-	1.0	
Colour	According to scale	-	10	ASTM D 1209
Dry residue at 100 °C	mg/kg		15	ISO 759
Water content	%m/m	-	6.5	ISO 760
Aldehydes calculated as acetic acid	%m/m	-	0.0025	ISO 1388-4
Sulphur content	mg/kg	-	10	ASTM D 5453
Esters, calculated as ethyl-acetate	%m/m	-	0.1	ASTM D 1617

(1) Cetane improver, as specified by the engine manufacturer, may be added to the ethanol fuel. The maximum allowed amount is 10%m/m.

(2) The values quoted in the specification are “true values”. In establishment of their limit values the terms of ISO 4259, Petroleum products - Determination and application of precision data in relation to methods of test, have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account in fixing a maximum and minimum value, the minimum difference is 4R (R - reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of a fuel should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specification, the terms of ISO 4259 should be applied.

(3) Equivalent ISO methods will be adopted when issued for all properties listed above.

1.4.9.4. Heavy Duty Type Approval with Gaseous Reference Fuels (Directive 2001/27/EC)

These procedures are detailed in **Part 2**, **Section B.1.4.7**.

1.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

1.5.1. Passenger Cars

There are currently no legal 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 received even greater emphasis after the Kyoto Protocol was signed in December 1997.

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 could 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 also proposed legislation for a monitoring system on the average CO_2 emissions from cars. This was published as the Decision of EP and Council 1753/2000/EC of 22/06/00. Item (1), above, was the subject of discussions between the EU Commission, ACEA and importers which resulted in a series of commitments:

- No later than 2000, some manufacturers introduced models emitting 120 g CO_2/km or less.
- A target fleet average for new car sales of 140 g CO_2/km is to be achieved by 2008. According to ACEA, this represents an average CO_2 reduction of 25%, compared to 1995.
- In 2003, ACEA were to review the potential for achieving the Community's goal of 120 g CO_2/km by 2012.
- For 2003, ACEA considered 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 was 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. Starting at 185 g/km in 1995, the average ACEA sales fleet achieved 163 g/km in 2003. The year-to-year improvement for both gasoline and diesel vehicles was steady during the first 5-6 years and on track to reach the 2008 140 g/km target. The rate of reduction has, however, been much lower since 2001. Data for 2004 and 2005 have

not been published as yet. Reaching the 2008 target will require sustained average yearly improvements of 4 to 5 g/km i.e. more than was achieved in the early years.

Background to this agreement is recorded in the **Appendix to Part 1**, **Section A.1.5**.

1.5.2. Other European Legislation

Details will be found in the **Appendix to Part 1**, **Section A.1.5**.

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

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. The following paragraphs outline this legislation, which does not apply to vehicles manufactured prior to 1 January 1970.

Spark Ignition Engined Vehicles

The test procedure consists of two elements:

(i) A visual inspection to ensure that:
- There are no leaks from the exhaust system.
- If applicable, any emissions control system is present.

(ii) An idle CO test, details as follows:

No load idle test, carried out after the manufacturer's recommended engine pre-conditioning period. The limit values are shown in **Table 1.35**. An additional "increased idle speed" test is required for vehicles fitted with 3-way catalysts and lambda control.

Table 1.35 EU In-Service Emission Limit Values - Gasoline Vehicles

Vehicle Description	Idle CO (%v/v)
All models not fitted with 3-way catalysts and lambda control	Initial type approval limit or 0.5 max.
Where these data are not available or Member States decide not to use these reference values, the following limits will apply:	
Manufactured before October 1986 (1) Manufactured after October 1986	4.5 3.5
All models fitted with 3-way catalyst and lambda control (2)	Either initial type approval limit or 0.5 max.

(1) Or the date on which Member States required the vehicles on first registration to comply with the Type Approval Directive 70/220/EEC, as amended.

(2) An additional no load test is to be conducted at a minimum idle speed of 2000 rpm. The following limit values apply:
CO : 0.3%v/v maximum.
Lambda : 1 ± 0.03, or in accordance with the manufacturer's specifications.

Diesel Vehicles

The test procedure consists of a free acceleration smoke test. That is, the engine is accelerated with the transmission in neutral (no load) from idle up to maximum (governor cut-off) speed and the smoke opacity is measured. The following maximum coefficient of light absorption is allowed:

Either Initial type approval limit plus a tolerance of 0.5 m^{-1}

Or Where these data are not available or Member States decide not to use these reference values, the following alternative maxima will apply:

Naturally aspirated diesel engines: 2.5 m^{-1}

Turbo-charged diesel engines: 3.0 m^{-1}

Frequency of Testing

Table 1.33 summarises the ages of vehicles at which testing should commence and the frequency of that testing.

Table 1.36 EU Frequency of In-Service Emissions Testing

Vehicle Description	Age (Years)	Test Frequency (Years)
Spark ignition engined passenger cars	3	1
Heavy commercial vehicles, taxis and ambulances	1	1
Commercial diesel vehicles (less than 3.5 t)	4	2

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**.

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.

1.6.2. Control of Compliance of Vehicles in Service

EU Directive 98/69/EC introduced revised criteria for in-service conformity checks. The details of in-service checks are summarised in the **Appendix to Part 1**, **Section A.1.6**.

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

System Requirements

The OBD system must indicate the failure of an emissions related component or system when that failure results in an increase in emissions above the limits given in **Table 1.37**.

Table 1.37 OBD Limit Values Indicating Emissions Control System Failure

Category	Class	Reference Mass RW (kg)	Limit Values (g/km)						
			CO		HC		NOx		PM (1)
			SI	CI	SI	CI	SI	CI	CI
M (2)	-	All	3.2	3.2	0.4	0.4	0.6	1.2	0.18
N_1 (3)	I	RW ≤1250	3.2	3.2	0.4	0.4	0.6	1.2	0.18
	II	1250 <RW ≤1700	5.8	4.0	0.5	0.5	0.7	1.6	0.23
	III	1700 <RW	7.3	4.8	0.6	0.5	0.8	1.9	0.28

(1) For compression ignition engines.

(2) Except vehicles designed to carry more than six occupants, including the driver and vehicles whose maximum mass exceeds 2500 kg.

(3) And those category M vehicles which are specified in Note 2.

The EU Commission's original proposals also included more stringent values for introduction in 2005 and these are shown in **Part 2**, **Section B.1.6**.

In order to meet the requirements of **Table 1.37**, the OBD system must, as a minimum, monitor for the following:

Table 1.38 OBD System - Minimum Monitoring Requirements

Engine Type	Minimum Monitoring Requirements
Positive-ignition engines	Reduction in the efficiency of the catalytic converter with respect to HC emissions only.
	Engine misfire within specified engine operating limits.
	Oxygen sensor deterioration.
	Circuit continuity of emission related powertrain components connected to the computer and the electronic evaporative emission purge control.
Compression-ignition engines	Reduction in the efficiency of the catalytic converter, if fitted.
	The functioning and integrity of the particulate trap, if fitted.
	The functioning and integrity of the fuel quantity and timing functions of the electronic fuel injection system.
	The failure of other emission control systems which may result in the tailpipe emissions exceeding the limits given in **Table 1.37**.
	Circuit continuity of other emission-related powertrain components connected to the computer.

System Testing

Tests are carried out on the vehicle used for the Type V durability test (or a suitably aged alternative). The procedure follows the Type I emissions cycle and, employs the relevant EU emissions reference fuel. The testing of the OBD system consists of the following phases:

1. Simulate the malfunction of a component of the engine management or emissions control system.
2. Precondition the vehicle incorporating the simulated malfunction.
3. Drive the vehicle over the Type I cycle and measure its emissions.
4. Determine if the OBD system reacts to the simulated malfunction and indicates the fault to the driver.

Alternatively, at the request of the manufacturer, malfunction of one or more components may be electronically simulated. Manufacturers may also request that monitoring is conducted outside the Type I cycle if it can be demonstrated that this would impose restrictive monitoring conditions in actual service. Full details of the procedure will be found in EU Directive 98/69/EC.

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 were to include:

- Unrestricted and standardised access to the OBD system for inspection, diagnosis, servicing and repairs,
- Standardisation of fault codes,

- Compatibility of spare parts to facilitate repair, replacement, and servicing of OBD-equipped vehicles.

Deliberations on the subject have been protracted.

2. OTHER EUROPEAN COUNTRIES, TURKEY AND RUSSIA

2.1. VEHICLE EMISSION LIMITS

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.

2.1.2. Russia

Table 2.1 Russian Federation Exhaust Emission Limits - Regulation OST 37. 001. 054-86. Gasoline cars without catalytic converters

Vehicle Reference Mass (kg)	Exhaust emission limits (g/test) Test Method: ECE 15			
	CO		HC+NOx	
	Type Approval	Conformity of Production	Type Approval	Conformity of Production
<1020	52	62	19.0	23.8
1021-1250	60	72	20.5	25.6
1251-1470	68	82	22.0	27.5
1471-1700	76	91	23.5	29.4
1701-1930	83	100	25.5	31.3
1931-2150	91	109	26.5	33.1
>2150	99	119	28.0	35.0

The limits for off-road vehicles, trucks and buses are stipulated by multiplying the above values by the following factors:
for <2000 kg: 1.25
for >2000 kg: 2.00

Table 2.2 Russian Federation Exhaust Emission Limits - Regulation OST 37. 001. 054-86. Gasoline cars with catalytic converters

Engine Cubic Capacity (litres)	Exhaust emission limits (g/test) Test Method: ECE 15					
	CO		HC+NOx		NOx	
	Type Approval	Conformity of Production	Type Approval	Conformity of Production	Type Approval	Conformity of Production
1.4-2.0	30	36	8.0	9.6	-	-
>2.0	25	30	6.5	7.8	3.5	4.2

The limits for off-road vehicles, trucks and buses are stipulated by multiplying the above values by the following factors:
for <2000 kg: 1.25
for >2000 kg: 2.0

Table 2.3 Russian Federation Exhaust Emission Limits - Regulation OST 37. 001. 234-81. Diesel engines

Exhaust emission limits (g/bhp.h) Test Method: ECE R49 13-Mode		
CO	**HC**	**NOx**
9.5	3.4	14.35

Table 2.4 Russian Federation Black Smoke Emission Limits - Regulation GOST 17. 2. 01-84. Diesel engines

Nominal Flow (l/s)	**Smoke Limits (opacity %)**
<42	60
50	56
75	50
100	45
125	41
150	39
175	37
200	35
>200	34

The procedure consists of two stages:

- Full load
- Constant engine speeds between max. speed and 45% of max. speed, but no less than 1000 rpm.

Opacity under free acceleration should not exceed the maximum approved level under steady regimes for naturally aspirated engines, or by more than 10% for turbo-charged engines.

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

Table 2.5 Central & Eastern European Gasoline Specifications (excluding Russia)

Country	**Belarus**	**Ukraine**
Standards	GOST 2084-77	GOST 2084-77
MON, min		85
RON, min	95	95
Density, 15ºC, max	-	-
Vapour pressure, 37.8ºC, kPa	66.7-93.3	66.7-93.3
Distillation		
IBP ºC, min	30	
T10 ºC, max	75	75
T50 ºC, max	120	120
T90 ºC, max	190	180
FBP ºC, max	(S) 205 (W) 195	S 205 W 195
Residue %v/v, max		2
Pb, mg/l, max	13	0.013
S, mg/kg, max	500-1000	1000 500(1)
Benzene, %v/v, max	-	5.0
Copper corrosion, 3 h, 50ºC, max	pass	pass
Oxidation stability, minutes, min.	360	360
Gum, kg/m^3, max	5	5

(1) City gasoline only.

2.1.4. Turkey Gasoline Specifications

Table 2.6 Turkey National Gasoline Specifications - 95 RON Premium Unleaded; Lead Replacement [1] and 98 RON Premium Unleaded Grades

Characteristic			Limit Values & Applicable Dates			Method
			Till 01/01/2007	01/01/2007 - 01/01/2009	After 01/01/2009	
Appearance/Colour			Clear & Bright	Clear & Bright	Clear & Bright	Visual
Corrosion, Copper Strip (3h at 50°C)	(rating)	max	1	1	1	EN ISO 2160
Density at 15°C	(kg/m^3)		720 - 775	720 - 775	720 - 775	EN ISO 3675 EN ISO 12185
Distillation	(%v/v)					EN ISO 3405
Evaporated at 70°C						
Summer grade [2]			15 - 48	20 - 48	20 - 48	
Winter grade [3]			17-50	22-50	22 - 50	
Evaporated at 100°C						
Summer grade [1]			40 - 71	46 - 71	46 - 71	
Winter grade [2]			43 - 71	46 - 71	46 - 71	
Evaporated at 150°C		min	75	75	75	
End point	(°C)	max	210	210	210	
Residue	(%v/v)	max	2	2	2	
Gum, Existent (Washed)l	(mg/100 m)	max	5	5	5	EN ISO 6246
Oxidation Stability	(minutes)	min	360	360	360	EN ISO 7536
95 Premium Grade RON		min	95.0	95.0	95.0	EN5164
		max	97.9	97.9	97.9	
Lead Replacement Grade RON		min	95.0	95.0	95.0	
		max	97.9	97.9	97.9	
98 Premium Grade RON		min	98.0	98.0	98.0	
MON (all three grades)		min	85.0	85.0	85.0	EN5163
Lead Content	(mg/l)	max	5	5	5	EN237
Sulphur	(mg/kg)	max	500	50	10	EN ISO 20846 EN ISO 20847 EN ISO 20884
Reid Vapour Pressure	(KPa)					EN 13016-1
Summer grade [2]			45 - 60	45 - 60	45 - 60	
Winter grade [3]			60 - 90	60 - 90	60 - 90	
VLI(Vapour Lock Index) [4]:						
Summer grade [2]			N/A	N/A	N/A	
Winter grade [3]		max	1150	1150	1150	
Benzene	(%v/v)	max	2.5	1.0	1.0	EN 12177 EN 238 EN 14517
Oxygen Content	(%m/m)	max	2.7	2.7	2.7	EN 1601 EN 13132
Hydrocarbon Type:	(%v/v)					ASTM D 1319 EN 14517
Olefins		max	18	18	18	
Aromatics		max	50	35	35	
Oxygenate Content	(%v/v)	max				EN 1601 EN 13132
- Methanol			3	3	3	
- Ethanol			5	5	5	
- Iso Propyl Alcohol			10	10	10	
- Iso Butyl Alcohol			10	10	10	
- Tert Butyl Alcohol			7	7	7	
- Ethers			15	15	15	
- Others			10	10	10	

(1) Lead replacement additives: min 8, max 20 mg/kg Potassium OR min 10, max 50 mg/kg Manganese. Manganese is only permitted if RON of base gasoline is below specification level.

(2) 1 April - 31 October (+/- 2 weeks)

(3) 1 November - 31 March (+/- 2 weeks)

(4) VLI = 10 x RVP + 7 x (% at 70°C)

Earlier specifications will be found in **Part 2**, **Section B.2.1.4**

2.1.5. Russia Gasoline Specifications

Table 2.7 Russia GOST R 51105-97 (Introduced 1 January 1999)

Physico-Chemical and Performance Characteristics

Property [1]		Normal-80	Regular-91	Premium-95	Super-98
RON	min	80	91	95	98
MON	min	76	82.5	85	88
Lead content, g/l	max	0.01	0.01	0.01	0.01
Manganese content, mg/l	max	50	18	-	-
Sulphur content, mg/kg	max	500	500	500	500
Existent gum, g/100ml	max	5	5	5	5
Copper corrosion	max	1	1	1	1
Benzene content, %v/v	max	5	5	5	5
Oxygenates content, %v/v	max	[2]	[2]	[2]	[2]
Density, kg/m^3		700 - 750	725 - 780	725 - 780	725 - 780
Oxidation stability, min	min	360	360	360	360
PFI/VDC Additives		[2]			
Specification		OKP 025112 370	OKP 025112 3702	OKP 025112 3703	OKP 025112 3704

(1) GOST Test Methods are quoted in the standard - these are directly equivalent to the appropriate ASTM, ISO and EN methods.

(2) Oxygenates, anti-oxidants and detergents are permitted but the standard does not specify limits or types.

Volatility Characteristics

Property [1]		Class [2]				
		1	**2**	**3**	**4**	**5**
Vapour pressure, kPa	min	35	45	55	60	80
	max	70	80	90	95	100
Distillation, °C:						
IBP	min	35	35	Report	Report	Report
10%	max	75	70	65	60	55
50%	max	120	115	110	105	100
90%	max	190	185	180	170	160
FBP	max	215	215	215	215	215
Residue %v/v	max	2	2	2	2	2
OR						
%v/v evap at 70°C	min/max	10-45	15-45	15-47	15-50	15-50
%v/v evap at 100°C	min/max	35-65	40-70	40-70	40-70	40-70
%v/v evap at 180°C	min	85	85	85	85	85
VLI = 10VP + 7E70	max	900	1000	1100	1200	1300

(1) GOST Test Methods are quoted in the standard - these are directly equivalent to the appropriate ASTM, ISO and EN methods.

(2) No guidance is provided in the standard regarding the selection of appropriate volatility classes for different climatic regions.

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

Table 2.8 Central & Eastern European Diesel Fuel Specifications (excluding Russia)

Country	Belarus	Ukraine
Standard	GOST 305-82	GOST 305-82
Cetane number, min	45	45
Cetane index, min	-	-
Sulphur, mg/kg, max	2000	2000
Polyaromatics, %v/v max	-	-
Density, @ 15°C	820-860 (4)	W: 840 max (3) S: 860 max (3)
Viscosity, mm^2/s, 40°C	W: 1.8-6.0 (4) S: 3.0-6.0 (4)	W: 1.8-5.0 (3) S: 3.0-6.0 (3)
Distillation		
T50, °C, max	280	280
T96, °C, max	360	360
Pour point, °C max	W: -30 S: -10	W: -35 S: -10
CFPP, °C. max (W)	-5	
CFPP, °C. max (T)		
CFPP, °C. max (S)		- 5
Cloud point, °C		W: -25 S: -5
Flash point, ºC, min	W: 40 S: 62	W: 40 S: 62
Carbon residue, 10%, %m/m, max	W. 0.2 S: 0.3	W: 0.2 S: 0.3
Ash, % (m/m) max	0.008	0.01
Copper corrosion, 3h, 50°C, class	pass	pass

2.1.7. Turkey Diesel Fuel Specification

Table 2.9 Turkey National On-Road & High Sulphur Off-Road Diesel Fuel Specifications

Characteristic			Limit Values & Applicable Dates (1)			Test Method
			Till 01/01/2007	01/01/2007 - 01/01/2008	After 01/01/2008	
Density at 15°C	(kg/m^3)		820 - 860	820 - 845	820 - 845	EN ISO 3675 EN ISO 12185
Flash Point	(°C)	min	55	55	55	EN 22719
Cold Filter Plugging Point (CFPP)	(°C)					
Winter grade (2)	(°C)	max	-15	-15	-15	EN116
Summer grade (3)	(°C)	max	5	5	5	EN116
Distillation:						
Recovered at 250ºC	(%v/v)	max	65	65	65	EN ISO 3405
Recovered at 350ºC	(%v/v)	min	85	85	85	EN ISO 3405
95%v/v Recovered	(°C)	max	370	360	360	EN ISO 3405
Sulphur (On-road) (1)	(mg/kg)	max	500	50	10	EN ISO 20846 EN ISO 20847 EN ISO 20884
Sulphur (Off-road) (1)	(mg/kg)	max	7000	2000	1000	
		min	2001	501	11	
Carbon Residue (on 10% residue)	(%m/m)	max	0.30	0.30	0.30	EN ISO 10370
Viscosity at 40°C	(mm^2/s)		2.0 - 4.5	2.0 - 4.5	2.0 - 4.5	EN ISO 3104
Copper Strip Corrosion (3h at 50°C)			1	1	1	EN ISO 2160
Ash	(%m/m)	max	0.01	0.01	0.01	EN ISO 6245
Cetane Index (Both grades		min	46	46	46	EN ISO 4264
Cetane Number (On-road)		min	51	51	51	EN ISO 5165
Cetane Number (Off-road) (1)		min	49	49	49	
Water content	mg/kg	max	200	200	200	EN ISO 12937
Particulate Matter	mg/kg	max	24	24	24	EN 12662
Oxidation Stability	gr/m3	max	25	25	25	EN ISO 12205
Polycyclic aromatic hydrocarbons	(%m/m)	max	11	11	11	EN 12916
Lubricity, corrected wear scar diameter (wsd 1,4) at 60ºC	μm	max	460	460	460	ISO 12156-1
Fatty acid methyl ester (FAME) content	(%v/v)	max	5	5	5	EN 14078

(1) Dates shown are for on-road fuel. Corresponding dates for off-road fuel are as follows: 01/01/2007; between 01/01/2006 and 01/01/2008; after 01/01/2008. All three grades (7000, 2000 and 500 mg/kg) are currently in use in commercial and private vehicles. From 1 January 2007 only 50 mg/kg sulphur fuel will be permitted for these vehicles. 2000 mg/kg sulphur fuel will continue to be available for off-road applications during 2007, reducing to 1000 mg/kg from 1 January 2008.

(2) 1 October-31 March (+/- 2 weeks).

(3) 1 April-30 September (+/- 2 weeks).

3. US FEDERAL REGULATIONS

3.1. VEHICLE EMISSION LIMITS

3.1.1. Tier 2 Motor Vehicle Emission Standards

3.1.1.1. Introduction

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. To understand how the programme functions, it is necessary first to understand the EPA's classification system for light duty vehicles and trucks. The light duty category of motor vehicles includes all vehicles and trucks under 8500 lb gross vehicle weight rating, or GVWR. **Table 3.1** shows the various light duty categories:

Table 3.1 Light Duty Vehicles and Trucks; Category Classifications

Vehicle	Acronym	Characteristics
Light Duty Vehicle	LDV	A passenger car or passenger car derivative seating 12 passengers or less.
Light Duty Trucks:	LDT	
Light Light Duty Truck	LLDT	Any LDT rated at up through 6000 lbs GVWR. Includes LDT1 and LDT2.
Heavy Light Duty Truck	HLDT	Any LDT rated at greater than 6000 lbs GVWR. Includes LDT3 and LDT4s.
Medium Duty Passenger Vehicle	MDPV	A heavy duty passenger vehicle rated at less than 10 000 lbs GVWR.

3.1.1.2. Basic Exhaust Emission Standards and "Bin" Structure

The final Tier 2 programme contains a basic requirement that each manufacturer meet, on average, a full useful life NOx standard of 0.07 g/mi for all its Tier 2 LDVs and LDTs. Manufacturers will have the flexibility to choose the set of standards that a particular test group of vehicles must meet. For a given test group of LDVs or LDTs, manufacturers will select a set of full useful life standards from the same row (''emission bin'' or simply ''bin'') in **Table 3.2** below. Each bin contains a set of individual NMOG, CO, HCHO, NOx, and PM standards. For technology harmonization purposes, the emission bins include or otherwise cover all of those adopted in California's LEV II programme.

Table 3.2 Tier 2 Light Duty Full Useful Life Exhaust Emission Standards

Bin No	Emission Limits (g/mile)					
	NOx	NMOG	CO	HCHO	PM	Notes
11	0.9	0.280	7.3	0.032	0.12	(1)
10	0.6	0.156/0.230	4.2/6.4	0.018/0.027	0.08	(2, 3, 4)
9	0.3	0.090/0.180	4.2	0.018	0.06	(3, 5)
8	0.20	0.125/0.156	4.2	0.018	0.02	(2, 6)
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) Bin 11 is only for MDPVs and is available up to and including the 2008 model year.

(2) Bin deleted at end of 2006 model year (2008 for HLDTs).

(3) The higher temporary NMOG, CO and HCHO values apply only to HLDTs and expire after 2008.

(4) Optional temporary NMOG standard of 0.280 g/mile applies for qualifying LDT4s and MDPVs only.

(5) Optional temporary NMOG standard of 0.130 g/mile applies for qualifying LDT2s only.

(6) Higher temporary NMOG standard is deleted at end of 2008 model year.

- A “test group” is the basic classification unit for certification of light duty vehicles and trucks under EPA certification procedures for the CAP 2000 programme (see the **Appendix to Part 1**, **Section A.3.1.3**). “Test group” is a broader classification unit than “engine family” used prior to the implementation of the CAP 2000 programme.

Under this ‘‘bins’’ approach, a manufacturer may select a set of emission standards (a bin) to comply with, and a test group must meet all standards within that bin. Ultimately, the manufacturer must also ensure that the emissions of a targeted pollutant - NOx in this case - from all of its vehicles taken together meet a ‘‘corporate average’’ emission standard. This corporate average emission standard of 0.07 g/mile NOx ensures that a manufacturer’s production yields the required overall emission reductions.

As an example of how the U.S. Tier 2 regulations will work, it seems likely that manufacturers will aim for Bin 5 for light duty diesels and try very hard to achieve that target. If they are unsuccessful, the higher bins allow a safety factor. However, the manufacturers would then have to offset the higher bin models with similar volumes of lower bin vehicles. This may prove difficult because it usually involves production of smaller vehicles which may not be popular with consumers.

3.1.1.3. Interim Standards

Table 3.3 shows the interim standards for LDVs and LLDTs not covered by Tier 2 standards during the phase in period.

Interim standards will begin in 2004 for HLDTs. These vehicles were not included in the earlier National Low Emissions Vehicle (NLEV) programme and will be subject only to the Tier 1 standards prior to model year 2004. Tier 1 standards permit NOx emissions of 0.98 g/mile for LDT3s and 1.53 g/mile for LDT4s. The interim

standards for HLDTs would apply beginning in the 2004 model year and would phase-in through the 2007 model year - details will be found in **Table 3.4**.

Table 3.3 Interim Exhaust Emission Standards for LDV/LLDTs

Bin No	Emissions (g/mile)				
	NOx	NMOG	CO	HCHO	PM
Full Useful Life (120 000 miles)					
5	0.60	0.156	4.2	0.018	0.06
4	0.30	0.090	4.2	0.018	0.06
3	0.30	0.055	2.1	0.011	0.04
2	0.07	0.090	4.2	0.018	0.01
1	0	0	0	0	0
Intermediate Useful Life (50 000 miles)					
5	0.40	0.125	3.4	0.40	0.125
4	0.20	0.075	3.4	0.20	0.075
3	0.20	0.040	1.7	0.20	0.040
2	0.05	0.075	3.4	0.05	0.075

- A corporate average full useful life NOx standard of 0.30 g/will apply for this interim programme. LDV/LLDTs, which will already be at NLEV levels, should readily be able to meet this average NOx standard.
- All of the bins shown for the Tier 2 programme may be used in the interim programme. Thus if a manufacturer had vehicles certified to Tier 2 bins that it did not need to comply with the Tier 2 NOx average standard and phase in percentage, it would have the additional option to use them in the interim programme.
- The 0.30 g/mile corporate average NOx standard (and the bins of standards) would apply only to non-Tier 2 LDV/LLDTs and only for the 2004 - 2006 model years. Manufacturers would compute, bank, average, trade, account for, and report NOx credits via the same processes and equations described for Tier 2 vehicles, substituting the 0.30 g/mile corporate average standard. These NOx credits would be good only for the 2004-2006 model years and would only apply to the interim non-Tier 2 LDV/LLDTs. Credits would not be subject to any discounts, and credit deficits from the 2004 and 2005 model year could be carried forward, provided they were covered with appropriate credits by the end of the 2006 model year.

Table 3.4 Interim Exhaust Emission Standards for HLDTs

Bin No	Emissions (g/mile)				
	NOx	NMOG	CO	HCHO	PM
Full Useful Life (120 000 miles)					
5	0.60	0.230	4.2	0.018	0.06
4	0.30	0.180	4.2	0.018	0.06
3	0.20	0.156	4.2	0.018	0.02
2	0.07	0.090	4.2	0.018	0.01
1	0	0	0	0	0
Intermediate Useful Life (50 000 miles)					
5	0.40	0.160	3.4	0.015	-
4	0.20	0.140	3.4	0.015	-
3	0.14	0.125	3.4	0.015	-
2	0.05	0.075	3.4	0.015	-

- The interim programme is based on a corporate average full-life NOx standard of 0.20 g/mile. Manufacturers would comply with the corporate average HLDT NOx standard by certifying their interim HLDTs to any of the full useful life bins shown in this Table. Where applicable, manufacturers

would also comply with the intermediate useful life standards also shown in this Table. Interim HLDTs not needed to meet the phase-in percentages during model years 2004 - 2006 would have to be certified to the standards of one of the bins in this Table, but would not be included in the calculation to demonstrate compliance with the 0.20 g/mile average. Thus, the emissions of all interim HLDTs would be capped at a NOx value of 0.60 g/mile.

- As with LDV/LLDTs, manufacturers would also have the flexibility to use any of the Tier 2 bins shown as additional bins for interim HLDTs. At the end of each model year, manufacturers would determine their compliance with the 0.20 NOx standard by calculating a sales weighted average of all the bins to which they certified any interim HLDTs, excluding those not needed to meet the phase-in requirements during 2004 - 2006.
- Given that the interim HLDT standards are "phase-in" standards through 2007, manufacturers could employ alternative phase-in schedules as established for the Tier 2 standards. Alternative phase-in schedules would have to provide 100% phase-in by the same year as the primary phase-in schedule (2007).

3.1.1.4. Phase-In Schedules

The EPA will phase in the Tier 2 standards for LDVs/LLDTs over a four year period beginning in 2004 and a delayed two year phase-in, beginning in 2008 for HLDTs. These phase-in schedules are shown in **Table 3.5**.

Table 3.5 Primary Phase-in Schedule for Sales of Tier 2 LDVs, LLDTs and HLDTs (1) (2)

Model Year	Required % of LDVs & LLDTs	Required % of HLDTs
2004	25	0
2005	50	0
2006	75	0
2007	100	0
2008	-	50
2009	-	100

(1) The EPA will permit alternative phase-in schedules as an option to provide additional flexibility to manufacturers. The alternative phase-in schedule provisions are structured to provide incentive to manufacturers to introduce Tier 2 vehicles before 2004 (or 2008 for HLDTs). Under this alternative, manufacturers that introduced vehicles earlier than required could earn the flexibility to make offsetting adjustments, on a one-for-one basis, to the phase-in percentages in later years. However, they would still need to reach 100% of sales in the MY 2007 (2009 for HLDTs). Manufacturers would have the option to use this alternative to meet phase-in requirements for LDV/LLDTs and/or HLDTs.

(2) Under these alternative schedules, manufacturers will have to introduce vehicles that meet or surpass the 0.07 g/ mi Tier 2 NOx average standard before they are required to do so, or else introduce vehicles that meet or surpass the 0.07 standard in greater quantities than required. Alternative phase-in schedules essentially credit the manufacturer for its early or accelerated efforts and allow the manufacturer greater flexibility in subsequent years during the phase-in. An alternative phase-in schedule will be acceptable if it passes a specific mathematical test.

3.1.1.5. 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. Details will be found in the **Appendix to Part 1**, **Section A.3.1.1**.

3.1.1.6. 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). Details will be found in the **Appendix to Part 1**, **Section A.3.1.1**.

3.1.1.7. Tier 2 Light Duty Evaporative Emission Standards

The EPA have adopted a set of more stringent evaporative emission standards for all Tier 2 light duty vehicles and light duty trucks. The standards shown in **Table 3.6** represent, for most vehicles, more than a 50% reduction in diurnal plus hot soak standards from those that will be in effect in the years immediately preceding Tier 2 implementation. The higher standards for HLDTs provide allowance for greater non-fuel emissions related to larger vehicle size.

Table 3.6 Tier 2 Evaporative Emission Standards

Vehicle Class	Evaporative Emissions (g/test)	
	3 day diurnal + hot soak	2 day diurnal + hot soak
LDVs & LLDTs	0.95	1.2
HLDTs	1.2	1.5

- Tier 2 evaporative standards will be phased in by the same mechanism as the Tier 2 exhaust standards; e.g., 25/50/75/100% beginning in 2004 for LDV/LLDTs and 50/100% beginning in 2008 for HLDTs. As for the proposed exhaust standards, alternative phase-in plans would be available.
- The above evaporative emissions standards are the same as those that manufacturers' associations proposed during the development of California's LEV II proposal.

3.1.1.8. Proposed Air Toxics Regulation

In December 2005, the EPA proposed a new “Mobile Source Air Toxic Regulation” (MSAT), to include low temperature HC emissions from passenger cars. The EPA consider that the current test procedure does not robustly control NMHC emissions at temperatures below 75°F (~ 24°C). The proposal would also set a 0.65%v/v annual average benzene content for gasoline from 2011.

The EPA is proposing the addition of an NMHC requirement to the cold temperature emissions test for passenger cars.

Table 3.7 Proposed Low Temperature (20°F) NMHC Emission Standards

Vehicle Weight (GVWR)	NMHC (g/mile)	Phase-In Schedule (%)					
		2010	2011	2012	2013	2014	2015
≤ 6000 lbs.	0.3	25	50	75	100		
≥ 6000 lbs.	0.3			25	50	75	100

3.1.2. Heavy Duty Highway Engine Legislation

3.1.2.1. 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 set out as the "baseline" limits in **Table 3.8** below. These limits will apply for on-highway heavy duty diesel-cycle engines fuelled by diesel, methanol, gaseous fuels and their blends to MY 2004 and later. All emissions standards other than NMHC and NOx applying to 1998 and later MY heavy duty engines continue at their 1998 levels. No new standards had been finalised for on-highway heavy duty gasoline engines at that time.

Table 3.8 2004 Highway HD Engine Standards (1)

Legislation Scenario	Limit Values (g/bhp.h)		
	Basic NMHC+NOx	Alternative (with discrete NMHC Limit)	
		NMHC+NOx	NMHC
Baseline	2.4	2.5	0.5

(1) All emissions standards other than NMHC and NOx applying to 1998 and later MY heavy duty engines continue at their 1998 levels.

- For heavy duty diesel engines, the EPA is allowing three options for NMHC measurement in alternative fuelled engines. They are as follows:
  1. Use a THC measurement in place of an NMHC measurement;
  2. Use a procedure specified by the manufacturer with prior approval of the Administrator;
  3. Subtract 2% from the measured THC value to obtain an NMHC value.
- The methodology must be specified at the time of certification and will remain the same for the engine family throughout the engines' useful life. For natural gas vehicles, the EPA is allowing the option of measuring NMHC through direct quantification of individual species by gas chromatography.

The EPA also committed to review the appropriateness of this standard in 1999. On 17 May 2000 the EPA reaffirmed those standards for diesel engines and finalized new standards for heavy duty gasoline engines.

Exhaust emissions from new 2007 and later model year diesel HDEs shall not exceed the following:

Table 3.9 Proposed 2007 Highway HD Diesel Engine Standards

Engine Type	Emissions Species	Emissions Limits	
		g/bhp.h	g/MJ
All HDEs	NOx (1)	0.20	0.075
Diesel, natural gas or LPG fuelled HDEs	NMHC	0.14	0.052
Methanol fuelled HDEs	NMHCE	0.14	0.052
All HDEs	CO	15.5	5.77
All HDEs	PM (2)	0.01	0.0037
All HDEs	Formaldehyde	0.016	0.0060
Methanol, natural gas or LPG fuelled HDEs	Idle CO	0.50% of exhaust gas flow at idle	

(1) A manufacturer may elect to include any or all of its diesel-cycle HDE families in any or all of the NOx and NOx plus NMHC emissions Average Banking and Trading (ABT) programmes for HDEs, If the manufacturer elects to include engine families in any of these programmes, the NOx family emissions limit (FEL) may not exceed 0.50 g/bhp.h (0.19 g/MJ). This ceiling value applies whether credits for the family are derived from averaging, banking, or trading programmes.

(2) A manufacturer may elect to include any or all of its diesel HDE families in any or all of the particulate ABT programmes for HDEs. If the manufacturer elects to include engine families in any of these programmes, the particulate FEL may not exceed 0.02 g/bhp.h (0.0075 g/MJ).

Table 3.10 Proposed 2007 Heavy Duty Vehicle Standards (1)

GVWR (lb)	Emission Limits (g/mile) (3)		
	PM	NOx	NMHC
8500 - 10 000 (2)	0.02	0.2	0.195
10 000 - 14 000	0.02	0.4	0.230

(1) These limit values are roughly comparable to the proposed engine-based standards in these size ranges.

(2) Not applicable to vehicles classified as medium duty passenger cars in the Tier 2 programme.

(3) No crankcase emissions shall be discharged into the ambient atmosphere from any new 2007 or later model year diesel HDE.

For model years 2007, 2008, and 2009, manufacturers may certify some of their engine families to the combined NOx plus NMHC standard applicable to model year 2006 engines, in lieu of the separate NOx, NMHC, and formaldehyde standards specified above. These engines must comply with all other requirements applicable to model year 2007 engines. The proposed standards would be implemented for complete heavy duty vehicles according to the same schedule. The following sales limits apply:

Table 3.11 Future Highway HD Diesel Engine Implementation Schedule

Model Year	Sales (%) (1)
2007	75
2008	50
2009	25

(1) For each model year, the combined number of engines in the engine families certified to the 2006 combined NOx plus NMHC standard may not exceed the above percentages of the manufacturer's US-directed production of heavy duty diesel motor vehicle engines.

During the phase-in period, manufacturers may not average together (as part of the ABT programme) engine families certified to the NOx plus NMHC standards applicable to model year 2006 and engine families certified to the separate NOx and NMHC standards specified in this section.

3.1.2.2. 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 **Table 3.12**:

Table 3.12 2007 Highway Otto-cycle HD Engine Standards

Engine Type	Emissions Species	Emissions Limits	
		g/bhp.h	g/MJ
All HDEs	NOx (1)	0.20	0.075
Gasoline, natural gas or LPG fuelled HDEs	NMHC	0.14	0.052
Methanol fuelled HDEs	NMHCE	0.14	0.052
All HDEs	CO	14.4	5.36
All HDEs	PM	0.01	0.0037
All HDEs	Formaldehyde	0.016	0.0060
All HDEs with after-treatment	Idle CO	0.50% of exhaust gas flow at idle	

(1) A manufacturer may elect to include any or all of its Otto-cycle HDE families in any or all of the NOx and NOx plus NMHC emissions Average Banking and Trading (ABT) programmes for HDEs. If the manufacturer elects to include engine families in any of these programmes, the NOx family emissions limit (FEL) may not exceed 0.50 g/bhp.h (0.19 g/MJ). This ceiling value applies whether credits for the family are derived from averaging, banking, or trading programmes.

Evaporative emissions from heavy duty vehicles shall not exceed the following standards, which apply equally to certification and in-use vehicles:

Table 3.13 2007 Highway Otto-cycle HD Engine Evaporative Emissions Standards

GVW (lb)	Emissions Limit (g/test) (1)			Emissions Limit (g/mile)
	3-diurnal Test (2)	2-diurnal Test (3)	Spit-back Test (4)	Running loss Test (4)
<14 000	1.4	1.75	1.0	0.05
>14 000	1.9	2.3	-	0.05

(1) Hydrocarbons for vehicles equipped with gasoline, natural gas or liquefied petroleum gas-fuelled engines; Total Hydrocarbon Equivalent for vehicles equipped with methanol-fuelled engines.

(2) Full three-diurnal test sequence, diurnal plus hot soak measurements.

(3) Supplemental two-diurnal test sequence, diurnal plus hot soak measurements (gasoline-fuelled vehicles only).

(4) Gasoline-fuelled vehicles only. The spit-back standard also applies to newly assembled vehicles.

- For certification vehicles only, manufacturers may conduct testing to quantify a level of non-fuel background emissions for an individual test vehicle. Such a demonstration must include a description of the source(s) of emissions and an estimated decay rate. The demonstrated level of non-fuel background emissions may be subtracted from emission test results from certification vehicles if approved in advance by the Administrator.
- All fuel vapour generated in a gasoline or methanol-fuelled heavy duty vehicle during in-use operations shall be routed exclusively to the evaporative control system (e.g., either canister or engine purge). The only exception to this requirement shall be for emergencies.
- No crankcase emissions shall be discharged into the ambient atmosphere from any new 2007 or later model year Otto-cycle HDE.

The rule also requires on-board diagnostic (OBD) systems for engines between 8500 and 14 000 lb to be phased-in, beginning in 2005. Vehicles less than

14 000 lb gross vehicle weight rating are subject to emission standards and testing similar to the current programme for LDVs and LDTs.

3.1.2.3. 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 3.14**, 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 3.14 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.

3.1.3. 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.

3.1.3.1. Engine Displacement, Motorcycle Classes

Engine displacement shall be calculated using nominal engine values and rounded to the nearest whole cubic centimetre, in accordance with ASTM E 29-67. For rotary engines, displacement means the maximum volume of a combustion chamber between two rotor tip seals, minus the minimum volume of the combustion chamber between those two rotor tip seals, times three times the number of rotors, according to the following formula:

cc = (max. chamber volume - min. chamber volume) × 3 × no. of rotors.

Motorcycles will be divided into classes based on engine displacement:

Table 3.15 Motorcycle and Motorcycle Engine Classes

Motorcycle class	Engine Displacement (cubic centimetres)	
	Through 2005 model year	2006 and later model years
Class I	50–169	0–169
Class II	170–279	170–279
Class III	280 and greater	280 and greater

At the manufacturer's option, a vehicle described in an application for certification may be placed in a higher class (larger displacement). All procedures for the higher class must then be complied with, compliance with emission standards will be determined on the basis of engine displacement.

3.1.3.2. Emission Limits

In general, the EPA are harmonizing the federal exhaust emission standards for all classes of motorcycles with those of the California programme, but on a delayed schedule relative to implementation in California.

Table 3.16 Final Class I and II Motorcycle Emission Standards

Class and displacement (cc)	HC (g/km)	CO (g/km)	Useful life
I–A (0–49)	1.0	12.0	5 years/6,000 km (1)
I–B (50–169)	1.0	12.0	5 years/12,000 km (1)
II (170–279)	1.0	12.0	5 years/18,000 km.

(1) In order to distinguish the two segments within Class I that have differing useful life definitions, the regulatory text defines Class I–A (0–49cc) and Class I–B (50–169cc).

Table 3.17 2006 Class III Motorcycle Emission Standards

Tier	Model year	Emission standards (g/km)	
		HC + NOx	CO
1	2006 - 2009	1.4	12.0
2	2010 and later	0.8	12.0

- The above standards refer to the exhaust emitted over the FTP highway motorcycle test cycle and measured and calculated in accordance with those procedures (see Section 3.3.2.)
- The proposed limits would apply to all motorcycles, regardless of fuel.
- Compliance with the HC + NOx standards In Table 3.17 may be demonstrated by using the averaging provisions described in the rule.
- No crankcase emissions shall be discharged into the ambient atmosphere from any new motorcycle subject to this proposal.

3.1.3.3. Highway Motorcycle Permeation Emission Standards

The EPA are finalizing new standards that will require an 85-percent reduction in plastic fuel tank permeation and a 95-percent reduction in fuel system hose permeation from new motorcycles beginning in 2008. These standards and their implementation dates are presented in **Table 3.18**. **Section 3.3.6** describes the test procedures associated with these standards. Test temperatures are stated in **Table 3.18** because they represent an important parameter in defining the emission levels. The permeation standards are based on the inside surface areas of the hoses and fuel tanks.

Table 3.18 Permeation Standards for Motorcycles

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

3.1.3.4. 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 **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 and details of these arrangements can be found in **Part 2**, **Section A.3.1.5.**

3.1.4. Non-road Diesel Emissions Standards

3.1.4.1. Tier 1 to 3 Emission Standards

The limits for engines rated under 37 kW were the first EPA emission standards for these power units. In general, new emission standards for engines rated between 37 and 560 kW were finalized in two tiers, building on the phase-in schedule adopted in 1994 for the Tier 1 rule. The new regulations were adopted as a final rule (40 CFR Parts 9, 86, and 89) on 23 October 1988 and the following Table lists the range of standards for the different power categories, including all the tiers of standards and the appropriate model years. The first new set of limits (Tier 2) generally mirrors the emission standards that applied beginning with 1998 model year highway engines. The second set of standards (Tier 3) parallel limits apply to 2004 highway engines. The standards for engines rated at or above 37 kW become effective from 2001 to 2006 for Tier 2 levels and 2006 to 2008 for Tier 3.

Table 3.19 Non-road Diesel Tier 1 to 3 Emissions Standards

Engine Power kW	Tier	Model Year	Emissions (g/kWh)				
			HC	NOx	NMHC+NOx	CO	PM
< 8	1	2000	-	-	10.5	8.0	1.00
	2	2005	-	-	7.5	8.0	0.80
8 - 19	1	2000	-	-	9.5	6.6	0.80
	2	2005	-	-	7.5	6.6	0.80
19 - 37	1	1999	-	-	9.5	5.5	0.80
	2	2004	-	-	7.5	5.5	0.60
37 - 75	1	1998	9.2	-	-	-	-
	2	2004	-	-	7.5	5.0	0.40
	3	2008	-	-	4.7	5.0	0.40
75 - 130	1	1997	9.2	-	-	-	-
	2	2003	-	-	6.6	5.0	0.30
	3	2007	-	-	4.0	5.0	0.30
130 - 225	1	1996	9.2	1.3	-	11.4	0.54
	2	2003	-	-	6.6	3.5	0.20
	3	2006	-	-	4.0	3.5	0.20
225 - 450	1	1996	9.2	1.3	-	11.4	0.54
	2	2001	-	-	6.4	3.5	0.20
	3	2006	-	-	4.0	3.5	0.20
450 - 560	1	1996	9.2	1.3	-	11.4	0.54
	2	2002	-	-	6.4	3.5	0.20
	3	2006	-	-	4.0	3.5	0.20
> 560	1	2000	9.2	1.3	-	11.4	0.54
	2	2006	-	-	6.4	3.5	0.20

3.1.4.2. Tier 4 Emission 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). New engine standards will begin to take effect in the 2008 model year, phasing in over a number of years. These standards are based on the use of advanced exhaust emission control devices. The fuel controls will be phased-in starting in mid-2007 and are detailed in **Section 3.1.4.5**. The Tier 4 non-road final rule is largely based on the Environmental Protection Agency's 2007 highway diesel programme.

To better ensure the benefits of the standards are realized in-use and throughout the useful life of these engines, the EPA are also adopting new test procedures, including not-to-exceed requirements, and related certification requirements. The rule also includes provisions to facilitate the transition to the new engine and fuel standards and to encourage the early introduction of clean technologies and clean non-road diesel fuel. Provisions have also been developed for both the engine and fuel programmes designed to address small business considerations.

Table 3.20 Non-road Diesel Tier 4 PM Emissions Standards

Engine Power	PM Emission Limits (g/bhp.h)					
	Model Year					
	2008	2009	2010	2011	2012	2013
hp < 25 (kW < 19)	0.30 (1)					
25 ≤ hp < 75 (19 ≤ kW < 56)	0.22 (2)					0.02
75 ≤ hp < 175 (56 ≤ kW < 130)					0.01	
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)				0.01		
hp 750 (kW > 560)	See **Table 3.22**					

(1) For air-cooled, hand-startable, direct injection engines under 11 hp, a manufacturer may instead delay implementation until 2010 and demonstrate compliance with a less stringent PM standard of 0.45 g/bhp-hr, subject also to additional provisions.

(2) A manufacturer has the option of skipping the 0.22 g/bhp-hr PM standard for all 50–75 hp engines. The 0.02 g/bhp-hr PM standard would then take effect one year earlier for all 50–75 hp engines, in 2012.

Table 3.21 Non-road Diesel Tier 4 NOx and MMHC Emissions Standards

Engine Power	Standard (g/bhp.h)		Phase-In Schedule (% by Model Year) (1)			
	NOx	NMHC	2011	2012	2013	2014
25 ≤ hp < 75 (19 ≤ kW < 56)	3.5 (NOx+NMHC) (2)				100	
75 ≤ hp < 175 (56 ≤ kW < 130)	0.3	0.14	50 (3)	50 (3)	100 (3)	
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	0.3	0.14	50	50	50	100
hp 750 (kW > 560)	See **Table 3.22**					

(1) Percentages indicate production required to comply with the Tier 4 standards in the indicated model year.

(2) This is the existing Tier 3 combined NMHC+NOx standard level for the 50–75 hp engines in this category. In 2013 it applies to the 25–50 hp engines as well.

(3) Manufacturers may use banked Tier 2 NMHC+NOx credits from engines at or above 50 hp to demonstrate compliance with the 75–175 hp engine NOx standard in this model year. Alternatively, manufacturers may forego this special banked credit option and instead meet an alternative phase-in requirement of 25/25/25% in 2012, 2013, and 2014 through 30 December, with 100% compliance required beginning 31 December, 2014.

Table 3.22 Non-road Diesel Tier 4 Emissions Standards for Engines over 750 hp

Engine Application	Emissions Limits (g/bhp.h)					
	2011			2015		
	PM	NOx	NMHC	PM	NOx	NMHC
Generator sets ≤1200 hp	0.075	2.60	0.30	0.02	0.50	0.14
Generator sets >1200 hp	0.075	0.50	0.30	0.02	(1)	0.14
All Other Equipment	0.075	2.60	0.30	0.02	(1)	0.14

(1) For equipment other than generator sets, EPA are deferring a decision on setting aftertreatment-based NOx standards to allow additional time to evaluate the technical issues involved in adapting NOx control technology to these applications and engines. The EPA expect to announce further plans regarding these issues in 2007

3.1.4.3. Alternative Tier 4 Phase-In Standards

The alternative NOx phase-in standards are shown in **Table 3.23**. They apply only during the NOx phase-in years. Manufacturers may use both approaches within a power category if desired, certifying some engines to the alternative standards, with the rest subject to the phase-in percentage requirement. Note that engines under 75 hp subject to Tier 4 NOx standards do not have an alternative standard because they do not have a NOx phase-in, and engines over 750 hp do not have an alternative standard because of the separate standards EPA are adopting for these engines.

Table 3.23 Non-Road Diesel Tier 4 Alternative NOx Phase-In Standards

Engine Power	NOx Standard (g/bhp.h)
75 ≤ hp < 175 (56 ≤ kW < 130)	1.7 (1)
175 ≤ hp ≤ 750 (130 ≤ kW ≤ 560)	1.5

(1) Under the option identified in footnote 3 of **Table 3.21**, by which manufacturers may meet an alternative phase-in requirement of 25/25/25% in 2012, 2013, and 2014 through 30 December, the corresponding alternative NOx standard is 2.5 g/bhp-hr.

The engines certified under these standards will also need to meet the Tier 4 PM and crankcase control requirements that take effect for all engines in the first phase-in year. They will also need to comply with all Tier 4 provisions that would apply to phase-in engines.

3.1.4.4. Tier 4 Crankcase Emissions Control

In addition to allowing for compliance through the routing of crankcase emissions to the engine air intake system, the EPA are also allowing manufacturers to instead meet the requirement by routing the crankcase gases into the exhaust stream, provided they keep the combined total of the crankcase emissions and the exhaust emissions below the applicable exhaust emission standards. EPA are allowing manufacturers to instead meet the requirement by measuring crankcase emissions instead of completely eliminating them, provided manufacturers add these measured emissions to exhaust emissions in assessing compliance with exhaust emissions standards. Manufacturers using this option must also modify their exhaust deterioration factors or develop separate deterioration factors to account for increases in crankcase emissions as the engine ages, and must ensure that crankcase emissions can be readily measured in use. The EPA see no reason to treat naturally-aspirated engines differently from turbocharged engines, and so are allowing these options for all Tier 4 engines subject to the crankcase control requirement, both turbocharged and naturally-aspirated.

3.1.4.5. Tier 4 Certification Fuel Sulphur Content

The EPA are establishing six provisions related to the sulphur content of fuel used in conducting non-road diesel engine emissions testing:

- 300–500 mg/kg for model year 2008 to 2010 engines,
- 7–15 mg/kg for 2011 and later model year engines,
- Extension through model year 2007 of the maximum 2000 mg/kg specification for Agency testing on pre-Tier 4 engines,

- 7–15 mg/kg for 2007–2010 model year engines that use sulphur-sensitive technology,
- 7–15 mg/kg for 2008–2010 model year engines under 75 hp,
- 300–500 mg/kg for some model year 2006–2007 engines at or above 100 hp.

The last 3 of these provisions are at the certifying manufacturer's option, and involve additional measures that the manufacturer must take to help ensure that the specified fuel is used in the field.

3.1.4.6. 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. Additional information is reported in the **Appendix to Part 1**, **Section A.3.1.6**.

3.1.5. Non-Road Large Spark Ignition Engines Exhaust Emissions

3.1.5.1. Introduction

The EPA have adopted emission standards for several groups of non-road engines (Final Rule 40 CFR Parts 89 et al - Federal Register/Vol. 67, No. 217/Friday, 8 November, 2002). Until this legislation was introduced, these power units had not been subject to EPA emission standards These engines are large spark-ignition engines such as those used in forklifts and airport ground-service equipment; recreational vehicles using spark-ignition engines such as off-highway motorcycles, all-terrain vehicles, and snowmobiles. Recreational marine diesel engines are also included in the legislation but will not covered in this report. One final rule encompasses all these engines but, for the sake of clarity, the standards for large spark ignition engines will be described here - **Section 3.1.6** covers the limits for small recreational engines.

This final rule applies only to spark-ignition engines. The EPA's most recent rulemaking for non-road diesel engines adopted a definition of ''compression ignition'' that addressed the status of alternative-fuel engines (63 FR 56968, 23 October, 1998). Consistent with the Clean Air Act, stationary-source engines are not non-road engines and are not included in this legislation.

3.1.5.2. 2004 Model Year Tier 1 Emission Standards and Compliance Dates

The EPA are adopting standards starting in the 2004 model year consistent with those adopted by California ARB. These standards, which apply to testing only with the applicable steady-state duty cycles, are 4.0 g/kW-hr (3.0 g/hp-hr) for HC + NOx emissions and 50 g/kW-hr (37 g/hp-hr) for CO emissions. The EPA expect manufacturers to meet these standards using three-way catalytic converters and electronically controlled fuel systems. These systems are similar to those used for many years in highway applications, but not necessarily with the same degree of sophistication.

Table 3.24 Non-Road Large Spark Ignition Engines Tier 1 Emission Standards [1]

Testing	General Emission Standards (g/kWh)		Alternate Emission Standards for Severe Duty Engines (g/kWh)	
	HC + NOx	CO	HC + NOx	CO
Certification and production-line testing	4.0	50.0	4.0	130.0
In-use testing	5.4	50.0	5.4	130.0

1. Adopting emission standards for these engines starting in 2004 allows a relatively short lead time. However, manufacturers will be able to achieve this by expanding their production of the same engines they will be selling in California at that time. The Agency has designed the 2004 standards to require no additional development, design, or testing beyond what California ARB already requires. The final requirements includes two principal adjustments to align with the California ARB standards:
   a) manufacturers' deterioration factors for 2004 through 2006 model years should be based on emission measurements over 3 500 hours of engine operation, rather than the full useful life of 5 000 hours.
   b) an emission standard of 5.4 g/ kW-hr (4.0 g/hp-hr) HC + NOx is applied for any in-use testing to account for the potential for additional deterioration beyond 3 500 hours. This allowance for higher in-use emissions is a temporary provision to ensure the feasibility of compliance in the early years of the programme. Testing has shown that with additional design time, manufacturers can incorporate emission-control technologies with sufficient durability that the long-term standards do not require a separate in-use standard.

3.1.5.3. 2007 Model Year Tier 2 Emission Standards and Compliance Dates

The EPA are adopting a second tier of standards to require additional emission reductions. These later standards require manufacturers to control emissions under both steady-state and transient engine operation. Setting the emission standards to require additional control involves separate consideration of the achievable level of control for HC + NOx and CO emissions. Emission control technology is able to simultaneously control these three pollutants, but a trade-off between NOx and CO emissions persists for any given system. To address this, the Agency are setting a combination of standards starting with the 2007 model year.

The emission standards apply to measurements during duty-cycle testing under both steady-state and transient operation, including certification, production-line and in-use testing. An option for manufacturers to certify their engines to different emission levels is also included. This is to allow manufacturers to build engines whose emission controls are more weighted toward controlling NOx emissions to reflect the inherent trade-off of NOx and CO emissions. Generally this involves meeting a less stringent CO standard if a manufacturer certifies an engine with lower HC + NOx emissions.

Starting in the 2007 model year, Tier 2 exhaust emission standards apply for transient measurement of emissions with the duty-cycle test procedures described later. The Tier 2 HC + NOx standard is 2.7 g/kW-hr and the Tier 2 CO standard is 4.4 g/kW-hr. For severe duty engines, the Tier 2 HC + NOx standard is 2.7 g/ kW-hr and the Tier 2 CO standard is 130.0 g/kW-hr. These standards do not apply for transient testing of high-load engines.

Engines may be optionally certified according to the following formula instead of the standards quoted above:

$$(HC + NOx) \times CO^{0.784} \leq 8.57.$$

The HC + NOx and CO emission levels selected to satisfy this formula, rounded to the nearest 0.1 g/kW-hr, become the emission standards that apply for those engines. HC + NOx emission standard higher than 2.7 g/kW-hr or a CO emission standard higher than 20.6 g/kW-hr cannot be selected. The following table illustrates a range of possible values:

Table 3.25 Examples of Possible Non-Road Large Spark Ignition Engines Tier 2 Emissions Standards

HC + NOx (g/kWh)	CO (g/kWh)
2.7	4.4
2.2	5.6
1.7	7.9
1.3	11.1
1.0	15.5
0.8	20.6

3.1.5.4. Evaporative Emissions.

The EPA are adopting requirements related to evaporative and permeation emissions from gasoline-fuelled Large SI engines. For controlling diurnal emissions, an emission standard of 0.2 grams of hydrocarbon per gallon of fuel tank capacity during a 24-hour period is being adopted. In addition, the EPA specify that manufacturers use fuel lines meeting an industry standard for permeation resistance. The Agency also require that manufacturers take steps to prevent fuel from boiling. The EPA expect certification of manufacturers' equipment to be design based, as compared with conducting a full emission-measurement programme during certification.

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

Background information and useful life durability provisions are reported in the **Appendix to Part 1**, **Section A.3.1.7**.

3.1.6. Non-Road Recreational Engines Exhaust Emissions

3.1.6.1. Introduction

The EPA have adopted emission standards for several groups of non-road engines that have not, till now, been subject to EPA emission standards (Final Rule 40 CFR Parts 89 et al - Federal Register/Vol. 67, No. 217/Friday, 8 November, 2002). These engines are large spark-ignition engines such as those used in forklifts and airport ground-service equipment; recreational vehicles using spark-ignition engines such as off-highway motorcycles, all-terrain vehicles, and snowmobiles. Recreational marine diesel engines are also included in the legislation but will not covered in this report. One final rule encompasses all these engines but, for the sake of clarity, the standards for smaller recreational engines will be described here. **Section 3.1.5** has dealt with the standards for large spark ignition engines.

3.1.6.2. Exhaust Emission Standards - Small Recreational Vehicles

Table 3.26 Exhaust Emission Standards for Snowmobiles

Phase	Model Year	Phase-In (%)	Emissions Standards (g/kWh)			Maximum Allowable Family Emission Limits (g/kWh)		
			HC [(1)]	HC + NOx	CO	HC [(1)]	HC + NOx	CO
1	2006	50	100	-	275	-	-	-
1	2007 - 2009	100	100	-	275	-	-	-
2	2010 & 2011	100	75	-	275	-	-	-
3	2012 and later	100	75	[(2)]	[(2)]	150	165	400

1. The exhaust emission standards are applied using each type of fuel for which they are designed to operate. The numerical emission standards for hydrocarbons must be met on the following types of hydrocarbon emissions for snowmobiles powered by the following fuels:
   (a) Gasoline- and LPG-fuelled snowmobiles: THC emissions.
   (b) Natural gas-fuelled snowmobiles: NMHC emissions.
   (c) Alcohol-fuelled snowmobiles: THCE emissions.
2. For Phase 3, the HC + NOx and CO standards are defined by a functional relationship. The corporate average HC+NOx and CO standards for each model year is chosen according to the following criteria:
   (i) Prior to production, select the HC + NOx standard and CO standard (specified as g/kW-hr) so that the combined percent reduction from baseline emission levels is greater than or equal to 100 percent; that is, that the standards comply with the following equation:
   $\{1 - [(HC + NOx)_{STD} - 15]/150\} \times 100 + \{1 - CO_{STD}/400\} \times 100 \geq 100$
   (ii) The corporate average HC + NOx standard may not be higher than 90 g/kW-hr.
   (iii) The corporate average CO standard may not be higher than 275 g/kW-hr.
   (iv) The averaging and banking provisions may be used to show compliance with these HC + NOx and CO standards.

Table 3.27 Exhaust Emission Standards for Off-Highway Motorcycles [(1)]

Phase	Model Year	Phase-In (%)	Emission Standards (g/km)		Maximum Allowable Family Emission Limits (g/km)	
			HC + NOx	CO	HC + NOx	CO
1	2006	50	2.0	25	20.0	50.0
	2007 and later [(2)]	100	2.0	25	20.0	50.0

1. The averaging, banking, and trading provisions may be used to show compliance with the HC + NOx and/or CO standards (an engine family meets emission standards even if its family emission limit is higher than the standard, as long as it is demonstrated that the whole averaging set of applicable engine families meet the applicable emission standards using emission credits, and the vehicles within the family meet the family emission limit). The phase-in values specify the percentage of US-directed production that must comply with the emission standards for those model years. This compliance percentage is based on a simple count of production units within the engine family. The comments regarding fuels and HC emissions for snowmobiles apply to off-highway motorcycles.
2. For model years 2007 and later a manufacturer may chose to certify all his off-highway motorcycles to an HC + NOx standard of 4.0 g/km and a CO standard of 35 g/km. To certify to the standards in this paragraph, certain provisions (detailed in the final rule) must be met.

Table 3.28 Exhaust Emission Standards for All-Terrain Vehicles (ATVs) and Off-road Utility Vehicles [(1)] (Chassis-Based Procedure)

Phase	Model Year	Phase-In (%)	Emission Standards (g/km)		Maximum Allowable Family Emission Limits (g/km)	
			HC + NOx	CO	HC + NOx	CO
1	2006	50	1.5	35	20.0	50.0
	2007 and later	100	2.0	25	20.0	50.0

(1) The averaging, banking, and trading provisions may be used to show compliance with these HC + NOx standards (an engine family meets emission standards even if its family emission limit is higher than the standard, as long as it is shown that that the whole averaging set of applicable engine families meet the applicable emission standards using emission credits, and the vehicles within the family meet the family emission limit). The Table also shows the maximum value that may be specified for a family emission limit. The phase-in values in the table specify the percentage of total US-directed production that must comply with the emission standards for those model years. This compliance percentage is based on a simple count of production units within the engine family. It applies to a manufacturer's total production of ATVs and off-road utility vehicles that are subject to the standards -; including both ATVs and off-road utility vehicles subject to the standards of this section and ATVs and off-road utility vehicles certified to the standards of other sections of this legislation. The comments regarding fuels and HC emissions for snowmobiles apply to ATVs and off-road utility vehicles.

Table 3.29 Optional Exhaust Emission Standards for All-Terrain Vehicles (ATVs) and Off-road Utility Vehicles [(1)] (Engine-Based Procedure)

Engine Displacement (cc)	Model Year	Phase-In (%)	Emission Standards (g/kWh)		Maximum Allowable Family Emission Limits (g/kWh)
			HC + NOx	CO	HC + NOx
< 225	2006	50	16.1	400	32.2
	2007 and 2008	100	16.1	400	32.2
≥ 225	2006	50	13.4	400	26.8
	2007 and 2008	100	13.4	400	26.8

(1) To meet ATV standards for model years before 2009, the exhaust emission standards shown above may be applied while measuring emissions using engine-based test procedures instead of chassis-based test procedures. Emission credits may be used to show compliance with these standards. Emission credits may not be exchanged with engine families meeting the standards. Exchange of credits between engine families certified to the standards for engines above 225 cc and engine families certified to the standards for engines below 225 cc are also not permitted. The phase-in percentages in the table specify the percentage of US-directed production that must comply with the emission standards for those model years. The comments regarding fuels and HC emissions for snowmobiles apply to ATVs and off-road utility vehicles.

3.1.6.3. 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. Details will be found in the **Appendix to Part 1**, **Section A.3.1.8**.

3.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

3.2.1. ASTM 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, diesel fuel and LPG are summarised in **Part 2**, **Section A.3.2.1, A.3.2.8**, and **A.3.2.10**.

3.2.2. Gasoline

3.2.2.1. Gasoline Volatility

Full details of the gasoline vapour pressure regulations applied to both conventional and reformulated gasolines will be found in the **Appendix to Part 1**, **Sections A.3.2.2** to **A.3.2.4**.

3.2.2.2. 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). Cap and average sulphur limits of 80 mg/kg and 30 mg/kg, respectively, will be phased in during 2004 - 2006 for the majority of conventional and reformulated US gasoline. The limits apply to gasoline leaving the refinery, slightly higher sulphur cap limits apply downstream of the refinery and at forecourts.

Table 3.30 Tier 2 Gasoline Sulphur Standards for Refiners and Importers (excluding small refiners)

Classification	Sulphur Limits (mg/kg) and Date of Compliance		
	01/01/04	01/01/05	01/01/06
Refinery Average	Not applicable	30	30
Corporate Pool Average	120	90	Not applicable
Per-Gallon Cap	300	300	80

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. Further details will be found in the **Appendix to Part 1**, **Section A.3.2.2**.

Future Sulphur Levels

The auto industry, represented by the Alliance of Automobile Manufacturers, supported a gasoline sulphur control programme that would require 30 mg/kg gasoline in 2004 with a further reduction to “near-zero” levels (less than 5 mg/kg) by 2007.

The EPA are also aware of concerns that advanced emission control and fuel efficient technologies (such as gasoline direct injection engines and automotive fuel cells), may require zero or near-zero sulphur levels to achieve Tier 2 emission levels over their full useful life. The EPA believes that the Tier 2 standards could be met with conventional technology if gasoline averaging 30 mg/kg is available. Nonetheless, for the reasons put forward by the auto industry and others, they also believe that *"it may be desirable in the long term for all gasoline in the US to average substantially below 30 mg/kg sulphur"*.

3.2.2.3. Reformulated Gasolines

The Clean Air Amendments required the introduction of "*Reformulated Gasoline*" in the ten major US cities with the worst ozone levels and the EPA announced its final rule for the programme on 15 December 1993. Other areas with similar problems were allowed to opt into the programme. Full details of the programme are given in the **Appendix to Part 1**, **Sections A.3.2.3** and **A.3.2.4**.

The Energy Policy Act of August 2005 (see **Section 3.2.5**), 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.

3.2.2.4. US Federal State Actions Banning MTBE

The history of the decline in use of MTBE in reformulated gasoline is described in the **Appendix to Part 1**, **Section A.3.2.3**. As of July 2005, the following states have either a partial or complete ban on methyl tertiary-butyl ether (MTBE).

Table 3.31 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
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)

3.2.2.5. 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 has applied during the four winter months (November-February) since 1992. In a few cities this requirement may be applied for a longer period. The area covered by this legislation included 41 cities which account for some 31% of total US gasoline sales. Comparing this data with the current market share for oxygenated gasoline in **Table 3.32** demonstrates the significant reduction in winter CO problems. Most cities which are no longer CO non-attainment areas have successfully petitioned the EPA to be exempt from the requirements.

3.2.2.6. 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. Data from the US Energy Information Administration illustrates that conventional grades remain the major gasolines supplied throughout the United States:

Table 3.32 US Market Shares by Gasoline Type

Gasoline Type	Market Share (% volume)		
	2002	**2003**	**2004**
Conventional	67.0	66.6	67.4
Oxygenated	2.0	3.2	3.0
Reformulated	31.0	30.2	29.6

3.2.2.7. 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 subject is described more fully in the **Appendix to Part 1**, **Section A.3.2.5**.

3.2.3. Diesel Fuel

3.2.3.1. ASTM 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 A.3.2.6**.

3.2.3.2. Legislated Quality Requirements - EPA On-Road Diesel Fuel Standards

2006 US Federal Standard

Table 3.33 2006 Federal Highway Diesel Fuel Standard

Property		Limit
Sulphur content (max) (1)	mg/kg	15
Cetane index and Aromatic content		
Either Cetane index (min)		40
Or Aromatic content (max)	%v/v	35

(1) Modified ASTM D 2622-98, Wavelength Dispersive X-ray Fluorescence Spectrometry

- Any kerosene that meets the definition of motor vehicle diesel fuel (i.e. used for blending) must meet the sulphur requirements.

The standard will be implemented according to the following schedule:

Table 3.34 Future Federal Highway Diesel Fuel Standard Implementation Schedule

Location	Date	Description
Refiners and importers	01/06/06	Fuel produced by any refinery or imported by any importer
Downstream of the refinery or importer (i.e. terminal level)	15/07/06	Fuel at any facility in the diesel fuel distribution system downstream of the refinery or importer except at retail outlets and wholesale purchaser-consumer facilities
Retailers and wholesale purchaser-consumers	01/09/06	Fuel at any facility in the diesel fuel distribution system

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.

Further information on refinery flexibility provisions, standards and identification requirements for additives and the quality assurance test method will be found in **Part 2**, **Section A.3.2.7**.

3.2.3.3. 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.

Beginning 1 June, 2007, refiners will be required to produce NRLM diesel fuel with a maximum sulphur content of 500 mg/kg. Then, beginning 1 June, 2010, the sulphur content will be reduced to a maximum of 15 mg/kg. The sulphur content of locomotive and marine diesel fuel will be reduced to 15 mg/kg beginning 1 June, 2012. The programme contains certain provisions to ease refiners' transition to the lower sulphur standards and to enable the efficient distribution of all diesel fuels. These provisions include the 2012 date for locomotive and marine diesel fuel, early credits for refiners and importers and special provisions for small refiners and other entities in the fuel distribution system.

3.2.4. Alternative Fuels

Specifications for US alternative fuels are tabulated in the **Appendix to Part 1**, **Section A.3.2.8**.

3.2.5. US Federal Energy Policy Act of 2005

Introduction

The Energy Policy Act of 2005 (H.R. 6) is an act which was passed by the United States Congress in an attempt to combat growing energy problems. It provides tax incentives and loan guarantees for energy production of various types, and is estimated to "cost" the U.S. Treasury $12.3 billion through 2015 in foregone tax revenue. It was passed by the United States Congress on 29 July, 2005 and signed into law on 8 August, 2005. The final bill is more than 1,700 pages in length.

Provisions

The Act is intended to establish a comprehensive, long-range energy policy. It provides incentives for traditional energy production as well as newer, more efficient

energy technologies, and conservation. The bill has hundreds of provisions. Major items of direct relevance to the automotive sector include:

- The elimination of the oxygen content requirement for reformulated gasoline;
- An increase in the amount of biofuel (usually ethanol) that must be mixed with gasoline sold in the United States to triple the current requirement (7.5 billion US gallons by 2012);
- The commencement of a partnership with diesel engine, diesel fuel injection system, and diesel vehicle manufacturers and diesel and biodiesel fuel providers, to include biodiesel testing in advanced diesel engine and fuel system technology. The programme shall provide for testing to determine the impact of biodiesel from different sources on current and future emission control technologies, with emphasis on the impact of biodiesel on emissions warranty, in-use liability, and anti-tampering provisions;
- Dual fuelled vehicles acquired pursuant to the Act shall be operated on alternative fuels unless either the alternative is not reasonably available to retail purchasers; or the cost of the alternative fuel is unreasonably more expensive compared to gasoline,
- The establishment of a programme to encourage domestic production and sales of efficient hybrid and advanced diesel vehicles. The programme shall include grants to automobile manufacturers to encourage domestic production of these vehicles and provides a tax credit of up to $3,400 for owners of Hybrid vehicles;
- The establishment of a transit bus demonstration programme to make competitive, merit-based awards for 5-year projects to demonstrate not more than 25 fuel cell transit buses (and necessary infrastructure) in five geographically dispersed localities.
- The authorization of loan guarantees for "innovative technologies" that avoid greenhouse gases, which might include advanced nuclear reactor designs as well as clean coal and renewable energy;
- The authorization of $50 million annually over the life of the bill for a biomass grant programme;
- The provision of subsidies for oil companies;

Two provisions that were not included in the final Act are:

- Limited liability for producers of MTBE
- Increasing vehicle efficiency standards (CAFE). However, the Act calls for an examination of the current policy .

It should be noted that in Congressional bills an "authorization" of a discretionary programme is a permission to spend money, while an "appropriation" is the actual decision to spend money. Thus none of the above authorizations mean anything if the money is never appropriated.

3.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

3.3.1. Light Duty Vehicle Emissions Test Procedures

As required by the US Clean Air Act Amendments, the EPA re-evaluated typical driving patterns in a number of cities and found that the basic FTP test cycle did not cover about 15% of contemporary driving conditions and behaviour. As a result the EPA issued on 22 October 1996 a Notice of Final Rulemaking setting out modifications to the procedure.

The main new element of the ruling was a Supplemental Federal Test Procedure (SFTP) covering the driving patterns not included in the existing FTP procedure. The EPA introduced revisions to the FTP for measuring tailpipe emissions to better represent actual driving conditions, including the use of air conditioning systems. The SFTP includes two new test driving cycles, the US06, representing aggressive and micro-transient driving and the SC03, representing driving immediately following vehicle start-up, air conditioning operation and micro-transient driving. Further details of these test procedures and the cold start procedure will be found in the **Appendix to Part 1**, **Section A.3.3.1**.

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) – see the **Appendix to Part 1**, **Section A.3.3.2**.

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 described in the **Appendix to Part 1**, **Section A.3.3.3**.

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 proposals are described in more detail in the **Appendix to Part 1**, **Section A.3.3.4**.

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. The tests are described in the **Appendix to Part 1**, **Section A.3.3.5**.

3.3.6. Off-highway Motorcycle and ATV Emissions Test Procedures

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 test data for both programmes. Further information will be found in the **Appendix to Part 1**, **Section A.3.3.6**.

3.3.7. Evaporative Emissions Test Procedure

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. Details of the revised test procedure, which include diurnal, hot soak and running losses, are given in the **Appendix to Part 1**, **Section A.3.3.7**.

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.

3.3.8. Permeation Emissions Test Procedure

The test procedures for determining permeation emissions from fuel tanks and hoses on recreational vehicles are described in the **Appendix to Part 1**, **Section A.3.3.8**.

3.3.9. Inspection and Maintenance Procedure - US IM 240

The IM 240 procedure is described in the **Appendix to Part 1**, **Section A.3.3.9**.

3.3.10. Illustration of Current US Test Cycles

Current US Test cycles are depicted throughout the **Appendix to Part 1**, **Section A.3.3**.

3.4. REFERENCE FUELS

3.4.1. Introduction

The following Reference Fuels are generally used in both the Federal States and California. However, California has, in some instances, proposed alternative specifications and reference should be made to **Section 4.4** for further details.

3.4.2. US Federal Certification Gasoline Specification

Fuel Property	Limits	Test Method
Octane (research)	93 (min)	D2699-88, D 2700-88
Sensitivity	7.5 (min)	D2699-88, D2700-88
Lead	0.05 g/US gal (max); no lead added	D3237, §2253.4(c), title 13 CCR
Distillation Range °F:		D 86, §2263, title 13 CCR[(b)]
IBP [(1)]	75 - 95	
10% point	120 - 135	
50% point [(c)]	200 - 230	
90% point [(d)]	300 - 325	
EP, maximum	415	
Residue		
Sulphur	0.10%m/m	D 1266, §2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	D3231, §2253.4(c), title 13 CCR
Vapour Pressure [(2, 3)]	8.7 - 9.2 psi	D323, §2263, title 13 CCR
Olefins	10%v/v (max)	D1319, §2263, title 13 CCR
Total aromatic hydrocarbons	35%v/v (max)	

- Unleaded gasoline representative of commercial gasoline which will be generally available through retail outlets shall be used in service accumulation.

(1) For testing at altitudes above 4000 ft (1219 m) the specified range is 75-105°F.

(2) For testing which is unrelated to evaporative emissions control, the specified range is 8.0-9.2 psi.

(3) For testing at altitudes above 4000 ft (1219 m) the specified range is 7.6-8.0 psi.

3.4.3. US Federal Motorcycle Reference Gasoline (Proposed)

Item	Procedure	Value
Distillation Range:		
IBP, °C	ASTM D 86-97	23.9 - 35.0
10% point, °C	ASTM D 86-97	48.9 - 57.2
50% point, °C	ASTM D 86-97	93.3 - 110.0
90% point, °C	ASTM D 86-97	148.9 - 162.8
End point, °C	ASTM D 86-97	212.8
Hydrocarbon composition:		
Olefins, volume %	ASTM D 1319-98	10 maximum
Aromatics, volume %	ASTM D 1319-98	35 minimum
Saturates	ASTM D 1319-98	Remainder
Lead (organic), g/litre	ASTM D 3237	0.013 maximum
Phosphorous, g/litre	ASTM D 3231	0.005 maximum
Sulphur, weight %	ASTM D 1266	0.08 maximum
Volatility (Reid vapour pressure), kPa	ASTM D 3231	55.2 to 63.4

(1) For testing at altitudes above 1219 m, the specified volatility range is 52 to 55 kPa and the specified initial boiling point range is 23.9 to 40.6°C.

3.4.4. US Federal Certification Diesel Fuel Specification

Fuel Property	Limit	Test Method
Natural cetane number	42 - 50	D 613-86
Distillation Range °F		D 86, §2282(g)(3), title 13, CCR
IBP	340 - 400	
10% point	400 - 460	
50% point	470 - 540	
90% point	560 - 630	
EP	610 - 690	
API gravity	32 - 37	D 287-82
Total sulphur	0.03 - 0.05%m/m	D 2622, §2282(g)(3), title 13, CCR
Additives	(1)	
Total aromatic hydrocarbons	27%v/v (min)	D 1319, §2282(g)(3), title 13, CCR
Flashpoint	130 °F (max)	D 93-80
Viscosity @ 40°F, mm^2/s	2.0 - 3.2	D 445-83

- Diesel fuel representative of commercial diesel fuel which will be generally available through retail outlets shall be used in service accumulation.

(1) The following non-metallic additives are allowed: cetane improver, metal deactivator, anti-oxidant, dehazer, anti-rust, pour depressant, dye, dispersant and biocide.

3.4.5. US Federal Proposed Diesel Reference Fuels Specifications

Item		ASTM Test Method	Type II-D
Cetane number		D 613	40 - 50
Cetane index		D 976	40 - 50
Distillation range:		D 86	
IBP	°F		340 - 400
	(°C)		(171.1 - 204.4)
10%	°F		400 - 460
	(°C)		(204.4 - 237.8)
50%	°F		470 - 540
	(°C)		(243.3 - 282.2)
90%	°F		560 - 630
	(°C)		(293.3 - 332.2)
FBP	°F		610 - 690
	(°C)		(321.1 - 365.6)
Gravity	°API	D 287	32 - 37
Total sulphur	mg/kg	D 2622	7 - 15
Hydrocarbon composition			
Aromatics, minimum (Remainder shall be paraffins, naphthenes, and olefins)	%	D 5186	27
Flashpoint, min.	°F	D 93	130
	(°C)		(54.4)
Viscosity	mm^2/s @ 40º C	D 445	2.0 - 3.2

Service Accumulation Fuel

Item		ASTM Test Method No.	Type II-D
Cetane number		D 613	38 - 58
Cetane index		D 976	min. 40
Distillation range:			
90%	°F	D 86	540 - 630
Gravity	°API	D 287	30 - 39
Total sulphur	mg/kg	D 2622	7 - 15
Flashpoint, min.	°F	D 93	130
	(°C)		(54.4)
Viscosity	mm^2/s @ 40º C	D 445	1.5 - 4.5

Alternative Diesel Reference Fuel

Item		ASTM Test Method	Type I-D	Type II-D
Cetane number		D 613	40 - 54	40 - 50
Cetane index		D 976	40 - 54	40 - 50
Distillation range:				
IBP	°F	D 86	330 - 390	340 - 400
	(°C)		(165.6 - 198.9)	(171.1 - 204.4)
10%	°F		370 - 430	400 - 460
	(°C)		(187.8 - 221.1)	(204.4 - 237.8)
50%	°F		410 - 480	470 - 540
	(°C)		(210.0 - 248.9)	(243.3 - 282.2)
90%	°F		460 - 520	560 - 630
	(°C)		(237.8 - 271.1)	(293.3 - 332.2)
FBP	°F		500 - 560	610 - 690
	(°C)		(260.0 - 293.3)	(321.1 - 365.6)
Gravity	°API	D 287	40 - 44	32 - 37
Total sulphur	mg/kg	D 2622	7 - 15	7 - 15
Hydrocarbon composition				
Aromatics, minimum (Remainder shall be paraffins, naphthenes, and olefins)	%	D 5186	8	27
Flashpoint, min.	°F	D 93	120	130
	(°C)		(48.9)	(54.4)
Viscosity	mm^2/s @ 40º C	D 445	1.6 - 2.0	2.0 - 3.2

Alternative Service Accumulation Fuel

Item		ASTM Test Method	Type I-D	Type II-D
Cetane number		D 613	40 - 56	38 - 58
Cetane index		D 976	min. 40	min. 40
Distillation range:				
90%	°F	D 86	440 - 530	540 - 630
	(°C)		(226.7 - 276.7)	(293.3 - 332.2)
Gravity	°API	D 287	39 - 45	30 - 39
Total sulphur	mg/kg	D 2622	7 - 15	7 - 15
Flashpoint, min.	°F	D 93	130	130
	(°C)		(54.4)	(54.4)
Viscosity	mm^2/s @ 40º C	D 445	1.2 - 2.2	1.5 - 4.5

3.4.6. US Federal Certification Alcohol Fuels Specifications

US Federal regulations do not specify an ethanol fuel. The US Federal specification for methanol fuel simply calls for a product which is representative of commercially available methanol fuel, containing at least 50% methanol by volume.

3.4.7. US Federal Certification Mixtures of Petroleum and Alcohol Fuels Specification for Flexible Fuel Vehicles

The US Federal Regulations simply call for a flexible fuel to comprise an appropriate petroleum fuel and a methanol fuel representative of the fuel expected to be found in use.

3.4.8. US Federal Certification Natural Gas Fuel Specification

Specification	Limits (1)
Methane	89.0% mole/mole (min)
Ethane	4.5% mole/mole (max)
C_3 and higher hydrocarbon content	2.3% mole/mole (max)
C_6 and higher hydrocarbon content	0.6% mole/mole (max)
Oxygen	0.5% mole/mole (max)
Inert gases (CO_2 + N_2)	4.0% mole/mole (max)

(1) For mileage accumulation purposes the US Federal regulations require the use of commercially available natural gas which will generally be available throughout retail outlets.

3.4.9. US Federal Certification Liquefied Petroleum Gas Fuel Specifications

US Federal regulations simply call for the use of commercially available LPG.

3.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

3.5.1. CAFE Standards

The Energy Policy and Conservation Act, passed in December 1975, and amended by the Motor Vehicle Information and Cost Saving Act, requires each vehicle manufacturer to determine sales weighted average fuel consumption figures for all passenger cars and for all light duty trucks produced by them. Electric cars or hybrid vehicles may be included in the fleet average calculations and a credit is given for flexible fuelled vehicles.

The standards are based on the combined City/Highway fuel figures and are known as the CAFE (Corporate Average Fuel Economy) standards. The limits, which have remained unaltered since 1991, are 27.5 miles/US gal for cars and 11.65 miles/US gal for light duty trucks (see **Part 2**, **Section B.3.5.1**).

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 is described in the **Appendix to Part 1**, **Section A.3.5.1**.

In mid-2003 the EPA issued a notice denying a petition to regulate greenhouse gases from motor vehicles. The agency stated that Congress has not granted the necessary authority under the Clean Air Act and that setting greenhouse gas emissions standards for motor vehicles "is not appropriate at this time".

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 summarised below and dealt with more fully in the **Appendix to Part 1**, **Section A.3.6**.

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.)

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.

3.6.3. Inspection and Maintenance Testing

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.

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 in the 1994 model year with 100% phase-in by the 1996 model year.

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 became mandatory on 1 January 1998, (1 January 1999 for OTR low-enhanced programmes) and repair of failed systems became mandatory on 1 January 2000.

3.6.5. Heavy Duty Smoke Tests

On 3 April 1997, the EPA recommended the use of the SAE J1667 procedure for state-operated in-use testing programmes 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 emitters. 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

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.

4. CALIFORNIAN REGULATIONS

4.1. VEHICLE EMISSIONS LIMITS

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 below. Earlier Tier 1 and LEV I limits will be found in **Part 2**, **Sections B.4.1.1** to **B.4.1.7**.

4.1.2. LEV II Exhaust Emissions Standards - Light and Medium Duty Vehicles

Table 4.1 LEV II Exhaust Mass Emission Standards for New 2004 and Subsequent Model LEVs, ULEVs, and SULEVs in the Passenger Car, LDT and MDV Classes [1]

Vehicle Description			Emission Limits (g/mile); (mg/mile for HCHO)				
Type	**Durability Mileage**	**Emission Category**	**NMOG [2]**	**CO**	**NOx**	**HCHO**	**PM [3] [4]**
All PCs; LDTs <8500 lb GVW. Vehicles in this category are tested at their loaded vehicle weight.	50 000	LEV	0.075	3.4	0.05	15	n/a
		LEV, Option 1	0.075	3.4	0.07	15	n/a
		ULEV	0.040	1.7	0.05	8	n/a
	120 000	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
	150 000 (Optional)	LEV	0.090	4.2	0.07	18	0.01
		LEV, Option 1	0.090	4.2	0.10	18	0.01
		ULEV	0.055	2.1	0.07	11	0.01
		SULEV	0.010	1.0	0.02	4	0.01
MDVs 8501 - 10 000 lb GVW. Vehicles in this category are tested at their adjusted loaded vehicle weight.	120 000	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06
	150 000 (Optional)	LEV	0.195	6.4	0.2	32	0.12
		ULEV	0.143	6.4	0.2	16	0.06
		SULEV	0.100	3.2	0.1	8	0.06
MDVs 10 001 - 14 000 lb GVW. Vehicles in this category are tested at their adjusted loaded vehicle weight.	120 000	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06
	150 000 (Optional)	LEV	0.230	7.3	0.4	40	0.12
		ULEV	0.167	7.3	0.4	21	0.06
		SULEV	0.117	3.7	0.2	10	0.06

(1) The LEV II standards represent the maximum exhaust emissions for the intermediate and full useful life from new 2004 and subsequent model-year LEVs, ULEVs, and SULEVs, including fuel-flexible, bi-fuel and dual fuel vehicles when operating on the gaseous or alcohol fuel they are designed to use. Prior to the 2004 model year, a manufacturer that produces vehicles meeting these standards has the option of certifying the vehicles to the standards, in which case the vehicles will be treated as LEV II vehicles for purposes of the fleet-wide phase-in requirements.

(2) For Tier 1 vehicles, NMOG = NMHC.

(3) Diesel vehicles only.

(4) Particulate standards are determined on a 50 000 mile basis for Tier 1 passenger cars and light duty trucks, on a 100 000 mile basis for all other passenger cars and light duty trucks and on a 120 000 mile basis for medium duty vehicles.

4.1.3. Exhaust Emissions Standards - Light and Medium Duty Vehicles: Subsidiary Legislation

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. Details will be found in the **Appendix to Part 1**, **Section A.4.1.2**.

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**.

4.1.4. Evaporative Emissions Standards - Light and Medium Duty Vehicles

Table 4.2 Evaporative Emissions Limits - Hot Soak/72 Hour Diurnal Test

Vehicle Type	Model Year	Hydrocarbons (1)	
		Three-Day Diurnal +Hot Soak (grams/test) Useful Life (2)	Running Loss (grams/mile) Useful Life (2)
Passenger cars	1995 - 2005	2.0	0.05
Light Duty Trucks		2.0	0.05
Medium duty vehicles (6001 - 8500 lbs. GVWR):			
with fuel tanks < 30 gallons		2.0	0.05
with fuel tanks > 30 gallons		2.5	0.05
(8501-14 000 lbs. GVWR) (3)		3.0	0.05
Hybrid electric passenger cars	1993 - 2005	2.0	0.05
Hybrid electric light duty trucks		2.0	0.05
Hybrid electric medium duty vehicles		2.0	0.05

(1) Organic Material Hydrocarbon Equivalent for alcohol-fuelled vehicles.

(2) For purposes of this paragraph, “useful life” shall have the same meaning as provided in Title 13, California Code of Regulations.

(3) For the 1995 through 2005 model years, the evaporative emission standards for incomplete vehicles in this weight range shall be 2.0 grams/test and compliance with the evaporative emission standards shall be based on the test procedures specified in paragraph 4.g. of the “California Evaporative Emission Standards and Test Procedures for 1978 and Subsequent Model Motor Vehicles.”

Table 4.3 Evaporative Emissions Limits - Hot Soak/48 Hour Diurnal Test

Vehicle Type	Model Year	Hydrocarbons[1] Two-Day Diurnal + Hot Soak (g/test) Useful Life [2]
Passenger cars	1996 - 2005 [3]	2.5
Light Duty Trucks		2.5
Medium duty vehicles (6001 - 8500 lbs. GVWR)		
with fuel tanks < 30 gallons		2.5
with fuel tanks > 30 gallons		3.0
(8501 - 14 000 lbs. GVWR)		3.5
Hybrid electric passenger cars		2.5
Hybrid electric light duty trucks		2.5
Hybrid electric medium duty vehicles		2.5

(1) Organic Material Hydrocarbon Equivalent for alcohol-fuelled vehicles.

(2) For purposes of this paragraph, “useful life” shall have the same meaning as provided in Title 13, California Code of Regulations

(3) The two-day diurnal plus hot soak evaporative emission standards (hereinafter “supplemental standards”) shall be phased-in beginning with the 1996 model year. Those vehicles certified under the running loss and useful life standards for the 1996 through 2005 model years must also be certified under the supplemental standards.

Zero-emission vehicles shall produce zero fuel evaporative emissions under any and all possible operational modes and conditions. Other options are reviewed in the **Appendix to Part 1**, **Section A.4.1.3**.

Table 4.4 Evaporative Emissions Limits - 2004 and Later Model Years

Vehicle Type	Hydrocarbon [1] Standards [2] [3] [4]		
	Running Loss (g/mile)	Three Day Diurnal + Hot Soak (g/test)	Two-Day Diurnal + Hot Soak (g/test)
Passenger cars	0.05	0.50	0.65
Light Duty Trucks			
6000 lbs. GVWR and under	0.05	0.65	0.85
6001 - 8500 lbs. GVWR	0.05	0.90	1.15
Medium duty vehicles (8501 - 14 000 lbs. GVWR)	0.05	1.00	1.25

(1) Organic Material Hydrocarbon Equivalent for alcohol-fuelled vehicles.

(2) For all vehicles certified to these standards, the “useful life” shall be 15 years or 150 000 miles, whichever first occurs.

(3) (a) These evaporative emission standards shall be phased-in beginning with the 2004 model year. Each manufacturer, except small volume manufacturers, shall certify at a minimum the specified percentage of its vehicle fleet to the evaporative emission standards in this table or the optional zero-evaporative emission standards according to the schedule set forth below. For purposes of this paragraph, each manufacturer’s vehicle fleet consists of the total projected California sales of the manufacturer’s gasoline-fuelled, liquefied petroleum-fuelled and alcohol-fuelled passenger cars, light duty trucks, medium duty vehicles, and heavy duty vehicles.

Model Year	Minimum % of Vehicles Certified
2004	40
2005	80
2006 and subsequent	100

A small volume manufacturer shall certify 100% of its 2006 and subsequent model vehicle fleet to the evaporative emission standards in the table or the optional zero-evaporative emission standards.
(b) 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.
(c) These evaporative emission standards do not apply to zero-emission vehicles.

(4) In-use compliance whole vehicle testing shall not begin until the motor vehicle is at least one year from the production date and has accumulated a minimum of 10 000 miles. For vehicles introduced prior to the 2007 model year, in-use compliance standards of 1.75 times the "Three-Day Diurnal + Hot-Soak" and "Two-Day Diurnal + Hot-Soak" gram per test standards shall apply for only the first three model years of an evaporative family certified to a new standard.

4.1.5. Hybrid Electric and Zero Emissions Vehicles - Exhaust Emission Standards

4.1.5.1. Introduction

On 24 April 2003, the ARB published Resolution 03-4 amending the Zero Emission Vehicle Regulation. Amendments to the existing regulation were needed to address legal challenges from the motor industry which prohibited the ARB from enforcing the regulation. Amendments were also needed to align the regulation with both the status of ZEV technology and market demand.

No pure ZEVs are ready for mass deployment and future ZEV development is difficult to predict. However the ARB's view is that real progress has been made on partial ZEV allowance vehicles (PZEVs) and "advanced technology PZEVs" (AT PZEVs). For example, 140 000 PZEV sales were expected in MY 2003. Note that pure ZEVs are often referred to as the "gold" category as they reduce emissions to the maximum feasible extent; AT PZEVs are referred to as the "silver" category and PZEVs are referred to as the "bronze" category. Further information can be found in **Part 2**, **Section B.1.4.6**.

4.1.5.2. Amendments to the Zero Emission Vehicle Regulation

The modifications to the regulation use a formula allowing a vehicle mix of 2% ZEVs, 2% AT-PZEVs (vehicles earning advanced technology partial ZEV credits) and 6% PZEVs. The ZEV obligation is based on the number of passenger cars and small trucks a manufacturer sells in California.

Alternatively, manufacturers may chose a new ZEV compliance strategy, meeting part of their ZEV requirement by producing their sales-weighted market share of approximately 250 fuel cell vehicles by 2008. The remainder of their ZEV requirements could be achieved by producing 4% AT-PZEVs and 6% PZEVs. The required number of fuel cell vehicles will increase to 2500 from 2009 - 2011, 25 000 from 2012 - 2014 and 50 000 from 2015 - 2017. Motor manufacturers can substitute battery electric vehicles for up to 50% of their fuel cell vehicle requirements.

4.1.6. Current Exhaust Emissions Legislation - Heavy Duty Vehicles

Table 4.5 Exhaust Emission Standards for Heavy Duty Diesel-Cycle Engines

Vehicle Category	Model Year	CO [1] (g/bhp.h)	NMHC [2] (g/bhp.h)	THC [2] (g/bhp.h)	NOx [3] (g/bhp.h)	PM [4] (g/bhp.h)
Diesel	from 1998	15.5	1.2	1.3	4.0	0.10
	from 2004	15.5	1.2	1.3	2.4	0.10
Urban Buses	from 1996	15.5	1.2	1.3	4.0	0.05 (0.07)[5]

(1) An idle limit of 0.5 %v/v CO applies to engines using exhaust after-treatment.

(2) NMHC are optional for all engines except methanol fuelled engines. For methanol engines THC limit is for OMHCE. A 0.05 g/bhp.h max limit for HCHO applies to methanol engines from 1996.

(3) Optional certification in 0.5 g/bhp.h NOx intervals below the limit allowed for the purpose of obtaining emissions credits. Useful life for NOx is 10 years for 1998 model year and later.

(4) Diesel engine smoke opacity limits of 20% in acceleration mode, 15% in lugging mode and 50% peak.

(5) In-use test value.

Table 4.6 California Emission Standards for 2005 and Subsequent Model Year Heavy Duty Otto-Cycle Engines [1]

Model Year	Emission Category	Emissions (g/bhp-hr)		
		NMHC + NOx	CO	HCHO
Standards for Heavy Duty Otto-Cycle Engines Used in Incomplete Medium Duty Vehicles: 8501 - 14 000 lb. GVWR [2]				
2005 and subsequent	ULEV	1.0 [3]	14.4	0.05
	SULEV	0.5	7.2	0.025
Standards for Heavy Duty Otto-Cycle Engines Used in Heavy Duty Vehicles - Over 14 000 lb. GVWR				
2005 and subsequent	n/a	1.0 [3]	37.1	0.05 [4]

(1) These standards apply to petroleum-, alcohol-, liquefied petroleum gas- and natural gas-fuelled Otto-cycle engines. Earlier standards are reported in **Part 2**, **Section B.4.1.11**.

(2) A manufacturer of engines used in incomplete medium duty vehicles may choose to comply with these standards as an alternative to the primary emission standards and test procedures for complete vehicles. A manufacturer that chooses to comply with these optional heavy duty engine standards and test procedures shall specify an in-use compliance test procedure.

(3) A manufacturer may request to certify to the Option 1 or Option 2 federal NMHC + NOx standards. However, for engines used in medium duty vehicles 8501 - 14 000 lbs. GVWR, the formaldehyde and carbon monoxide standards must meet the levels specified above.

(4) This standard only applies to methanol-fuelled Otto-cycle engines.

Table 4.7 HD Evaporative Emissions Limits

Vehicle Type	Model Year	Hydrocarbons [1]		
		Three-Day Diurnal +Hot Soak (grams/test) Useful Life [2]	Running Loss (grams/mile) Useful Life [2]	Two-Day Diurnal + Hot Soak (g/test) Useful Life [2]
Heavy Duty vehicles (over 14 000 lbs. GVWR)	1995 - 2005	2.0	0.05	-
	1996 - 2005	-	-	4.5
	Post 2004	1.0	0.05	1.25

(1) Organic Material Hydrocarbon Equivalent for alcohol-fuelled vehicles.

(2) For purposes of this table, “useful life” shall have the same meaning as provided in Title 13, California Code of Regulations.

4.1.7. 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. Exhaust emissions from new 1985 - 2003 heavy-duty diesel cycle urban bus engines are tabulated in **Part 2**, **Section B.4.1.12**. Limits for more modern vehicles shall not exceed the following:

Table 4.8 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.

4.1.8. Fleet Rule for Transit Agencies - Urban Bus Requirements

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. These rules are complex and will be found in the **Appendix to Part 1**, **Section A.4.1.7**.

4.1.9. 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. Details will be found in the **Appendix to Part 1**, **Section A.4.1.8**.

4.1.10. Motor Cycle Emissions Standards

Current and future emissions limits are shown in the following table:

Table 4.9 California Motor Cycle Emissions Standards (1)

Engine Displacement (cc)	Model Year	Emission Limits (g/km)		
		HC	HC+NOx	CO
50 - 279	From 1982	1.0	-	12.0
280 - 699	1988 - 2003	1.0 (2)	-	12.0
≥ 700	1998 - 2003	1.4 (2)	-	12.0
≥ 280	2004 - 2007	-	1.4	12.0
≥ 280	From 2008	-	0.8	12.0

(1) Measured over the FTP Urban Dynamometer Driving (UDDS) cycle, modified for small displacement models.

(2) Applied as a corporate average provided that each engine family shall have only one applicable standard. Refer to the legislation for details of the method of determining the "corporate average".

The background to this legislation will be found in **Part 2**, **Section A.4.1.9**

4.1.11. Non-road Diesel Emissions Standards

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

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

Manufacturers shall comply with the following exhaust emissions from new off-highway recreational vehicles and engines that are "sold, leased, used, or introduced into commerce" in California:

Table 4.10 California 1997 and Later Model Year Off-Road Recreational Vehicles and Engines Exhaust Emission Standards

Vehicle & Model Year	Emission Limits (g/km)			
	HC	NOx	CO	PM (1)
Off-Road Motorcycles and All-Terrain Vehicles with engines greater than 90 cc; 1977 and later	1.2 (2)	-	15.0	-
Off-Road Motorcycles and All-Terrain Vehicles with engines less than 90 cc; 1979 and later	1.2 (2)	-	15.0	-
All-Terrain Vehicles option; 1997 and later	All-Terrain Vehicle Shall comply with exhaust emission standards equivalent to the off-road motorcycle and all-terrain vehicle standard using the 1995 and later Utility and Lawn and Garden Equipment Engines standards			
Golf Carts in Federal Ozone Non-Attainment Areas; 1997 and later	0	0	0	0

(1) Applicable to diesel and two-stroke spark ignited engines only.

(2) Compliance with the 1.2 gram per kilometre HC standard to be applied as a "corporate average"

4.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

4.2.1. Gasoline

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

Table 4.11 The California Reformulated Gasoline Phase 2 and Phase 3 Standards

Property	Units	Flat Limits		Averaging Limits		Cap Limits	
		Phase 2	Phase 3	Phase 2	Phase 3	Phase 2	Phase 3
Vapour pressure (1)	psi	7.00	7.00 or 6.90 (2)	N/A	N/A	7.00 (3)	6.40 -7.20
Sulphur content	mg/kg	40	20	30	15	80	60 (4) / 30 (4)
Benzene content	%v/v	1.00	0.80	0.80	0.70	1.20	1.10
Aromatics content	%v/v	25.0	25.0	22.0	22.0	30.0 (3)	35.0
Olefins content	%v/v	6.0	6.0	4.0	4.0	10.0	10.0
T50	°F	210	213	200	203	220	220
T90	°F	300	305	290 (5)	295	330	330
Oxygen content	%m/m	1.8 - 2.2	1.8 - 2.2	N/A	N/A	1.8 (6) - 3.55 0 (6) - 3.55	1.8 (6) -3.5 (7) 0 (6) - 3.5 (7)
MTBE and other oxygenates		See Notes and Subsection entitled "Prohibition of MTBE and oxygenates other than ethanol in Californian gasoline starting 31 December 2003"					

(1) The Reid vapour pressure standards apply only during the warmer weather months.

(2) The 6.90 psi standard applies only when a producer or importer is using the evaporative emissions model element of the California RFG Phase 3 Predictive Model.

(3) For sales, supplies, or offers of California gasoline downstream of the production or import facility starting on the date on which early compliance with the California RFG Phase 3 standards is permitted by the executive officer, the RFG Phase 2 cap limits for Reid vapour pressure and aromatics content shall be 7.20 psi and 35.0% by volume respectively.

(4) The RFG Phase 3 sulphur content cap limits of 60 and 30 mg/kg are phased in starting 31 December 2002, and 31 December 2004, respectively.

(5) Designated alternative limit may not exceed 310°F.

(6) The 1.8%m/m minimum oxygen content cap only applies during specified winter months in specific areas.

(7) If the gasoline contains more than 3.5%m/m oxygen but no more than 10 %v/v ethanol, the maximum oxygen content cap is 3.7 %m/m.

Details relating to the cap limits will be found in the **Appendix to Part 1**, **Section A.4.2.1**.

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**.

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 and a typical certified formulation are given in the **Appendix to Part 1**, **Section A.4.2.2**.

4.2.3. Alternative Fuels

California specifications for alternative fuels are tabulated in the **Appendix to Part 1**, **Section A.4.2.3**.

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 in the **Appendix to Part 1**, **Section A.4.3**.

4.4. REFERENCE FUELS

4.4.1. Introduction

California has proposed alternative specifications to most of the US Federal Reference Fuels. The following should therefore be read in conjunction with **Section 3.4**.

4.4.2. Californian Certification Gasoline Specification

Fuel Property	Limits	Test Method [a]
Octane (R+M)/2	91 (min)	D2699-88, D 2700-88
Sensitivity	7.5 (min)	D2699-88, D2700-88
Lead	0.01 g/US gal (max); no lead added	D3237, §2253.4(c), title 13 CCR
Distillation range °F: [b]		D 86, §2263, title 13 CCR[b]
IBP		
10%	130 - 150	
50% [c]	200 - 210	
90% [d]	290 - 300	
FBP, maximum	390	
Residue	2.0%v/v (max)	
Sulphur	30 - 40 mg/kg	D 1266, §2263, title 13 CCR
Phosphorous	0.005 g/gal (max)	D3231, §2253.4(c), title 13 CCR
VP	6.7 - 7.0 psi	D323, §2263, title 13 CCR
Olefins	4.0 - 6.0%v/v	D1319, §2263, title 13 CCR
Total aromatic hydrocarbons	22 - 25%v/v	
Benzene	0.8 - 1.0%v/v [e]	
Multi-substituted alkyl aromatic hydrocarbons	12 - 14 v/v % [f]	
MTBE	10.8 - 11.2 v/v %	§2263, title 13 CCR
Additives	[h]	
Copper corrosion	No. 1	D 130-88
Gum, washed	3.0 mg/100 ml (max)	D 381-86
Oxidation stability	1000 minutes (min)	D 525-88
Specific gravity	Report [g]	
Heat of combustion	Report [g]	
Carbon	Report wt. % [g]	
Hydrogen	Report wt. % [g]	

- The Californian proposed alternative can be used as an alternative to the Federal specification for certification to the 2001 Californian emission standards.
- Unleaded gasoline representative of commercial gasoline which will be generally available through retail outlets shall be used in service accumulation.

a) ASTM specification unless otherwise noted. A test method other than that specified may be used following a determination that the other method produces results equivalent to the results with the specified method.

b) Although §2263, title 13, CCR refers to the temperatures of the 50 and 90% points, this procedure can be extended to the 10% and end point temperatures, and to the determination of the residue content.

c) The range for inter-laboratory testing is 195-215^{o} F.

d) The range for inter-laboratory testing is 285-305^{o} F.

e) The range for inter-laboratory testing is 0.7-1.1% by volume.

f) "Detailed Hydrocarbon Analysis of Petroleum Hydrocarbon Distillates, Reformates, and Gasoline by Single Column High Efficiency (Capillary) Column Gas Chromatography," by Neil Johansen, 1992, Boulder, CO.

g) The fuel producer should report this fuel property to the fuel purchaser. Any generally accepted test method may be used and shall be identified in the report.

h) Sufficient to meet requirements of §2257,title 13 CCR

4.4.3. Californian Certification Diesel Fuel Specification

Fuel Property	Limit	Test Method [(a)]
Natural cetane number	47 - 55	D 613-86
Distillation Range °F		D 86, §2282(g)(3), title 13, CCR
IBP	340 - 420	
10% point	400 - 490	
50% point	470 - 560	
90% point	550 - 610	
FBP	580 - 660	
API gravity	33 - 39	D 287-82
Total sulphur	0.01 - 0.05% mass	D 2622, §2282(g)(3), title 13, CCR
Additives		
Nitrogen content	100 - 500 ppm m/m	§2282(g)(3), title 13, CCR
Total aromatic hydrocarbons	8 - 12%v/v	D 1319, §2282(g)(3), title 13, CCR
Polycyclic aromatic hydrocarbons	1.4 wt. % (max)	
Flashpoint	130 °F (max)	D 93-80
Viscosity @ 40°F, mm^2/s	2.0 - 4.1	D 445-83

- The Californian proposed alternative can be used as an alternative to the Federal specification for certification to the 2001 Californian emission standards.
- Diesel fuel representative of commercial diesel fuel which will be generally available through retail outlets shall be used in service accumulation.

(a) ASTM specifications unless otherwise noted. A reference to a subsection of §2282, title 13, CCR, means the test method identified in that subsection for the particular property. A test method other than that specified may be used if the other method produces results equivalent to the results of the specified method.

4.4.4. Californian Certification Alcohol Fuels Specifications

Specification	California (Proposed Alternative)Limit
M-100 Fuel Methanol	
Methanol	98.0 ± 0.5%v/v
Ethanol	1.0 ± 0.1%v/v
Petroleum fuel	1.0 ± 0.1%v/v
E-100 Fuel Ethanol	
Ethanol	98.0 ± 0.5%v/v
Methanol	1.0 ± 0.1%v/v
Petroleum fuel	1.0 ± 0.1%v/v

US Federal regulations do not specify an ethanol fuel. The US Federal specification for methanol fuel simply calls for a product which is representative of commercially available methanol fuel, containing at least 50% methanol by volume. The Californian proposed alternative can be used for certification to the 2001 Californian emission standards.

- **Mileage accumulation fuel**. For Otto-cycle or diesel alcohol vehicles and hybrid electric vehicles which use Otto-cycle or diesel alcohol engines, methanol or ethanol fuel used for service accumulation have to meet the applicable specifications in section 2292.1, title 13, CCR, (Specifications for M-100 Fuel Methanol) or section 2292.3 (Specification for E-100 Fuel Ethanol).
- **Fuel additives and ignition improvers** intended for use in alcohol test fuels must be officially approved. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

4.4.5. Californian Certification Mixtures of Petroleum and Alcohol Fuels Specification for Flexible Fuel Vehicles

Specification	California (Proposed Alternative)Limit
M-85 Fuel Methanol	
Petroleum fuel.	13-16%v/v
Reid vapour pressure	8.0-8.5 psi, using common blending components from the gasoline stream.
E-85 Fuel Ethanol	
Petroleum fuel	15-21%v/v
Reid vapour pressure	8.0-8.5 psi, using common blending components from the gasoline stream.

The US Federal Regulations simply call for a flexible fuel to comprise an appropriate petroleum fuel and a methanol fuel representative of the fuel expected to be found in use. The Californian proposed alternative can be used for certification to the 2001 Californian emission standards.

- **Mileage accumulation fuel.** For flexible fuel Otto-cycle or diesel alcohol vehicles and hybrid electric vehicles that use Otto-cycle or diesel alcohol engines, petroleum fuel must meet the applicable specifications in Part II, Sections A.100.3.1 or 100.3.2 and methanol or ethanol fuel must meet the applicable specifications set out in section 2292.2, title 13, CCR, (Specifications for M-85 Fuel Methanol) or section 2292.4 (Specification for E-85 Fuel Ethanol). Mileage accumulation procedures are subject to the requirements of 40 CFR §86.1831-01(a) and (b) and require prior approval. A manufacturer shall consider expected customer fuel usage as well as emissions deterioration when developing its durability demonstration.

- **Evaporative emission test fuel for emission-data and durability-data vehicles.** For Otto-cycle or diesel alcohol vehicles and hybrid electric vehicles which use Otto-cycle or diesel alcohol engines, a blend of methanol or ethanol fuel used for evaporative emission testing must meet the applicable specifications in section 2292.2, title 13, CCR, (Specifications for M-85 Fuel Methanol) or section 2292.4 (Specifications for E-85 Fuel Ethanol) and gasoline meeting the specifications of Part II section A.100.3.1 of these test procedures such that the final blend is composed of either 35%v/v methanol (± 1.0%v/v of total blend) for methanol-fuelled vehicles or 10%v/v ethanol (± 1.0%v/v of total blend) for ethanol-fuelled vehicles. Alternative alcohol-gasoline blends may be used in place of M35 or E10 if demonstrated to result in equivalent or higher evaporative emissions.
- **Additive requirements.** Fuel additives and ignition improvers intended for use in alcohol test fuels must be approved. In order for such approval to be granted, a manufacturer must demonstrate that emissions will not be adversely affected by the use of the fuel additive or ignition improver.

4.4.6. Californian Certification Natural Gas Fuel Specification

Specification	California (Proposed Alternative) [(a) (b)]
Methane	90.0 ± 1.0% mole/mole (min)
Ethane	4.0 ± 0.5% mole/mole (max)
C_3 and higher hydrocarbon content	2.0 ± 0.3% mole/mole (max)
C_6 and higher hydrocarbon content	
Oxygen	0.5% mole/mole (max)
Inert gases (CO_2 + N_2)	3.5 ± 0.5%v/v (max)

(a) Californian proposed alternative, which can be used for certification to the 2001 Californian emission standards.

(b) **Mileage accumulation fuel.** For dedicated, dual-fuelled or hybrid electric vehicles which use natural gas, fuel used for service accumulation shall meet the specifications listed in section 2292.5, title 13, CCR, (Specifications for Compressed Natural Gas).

4.4.7. Californian Certification Liquefied Petroleum Gas Fuel Specification

Specification	California (Proposed Alternative)Limit [(a) (b)]
Propane	93.5 ± 1.0%v/v
Propene	3.8 ± 0.5%v/v
Butane and heavier components	1.9 ± 0.3%v/v

- US Federal regulations simply call for the use of commercially available LPG. The Californian proposed alternative can be used for certification to the 2001 Californian emission standards.
- **Mileage accumulation fuel**. For dedicated, dual-fuelled or hybrid electric vehicles which use liquefied petroleum gas, fuel used for service accumulation has to meet the specifications listed in section 2292.6, title 13, CCR, (Specifications for Liquefied Petroleum Gas).

4.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

4.5.1. Fuel Consumption Regulations

See **Section 3.5.1**.

4.5.2. Proposed Regulations to Control Motor Vehicle Greenhouse Gas Emissions

Introduction

In December 2004 CARB reported to the Legislature and Governor with their proposals. In setting greenhouse gas emission standards, CARB performed a detailed evaluation of the technologies and fuels available to reduce vehicular greenhouse gas emissions, the reductions that could be achieved, and their cost. The technology assessment reviewed baseline vehicle attributes and their contribution to atmospheric climate change emissions, and evaluated technologies that have the potential to decrease these emissions. The technologies explored are currently used on some vehicle models, or have been demonstrated by auto companies and/or vehicle component suppliers in at least prototype form.

Based on the technology evaluation, the regulation approved by the Board imposes climate change emission standards that are incorporated into the current Low-Emission Vehicle (LEV) programme, along with the other light and medium-duty automotive emission standards. This approach was taken to ensure that manufacturers can meet the standards while continuing to provide the full range of vehicles available today. The standards phase in during the 2009 through 2016 model years, allowing changes to be made as part of the normal product improvement cycle. When fully phased in, the near term (2009-2012) standards will result in about a 22% reduction in greenhouse gas emissions as compared to the 2002 fleet, and the mid-term (2013-2016) standards will result in about a 30% reduction.

Motor manufacturers have criticized the staff technology analysis and cost estimates. The primary issues raised include the effect of the proposal on vehicle cost, vehicle availability, and vehicle attributes. CARB has reviewed the various issues raised and has not identified any concerns that lead to a change in their conclusions.

Content of the Proposed Regulation

The greenhouse gas emission standards are incorporated into the current Low-Emission Vehicle (LEV) programme, along with the other light and medium-duty automotive emission standards. Because different pollutants vary in the severity of their climate change impact, the standards are expressed in terms of "CO_2-equivalent" emissions. Accordingly, there is one CO_2-equivalent fleet average emission requirement for the passenger car/light-duty truck 1 (PC/LDT1) category, and another for the light-duty truck 2 (LDT2) category, just as the LEV programme currently has fleet average NMOG emission requirements for both categories of vehicles.

The standards approved by the Board phase in during the 2009 through 2016 model years, allowing changes to be made as part of the normal product improvement

cycle. The specific standards, by vehicle type and model year, are presented in **Table 4.12** below:

Table 4.12 CO_2-equvalent Emissions Standards

Tier	Year	CO_2-equivalent Emission Standard (g/mile)	
		PC/LDT1 (1)	LDT2 (2)
Near-term	2009	323	439
	2010	301	420
	2011	267	390
	2012	233	361
Mid-term	2013	227	355
	2014	222	350
	2015	213	341
	2016	205	332

(1) Passenger cars and small trucks/SUVs.

(2) Large trucks/SUVs

The regulation takes into account and fully credits any differences in greenhouse gas emissions due to the use of alternative fuels. To maintain simplicity, the regulation uses the upstream emissions for vehicles that use conventional fuels as a "baseline" against which to compare the relative merits of alternative fuel vehicles. Therefore, the emissions standards as shown above do not directly reflect upstream emissions. Rather, when certifying gasoline or diesel-fuel vehicles manufacturers report only the "on vehicle" emissions. For alternative fuel vehicles, exhaust CO_2 emissions values are adjusted in order to compensate for the differences in upstream emissions. This approach simplifies the regulatory treatment of gasoline vehicles, while at the same time recognizing any emission changes due to the use of alternative fuels.

The regulation allows manufacturers significant flexibility in complying with the proposed emission standards. Specifically, the regulation would allow manufacturers to average emissions across their vehicle models, aggregate the different climate change pollutants, bank excess credits for later use, and trade credits in order to meet the greenhouse gas emission standards. The regulation also includes an alternative compliance mechanism.

Small Volume, Independent Low Volume, and Intermediate Volume manufacturers are not required to comply with the climate change requirements until the final year of the phase-in (2016).

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 summarised below and dealt with more fully in the **Appendix to Part 1**, **Section A.4.6**.

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 only perform 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 4.13** compares the Enhanced and Basic I/M programmes in more detail. The key additional elements of the Enhanced programme are shown in bold.

Table 4.13 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**

Additional details and the Bureau of Automobile Repair (BAR) Regulations are summarised in the **Appendix to Part 1**, **Section A.4.6.1**.

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 original OBD regulation specified monitoring requirements for the oxygen sensor, EGR system and other emissions-related components. In July 1990 the CARB adopted the so-called OBD II regulations. These required 1994 and subsequent model passenger cars, light-duty trucks and medium-duty vehicles and engines, to be fitted with on-board diagnostic systems to monitor catalyst efficiency, engine misfire, evaporative system integrity, secondary air injection, and chlorofluorocarbon (CFC) containment. These requirements were amended in 1991, 1993 and more extensively in 1995. The amendments allow manufacturers to take advantage of advances in technology in meeting the requirements and to allow more time to address the problems associated with low emissions vehicles, and

vehicles with engines using diesel fuel, alternative fuels or with lean-burn combustion systems. 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). More information on the OBD II requirements will also be found in the **Appendix to Part 1**, **Section A.4.6.2**.

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).

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. Further details will be found in the **Appendix to Part 1**, **Section A.4.6.4**.

5. CANADA REGULATIONS

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.

5.1.1. 2004 Emissions Legislation - Light Duty Vehicles and Light Duty Trucks

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 apply to vehicles and engines that are manufactured or imported into Canada on or after January 1 2004. They essentially establish emission standards and test procedures for on-road vehicles and engines that are aligned with those of the US EPA and are described in greater detail in the **Appendix to Part 1**, **Section A.5.1.1**.

5.1.2. Future Emissions Legislation - Heavy Duty Vehicles and Engines

The new chassis-based exhaust emission standards and phase-in schedules for complete heavy duty vehicles again follow US EPA rules and are summarized in the **Appendix to Part 1**, **Section A.5.1.2**.

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.

5.1.4. Future Emissions Legislation - Background Details and Additional Information

See the **Appendix to Part 1**, **Section A.5.1.4**.

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. Please refer to the **Appendix to Part 1**, **Section A.5.1.5** for further details.

5.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

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. Key elements include:

- Benzene at 1% flat or 0.95 v/v% yearly pool average (YPA), by 1 July 1999.
- Maximum batch-to-batch ceiling of 1.5 v/v% benzene if using YPA.
- The Benzene Emissions Number (BEN) calculated by a modified EPA Complex Model, must be capped at prescribed industry baselines, either as flat limits or as YPAs, beginning 1 July 1999, adjusted for benzene reductions in 1999, or capped at an individual refinery's own YPA baseline for either of the years 1994, 1995 or 1996.
- The Regulations include detailed provisions for sampling analyses, auditing and record keeping to ensure compliance with the YPAs.

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.

Vapour pressure controls at marketing and distribution systems were recommended for existing facilities in the Lower Fraser Valley (LFV) and the Windsor Quebec Corridor. These facilities were regulated in the LFV in 1995, in Ontario in 1994 and in Quebec (Montreal area only) in 1998. In 1995 British Columbia further reduced the maximum summertime limit on vapour pressure to 8 psi or 55 kPa from 16 July to 14 August in the Lower Fraser Valley. If the gasoline contains alcohols produced wholly from biomass or by ethers where the alcohol component of the ether is produced wholly from biomass and the oxygen content is 3.4% by weight or greater, the gasoline vapour pressure can be 7 kPa greater than the regulated standard between 15 April and 15 September each year.

Reduced vapour pressure for the Ontario part of the Windsor-to-Montreal Corridor (WMC) was regulated by Ontario for the summer of 1997 to 62 kPa (9 psi). Quebec also regulated 62 kPa (9 psi) summer gasoline in the Montreal area in 1998.

Sulphur

The final Sulphur in Gasoline Regulations were published in the Canada Gazette, Part II, 23 June 1999. The regulations set the phase-in introduction of low-sulphur gasoline as follows:

- Maximum of 170 mg/kg sulphur (every batch), effective 1 July 2002 **or**
- 150 mg/kg (annual pool average) for the period between 1 July 2002 and 31 December 2004.
- Refiners and importers can choose to meet an average of 150 mg/kg for the thirty month period between 1 July 2002 and 31 December 2004 or meet the 150 mg/kg for each annual period (1 July 2002 to 31 December 2002, year 2003, and year 2004)

- Maximum of 300 mg/kg, effective 1 October 2003, for refiners and importers who chose to meet the regulations based on annual pool average.
- Maximum of 40 mg/kg sulphur (every batch), effective 1 January 2005 **or**
- 30 mg/kg (annual pool average), and a maximum of 80 mg/kg sulphur, every single batch.
- Maximum of 80 mg/kg sulphur, effective 1 April 2005, at the retail level, throughout Canada.

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.

In May 2001, Environment Canada published a notice requiring details (from 1991 onward) of MTBE or gasoline containing >0.6% MTBE, either imported, produced and/or blended, exported, leaked or spilled. Details of preventative measures for leaks etc., and projections of future use were also required. Responses to the Notice were due by 31 July 2001.

Following a review of this information, Environment Canada will consider whether further action in respect of MTBE is warranted.

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).

Table 5.1 British Columbia Cleaner Gasoline Standard

Parameter	Summer	Winter
Vapour pressure (psi)	9.4, 11.0 or 12.9 (1)	15.5
Benzene (%v/v)	1.8 (2)	2.1 (2)
Sulphur (% mass)	0.0250 (3) (4)	0.0250 (3) (4)
Aromatics (%v/v)	41.6 (5)	37.1 (5)
Olefins (%v/v)	16 (5)	18.3 (5)
Oxygenates (%m/m)	0.53	0.14
Distillation - E200°F (%v/v)	50	58
Distillation - E300°F (%v/v)	83.3	87.7

(1) Vapour pressure is set to 9.4 psi for gasoline possessed for sale in the Lower Fraser Valley, 11.0 psi for gasoline possessed for sale in Zone 1 of British Columbia except for the Lower Fraser Valley, and

12.9 psi for gasoline possessed for sale in Zone 2 of British Columbia, where Zone 1 and 2 are as specified in the standard referred to section 1(a) of Schedule 1.

(2) The summer and winter value for benzene is set to 0.95 per cent by volume on and after 1 January, 1999.

(3) On and after 1 January 1999, the summer and winter value for sulphur is set to 0.015% mass for gasoline possessed for sale in the Lower Fraser Valley and Vancouver Island.

(4) On and after 1 January 2000, the summer and winter volume for sulphur is set to 0.020% mass for gasoline possessed for sale in that part of British Columbia not referred to in note 3.

(5) On and after 1 January 2005, the values for aromatics are 33.3 and 29.7 per cent by volume in the summer and winter, and for olefins are 12.8 and 14.6 per cent by volume in the summer and winter.

- For the period 1 January 1996 to 31 December 1998, the director may approve an alternative baseline gasoline to that specified in Columns 2 and 3 for individual primary distributors, except for the parameter of vapour pressure.
- For the period 1 January 1999 to 31 December 2000, the director may approve an alternative baseline gasoline to that specified in Columns 2 and 3 for individual primary distributors, except for the parameters of vapour pressure, benzene and sulphur.

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 5.2**, 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 5.2 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 5.2**, with the adjustment for altitude and climatic conditions specified in the **Appendix to Part 1**, **Section A.5.2.2**. 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 5.3 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.

Given the land mass of Canada and the extreme variations in temperature, the seasonal and geographical schedules of antiknock index reductions, vapour pressure class and distillation class characteristics are highly complex and will be found in the **Appendix to Part 1**, **Section A.5.2.2**.

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 5.4** 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 5.4 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 5.4**, with the adjustment for altitude and climatic conditions specified in the **Appendix to Part 1, Section A.5.2.3**. ASTM Methods D 269-93, D 270-03 or D 2885 may be used, (The latter two are referee method(s) to be used in the event of a dispute).

Table 5.5 Detailed Requirements

Characteristic	All Grades		Test Method ASTM
	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, mg/kg)		1000	D 1266, D 2622, D 3120), D 4294
Corrosion, Steel in Water		B+	NACE TM0172
Oxygen Content, (%m/m)	0.5	3.7	
Ethanol, %v/v of Oxygenate	50.0		D 4815
Methanol Content, (%v/v)		0.3	D 4815
Antiknock Performance	See **Tables 5.4** and the **Appendix to Part 1, Section A.5.2.3**		D 2699 and D 2700 D 2885
Vapour Pressure	See the **Appendix to Part 1, Section A.5.2.3**		D 4953, D 5190 D 5191
Distillation			D 86
Water Tolerance			D 4814, Annex A3

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 5.6 Ethanol Limit Values

Ethanol Characteristic	Min	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.

Given the land mass of Canada and the extreme variations in temperature, the seasonal and geographical schedules of antiknock index reductions, vapour pressure class, water tolerance and distillation class characteristics are highly complex and will be found in the **Appendix to Part 1**, **Section A.5.2.3**.

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.

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.

This standard applies to four types of diesel fuel, Type A-LS, Type A-ULS, Type B-LS and Type B-ULS, intended for use in high-speed diesel engines that require low-sulphur diesel fuel to meet emission control regulations. Types A-LS and A-ULS are intended for use in urban transit buses and passenger automobiles or when ambient temperatures require better low temperature properties than those specified for Types B-LS and B-ULS. Types B-LS and B-ULS are intended for use in engines in services involving relatively high loads as found in industrial and heavy mobile equipment, such as intercity trucks and construction equipment, and when ambient temperatures and fuel storage conditions allow use of such fuel. The - ULS grades are identical to the - LS grades, with the exception of sulphur content:

Table 5.7 Specified Limiting Values

Characteristics	Type A-LS		Type B-LS		ASTM Test Method
	min	max	min	max	
Flash point, (°C)	40.0	-	40.0	-	D 93 or D 3828
Kinematic viscosity at 40°C, (mm^2/s) (1)	1.30	3.60	1.70	4.10	D 445
Distillation, 90% recovered, (°C)	-	290.0	-	360.0	D 86
Water and sediment, (%v/v)	-	0.05	-	0.05	D 1796 (modified) or D 2709
Acid number, (mg KOH/g)	-	0.10	-	0.10	D 974
Sulphur, (mg/kg):					
Types A-LS and B-LS	-	500		500	D 2622 or D 5453 (2)
Types A-ULS and B-ULS	-	15		15	
Copper strip corrosion, 3 h at 50°C	-	No. 1	-	No. 1	D 130
Carbon residue on 10% bottoms, (%m/m):					
a.	-	0.10	-	0.16	D 4530 (3)
b.	-	0.15	-	0.20	D 524 (3)
Ash, (%m/m)	-	0.010	-	0.010	D 482
Ignition quality, cetane number (4)	40.0	-	40.0	-	D 613
Electrical conductivity at point, time and temperature of delivery to purchaser, pS/m (5)	25	-	25	-	D 2624

(1) If the fuel is designed for an operability temperature of below - 20°C, then the minimum viscosity shall be 1.30 mm2/s.

(2) For Types A-ULS and B-ULS testing shall be conducted in accordance with ASTM D 5453.

(3) Testing shall be performed prior to the addition of any additives to the fuel. ASTM D 524 may be used as an alternative test to ASTM D 4530. (0.15% by ASTM D 524 is equivalent to 0.10% by ASTM D 4530, and 0.20% by ASTM D 524 is equivalent to 0.16% by ASTM D 4530.) In the event of a dispute, ASTM D 4530 shall be the referee test method.

(4) The calculated cetane index according to ASTM D 976 or D 4737, CAN/CGSB-3.0 No. 20.9, or other calculation techniques that approximate cetane number by ASTM D 613, may be used with the diesel fuel for control purposes. The user should refer to the appropriate test method. Calculation techniques shall not be used for determining the ignition quality of fuel containing cetane improver additives. Derived cetane number using ASTM D 6890 may be used for control purposes for diesel fuel with or without a cetane improver additive. In the event of a dispute, ASTM D 613 shall be the referee test method.

(5) Due to the normal depletion of fuel conductivity during commingling, storage, and distribution, or at low temperatures, the fuel should be sufficiently treated with conductivity-improver additive to ensure that the electrical conductivity requirement is met. The temperature at the point of use and the method of distribution could require a substantially higher conductivity level than 25 pS/m at the point of additive treatment. For more information on this subject, see ASTM D 4865 and D 2624.

- A lubricity additive shall be incorporated in the base fuel when the operability temperature is - 20°C or lower. This requirement is based upon a correlation between the operability temperature and Lab Bench test results (using the high frequency reciprocating rig test) as described in SAE Paper 961181. When test results on a representative base fuel for any one of the criteria listed below are available, they shall take precedence over the above requirement.

  If a lubricity additive is required, its dosage must be shown to provide acceptable performance in a representative fuel and to give acceptable performance in accordance with any one of the following criteria:

  Pump Wear with a Representative Fuel in a Distributor-Type Diesel Fuel Injection Pump in a Vehicle Field Test. The required vehicle field test methodology is described in SAE Paper 952370. An acceptable pump-wear result is defined as an Overall Pump Rating of 4.0 or less using the rating method described in SAE Paper 961180.

  Pump Wear with a Representative Fuel in a Distributor-Type Diesel Fuel Injection Pump Rig Test. The required pump rig test methodology is described in SAE Paper 981363. SAE Papers 961180 and 952370 provide additional background information. An acceptable pump-wear result is defined as an Overall Pump Rating of 4.0 or less using the rating method described in SAE Papers 981363 and 961180.

  Pump Wear with a Representative Fuel in a Rotary-Type Diesel Fuel Injection Pump Rig Test. The required pump rig test methodology and rating method are described in SAE Paper 961944. An acceptable pump-wear result is defined as an Overall Pump Rating of 5.3 or less using the rating method described in SAE Paper 961944.

  Lab Bench Test Results with a Representative Fuel Using the High Frequency Reciprocating Rig Test. The required high frequency reciprocating rig test is described in ASTM D 6079 and shall be run at 60°C. An acceptable test result is defined as a wear scar diameter of less than 460 µm at 60°C.

  Lab Bench Test Results with a Representative Fuel Using the Scuffing Load BOCLE Test. The required test is described in ASTM D 6078. An acceptable test result is defined as a scuffing load of greater than
  3100 g.

Low-Temperature Flow Properties

Given the land mass of Canada and the extreme variations in temperature, it is not possible to replicate in this publication the complexities of the cold operability requirements. Interested readers should consult the appropriate source documents. The following guidelines will be found in the standard:

Low-temperature flow properties of the fuel shall be designed to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature for the period and location of intended use. However, when the 2.5% low-end

design temperature is colder than - 48°C, a fuel meeting a - 48°C operability limit may be provided.

The following shall be reported:

a. The 2.5% low-end temperature to which the fuel is designed.

b. The test method used to determine the operability temperature:

i. Cloud point (ASTM D 2500 or D 5773); or
ii. Wax appearance point (ASTM D 3117); or
iii. Low-temperature flow test (LTFT) for diesel fuels.

c. The test method result.

In some remote northern locations a single fuel conforming to both Jet A-1 and diesel fuel requirements is commonly used.

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.

Table 5.8 Specified Limiting Values

Characteristics	Type A		Type B		Test Method	
	min	max	min	max	ASTM	CGSB
Flash point, (°C)	40.0	-	40.0	-	D 93 or D 3828	-
Kinematic viscosity at 40°C, (mm^2/s) (1)	1.30	3.60	1.70	4.10	D 445	-
Distillation, 90% recovered, (°C)	-	290.0	-	360.0	D 86	-
Water and sediment, (%v/v)	-	0.05	-	0.05	D 1796 (modified) or D 2709	-
Acid number, (mg KOH/g)	-	0.10	-	0.10	D 974	-
Sulphur, (mg/kg) (2)	-	3000	-	5000	D1266 D 1552 D 2622 D 4294 or D 5453	CAN/CGSB-3.0 No. 16.0
Copper strip corrosion, 3 h at 50°C	-	No. 1	-	No. 1	D 130	
Carbon residue on 10% bottoms, (%m/m):						
a.	-	0.10	-	0.16	D 4530 (3)	
b.	-	0.15	-	0.20	D 524 (3)	
Ash, (%m/m)	-	0.010	-	0.010	D 482	
Ignition quality, cetane number (4)	40.0	-	40.0	-	D 613	
Electrical conductivity at point, time and temperature of delivery to purchaser, pS/m (5)	25	-	25	-	D 2624	

(1) If the fuel is designed for an operability temperature of below - 20°C, then the minimum viscosity shall be 1.30 mm^2/s.

(2) Reference method in case of dispute: ASTM D 5453.

(3) Testing shall be performed prior to the addition of any additives to the fuel. ASTM D 524 may be used as an alternative test to ASTM D 4530. (0.15% by ASTM D 524 is equivalent to 0.10% by ASTM D 4530, and 0.20% by ASTM D 524 is equivalent to 0.16% by ASTM D 4530.) In the event of a dispute, ASTM D 4530 shall be the referee test method.

(4) The calculated cetane index according to ASTM D 976 or D 4737, CAN/CGSB-3.0 No. 20.9, or other calculation techniques that approximate cetane number by ASTM D 613, may be used with the diesel fuel for control purposes. The user should refer to the appropriate test method. Calculation techniques shall not be used for determining the ignition quality of fuel containing cetane improver additives. Derived cetane number using ASTM D 6890 may be used for control purposes for diesel fuel with or without a cetane improver additive. In the event of a dispute, ASTM D 613 shall be the referee test method.

(5) Due to the normal depletion of fuel conductivity during commingling, storage, and distribution, or at low temperatures, the fuel should be sufficiently treated with conductivity-improver additive to ensure that the electrical conductivity requirement is met. The temperature at the point of use and the method of distribution could require a substantially higher conductivity level than 25 pS/m at the point of additive treatment. For more information on this subject, see ASTM D 4865 and D 2624.

- A lubricity additive shall be incorporated in the base fuel when the operability temperature is - 20°C or lower. This requirement is based upon a correlation between the operability temperature and Lab Bench test results (using the high frequency reciprocating rig test) as described in SAE Paper 961181. When test results on a representative base fuel for any one of the criteria listed in the footnotes to **Table 5.7** are available, they shall take precedence over the above requirement.

Low-Temperature Flow Properties

Given the land mass of Canada and the extreme variations in temperature, it is not possible to replicate in this publication the complexities of their cold operability requirements. Interested readers should consult the appropriate source documents. The following guidelines will be found in the standard:

Low-temperature flow properties of the fuel shall be designed to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature for the period and location of intended use. However, when the 2.5% low-end design temperature is colder than - 48°C, a fuel meeting a - 48°C operability limit may be provided.

The following shall be reported:

a. The 2.5% low-end temperature to which the fuel is designed.

b. The test method used to determine the operability temperature:

i. Cloud point (ASTM D 2500 or D 5773); or
ii. Wax appearance point (ASTM D 3117); or
iii. Low-temperature flow test (LTFT) for diesel fuels.

c. The test method result.

In some remote northern locations a single fuel conforming to both Jet A-1 and diesel fuel requirements is commonly used.

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.

These types and their general applicability for use in diesel engines are broadly indicated as follows:

- Type A-LS, Bx is intended for use in urban transit buses and passenger automobiles or when ambient temperatures require better low-temperature properties than Type B-LS, Bx.
- Type B-LS, Bx is intended for use in engines in services involving relatively high loads as found in industrial and heavy mobile equipment, such as intercity trucks and construction equipment, and when ambient temperatures and fuel storage conditions allow use of such fuel.

Both types, Type A-LS, Bx and Type B-LS, Bx, may be used interchangeably with fuel meeting CAN/CGSB-3.517, Types A-LS and Type B-LS respectively.

Biodiesel Ester Requirements

The biodiesel ester component shall comply with ASTM D 6751 or EN 14214. The maximum allowable concentration of biodiesel ester shall be 5% by volume in the finished fuel blend. (Note: This level is based upon existing experience with biodiesel fuel blends and the position taken by equipment manufacturers).

A minimum level of 1.0% by volume biodiesel ester is specified to differentiate this standard from similar standards. The concentration of 1.0% is intentionally stated to one decimal place to ensure that the minimum concentration of biodiesel ester in a fuel identified as a low-level biodiesel fuel blend shall be at least 0.95% by volume.

Percentage concentrations of biodiesel ester (x) shall be expressed in whole numbers, such as 5% by volume, with the exception that a low-level biodiesel fuel blend at the minimum concentration of the allowable range shall be expressed as 1.0% by volume. Normal rounding practices in accordance with the Rounding-off method of ASTM E 29 apply. When reporting the concentration of the biodiesel ester used to prepare a blend, metered (measured) volumes may be used in place of analytical tests when the component is added.

Low-Temperature Flow Properties

Given the land mass of Canada and the extreme variations in temperature, it is not possible to replicate in this publication the complexities of the cold operability requirements. Interested readers should consult the appropriate source documents. The following guidelines will be found in the standard:

Low-temperature flow properties of the fuel shall be designed to give satisfactory performance at the temperatures indicated by the 2.5% low-end design temperature for the period and location of intended use. However, when the 2.5% low-end design temperature is colder than - 48°C, a fuel meeting a - 48°C operability limit may be provided.

The following shall be reported:

a. The 2.5% low-end temperature to which the fuel is designed.

b. The test method used to determine the operability temperature:

i. Cloud point (ASTM D 2500 or D 5773); or
ii. Wax appearance point (ASTM D 3117); or
iii. Low-temperature flow test (LTFT) for diesel fuels.

c. The test method result.

Table 5.9 Specified Limiting Values

Property	Type A-LS, Bx		Type B-LS, Bx		Test Method
	min	max	min	max	
Flash point, (°C)	40.0	-	40.0	-	ASTM D 93 or ASTM D 3828
Kinematic viscosity at 40°C, (mm^2/s)	1.30	3.60	1.70 (1)	4.10	ADTM D 445
Distillation, 90% recovered, (°C)	-	290.0	-	360.0	ASTM D 86
Water and sediment, (%v/v)	-	0.05	-	0.05	ASTM D 1796 (modified) or ASTM D 2709
Acid number, (mg KOH/g)	-	0.10	-	0.10	ASTM D 974
Sulphur, mg/kg	-	500	-	500	ASTM D 2622, ASTM D 5453 or CAN/CGSB-3.0 No. 16.0
Copper strip corrosion, 3 h at 50°C	-	No. 1	-	No. 1	ASTM D 130
Carbon residue on 10% distillation residue, % by mass	-	0.10	-	0.16	ASTM D 4530
Ash, % by mass	-	0.010	-	0.010	ASTM D 482
Ignition quality, cetane number	40.0	-	40.0	-	ASTM D 613
Electrical conductivity at point, time and temperature of delivery to purchaser, (pS/m) (.2)	25	-	25	-	ASTM D 2624

(1) If the fuel is designed for an operability temperature of below -20°C, then the minimum viscosity shall be 1.30 mm^2/s.

(2) Due to the normal depletion of fuel conductivity during commingling, storage and distribution, or at low temperatures, the fuel should be sufficiently treated with conductivity improver additive to ensure that the electrical conductivity requirement in par. 6.19 is met. The temperature at the point of use and the method of distribution could require a substantially higher conductivity level than 25 pS/m at the point of additive treatment. For more information on this subject, see ASTM D 4865 and D 2624.

- A lubricity additive shall be incorporated in the base fuel when the operability temperature is - 20°C or lower. This requirement is based upon a correlation between the operability temperature and Lab Bench test results (using the high frequency reciprocating rig test) as described in SAE Paper 961181. When test results on a representative base fuel for any one of the criteria listed in the footnotes to **Table 5.7** are available, they shall take precedence over the above requirement.

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. A summary of the "Cleaner Fuels" measures will be found in the **Appendix to Part 1**, **Section A.5.2.8**.

5.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

Canada has adopted US Federal test procedures.

5.4. REFERENCE FUELS

As Canadian emissions standards are harmonised with the US Federal standards, similar certification fuels are employed.

5.5. FUEL CONSUMPTION 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. Under the Memorandum of Understanding, automobile manufacturers voluntarily agreed to reduce greenhouse gas (GHG) emissions from new vehicles in Canada so that by 2010, annual emissions reductions will reach 5.3 mega tonnes.

A key component of this agreement is the joint government-industry monitoring of annual industry performance against projected interim GHG reduction goals.

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.

5.6.1. On-board Diagnostic Systems

All light duty vehicles and light duty trucks are currently required to be equipped with OBD systems. The Regulations will phase in new OBD requirements for medium duty passenger vehicles, complete heavy duty vehicles and heavy duty engines intended for use in vehicles with a GVWR of up to 6350 kg (14 000 lb.). The implementation schedule for the new OBD requirements depends on the class of vehicle and engine and covers the 2004 to 2008 model year period.

5.6.2. Emission Control Systems

There are general provisions in the Regulations concerning the performance of emission control systems, including a prohibition on the use of defeat devices. Strategies necessary to protect the vehicle against damage or to start the engine are not considered to be defeat devices.

6. CENTRAL & SOUTH AMERICA REGULATIONS

6.1. VEHICLE EMISSIONS LIMITS

A number of countries in South America have introduced emissions limits based generally on US or EU regulations. The existing legislation in Argentina, Brazil, Chile, Colombia, Costa Rica and Mexico is summarised in the following table and given in some detail in the **Appendix to Part 1**, **Section A.6.1**.

Table 6.1 Summary of Central & South American Exhaust Emissions Regulations

Country	Vehicle Type	Fuel	Effective Date	Equivalent Emission Limits	Reference
Argentina	Light duty	gasoline diesel	27/06/94	US 1981	Official Bulletin No. 27.919
	Heavy duty	natural gas	21/11/02	1999/96/EC	Resolución 1237/02
Brazil	Light duty		2000	US 1984	
	Heavy duty		Phases II and III started in 1994 for all imports and buses and in 1996 for all other vehicles. (1)		
Chile	Light duty - Santiago (2) Light duty - Remainder		09/93 09/94	US 1984 US 1984	
Colombia	Light, medium & heavy duty	gasoline diesel	Imports 1997 Local 1998		Legislation dated 1996
Costa Rica	Light duty Heavy duty	gasoline diesel	1995	US 1981 US 1988 US 1991 or ECE R 83/R 49/R 24	Regulation Ley de Transito por Vias Publicas Terrestres, Section V
Mexico (3)	Light duty		Phase in by 1993	US 1981	6 June 1988
	Heavy duty		1994 1998	US 1994 US 1998	

(1) A smoke emissions standard is under consideration, possibly with limits of 30 HSU and 40 HSU for naturally aspirated and turbocharged diesels respectively, under free acceleration conditions. Meanwhile manufacturers must report smoke emissions under wide open throttle acceleration conditions in certification tests.

(2) Such cars will be permitted to use the roads in Santiago at all times, while existing non-catalyst cars will be subject to a 20% off the road restriction on weekdays. Retrofitting some of the older cars with catalysts is also under consideration. In addition, evaporative emissions control for plants, service stations and vehicles is being implemented.

(3) The Environment Ministry (SEMARNAT) is proposing to revise a number of emissions standards in 2004. The first draft is NOM-042 which will establish more stringent standards for new light duty vehicles. This will 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.

6.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

6.2.1. Regional Unleaded Gasoline Summary

The following table summarises specifications for unleaded gasolines in the region. Readers are directed to the **Appendix to Part 1**, **Section A.6.2** for more comprehensive information, including details of leaded grades and anticipated specification developments.

Table 6.2 Central & South America Unleaded Gasoline Specifications - Summary

Property		Argentina		Bolivia		Brazil		Chile		Colombia			
		Reg.	**Prem.**	**Reg.**	**Prem.**	**Reg.**	**Prem.**	**Reg.**	**Prem.**	**Reg. (10)**	**Prem. (10)**	**Reg.**	**Prem.**
RON	mín	83	93	85	95			93	97				
MON	mín	75	84	Report	Report	82		Report	Report				
(RON + MON)/2	mín					87	91			84	89	81	87
RVP (kPa)		35-70 (1)	35-70 (1)										
RVP (psi)				7.0-9.5	7.0-9.5	10	10	8, 10 & 12.5 (5)	8, 10 & 12.5 (5)	9.3	9.3	8.5	8.5
Sulphur (mg/kg)	max	600	350	500	500	1000	1000	100/30 (6)	100/30 (6)	1000	1000	1000	1000
Benzene (%v/v)	max	2.5	2.5	3.0	3.0	1.0	1.5	1.0	1.0	1.0 (11)	2.0 (11)	1.0	2.0
Aromatics (%v/v)	max	45	45	42	48	45	45	38/50 (7)	38/50 (7)	25	30	28	35
Olefins (%v/v)	max			18	18	30	30	12/40 (8)	12/40 (8)				
Lead (mg/l)	max	13	13	13 (3)	13 (3)	5	5	13	13	13	13	13	13
Oxygen (%m/m)	max	2.7 (2)	2.7 (2)	2.7	2.7			2.0 (9)	2.0 (9)	3.5	3.5		
MTBE (%v/v)	max	15	15					Report	Report				
Ethanol (%v/v)	max	5	5			(4)	(4)			10±0.5	10±0.5		

(1) Regional and seasonal variations – (A): 35-70; (B): 45-80; (C): 55-90

(2) Maximum permitted oxygen concentration if displayed at the dispensing pump: 3.7%m/m.

(3) 18 mg/l of Manganese is permitted.

(4) 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.

(5) 8 and 10 psi grades apply in metropolitan areas. 10 and 12.5 psi is stipulated for the rest of the country.

(6) Lower sulphur grades apply to metropolitan areas only.

(7) Lower aromatic grades apply to metropolitan areas only.

(8) Lower olefinic grades apply to metropolitan areas only.

(9) Maximum oxygen content specified for metropolitan areas. Elsewhere oxygen content to be reported.

(10) Refers to anhydrous ethanol addition and for oxygenated gasolines to be distributed in cities larger than 500,000 inhabitants.

(11) Dilution effect for ethanol not included.

Property		Costa Rica		Ecuador		El Salvador		Guadeloupe	Guatemala		Honduras	
		Reg.	Prem.	Reg.	Prem.	Reg.	Prem.	Prem.	Reg. (3)	Prem.	Reg.	Prem.
RON	mín	88	94	80	89	87 (1)	95 (1)	95	87	95	87	95
MON	mín					77 (1, 2)	85 (1, 2)	85				
(RON + MON)/2	mín					82 (1)	90 (1)					
RVP (kPa)												
RVP (psi)		10	10	8-12	8-12	10	10	10-12.5	10	10	10	10
Sulphur (mg/kg)	max	1500	1000	2000	2000	1500	1500	1000	1500	1500	1500	1500
Benzene (%v/v)	max			1.0	2.0			5	3	3		
Aromatics (%v/v)	max			20	30				45	45		
Olefins (%v/v)	max			20.0	25.025				25	25		
Lead (mg/l)	max	13	13	13	13	13	13	13	13	13	13	13
Oxygen (%m/m)	max	2.8	2.8						2.7	2.7		
MTBE (%v/v)	max								15	15		
Ethanol (%v/v)	max											

(1) 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.

(2) Verified over a period of at least six months.

(3) Gasohol is also supplied, comprising a mixture of 90%v/v of regular gasoline and 10%v/v of anhydrous denatured ethanol. RON = 91; MON= 83.

Property		Jamaica	Mexico (4)		Martinique	Nicaragua		Panama			Paraguay		
			Reg.	Prem.		Reg.	Prem.	Reg.	Med.	Prem.	Reg.	Med.	Prem.
RON	mín		Report	95	95	87	95	87	91	95	85	95	97
MON	mín		82	Report	85	77	83	78	82	85			
(RON + MON)/2	mín	87	87	92									
RVP (kPa)													
RVP (psi)		10	6.5-7.8	6.5-7.8	6.5-8.7	10	10	10	9.8	10	7.8-11	7.8-11	7.8-11
Sulphur (mg/kg)	max	1500	500 or 1000 (5)	250-300 (5)	150	1000	1000	1000	1000	1000	1000	1000	1000
Benzene (%v/v)	max	5	1.0-4.9	1.0-2.0	3.5	5.0	5.0						
Aromatics (%v/v)	max	45 (1)	25-30	25 or 32	Report								
Olefins (%v/v)	max	Report	10-12.5	10 or 15	Report			20	20	20			
Lead (mg/l)	max	13 (2)	26		5	20 (2)	20 (2)	13	13	13	13	13	13
Oxygen (%m/m)	max	2.7 (3)	1.0-2.0	1.0-2.0	2.7						4.2 (6)		4.2 (6)
MTBE (%v/v)	max												
Ethanol (%v/v)	max	10 (3)											

(1) To be reviewed annually.

(2) 18 mg/l of Manganese is permitted.

(3) The oxygen limit applies to ethers with 5 or more carbon atoms. The ethanol limit is an alternative to oxygen content.

(4) There are 4 regular and 4 premium grades specified. See the **Appendix to Part 1, Section A.6.2** for further details.

(5) Premium sulphur content reduced to 250/200 mg/kg in 2004 and further reduced to 30/80 mg/kg in 2006. Regular, supplied in Mexico City, Guadalaraja and Monterrey, was limited to 300/500 mg/kg sulphur in 2004, reducing to 30/80 mg/kg in 2008. The rest of the country also introduced the 300/500 limit in 2004, but the 30/80 mg/kg sulphur specification will be delayed until 2009.

(6) Equivalent to 12%v/v ethanol. The use of 20% is under study.

Property		Peru	Trinidad & Tobago			Uruguay			Venezuela	
			Reg.	Prem.	Super	Reg.	Prem.	Super	Reg.	Prem.
RON	mín	(1)	83	95	92	87	95	97		
MON	mín		80	85	82	75	81	83	82	87
(RON + MON)/2	mín					81	88	90	87	91
RVP (kPa)										
RVP (psi)		10	9	9	9	(S) 12.0 (W) 10.5	(S) 12.0 (W) 10.5	(S) 12.0 (W) 10.5	9.5	9.5
Sulphur (mg/kg)	max	1000	1500	1500	1500	1000	1000	1000	1500	600
Benzene (%v/v)	max	2.5	5	5	5	2.5	2.5	2.5		
Aromatics (%v/v)	max	45				40	45	45		
Olefins (%v/v)	max	25	20	20	20	25	25	25		
Lead (mg/l)	max	13	13	13	13	13	13	13	13	13
Oxygen (%m/m)	max	2.7				2.7	2.7	2.7		
MTBE (%v/v)	max					15	15	15		
Ethanol (%v/v)	max									

(1) Four unleaded grades exist with the following minimum RON limits: Regular: 84.0: Super: 90.0; Premium: 95.0 and Super Extra: 97.0. All other characteristics are identical.

6.2.2. Regional Diesel Fuel Summary

The following table summarises specifications for diesel fuels in the region. The **Appendix to Part 1**, **Section A.6.2** provides more detailed information, including anticipated specification developments.

Table 6.3 Central & South America Diesel Fuel Specifications - Summary

Property		Argentina		Bolivia	Brazil (1)		Chile		Colombia	
		Other	Metro	1D	B	D	Regional	Metro	Regular	Bogotá
Cetane number	min	50	50	48	42	42	46	50	43	45
Cetane index	min	48	48	50	45	45		50	45	45
Density (kg/m^3)				800-860	820-865	820-860	830-850 (2)	830-850	Report	Report
Sulphur (mg/kg)		2500	1500	2000	2000	500	500 (3)	50	4500	1200
90% Distillation °C	max	360	360	282-382	370	360	282-350	282-338	360	282-338
Aromatics (%v/v)	max			25			35	35	35	35
Polycyclic Aromatics (%v/v)	max						20	5		

(1) Grade B: Other regions; Grade D: Metropolitan Areas.

(2) For regions XI and XII the minimum density is 815 kg/m^3.

(3) For regions I, II, III, XI and XII the maximum sulphur content will be 1000 mg/kg.

Property		Costa Rica	Ecuador		El Salvador	Guadeloupe	Guatemala	Honduras	Jamaica	Martinique
			Premium	No. 2						
Cetane number	min						45		45	
Cetane index	min	45	46	45	45	47	45	45	45	46
Density (kg/m^3)		Report			Report	810-865	875.3 (2)	875.3 (2)	829-870	820-845
Sulphur (mg/kg)		4000	500	7000	5000	8000	5000 (3)	5000	5000	350
90% Distillation °C	max	360	360	360	282-363	390 (1)	282-350	Report	352	360 (1)
Aromatics (%v/v)	max						30			
Polycyclic Aromatics (%v/v)	max									11

(1) 95% Distillation °C.

(2) Density @ 15.56°C. Original unit: API Gravity @ 15.56°C.

(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.

Property		Mexico				Nicaragua	Panama	Paraguay
		Pemex	De-sulphurized	Especial	Industrial			
Cetane number	min	48				45	45	
Cetane index	min	48	45	40		45	45	45
Density (kg/m^3)		Report		Report	Report	Report	820.3 – 860.2 (2)	
Sulphur (mg/kg)		5000	500 (3)	500	500	5000	5000	5000
90% Distillation °C	max	345	345	350		282-363	338	370
Aromatics (%v/v)	max					Report (1)		
Polycyclic Aromatics (%v/v)	max							

(1) Report to EIA Quality Advisor if this value is less than 20% vol.

(2) Original Unit: API Degrees.

(3) Reduced to 300 mg/kg in 2006. In 2007 a 15 mg/kg sulphur limit will apply in the US frontier zone and this limit is expected to be adopted countrywide in 2008.

Property		Peru			
		No. 1D	No. 2D	Especial	Superior
Cetane number	40	40	45	50	51
Cetane index	40	40	40	45	46
Density (kg/m^3)					820-845
Sulphur (mg/kg)	5000	5000	5000	1500	350
90% Distillation °C	288	288	282-360	282-360	360 (1)
Aromatics (%v/v)	max				
Polycyclic Aromatics (%v/v)	max				

(1) 95% Distillation °C.

6.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

CONCAWE have no information on emissions and fuel economy test procedures for the region.

6.4. REFERENCE FUELS

Argentine reference fuels are tabulated in the **Appendix to Part 1**, **Section A.6.4**.

6.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

CONCAWE are unaware of any current fuel consumption and CO_2 regulations in the region.

6.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

See the **Appendix to Part 1**, **Section A.6.6**.

7. JAPAN

7.1. VEHICLE EMISSIONS LIMITS

7.1.1. Introduction

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 **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 **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 **Section 7.1.3**.

7.1.2. Japan – Current Gasoline and LPG Vehicle Exhaust Emission Limits

Table 7.1 Exhaust emission limits - Gasoline and LPG Vehicles

Vehicle Category		Test Mode (1)	Emission Species	Regulation			Notes
				Year	Maximum Value (2)	Average Value (2)	
Passenger cars	4-stroke and 2-stroke	10·15M (g/km)	CO	1975	2.70	2.10	(3)
			HC	1975	0.39	0.25	
			NOx	1978	0.48	0.25	
		11M (g/test)	CO	1975	85.0	60.0	
			HC	1975	9.50	7.00	
			NOx	1978	6.00	4.40	
Trucks and buses	4-stroke mini-size	10·15M (g/km)	CO	1998	8.42	6.50	
			HC	1998	0.39	0.25	
			NOx	1998	0.48	0.25	
		11M (g/test)	CO	1998	104	76	
			HC	1998	9.50	7.00	
			NOx	1998	6.00	4.40	
	LD (GVW≤1.7t)	10·15M (g/km)	CO	1988	2.70	2.10	
			HC	1988	0.39	0.25	
			NOx	1988	0.48	0.25	
		11M (g/test)	CO	1988	85.0	60.0	
			HC	1988	9.50	7.00	
			NOx	1988	6.00	4.40	
	MD (1.7t<GVW≤2.5t)	10·15M (g/km)	CO	1998	8.42	6.50	
			HC	1998	0.39	0.25	
			NOx	1994	0.63	0.40	
		11M (g/test)	CO	1998	104	76	
			HC	1998	9.50	7.00	
			NOx	1994	6.60	5.00	
	HD (2.5t<GVW)	G13M (g/kWh)	CO	1998	68.0	51.0	(4)
			HC	1998	2.29	1.80	
			NOx	1995	5.90	4.50	

(1) 10·15-mode (10·15M) represents a typical driving pattern in urban areas. 11-mode (11 M) is typical driving pattern of cold-started vehicle travelling from the suburbs to the urban centre.

(2) 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.

(3) 2-stroke vehicles are not currently in production.

(4) CO limits on LPG-fuelled vehicles: 105 g/kWh max., 76 g/kWh average.

- Maximum permitted age for vehicles in urban areas:

Vehicle Type	Age (Years)
Passenger cars	10
Commercial vehicles <5t	8
Heavy trucks	9
Buses	12

Table 7.2 Exhaust emission limits – Two wheeled vehicles

Vehicle Category	Test Mode [1]	Emission Species	Regulation			Notes
			Year	Maximum Value [1]	Average Value [1]	
4-stroke	2-wheel motor vehicles (g/km)	CO	1998, 1999	20.0	13.0	(2)
		HC		2.93	2.00	
		NOx		0.51	0.30	
2-stroke		CO		14.4	8.00	
		HC		5.26	3.00	
		NOx		0.14	0.10	

(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.

(2) Enforcement year
(i) Motorcycle type I, mini-size two-wheel motor vehicle: 1998
(ii) Motorcycle type II, two-wheel motor vehicle: 1999

On-Board Diagnostic Systems

The installation of OBD has become a statutory obligation.

Evaporative Emissions

Current test limits are to be retained but the existing Carbon Trap method of determination has been replaced by a new procedure employing a SHED. A “mid-summer” diurnal test will be incorporated. The new procedure was introduced between 2000 and 2002, depending on vehicle model.

7.1.3. Japan – Current Diesel Vehicle Exhaust Emission Limits

Short-Term Diesel Emissions Target

Between 2002 and 2004 (depending on vehicle category) NOx limits were reduced by 25 - 30% and those for PM by 28 - 35%. HC and CO emission limits 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 is to be “drastically” increased and OBD will become obligatory.

The short term targets are shown in Table **7.3**:

Table 7.3 2002/2004 Diesel 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 durability requirements for diesel vehicles are compared with the previous limits in **Table 7.4**:

Table 7.4 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 Retro-fit Regulations for Tokyo Area

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 and three neighbouring prefectures (Saitama, Chiba and Kanagawa). The regulations were enforced from 1 April 2003 for older vehicles. Any diesel vehicle not fitted with a DPF has been banned from Tokyo since April 2006.

Long-Term Diesel Emissions Target

In early 2002, the CEC recommended new long-term regulations for vehicles and fuels. The proposals are particularly stringent for heavy duty buses and trucks (above 3.5 tons) with regard to PM and NOx emissions.

Vehicles not meeting these standards will not be allowed on the market. Japan's NOx standard for diesel trucks, effective from 2003, is more stringent than those in the US or Europe, and the ministry aimed to further tighten them in 2005. In addition, the PM emission limits, which were quite lax compared to the NOx standards, will also be more stringent than those in the US and Europe. The emission limits for Japan are shown in the following table.

Talks on setting emissions limits for gasoline passenger cars to harmonize the potential fuel economy and CO_2 benefits of direct injection engines have also taken place (see **Section 7.1.4**).

Modifications to fuel specifications and test cycles have also been proposed and these are described in more detail in **Sections 7.2.** and **7.3.1** respectively.

Table 7.5 Emissions Regulations for 2003 and 2005

Proposed 2003 Standards						
Vehicle Type	**Average Limit (g/km)**				**Test Cycle**	**Effective Date**
	NOx	**THC**	**CO**	**PM**		
Passenger Cars						
IW < 1250 kg	0.28	0.12	0.63	0.052	10·15 mode	2002
IW > 1250 kg	0.30	0.12	0.63	0.056	10·15 mode	2002
Commercial Vehicles						
GVW < 1700 kg	0.28	0.12	0.63	0.052	10·15 mode	2002
1700 < GVW < 2500 kg	0.49	0.12	0.63	0.060	10·15 mode	2003
	Average Limit (g/kWh)					
GVW > 2500 kg	3.38	0.87	2.22	0.180	D13 mode	2003
Proposed 2005 Standards						
Vehicle Type	**Average Limit (g/km)**				**Test Cycle**	**Effective Date**
	NOx	**NMHC**	**CO**	**PM**		
Passenger Cars						
IW < 1250 kg	0.14	0.024	0.63	0.013	New mode	2005
IW > 1250 kg	0.15	0.024	0.63	0.014	New mode	2005
Commercial Vehicles						
GVW < 1700 kg	0.14	0.024	0.63	0.013	New mode	2005
1700 < GVW < 2500 kg	0.25	0.024	0.63	0.015	New mode	2005
	Average Limit (g/kWh)					
GVW > 2500 kg	2.00	0.170	2.22	0.027	New mode	2005

7.1.4. Proposed 2009/2010 Standards

The Japanese Central Environmental Council issued proposed new limits for diesel and gasoline cars and trucks in early 2005. Since the vehicle and engine manufacturers agreed to the proposal before it was released, no changes to the limit values are expected after the comment period.

Table 7.6 Proposed Diesel Emissions Regulations for 2009/2010

Vehicle Type	Emission Limits (g/km)				Implementation Date
	PM	NOx	NMHC	CO	
Passenger Cars	0.005	0.08	0.024	0.63	2009
Trucks, Buses					
GVW ≤ 1.7t	0.005	0.08	0.024	0.63	2009
GVW 1.7 - 3.5t	0.007	0.15	0.024	0.63	1.7 – 2.5t: 2010 2.5 – 3.5t: 2009
	Emission Limits (g/kWh)				
GVW > 3.5t	0.01	0.7 (1)	0.17	2.22	3.5 – 12t: 2010 > 12t: 2009

(1) "Challenge" target ~ 33% of 0.7 g/kWh.

Table 7.7 Proposed Gasoline Emissions Regulations for 2009/2010

Vehicle Type	Emission Limits (g/km)				Implementation Date
	PM (1)	NOx	NMHC	CO	
Passenger Cars	0.005	0.05	0.05	1.15	2009
Trucks, Buses					
GVW ≤ 1.7t	0.005	0.05	0.05	1.15	2009
GVW 1.7 - 3.5t	0.007	0.07	0.05	2.55	2009
	Emission Limits (g/kWh)				
GVW > 3.5t	0.01	0.7	0.23	16.0	2009

(1) Applies only to direct-injection lean-burn engines, fitted with NOx traps.

7.1.5. Non-road Vehicles

New regulations was 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 all controlled, with particular emphasis being placed on nitrogen oxides and particulates. The C1 mode of the ISO draft test method will be used and the target values for reduction are very similar to the second phase of limits 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.

7.1.6. Japan Clean Air Programme

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.

7.1.6.1. JCAP I

JCAP I activities were carried out for five years (1997 - 2001) as the first stage of the Japan Clean Air Programme. The programme can be summarized as follows:

- Analysis of the relationship between fuel properties and exhaust emissions reduction measures for current/future technology low emission engines (both spark- and compression ignition).
- Combustion analysis in diesel engines.
- An examination of the health effects of diesel particulate matter.

The first stage was completed in time for the results to be fed into the Japan Clean Air Act Three Year Amendment in 1999, leading to the gasoline vapour pressure voluntary agreement and phased reduction of fuel sulphur described in **Section 7.2**.

7.1.6.2. JCAP II

JCAP II was launched in 2002 as a five year project and the targets are as follows:

Gasoline Vehicles

- Analyse the relationship between fuel properties and exhaust emissions reduction measures for current/future technology low emission engines and ideal fuels.
- Evaluate the influence of fuel properties and additives on deposits in direct injection engines.
- Review the concept of optimum octane number aimed at an overall reduction in the CO_2 emissions inventory.

Diesel Vehicles

- Analyse the relationship between fuel properties and exhaust emissions reduction measures for current/future technology low emission engines and ideal fuels, aimed at an overall reduction in the CO_2 emissions inventory.
- Evaluate the influence of engine oil properties on the performance of exhaust after-treatment systems.
- Study measurement methods for ultra-fine particulates to establish exhaust emissions measurement procedures under simulated driving conditions.

Air Quality Modelling

- Studies will be carried out on the development of an air quality simulation programme with high accuracy.
- Effects of various air quality improvement policies will be evaluated.

7.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

7.2.1. Gasoline

In the spring of 2002, the Central Environment Council (CEC) recommended new long-term regulations for vehicles and fuels. The proposed fuel quality requirements included a reduction in sulphur for both gasoline and diesel to less than 50 mg/kg by the end of 2004. The sulphur content of diesel fuel was reduced to 50 mg/kg in April 2003, ahead of the deadline. The CEC also suggested a further study of sulphur reduction to facilitate the use of sophisticated after-treatment systems. In addition, the Council requested that the vapour pressure of gasoline be set to below 65 kPa, commencing summer 2005 and the industry has adopted this voluntary limit.

The CEC issued proposed new 2009/2010 emission limits for diesel and gasoline cars and trucks in early 2005. In parallel with these tighter standards, gasoline (and diesel) sulphur levels must be reduced to 10 mg/kg maximum by 2007. The oil industry announced that all gasoline and diesel fuel would meet this limit by 1 April 2005.

The current specifications are shown in the following table:

Table 7.8 Japan - Current Gasoline Standard (JIS K 2202)

Property		Grade	
		Premium No. 1	**Regular No. 2**
Octane number			
Research	min	96.0	89.0
Volatility			
Distillation			
10% (°C)	max	70	70
50% (°C)		75 - 110	75 - 110
90% (°C)	max	180	180
FBP (°C)	max	220	220
Residue %v/v	max	2.0	2.0
Vapour pressure @ 37.8°C kPa	max	44 - 78 (1)	44 - 78 (1)
Composition:			
Sulphur (mg/kg)	max	100 (2)	100 (2)
Benzene (%v/v)	max	1.0 (3)	1.0 (3)
MTBE (%v/v)	max	7.0	7.0
Methanol		none	None
Other Parameters			
Density @ 15 °C kg/l	max	0.783	0.783
Copper corrosion (3h/50°C) (4)	max	1	1
Oxidation stability (min) (5)	min	240	240
Existent gum (mg/100 ml) (6)	max	5	5
Colour		orange	orange

(1) Limits shown refer to official summer specifications.
In 2001 the oil industry adopted a voluntary summer limit of 72 kPa max. This was further reduced to 65 kPa max in the summer of 2005.
Vapour pressure 93 kPa (max) for cold climates/winter grades.

(2) Limits shown refer to official specifications. The oil industry announced that all gasoline and diesel fuel would meet a voluntary limit of 10 mg/kg by 1 April 2005, not 2007 as recommended by CEC.

(3) 1.0%v/v limit effective 2000, prior to that date 5.0%v/v (max) was permitted.

(4) ISO 2160-1985.

(5) Induction period method.

(6) Limit refers to washed gum; unwashed gum limit = 20mg/100ml

7.2.2. Diesel Fuel

In the spring of 2002, the CEC recommended new long-term regulations for vehicles and fuels. The proposed fuel quality requirements included a reduction in sulphur for both gasoline and diesel down to less than 50 mg/kg by the end of 2004. The CEC has also suggested to further study sulphur reduction to facilitate the use of sophisticated after-treatment systems.

The CEC issued proposed new 2009/2010 emission limits for diesel and gasoline cars and trucks in early 2005. In parallel with these tighter standards, diesel fuel (and gasoline) sulphur levels must be reduced to 10 mg/kg maximum by 2007. The

oil industry announced that all diesel and gasoline would meet this limit by 1 April 2005.

The current diesel fuel specifications are shown in the following table:

Table 7.9 Japan - Current Diesel Fuel Standard

Property		Grades				
		Special No.1	**No.1**	**No.2**	**No.3**	**Special No.3**
Cetane number	min	50	50	45	45	45
or Cetane index	min	50	50	45	45	45
Sulphur (mg/kg) (1)	max	500	500	500	500	500
Distillation						
90%v/v rec. (°C)	max	360	360	350	330	330
Pour point (°C)	max	+5	-2.5	-7.5	-20	-30
Viscosity @ 30°C (mm^2/s)	max	2.7	2.7	2.5	2.0	1.8
Flash point PM (°C)	min	50	50	50	50	50
CCR 10% (%m/m)	max	0.1	0.1	0.1	0.1	0.1
CFPP (°C)	max	-	-1	-5	-12	-19

(1) Limits shown refer to official specifications. The sulphur content limit reduced to 50 mg/kg in April 2003. The oil industry announced that all gasoline and diesel fuel would meet a voluntary limit of 10 mg/kg by 1 April 2005, not 2007 as recommended by CEC.

7.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

7.3.1. Introduction

The range of Japanese exhaust emissions procedures was extensively modified in 1991. A summary of the changes and latest methods are given in the **Appendix to Part 1**, **Section A.7.3**.

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 therefore introduced two new transient emission test cycles:

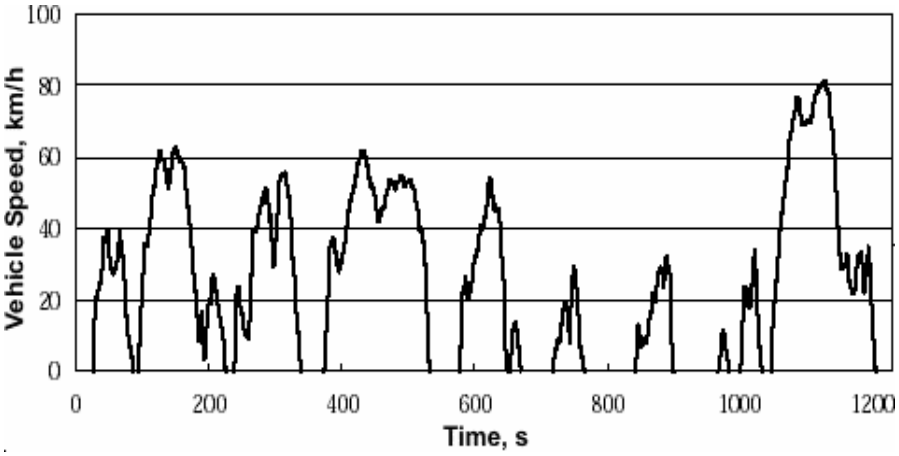
- New test mode for light vehicles of GVW < 3500 kg. Note that this test mode has yet to be formally adopted by the Ministry of Environment.
- JE05—new test mode for heavy vehicles of GVW above 3500 kg

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 became 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.

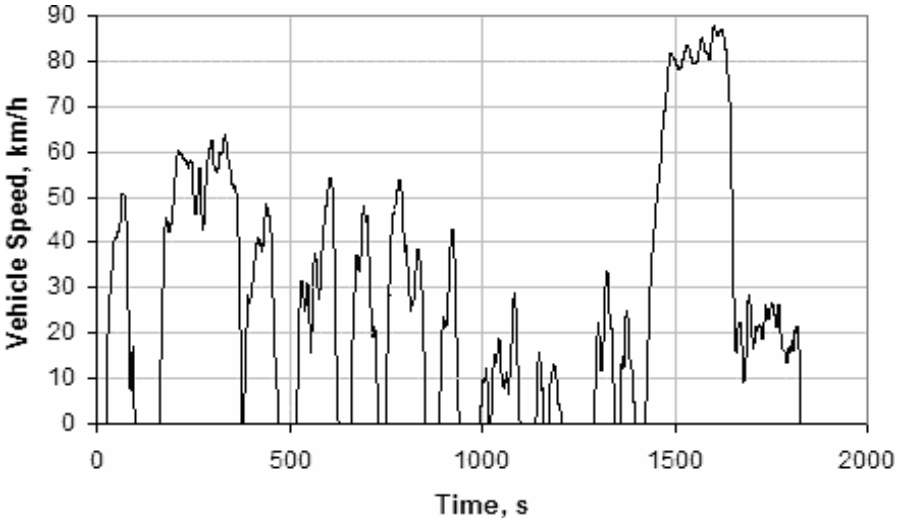
The current hot start test modes (modes 10 - 15) and cold start mode (mode 1) for LD vehicles, and mode 13 for HD vehicles will be replaced with those shown in **Figures 7.1** and **7.2** respectively.

Figure 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 7.2 Japan - JE05 Heavy Duty Transient Driving Cycle



7.3.2. Illustration of Current Japanese Test Cycles

See the **Appendix to Part 1**, **Section 7.3.2**.

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 **Tables 7.10** and **7.11**.

Table 7.10 Japanese Gasoline Vehicle Fuel Economy Targets for 2010

Vehicle Class		**Target Fuel Economy (km/l) (1)**								
		Vehicle Mass kg)								
		≤702	**703 - 827**	**828 - 1015**	**1016 - 1265**	**1266 - 1515**	**1516 - 1765**	**1766 - 2015**	**2016 - 2265**	**≥2266**
Passenger Cars	All types	21.2	18.8	17.9	16.0	13.0	10.5	8.9	7.8	6.4
Light Commercial Vehicles	Car derivative, A/T (2)	18.9	16.5	-	-	-	-	-	-	-
	Car derivative, M/T (2)	20.2	18.0	-	-	-	-	-	-	-
	Others - A/T (2)	16.2	15.5	14.9	14.9	13.8 (3)	-	-	-	-
	Others - M/T (2)	17.0	16.7	15.5	17.8	15.7 (3)	-	-	-	-

		≤1265 kg	**1266 - 1515 kg**	**≥1516 kg**
Medium Commercial Vehicles	Car derivative, A/T (2)	12.5	11.2	10.3
	Car derivative, M/T (2)	14.5	12.3	10.7/9.3

(1) 10-15 mode test adopted. Consideration is being given to a combined cold/hot start test and target values would be reviewed if such a procedure was adopted.

(2) A/T = automatic transmission; M/T = manual transmission.

Table 7.11 Japanese Diesel Vehicle Fuel Economy Targets for 2005

Vehicle Class		Target Fuel Economy (km/l) [1]							
		Vehicle mass (kg)							
		≤1015	**1016 - 1265**	**1266 - 1515**	**1516 - 1765**	**1766 - 2015**	**2016 - 2265**	**≥2266**	**-**
Passenger Cars	All types	18.9	16.2	13.2	11.9	10.8	9.8	8.7	-

Vehicle Class		Target Fuel Economy (km/l) [1]			
		All masses			
Light Commercial	A/T [2]	15.1			
	M/T [2]	17.7			
		≤1265 kg	**1266 - 1515 kg**	**1516 - 1765 kg**	**≥1766 kg**
Medium Commercial	Car derivative, A/T [2]	14.5	-	-	-
	Car derivative, M/T [2]	17.4	-	-	-
	Others, A/T [2]	12.6	12.3	10.8	9.9
	Others, M/T [2]	14.6	14.1	12.5	12.5

(1) 10-15 mode test adopted. Consideration is being given to a combined cold/hot start test and target values would be reviewed if such a procedure was adopted.

(2) A/T = automatic transmission; M/T = manual transmission.

7.5. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

Full details will be found in the **Appendix to Part 1**, **Section A.7.5** Emissions testing forms an integral part of the Japanese roadworthiness test ("Shaken"). Vehicles must be submitted for testing once they are three years old and thereafter every two years.

8. AUSTRALASIA

8.1. VEHICLE EMISSIONS LIMITS

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. Five new ADRs were required to implement the package of new emission standards:

ADR No.	Title	Purpose	Application	Implementation Dates
30/01	Smoke Emission Control for Diesel Vehicles	Smoke emission requirements for diesel vehicles	All diesel passenger and goods vehicles	New models: 01/01/2002 All models: 2003
79/00	Emission Control for Light Vehicles	Implementing Euro 2 exhaust/evaporative emissions standards for light vehicles	All passenger and goods carrying vehicles with a GVW ≤ 3.5 t	New diesel models: 01/01/2002 All diesel models: 2003 New SI models: 2003 All SI models: 2004
79/01	Emission Control for Light Vehicles	Implementing Euro 3 and Euro 4 exhaust/evaporative emissions standards for light vehicles	All passenger and goods carrying vehicles with a GVW ≤ 3.5 t	Euro 4 New diesel models: 01/01/2006 All diesel models: 2007 Euro 3 New SI models: 2005 All SI models: 2006
80/00	Emission Control for Heavy Vehicles	Implementing Euro 3 exhaust emissions standards for HD vehicles	All passenger and goods carrying vehicles with a GVW > 3.5 t	New models: 2002 (1) All models: 2003 (1)
80/01	Emission Control for Heavy Vehicles	Implementing Euro 4 exhaust emissions standards for HD vehicles	All passenger and goods carrying vehicles with a GVW > 3.5 t	New models: 2006 (2) All models: 2007 (2)

(1) For vehicles operating on diesel, liquefied petroleum gas and natural gas, US 1998 standards accepted as an alternative. For vehicles operating on gasoline the rule enforced US 1996 standards to new models from 2003 and all vehicles from 2004.

(2) For vehicles operating on diesel, liquefied petroleum gas and natural gas, US 2004 standards accepted as an alternative. For vehicles operating on gasoline the rule enforced US 1996 standards to new models from 2005 and all vehicles from 2006.

Discussions have been started between the Government and interested parties on mechanisms to ensure that vehicles converted to LPG or CNG are not higher emitters than the original vehicles.

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. ADR 79/02 encompasses light duty vehicles and ADR 80/02 will cover heavy duty vehicles. For LD vehicles, the MVEC is proposing the adoption of Euro 4 emission standards from 1 January 2008 for new models and 1 January 2009 for all production. For HD vehicles it is proposed that Euro 5 limit values be adopted from 1 January 2009 for new models and 1 January 2011 for all production. US Federal 2007 or Japanese 05 standards would be accepted as alternatives.

8.1.3. New Zealand Land Transport Rule - Vehicle Exhaust Emissions 2003

Objective of the Rule

The Land Transport Rule: Vehicle Exhaust Emissions 2003 (Rule 33001) - 6 December 2002 is one of a series of rules that sets requirements and standards for systems and components in motor vehicles operating in New Zealand. This rule puts in place a vehicle exhaust emissions standards regime for motor vehicles that are manufactured after 1990. The aim of the rule is to ensure that all such motor vehicles entering the fleet for the first time have been manufactured to the applicable emissions standards specified in the rule, to the extent that those standards apply to exhaust emissions. The rule comes into force progressively over the period 1 January 2004 to 1 January 2007, depending upon vehicle and fuel type.

Fuel specification changes took effect in three stages from 2002 until 2006, as provided in the *Petroleum Products Specifications Regulations 2002* (see **Section 8.2.6)**. The phase-in of more stringent rule requirements will also allow time for heavy vehicles, in particular, to have their designs changed. During this period, the rule will bring about the progressive exclusion of vehicles manufactured after 1990 that are not manufactured to certain emissions standards.

Scope of the Rule

This rule does not apply to:

1. motor vehicles that are not required by *Land Transport Rule: Vehicle Standards Compliance 2002* to be certified for entry into service; or
2. tractors that are required by the *Land Transport Rule: Vehicle Standards Compliance 2002* to be certified for entry into service; or
3. motor vehicles manufactured before 1990.

This rule specifies requirements that:

1. must be complied with before a motor vehicle may be certified for entry into service in New Zealand; and
2. are, for the purposes of Land Transport Rule: Vehicle Standards Compliance 2002, the applicable requirements for the exhaust emission systems of vehicles certified for entry into service in New Zealand after this rule comes into force.

8.1.4. Implementation Dates

This rule comes into force according to the following schedule:

Table 8.1 New Zealand Vehicle Exhaust Emissions 2003 (Rule 33001) Proposed Implementation Schedule

Date	Vehicle Type	Model	Fuel
1 January 2004	Light duty	New models or used vehicles	Gasoline or diesel
1 January 2006	Heavy duty	Existing models	Diesel
1 January 2005	All other types		

8.1.5. Approved Vehicle Emissions Standards

The approved vehicle emissions standards for motor vehicles are as follows:

Table 8.2 New Zealand Vehicle Exhaust Emissions 2003 (Rule 33001) Proposed Emissions Standards (1)

Gasoline Fuelled Vehicles	Diesel Fuelled Vehicles
UN/ECE Regulation No 15	A standard specified for gasoline vehicles; or
UN/ECE Regulation No 83	UN/ECE Regulation No 49
Council Directive 70/220/EEC of 20 March 1970	Council Directive 88/77/EEC of 3 December 1987
Federal Regulation 40 CFR part 86	UN/ECE Regulation No 24
Title 13 of the California Code of Regulations	Council Directive 72/306/EEC of 2 August 1972
Australian Design Rule 36	Australian Design Rule 30 (2)
Australian Design Rule 37	
Australian Design Rule 79	
Australian Design Rule 80	
Circular of Chigi No. 129 of April 4, 1985 (Japan)	

(1) The above approved vehicle emissions standards include all amendments to that standard, some of which may apply to classes of motor vehicle additional to those covered by the original standard. A motor vehicle must be manufactured in accordance with the version of an approved vehicle emissions standard that is applicable under the above table; or applicable in the relevant standard-setting jurisdiction to the date of manufacture of the motor vehicle, or as specified in the standard; or a more recent version of the standard.

(2) Diesel Engine Exhaust Smoke Emissions rule and one of the following:
Australian Design Rule 70, Exhaust Emission Control for Diesel Engined Vehicles;
Australian Design Rule 79, Emission Control for Light Vehicles;
Australian Design Rule 80, Emission Control for Heavy Vehicles

Table 8.3 Proposed Gasoline Vehicle Exhaust Emissions Requirements

Date of Border Inspection	Approved Vehicle Emissions Standard			
	Vehicles that Operate on Gasoline			
	Light		Heavy	
	New Model	Existing Model	New Model	Existing Model
On or after 1 January 2004 and before 1 January 2005	ADR 79/00; Euro 2; US 2001; or Japan 03	No emissions standard required	No emissions standard required	No emissions standard required
On or after 1 January 2005 and before 1 January 2006	ADR 79/00; Euro 2; US 2001; or Japan 03	ADR 79/00; Euro 2; US 2001; or Japan 03	ADR 80/00; US 96; or Japan 99	No emissions standard required
On or after 1 January 2006 and before 1 January 2007	ADR 79/01; Euro 3; US 2004; or Japan 03	ADR 79/01; Euro 3; US 2004; or Japan 03	ADR 80/01; US 98P; or Japan 99	ADR 80/00; US 96; or Japan 99
On or after 1 January 2007	ADR 79/01; Euro 3; US 2004; or Japan 03	ADR 79/01; Euro 3; US 2004; or Japan 03	ADR 80/01; US 98P; or Japan 99	ADR 80/01; US 98P; or Japan 99

Table 8.4 Proposed Diesel Vehicle Exhaust Emissions Requirements

Date of Border Inspection	Approved Vehicle Emissions Standard			
	Vehicles that Operate on Diesel Fuel			
	Light		Heavy	
	New Model	Existing Model	New Model	Existing Model
On or after 1 January 2004 and before 1 January 2005	ADR 79/00 and ADR 30/01; Euro 2; US 2004; or Japan 03	No emissions standard required	No emissions standard required	No emissions standard required
On or after 1 January 2005 and before 1 January 2006	ADR 79/00 and ADR 30/01; Euro 2; US 2004; or Japan 03	ADR 79/00 and ADR 30/01; Euro 2; US 2004; or Japan 03	ADR 80/00 and ADR 30/01; Euro 3; US 98D; or Japan 03/04	No emissions standard required
On or after 1 January 2006 and before 1 January 2007	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 80/00 and ADR 30/01; Euro 3; US 98D; or Japan 03/04	ADR 80/00 and ADR 30/01; Euro 3; US 98D; or Japan 03/04
On or after 1 January 2007 and before 1 January 2008	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 80/01 and ADR 30/01; Euro 4; US 2004; or Japan 05/06	ADR 80/00 and ADR 30/01; Euro 3; US 98D; or Japan 03/04
On or after 1 January 2008	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 79/01 and ADR 30/01; Euro 4; US 2004; or Japan 05	ADR 80/01 and ADR 30/01; Euro 4; US 2004; or Japan 05/06	ADR 80/01 and ADR 30/01; Euro 4; US 2004; or Japan 05/06

8.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

8.2.1. Australia Fuel Quality Standards Act 2000

The *Fuel Quality Standards Act 2000* (Act No. 153 – as amended) and the *Fuel Quality Standards Regulations 2001* create national specifications for fuels and provides a framework for enforcing these standards. Australian fuel quality specifications are being harmonised with international standards. This compilation was prepared on 1 January 2002 taking into account amendments up to Act No. 118 of 2001. The legislation regulates any substance that is sold or represented as a fuel for which a fuel standard has been made. Fuel quality standards for gasoline and diesel have been made under the Act. The new specifications are prescribed in the *Fuel Standard (Petrol) Determination 2001*, and the *Fuel Standard (Diesel) Determination 2001.*

Because Western Australia (WA) already had fuel standards in place, the Commonwealth specifications will operate concurrently. Importantly, where WA's standards are more stringent or regulate a fuel characteristic not covered by the Commonwealth standard, the WA standards will apply.

Under the legislation it can be an offence to:

- supply fuel in Australia that does not comply with a fuel specification, or an approval to vary that standard;
- alter fuel in Australia that is the subject of a fuel specification, or an approval to vary that standard, if the fuel is intended for use in Australia;
- supply a fuel additive in Australia that is listed on the Register of Prohibited Fuel Additives;
- fail to provide a statement or other information about whether supplied fuel complies with a fuel quality standard; and
- not comply with the record keeping and reporting obligations of the legislation.

The Commonwealth Government is also developing specifications for other fuels such as LPG, CNG and biodiesel, plus standards to enable the more effective operation of gasoline and diesel motor vehicle engines.

8.2.2. Australia Fuel Specifications

Table 8.5 Australia - Gasoline Specifications (1 January 2002)

Fuel Parameter		Unit	Grade and Location	Limit
RON		(min.)	ULP (Regular unleaded)	91
			LRP (Lead replacement)	96
			PULP (Premium unleaded & ultimate - 98 RON fuel)	95
Sulphur		mg/kg (max.) (1)	ULP and LRP	350
			PULP	150
			WA (Western Australia)	150
Lead		g/l (max.)	All grades	0.005
Oxygen		%m/m (max.)	All grades (Except ethanol blends)	2.7
Phosphorous		g/l (max.)	ULP and PULP	0.0013
			LRP	(2)
DIPE Di-isopropyl ether		%v/v (max.)	All grades	1.0
TBA Tertiary butyl alcohol		%v/v (max.)	All grades	0.5
Aromatics		%v/v (max.)	All grades	(3)
			WA - All grades	42.0
Benzene (4)		%v/v (max.)	SA (South Australia) - All grades	4.9
			WA - All grades	1.0
			QLD (Queensland) - All grades	(5)
			Other States - All grades	5.0
Olefins (6)		%v/v (max.)	WA - All grades	18.0
MTBE (7) Methyl tertiary butyl ether		%v/v (max.)	WA - All grades	0.10
TAME Tertiary amyl methyl ether		%v/v (max.)	SA - All grades	1.0
ETBE, TAME and MTBE		%v/v (max.)	QLD - All grades	1.0
RVP (Summer monthly average)		KPa	QLD (South East only) (8)	76.0
			SA and WA (Perth only)	67.0
			New South Wales (Sydney only)	62.0
Operability Standards (Implemented Sept. 2002)	MON	(min.)	PULP	85.0
			ULP	81.0
			LRP	82.0
	Copper corrosion (3hrs. @ 50ºC)	Class (max.)	All grades	1
	Existent gum (washed)	mg/l (max.)	All grades	50
	Induction Period	mins (min.)	All grades	360
Parameters currently excluded from regulations	FVI		All grades	(9)
	Colour		ULP	Purple/Bronze
			LRP	Red/Orange
			PULP	Yellow
	Appearance @ 20ºC		All grades	Clear & Bright
	Driveability index		-	(9)
Ethanol content			Standard (limit) to be set.	
Distillation: FBP		ºC (max.)	Applies from 1 January 2005	210

(1) Sulphur: All grades 150 mg/kg (max) by 1 January 2005. An early move to 10 mg/kg is under consideration.

(2) Lead replacement grade is exempt from the phosphorous limitation as some anti-valve seat recession additives contain this metal.

(3) Aromatics: 45%v/v pool average over 6 months with a cap of 48%. By 1 January 2005, the pool average must fall to 42%v/v, with a cap of 45%.

(4) Benzene: All grades 1%v/v maximum by 1 January 2006.

(5) 3.5%v/v maximum average over 6 months (or 6 consecutive batches).

(6) Olefins: All grades 18%v/v pool average over 6 months with a cap of 20% by 1 January 2004. All grades 18%v/v maximum by 1 January 2005.

(7) MTBE: All grades 1%v/v maximum by 1 January 2004.

(8) Queensland: Summer monthly average RVP - Summer 2001/2002: 76kPa; Summer 2002/2003: 67kPa.

(9) As per season and location.

- ETBE, TAME and ETAE are not listed on the Australian Inventory of Chemical Substances. In accordance with the Industrial Chemicals (Notification and Assessment) Act 1989, these chemicals are currently prohibited from import and manufacture.

Table 8.6 Australia - Diesel Specifications (1 January 2002)

Fuel Parameter		Unit	Limit
Polyaromatic hydrocarbons		%m/m (max) [1]	11.0
Sulphur		mg/kg (max.) [2]	500
Ash & suspended solids		mg/kg (max.)	100
Distillation - 95% recovered [3]		ºC (max.)	370
Cetane index		(min.)	46.0
Density [4]		kg/m^3	820 - 860
Viscosity		cSt @ 40ºC	2.0 - 4.5
Operability Standards (Implemented Sept. 2002)	Carbon residue (10% distillation residue)	% m (max.)	0.2
	Water & sediment [5]	%v/v (max.)	0.05
	Conductivity at ambient temperature	pS/m (min.)	50
	Oxidation stability	mg/l (max.)	25
	Colour	(max.)	2
	Acidity - total	mg KOH/g (max.)	0.08
	Acidity - strong		nil
	Copper corrosion (3hrs. @ 50ºC)	Class (max.)	1
	Flash point	ºC (min.)	61.5
	Filter blocking tendency	(max.)	2.0
	Lubricity [6]	mm (max.)	0.460
Cloud point and CFPP ºC [7]		See AS3570 - 1998	
Appearance @ 20ºC [7]			Clear & bright

(1) A polyaromatic hydrocarbon limit of 11.0%m/m maximum will be applied by 1 January 2006.

(2) Sulphur: 50 mg/kg (max) by 1 January 2006.

(3) Distillation: 95% recovered limit will fall to 360ºC by 1 January 2006.

(4) Density: Limits of 820 - 850 kg/m^3 will apply from 1 January 2006.

(5) Only conducted if the appearance test fails.

(6) Only applies to fuels containing less than 500 ppm sulphur.

(7) Parameters currently excluded from the regulation.

Table 8.7 Australia Automotive LPG Specification (Fuel Standard "Autogas Determination 2003")

Property		Limit	Test Method
MON	min	90.5	(1)
Vapour Pressure (gauge) @ 40°C (kPa)		800 - 1530	ISO 8973
Copper strip corrosion	max	1	EN ISO 6251
Free water @ 0°C (%m/m)	max	0	EN 589
Odour	max	(2)	
Dienes (mol%)	max	0.3	ISO 7941
Residue on evaporation (mg/kg)	max	100	JLPGA-S-03 (3)
Sulphur after stenching (mg/kg)	max	100	ASTM D 2784
Hydrogen sulphide	max	(4)	EN ISO 8819
Volatile residues - C_5 and higher (mol%)	max	2.0	ISO 7941

(1) Composition by ISO 7941. Calculation by EN 589, Annex B.

(2) Detectable in air at 20% of the lower flammability limit.

(3) By mass method at 105°C.

(4) Hydrogen sulphide negative within the meaning of the test method.

The above specification was published on 19 December 2003 under Section 21 of the Fuel Quality Standards Act 2000. It became effective on 1 March 2004

Approved variations of theses standards and additional historical information on automotive fuel specifications for Australasia will be found in the **Appendix to Part 1**, **Section 8.2.1**.

8.2.3. Record Keeping and Reporting Obligations, Exceptions to Compliance, Monitoring Compliance and Application for an Approval to Vary the Fuel Standard

Details will be found in the **Appendix to Part 1**, **Section 8.2.1**.

8.2.4. Ethanol Regulations

From 1 July 2003, 10%v/v maximum ethanol is permitted in gasoline. Labelling (of the ethanol content) requires an amendment to the Fuel Quality Standards Act 2000 and will be completed at a later date. An ethanol standard is to be developed and will probably involve the adoption of an existing ethanol specification. The ethanol excise rate will be zero until 30 June 2008, thereafter a five step adjustment from July 2008 to June 2012 will take place. A new excise rate comes into force from July 2012

At least two major oil companies are marketing E10 grades.

8.2.5. Proposed Future Fuel Standards

As reported in **Section 8.1.2**, the Government's Motor Vehicle and Environment Committee (MVEC) has issued draft proposals for emissions requirements beyond 2006. ADR 79/02 encompasses light duty vehicles and ADR 80/02 will cover heavy duty vehicles. The draft proposes the adoption of Euro 4 and Euro 5 emissions standards for LD and HD vehicles respectively. In parallel with these proposals more stringent sulphur limits have been suggested:

Proposed Date	Grade	Proposed Sulphur Content (mg/kg)
1 January 2008	95 RON Unleaded Gasoline	50
1 January 2010	95 RON Unleaded Gasoline	10
1 January 2009	Diesel Fuel	10

Review of the Fuel Quality Standards Act 2000

Section 72 of the *Fuel Quality Standards Act 2000* requires that the first review of the operation of the Act must be undertaken as soon as possible after the second anniversary of the commencement of Part 2 of the Act, that is, two years from 1 January 2002.

The review will examine the operation of the Act. It will focus on the impacts of the Act on stakeholders, and the effectiveness of provisions relating to the level of compliance and enforcement. Fuel standards, or fuel quality information standards that have been made under the Act, will not be examined during the review.

8.2.6. 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. Earlier specifications will be found in **Part 2**, **Section B.8.2.4**.

Table 8.8 New Zealand Gasoline Specifications

Property and Grade		Limits and Effective Dates			Test Method
		01/09/02	01/01/04	01/01/06	
RON	(Premium) min	95.0	95.0	95.0	ASTM D2699
MON	(Premium) min	85.0	85.0	85.0	ASTM D2700
RON	(Regular) min	91.0	91.0	91.0	ASTM D2699
MON	(Regular) min	82.0	82.0	82.0	ASTM D2700
Colour		Not to be mistaken for water			Visual
Distillation:					ASTM D86
E70	%v/v min	22	22	22	
	%v/v max	48	48	48	
E100	%v/v min	45	45	45	
	%v/v max	70	70	70	
E180	%v/v min	90	N/A	N/A	
E150	%v/v min	N/A	75	75	
FBP	ºC max	220	215	210	
Residue	%v/v max	2.0	2.0	2.0	
FVI	[VP (kPa + 0.7E70] max	115.0	115.0	115.0	ASTM D86 & D5191
Vapour pressure	kPa	See **Table 8.9**			ASTM D5191
Copper strip corrosion	3 hours @ 50ºC max	Class 1	Class 1	Class 1	ASTM D130
Sulphur content (1)	(Premium) mg/kg max	150	150	150	IP 336 or ASTM D5453
	(Regular) mg/kg max	350	350	150	
Existent gum (solvent washed)	mg/100ml max	5	5	5	ASTM D381
Oxidation stability induction period	minutes min	360	360	360	ASTM D525
Lead content	mg/l max	5	5	5	IP224
Benzene content	%v/v max	4	5, 3, 1 (2)	1	ASTM D5580
Total aromatics (including benzene)	%v/v Pool average max	42	42	42	ASTM D5580
	%v/v Cap max	45	45	45	ASTM D5580
Oxygenates (excluding ethanol)	%v/v max (3)	1	1	1	ASTM D4815
Ethanol (4)	%v/v max	10	10	10	ASTM D4815
Manganese (5)	mg/l max	2.0	2.0	2.0	ASTM D3831
Phosphorous	mg/l max	1.3	1.3	1.3	ASTM D3231

(1) Sulphur: "Indicative" maximum of 50 mg/kg from 2008. The ultimate requirement is for "sulphur-free" gasoline of 10 - 15 mg/kg maximum sulphur content.

(2) Benzene: 3%v/v maximum if 20%v/v maximum olefins content, or 1%v/v maximum if 25%v/v maximum olefins.

(3) Up to 11%v/v MTBE was allowed until 1 March 2003, as long as the total volume of all oxygenates did not exceed this figure.

(4) The sale of ethanol blended gasoline must be accompanied by consumer information about the possible vehicle maintenance requirements that may result from using ethanol blends.

(5) To be reviewed by 2006.

- The following general notes apply equally to **Tables 8.8, 8.9** and **8.10** (diesel fuel).
- The procedure for obtaining a representative sample of fuel for testing by the test methods set out in these regulations is set out in BS EN 228 and BS EN 590. In the event of a dispute as to the appropriate value, nature, or rating of any of the properties listed in the schedules or referred to in these regulations, the relevant procedures specified in ISO 4259 must be used to interpret the laboratory results.
- An alternative test method to any of those specified in the table may be agreed by the chief executive if a request is made in writing from a fuel importer or wholesale supplier or retailer of fuel and if the chief executive is satisfied that the alternative test method is at least as good as the test method specified in the table.
- The fuel importer or wholesale supplier of any fuel to which these regulations apply must, at the request of a person authorised in writing by the chief executive, supply the authorised person with a certificate describing the properties and value of any such fuel.

Table 8.9 New Zealand Gasoline Vapour Pressure Requirements (1) (Test Method ASTM D5191)

Location	Season (2)	Limits (kPa) and Effective Dates		
		01/09/02	01/01/04	01/01/06
Countrywide	Summer (max)	85	75	-
	Spring/Autumn (max)	90	85	-
	Winter (max)	95	95	-
	All Year Minimum	45	45	-
Auckland and Northland	Summer (max)	-	-	65
	Spring/Autumn (max)	-	-	80
	Winter (max)	-	-	90
	All Year Minimum	-	-	45
Rest of North Island	Summer (max)	-	-	70
	Spring/Autumn (max)	-	-	80
	Winter (max)	-	-	90
	All Year Minimum	-	-	45
South Island	Summer (max)	-	-	75
	Spring/Autumn (max)	-	-	85
	Winter (max)	-	-	95
	All Year Minimum	-	-	45

(1) Gasoline that complies with the previous season's quality and that is stored in a filling station tank to which fewer than 3 deliveries have been made since 6 weeks before the start of the season is regarded as complying with this specification.

(2) Summer: 1 December - 31 March
Autumn: 1 April - 31 May
Winter: 1 June - 31 August
Spring: 1 September - 30 November

- See general notes at the foot of **Table 8.8**.

Table 8.10 New Zealand Diesel Fuel Requirements

Property		Limits and Effective Dates			Test Method
		01/09/02	01/01/04	01/01/06	
Density @ 15ºC	kg/m^3 max	860	850	850	ASTM D1298
	kg/m^3 min	820	820	820	
Distillation - T95	ºC max	370	370	360	ASTM D86
Cetane index or	min	47	49	51	ASTM D976
Cetane number	min	47	49 (1)	51 (1)	ASTM D613
Appearance @ 15ºC		(2)	(2)	N/A	ASTM D4176(B)
Water content	mg/kg max	200 (3)	200 (3)	200	ASTM D6304
Particulates	mg/l max	24 (3)	24 (3)	24	ASTM D6217
Colour	ASTM Colour max	3	3	3	ASTM D1500
Cloud point (4)	Summer ºC max	+ 4	+ 4	+ 4	ASTM D1500
	Winter ºC max	+ 2	+ 2	+ 2	
CFPP (4)	Winter ºC max	- 6	- 6	- 6	IP 309
Sulphur content (5)	Auckland and Northland				IP 336 or ASTM D5453
	Pool Average mg/kg (max)	1000	500 (6)	50	
	Cap mg/kg (max)	1400	600 (6)	-	
	Rest of Country				
	Pool Average mg/kg (max)	2200	500 (6)	50	
	Cap mg/kg (max)	3000	600 (6)	-	
Polycyclic aromatic hydrocarbons	%m/m max	-	-	11	IP 391
Filter blocking tendency		(7)	(7)	(7)	(7)
Lubricity - HFRR wsd @ 60ºC	µm	460	460	460	IP 450
Viscosity	mm^2/s @ 40ºC max	1.5	1.5	2.0	ASTM D445
	mm^2/s @ 40ºC min	4.5	4.5	4.5	
Oxidation stability	g/m^3 max	25	25	25	ASTM D4530
Carbon residue (on 10% distillation residue)	%m/m max	0.25	0.25	0.25	ASTM D4530
Copper strip corrosion (3 hours @ 50ºC)	Class max	1	1	1	ASTM D130
Ash	%m/m max	0.01	0.01	0.01	ASTM D482
Flash point	ºC min	61	61	61	ASTM D93

(1) If ignition quality is controlled by cetane number, the Cetane index can be relaxed to a minimum of 47.

(2) Clear and bright or compliance with the water content and particulate specification quoted in the table.

(3) Water content and particulate requirements are waived if the appearance specification is met.

(4) Winter: 15 April - 14 October; Summer: 15 October - 14 April. The cold flow properties are maximum criteria and the fuel must be fit for common purposes in the region and season in which it is sold. Diesel fuel that complies with last season's specification and that is stored in a filling station tank to which fewer than 3 deliveries have been made since 6 weeks before the start of the season is regarded as complying with this specification.

(5) Diesel fuel sulphur content is to be reviewed by mid-2005. A 10 - 15 mg/kg maximum sulphur content is to be required no later than 2009/10.

(6) With effect from 1 August 2004.

(7) Fuel must be of acceptable filterability so that it is fit for common purposes. Indicative test methods for monitoring purposes are IP 387 or ASTM D2068 (2.5 max. limit). To be reviewed by 2006.

- See general notes at the foot of **Table 8.8**.

Table 8.11 New Zealand Diesel Fuel Cold Flow Requirements

Auckland, Wiri, and Whangarei			**Dunedin and Bluff**		
01/09 to 28-29/02	Cloud point, °C	max. + 3	01/10 to 31/12	Cloud point, °C	max. + 3
01/03 to 31/03 and 01/08 to 31/08	CFPP, °C	max. - 6	01/01 to 28-29/02 and 01/09 to 30/09	CFPP, °C	max. - 6
	Cloud point, °C	max. + 3		Cloud point, °C	max. + 3
01/04 to 31/07	CFPP, °C	max. - 6	01/03 to 31/07	CFPP, °C	max. - 15
	Cloud point, °C	max. - 1		Cloud point, °C	max. - 1
			01/08 to 31/08	CFPP, °C	max. - 6
				Cloud point, °C	max. - 1
Remainder of North Island			**All other South Island Locations**		
01/10 to 31/01	Cloud point, °C	max. + 3	01/10 to 31/12	Cloud point, °C	max. + 3
01/02 to 31/03 and 01/09 to 30/09	CFPP, °C	max. - 6	01/01 to 28-29/02 and 01/09 to 30/09	CFPP, °C	max. - 6
	Cloud point, °C	max. + 3		Cloud point, °C	max. + 3
01/04 to 31/07	CFPP, °C	max. - 9	01/03 to 31/07	CFPP, °C	max. - 9
	Cloud point, °C	max. - 1		Cloud point, °C	max. - 1
01/08 to 31/08	CFPP, °C	max. - 6	01/08 to 31/08	CFPP, °C	max. - 6
	Cloud point, °C	max. - 1		Cloud point, °C	max. - 1

8.2.7. Calculating pool average

Details will be found in the **Appendix to Part 1**, **Section A.8.2.4**.

8.2.8. 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.

8.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

Test procedures commensurate with the adopted emissions standards have been adopted.

8.4. REFERENCE FUELS

CONCAWE have no information available.

8.5. FUEL ECONOMY AND CO_2 REGULATIONS

8.5.1. Australia

In 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. Details can be found in the **Appendix to Part 1**, **Section A.8.5.1**.

8.6. INSPECTION AND MAINTENANCE

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.

The NISE 2 Preliminary Phase will establish:

- an Australian composite urban emissions drive cycle (CUEDC) for light duty petrol vehicles;
- a short test, of no longer than 4 minutes, which can provide a reliable measure of emissions performance; and
- the degree of correlation between vehicle emissions measured using the derived CUEDC drive cycle, the short drive cycle, the ADR37 drive cycle and the IM 240 drive cycle.

The principal focus for the Preliminary Phase of NISE 2 is to develop and validate reliable emission tests for light duty gasoline vehicles, based on "real world" driving patterns. These tests will be used, along with the standard certification tests, in the subsequent Main Phase, to estimate the emissions performance of the current in-service light duty gasoline vehicle fleet. The Preliminary Phase will provide the basic tools for use in the Main Phase to generate a more accurate and representative measure of the actual amount of pollutants emitted from the Australian light duty gasoline vehicle fleet, by testing vehicles over a vehicle driving cycle based on actual Australian on-road conditions and driving patterns.

The Main Phase of NISE 2 will follow the Preliminary Phase, and will:

- establish the current emissions performance of light duty gasoline vehicles built in the period 1986-2002 through vehicle testing on a range of emissions tests;
- compare the emissions performance with original ADR requirements; and
- compare emissions performance of the current vehicle population with that of the vehicle sample tested in the NISE 1 study.

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**.

9. OTHER ASIAN COUNTRIES

9.1. VEHICLE EMISSION LIMITS

The exhaust emissions legislation for Asian countries other than Japan are summarised in below. The legislation is covered in greater detail in the **Appendix to Part 1, Section A.9.1**.

Table 9.1 Summary of Asian Exhaust Emissions Regulations

Country	Vehicle Type	Fuel	Effective Date	Equivalent Emission Limits	Reference/Notes
Bangladesh	Light & heavy duty	gasoline	2006	Euro 2	NMHC limits for CNG vehicles
	Light & heavy duty	diesel	2006	Euro 1	PM limits apply to CNG vehicles
Cambodia	2-stroke motorcycle 4-stroke motorcycle Four wheeled vehicles	gasoline	1991	Idle emission limits, see the **Appendix to Part 1, Section A.9.1**	
	Four wheeled vehicles	diesel			
China [1]	Light duty (<3.5t) [2] - National	gasoline diesel	1993	ECE 15.03 with higher HC limits	Regulation GB-11641.1-93
	Light duty (<3.5t) [2] - Beijing and Shanghai	See following paragraphs.			
	Heavy duty		1996 - 1999	Chinese 9-mode test cycle	Regulation GB-14761.2-93
	Motorcycles			ECE R 40	
Hong Kong	Light duty [3]		13/07/96 01/01/2006	94/12/EEC Euro 4	
	Heavy duty [4]		13/07/96 01/10/2007	91/542/EEC Euro 4	
India	Light duty - National		2000	91/441/EEC [5]	
	Light duty - Delhi region		04/00	Euro 2	Represents about one third of new car sales
	Heavy duty below 85 kW		2000	PM: 0.36 g/kWh (max)	For future light and heavy duty regulations, refer to the **Appendix to Part 1**. **Section A.9.1**.
Indonesia	Gasoline engines Diesel engines		1989	Idle CO & HC Free accln. Smoke	KM 8/1989
	Gasoline engines Diesel engines		2005	Euro 2	Flexibility in the legislation means that implementation may be delayed until 2007
Malaysia	Light duty	gasoline	01/01/00	94/12/EEC	Limits apply to both new vehicles and those fitted with replacement engines.
		Diesel	01/01/00	94/12/EEC	
	Heavy duty		01/01/97	93/59/EEC (Euro 1)	
Nepal	Light duty – Imported		01/02	Euro 1	Minimum requirement
	Light duty – Owned by the government, public corporations and diplomatic missions		19/02/02		Must be fitted with emission control devices
	2-Stroke Motorcycles		08/01		Imports banned
	Auto-rickshaws		08/01		Banned in Kathmandu
Philippines	Light duty			ECE R 15-04 [6]	Section 7 of Presidential Decree No. 1181. See also Footnote [7].
	Medium & heavy duty		01/01/97	ECE R 49-01	
	Motorcycles			Idle CO: 6% (max)	
	Light duty		2003	91/441/EEC and 93/59/EEC	Clean Air Act (June 1999)
	Heavy duty		2003	91/542/EEC	

Table 9.1 Summary of Asian Exhaust Emissions Regulations (continued)

Country	Vehicle Type	Fuel	Effective Date	Equivalent Emission Limits	Reference/Notes
Singapore	Light duty	gasoline diesel	01/2001 10/2006	Euro II 98/69/EC Euro IV	
	Heavy duty	gasoline diesel	01/2001 10/2006	91/542/EEC Euro II 1999/96/EC Euro IV	
	Motorcycles		04/95	US CFR Title 40	
South Korea	Gasoline Diesel			US procedures ECE R 49	See **Appendix to Part 1, Section A.9.1**.
Sri Lanka	Gasoline Diesel		01/01/2003	Euro 2	Standard issued in 2000
Taiwan	Passenger cars [8] Goods vehicles & buses [8]	gasoline gasoline	07/90 07/98	US 1984 limits US 1984 LDT	See **Appendix to Part 1, Section A.9.1**.
	Light duty	diesel	07/98	US 1984 LDT	
	Heavy duty	diesel		US transient test	
	Motorcycles				
Thailand	Light duty	all	25/08/2001	96/69/EC	
		all	see note [9]	98/69/EC (Row A) – Euro 3	
	Heavy duty	diesel	23/05/2000	Euro II	
	Motorcycles/mopeds		≤ 110cc: 01/07/2003 All: 01/07/2004	CO ≤ 3.5 g/km HC + NOx ≤ 2.0 g/km White smoke ≤ 15% Evaporative emissions: 2 g/test	

(1) See the **Appendix to Part 1, Section A.9.1.2**. The Chinese State Environment Protection Agency (SEPA) proposed the adoption of EU Directive 91/441/EEC in 2001.

(2) A government notice, posted on 27 June 2001, required the immediate cessation of production of carburetted vehicles. Production was halted immediately and sales were banned from 1 September 2001.

(3) Gazette No: L.N. 102 of 2001 (Version date 01/01/2002) require more stringent emissions standards on certain classes of motor vehicle, including an OBD requirement for gasoline models. In addition, no new diesel taxis were allowed to be registered. Euro 3 or equivalent standards will apply to certain classes of vehicles under 3.5 tonnes on or after 1 January 2002. From 1 January 2006, LD diesels must comply with Californian regulations. Euro 4 introduced from 01/01/2006 for vehicles up to 2.5 tonnes, extending to 3.5 tonnes from 01/01/2007.

(4) Euro 3 standards (or equivalent US or Japanese limits) will apply to vehicles over 3.5 tonnes, first registered on or after 1 October 2001. Euro 4 limits – planned implementation date. Pre-Euro standard diesel vehicles must be retro-fitted with oxidation catalysts capable of reducing PM by 30% and HC and CO emissions by 50%.

(5) Employs a modified Indian Driving Cycle. This is similar to the ECE15+EUDC cycle, except that the maximum speed is limited to 90 km/h. The durability of passenger cars fitted with catalytic converters will only be assessed on the basis of a deterioration factor of 1.2, without actually conducting endurance tests.

(6) Evaporative emissions for spark ignition engines shall not exceed 2.0 grams per test. Crankcase emissions should be eliminated.

(7) Prior to first registration, any imported used or any rebuilt motor vehicles registered for the first time on or after 1 January 2000 shall 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.

(8) Evaporative emissions for spark ignition engines shall not exceed 2.0 grams per test.

(9) Proposed to the National Environment Board for implementation as follows: RM ≤ 1305kg from 1 January 2003; RM > 1305kg from 1 January 2004. Implementation of Row B of 98/69/EC (Euro 4) is under discussion.

9.1.1. 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**.

In Shanghai all new passenger cars have had to comply with Euro 1 standards from July 1999. In addition, all light duty vehicles sold in the Shanghai region after 1 January 1998 were required to be retrofitted to the Euro 1 limits by the end of 1999. The cost was to be shared between the vehicle manufacturer, owner and the government. Euro 1 standards for heavy duty vehicles became effective in 2002. Euro 3 limits are to be introduced in 2007 and Euro 4 will probably be implemented in 2009.

From 1 July 2004 a 30% consumption tax rebate will be applied to vehicles meeting Euro 3 emissions standards. The rebate, currently awarded to cars meeting Euro 2 limits, was discontinued from 1 January 2004.

SEPA promulgated five new national regulations for vehicle emissions on 27 April 2005. These include limits and measurement methods for:

- Phase 3 and Phase 4 light duty vehicle emission limits. Phase 3 (Euro 3) will become effective on 1 July 2007; Phase 4 (Euro 4) on 1 July 2010.
- Crankcase and evaporative emission limits for heavy-duty spark ignition engines.

Beijing will probably implement these emission standards at an earlier date.

9.1.2. 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. In Delhi, all buses and most three-wheeled taxis use CNG.

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.

Full details will be found in the **Appendix to Part 1, Section A.9.1.4**.

9.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

9.2.1. Unleaded Gasoline Summary

The following table summarises specifications for unleaded gasolines in the region. Readers are directed to the **Appendix to Part 1**, **Section A.9.2** for more comprehensive information, including details of leaded grades and anticipated specification developments.

Table 9.2 Asian Unleaded Gasoline Specifications – Summary

Property		Bangladesh		Brunei	Cambodia	China			Hong Kong			India [4]	
		Reg.	Prem.			No. 90	No. 93	No. 95	Reg.	Prem.	Prem.	Reg.	Prem.
RON	mín	80	95	85/92/97	92/97	90	93	95	90	95	97	88	93
MON	mín			Report	83.6/85.6					85			
(RON + MON)/2	mín					85	88	90	85		92	84	88
RVP (kPa)				Report		88 (W) 74 (S)	88 (W) 74 (S)	88 (W) 74 (S)	88 (W) 60 (S)	88 (W) 60 (S)	88 (W) 60 (S)	35-60	35-60
RVP (psi)		10	10										
Sulphur (mg/kg)	max	1000	1000	1000	1000	800	800	800	150	150	150	1000 [5]	1000 [5]
Benzene (%v/v)	max			5.0		2.5	2.5	2.5	1.0	1.0	1.0	5.0 [6]	5.0 [6]
Aromatics (%v/v)	max					40	40	40	42	42	42		
Olefins (%v/v)	max					35	35	35	18	18	18		
Lead (mg/l)	max	13	13	13	13	5 [1]	5 [1]	5 [1]				13	13
Oxygen (%m/m)	max					[2]	[2]	[2]				[7]	[7]
MTBE (%v/v)	max			15 [3]					0-10 [3]	0-10 [3]	0-10 [3]		
Ethanol (%v/v)	max												

Table 9.2 Asian Unleaded Gasoline Specifications – Summary (Continued)

Property		Malaysia [8]		Pakistan			Philippines	Singapore		South Korea	
		Prem.	Reg.	Reg.	Prem.	Super	Prem.	Reg.	Super	Reg.	Prem.
RON	min	97	92	80	87	97	93	92	98	91-94	> 94
MON	min										
(RON + MON)/2	min										
RVP (kPa)		70	70	69 (W) 62 (S)	69 (W) 62 (S)	69 (W) 62 (S)	70			44-96 (W) 44-70 (S)	44-96 (W) 44-70 (S)
RVP (psi)											
Sulphur (mg/kg)	max	1500	1500	2000	2000	2000	1000			130	130
Benzene (%v/v)	max						5.0			1.5	1.5
Aromatics (%v/v)	max						55 [9]			35	35
Olefins (%v/v)	max									23	18
Lead (mg/l)	max	13	13				13			13	13
Oxygen (%m/m)	max						Permitted [10]				
MTBE (%v/v)	max										
Ethanol (%v/v)	max										

(1) A maximum manganese content of 18 mg/l is permitted. Iron should not be added and the maximum iron content is 10 mg/l. Detergent additives must be used in gasolines supplied to Beijing, Shanghai and Guangzhou. Gasoline meeting Euro 3 requirements will be required from 1 July 2007 (probably earlier in Beijing). Euro 3 will first be required in the large conurbations and coastal cities. This demand accounts for only a small proportion of the national total oil product supply.

(2) When oxygenates are added, a maximum oxygen content of 2.7%m/m is permitted.

(3) The ether chemistry is not specified.

(4) Refer to the **Appendix to Part 1**, **Section.A.9.2.5** for proposed replacement grades.

(5) 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.

(6) 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.

(7) Oxygenates permitted as per EU Directive 98/70/EC (see **Report 2/01**, Table **A.5.2**).

(8) Malaysia is planning to implement its future gasoline specifications in two phases, Stage 1 in the first quarter of 2005 and Stage 2 from 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 as low as 1.0%v/v in Stage 2. A new density specification is also planned to be introduced in Stage 1 - See the **Appendix to Part 1**, **Section 9.2.7** for details.

(9) Aromatics may increase to 65%v/v max if no MTBE added.

(10) Oxygenates content (%m/m) varies seasonally: 0.5 - 2.3 (S); 1.0 – 2.3 (W).

Table 9.2 Asian Unleaded Gasoline Specifications – Summary (Continued)

Property		Sri Lanka	Taiwan [1]		Thailand [2]			Vietnam [5]		
			Reg.	Prem.	Reg.	Inter.	Prem.			
RON	mín	90-95	92	98	87	91	95	90	92	95
MON	mín				76	80	84			
RON + MON)/2	mín									
RVP (kPa)		35-60	69	69	62 (W) 48 (S)	62 (W) 48 (S)	62 (W) 48 (S)	43-80	43-80	43-80
RVP (psi)										
Sulphur (mg/kg)	max		180	180	1000	1000	1000	1500	1500	1500
Benzene (%v/v)	max	4.0	1.0	1.0	3.5	3.5	3.5	5.0	5.0	5.0
Aromatics (%v/v)	max	45	37	37	35	35	35			
Olefins (%v/v)	max		18	18				10	10	10
Lead (mg/l)	max	13	15	13	13	13	13	13	13	13
Oxygen (%m/m)	max	2.7	2.0	2.0	[3]	[3]	[3]			
MTBE (%v/v)	max				5.5-11.0	11.0				
Ethanol (%v/v)	max				[4]	[4]	[4]			

(1) 2002 specifications. The Taiwan EPA revised the "Standards for the Composition and Properties of Automobile Gasoline and Diesel Fuels" on 6 November 2004 for implementation in 2007. Composition controls have been adopted for gasoline. This draft replaces performance control standards with limits on aromatics and olefin contents. See the **Appendix to Part 1**, **Section 9.2.13** for details.

(2) See the **Appendix to Part 1**, **Section 9.2.14** for details of the 2010 proposed grades.

(3) 3.0%v/v max oxygen in methanol blends.

(4) From 01/01/2007, all gasolines must contain 10%v/v ethanol.

(5) See the **Appendix to Part 1**, **Section 9.2.15** for details of the July 2006 proposed grades.

9.2.2. Diesel Fuel - Summary

The following table summarises specifications for diesel fuels in the region. The **Appendix to Part 1**, **Section A.9.2** provides more detailed information, including anticipated specification developments.

Table 9.3 Asian Diesel Fuel Specifications – Summary

Property		Brunei	Cambodia			China [3]	Hong Kong
			45-49	51	LSD		
Cetane number	min		45-46			45	
Cetane index	min	47	820-860/ 800-840	820-845	45	47	45
Density (kg/m^3)			500	350			
Sulphur (mg/kg)		1000 [1]	365	360	15000	5000	5000
90% Distillation °C	max	[2]				370	365
Aromatics (%v/v)	max			11.0			
Polycyclic Aromatics (%v/v)	max						

Property		India [4]	Indonesia	Malaysia [5]	Pakistan	Philippines	South Korea
Cetane number	min	45	45				
Cetane index	min	48	47	45		45	
Density (kg/m^3)		820-870			47		
Sulphur (mg/kg)		5000	5000	3000	870 max	815-855	
90% Distillation °C	max		370	370	5000	430	
Aromatics (%v/v)	max				report	360	
Polycyclic Aromatics (%v/v)	max						

Property		Sri Lanka	Taiwan [6]		Thailand	Vietnam [8]
			Prem.	Reg.	Type II [7]	
Cetane number	min	48			47	
Cetane index	min	46	48	40	47	45
Density (kg/m^3)		820-860			810-870	Report
Sulphur (mg/kg)		3000	350	10000	350	500/2500/5000
90% Distillation °C	max	370	338	357	357	370
Aromatics (%v/v)	max					
Polycyclic Aromatics (%v/v)	max					

(1) Sulphur by XRF, %m/m, max: 0.3.

(2) Distillation, E300, %v/v, min 60; E350, %v/v, min: 85.

(3) China has seven diesel fuel grades, the very low temperature operability fuels exhibiting lower cetane quality and density. See the **Appendix to Part 1**, **Section A.9.2.18** for full details. Diesel fuel meeting Euro 3 requirements will be required from 1 July 2007 (probably earlier in Beijing). Euro 3 will first be required in the large conurbations and coastal cities. This demand accounts for only a small proportion of the national total oil product supply.

(4) Refer to the **Appendix to Part 1, Section A.9.2.20** for proposed replacement grades. For diesel fuel processed from Assam crude, either CN of 45 min. or CI 43 min. and a density of 820 - 870 kg/m3 shall be applicable. 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.

(5) Malaysia is planning to implement its future diesel specifications in two phases, Stage 1 in the first quarter of 2005 and Stage 2 later 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 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. See the **Appendix to Part 1**, **Section A.9.2.22** for full details.

(6) 2002 Specifications. The EPA revised the “Standards for the Composition and Properties of Automobile Gasoline and Diesel Fuels” on 6 November 2004 for implementation in 2007. The new limits are aimed at aligning Taiwan's regulations with international trends and the future activation of Taiwan's phase 4 emissions standards for diesel cars. The latter are based on Euro 4 limits. For diesel, the new standards lower the allowable level of sulphur and, as the Ministry of Economic Affairs Bureau of Standards, Metrology and Inspection already has Cetane Index controls, replaces these controls with limits on aromatic hydrocarbons levels. See the **Appendix to Part 1**, **Section A.9.2.25** for details.

(7) Either cetane number or calculated cetane index. Must include 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 inline injector system must be submitted (effective January 1, 1999). Strong acid number, mgKOH/g, max: Nil. Must incorporate a detergent additive which has passed superior level for the Cummins L-10 test, using Caterpillar 1-K diesel oil or equivalent. The aim is to implement Euro IV equivalent fuel requirements around 2010 - see the **Appendix to Part 1**, **Section A.9.2.28** for details.

(8) Refer to the **Appendix to Part 1**, **Section A.9.2.30** for details of the proposed July 2006 grade.

9.2.3. China Euro 3 and Euro 4 Gasoline and Diesel Fuel Specifications

The State Environmental Protection Administration (SEPA) announced in early 2005 that Euro III emission specifications for light vehicles will be introduced from 1 July, 2007 and Euro IV specifications, July 1, 2010. Beijing was to implement the Euro III emission specifications on 1 July, 2005, two years ahead of the effective date for the whole country, and the Euro IV specifications before 2008.

CNPC began a trial supply of gasoline meeting the Euro III specifications in Beijing in May 2005. There is some debate in government circles regarding the sulphur limits to be applied to both gasoline and diesel fuel. A widespread view (at the end of 2005) was that a maximum limit of 150 mg/kg sulphur was likely to be applied to gasoline, but no consensus had been achieved for diesel fuel.

9.3. TEST PROCEDURES

Individual countries have adopted test procedures appropriate to the emissions legislation standards adopted.

9.4. REFERENCE FUELS

CONCAWE have no data on reference fuels for Asian countries other than Japan.

9.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

9.5.1. South Korea

The South Korean government issued requirements in 1992 for implementation from 1 January 1996 and announced it would introduce more severe requirements from 2000. Details will be found in the **Appendix to Part 1**, **Section A.9.5.1**.

9.5.2. Taiwan

Taiwan has fuel economy regulations governing both passenger cars and motorcycles. Details will be found in the **Appendix to Part 1**, **Section A.9.5.2**.

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 but CONCAWE's information is at least five years old. As a consequence they are reported in **Part 2**, **Section B.9.6.1**. CONCAWE are unaware of any on-board diagnostic system legislation in place.

10. MIDDLE EAST & AFRICA

10.1. VEHICLE EMISSION LIMITS

10.1.1. Israel

In May 2002, the Ministry of Transportation Motor Vehicle Division issued new mandatory requirements for Model Year 2003 Category M vehicles which follow EU practice. In January 2003, the Ministry of Transportation Motor Vehicle Division further revised the requirements for Model Year 2004 Category M vehicles. Emission standards generally follow current EU requirements and more details will be found in the **Appendix to Part 1**, **Section A.10.1.1**.

10.1.2. Saudi Arabia

Saudi Arabia has adopted standards equivalent to ECE R 15.03.

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), which is described in more detail in the **Appendix to Part 1**, **Section A.10.1.3**.

10.2. FUEL QUALITY REGULATIONS AND SPECIFICATIONS

10.2.1. Regional Gasoline Summary

The following data were gathered over the years 2000 to 2005. No information is available for countries omitted from the table. Lead was banned in sub-Sahara Africa on 1 January 2006 with a maximum allowable limit 13 mg/l. The position of the other countries in the continent is unclear. Specifications for Israel and South Africa are included in the **Appendix to Part 1**, **Sections A.10.2.1** and **A.10.2.2** respectively.

Table 10.1 Africa – Unleaded Gasoline Specifications

Property	Units	Angola Gasolina 91 (1)	Angola Gasolina 93 (1)	Benin (2)	Côte d'Ivoire (3)	Eritrea (4)	Ghana (5)
RON	min	91	93	91	95.0	87	91
MON	min						
Lead content	max (mg/l)	5-13	5-13	0	13	13	13
Manganese content	max (mg/l)	18	18		18		18
Distillation:							
Recovered @ 70 C	min (%v/v)	10	10				
Recovered @ 125 C	min (%v/v)	50	50				
Recovered @ 180 C	min (%v/v)	90	90				
10% Recovered	C (range or max)			45-70	78	50-65	70
50% Recovered	C (range or max)			88-125		115	115
90% Recovered	C (range or max)			120-180		180	180
FBP	max C	204	204	205	216	215	204
Residue	max %v/v	2	2	1.5	2.0	2.0	2
RVP	kPa				65		67
RVP	max (psig)	9.0	9.0			9.0	
RVP	max ($g/cm^{2)}$			585-630			
Density @ 15°C	kg/m^3	710-780	710-780	720-765	720-780	705 (min)	725-790
Mercaptan sulphur	max (mg/kg)	1.5	1.5				
Doctor Test		Negative	Negative				
Sulphur content	max (mg/kg)	1500	1500	2500	500	1000	1000
Oxidation stability	min (mins.)	240	240	240	240	240	240
Gum content (solvent washed)	max (mg/100 ml)	4.0	4.0	4.0	5.0	4.0	5
Copper strip corrosion (3 h @ 50°C)	max (rating)	1	1	1a or 1b	1b	1	1
Appearance/Colour		Rose	Green	Clear & Bright		Yellow/ Orange	Red
Water & Sediment	max (%v/v)						0.01
Hydrocarbon type content							
- olefins	max (%v/v)				Report		
- aromatics	max (%v/v)				Report		
Benzene content	max (%v/v)				Report		
Oxygen content	max (%m/m)				0		

(1) Gasolina 91 (Anexo II-I, A que refere o Artico 5) and Gasolina 93 (Anexo II-2, A que refere o Artico 5).

(2) No. 29/SG/REL (22 July 2004).

(3) 225-03-1-UEMOA (01/12/2004).

(4) Specification dated 2004.

(5) Domestically produced specification. For imports: RON = 93 (min); Manganese = Nil; Benzene and Aromatics content to be reported and Oxygenates = Nil.

- All countries quote internationally recognized test methods. In some instances alternative national test methods are specified.
- Some countries include an odour specification, describing the characteristic as "commercial" or "merchantable".

Property	Units	Kenya Premium [1]	Kenya Regular [1]	Madagascar [2]	Mauritania	Mauritius	Nigeria [5]
RON	min	93	83	95	91	95	
MON	min	87	77		82		
Lead content	max (mg/l)	15	15	13	13	13 [3]	Nil
Manganese content	max (mg/l)						
Distillation:							
Recovered @ 70 C	min (%v/v)						10-45
Recovered @ 100 C	min (%v/v)			46-71			36-70
Recovered @ 180 C	min (%v/v)						90
10% Recovered	C (range or max)	71	71		70	65	
50% Recovered	C (range or max)	Report	Report		88-125	77-115	
80% Recovered	C (range or max)				180		
90% Recovered	C (range or max)	Report	Report			185	
FBP	max C	210	210	215	204	215	205
Residue	max %v/v			2	2	2	2
RVP	kPa			45-90	60	45-75	62
RVP	max (psig)						9.0
FVI	max	93	93				
Density @ 15°C	kg/m^3	780 (max)	780 (max)	720-775	715-780	710-785	720-760
Mercaptan sulphur	max (mg/kg)	0.002	0.002			0.0015	
Doctor Test				Negative	Negative	Negative	
Sulphur content	max (mg/kg)	1500	1500	2000	1000	1000	1000
Oxidation stability	min (mins.)	360	360		240	360	360
Gum content (solvent washed)	max (mg/100 ml)	4	4	5	4	4	4
Copper strip corrosion (3 h @ 50°C)	max (rating)	1	1	1	1b		1b
Appearance/Colour		Red or Orange	Green	Green	Clear	Green [4]	Clear & Bright [6]
Water & Sediment	max (%v/v)	Visually free					Nil
Hydrocarbon type content							
- olefins	max (%v/v)			18.0			
- aromatics	max (%v/v)			42.0			
Benzene content	max (%v/v)	5.0	5.0	2.5	5.0	5.0	
Oxygen content	max (%m/m)				2.8		
Oxygenates content	max (%v/v)						
- methanol				3			
- ethanol				5			
- iso-propyl alcohol				10			
- iso-butyl alcohol				10			
- tertiary-butyl alcohol				7			
- ethers (5 or more C atoms)				15			
- other oxygenates							

(1) Premium and Regular Grade Motor Petrol; KS 275 – 2:2003 (September, 2003).

(2) Arrêté No. 24.538 of 21 December 2004. Neutral colour when imported. Not to include any material based on phosphorous. Additives only to be employed with prior agreement with the Ministry of Energy.

(3) Supplier's specification is applicable ex-Refinery gate. No intentional addition of Manganese shall be permitted.

(4) Clear and free from visible water, sediments and suspended matter.

(5) Unleaded Motor Spirit (Gasoline) Specification – NIS 116:2003.

(6) Report colour.

- All countries quote internationally recognized test methods. In some instances alternative national test methods are specified.
- Some countries include an odour specification, describing the characteristic as "commercial" or "merchantable".

Property	Units	Tanzania Premium [1]	Tanzania Regular [1]	Zambia
RON	min	95	87	91 [4]
MON	min	85	77	81 [4]
Lead content	max (mg/l)	13	13	20
Manganese content	max (mg/l)			
Distillation:				
Recovered @ 70 C	min (%v/v)			Report
Recovered @ 100 C	min (%v/v)			
Recovered @ 180 C	min (%v/v)			
10% Recovered	C (range or max)	71	71	65
50% Recovered	C (range or max)	77-115	77-115	75-115
90% Recovered	C (range or max)			185
FBP	max C	205	205	215
Residue	max %v/v	2	2	2
RVP	kPa			45-62
RVP	max (psig)			
FVI	max			(S) 89 (W) 94 [5]
Density @ 15°C	kg/m^3	725-780	725-780	710-785
Mercaptan sulphur	max (mg/kg)			
Doctor Test				
Sulphur content	max (mg/kg)	500	500	1000
Oxidation stability	min (mins.)	360	360	360
Gum content (solvent washed)	max (mg/100 ml)	4	4	4
Potential gum	max (mg/100 ml)			4
Copper strip corrosion (3 h @ 50°C)	max (rating)	1	1	1
Appearance/Colour		[2]		Yellow
Water & Sediment	max (%v/v)	[3]	[3]	
Hydrocarbon type content - olefins	max (%v/v)			
- aromatics	max (%v/v)			Report
Benzene content	max (%v/v)	5.0	5.0	Report
Oxygen content	max (%m/m)			3.7
Oxygenates content - methanol - ethanol - iso-propyl alcohol - iso-butyl alcohol - tertiary-butyl alcohol - ethers (5 or more C atoms) - other oxygenates	max (%v/v)			

(1) Finalized Unleaded Petrol (Gasoline) Specification – TZS 672:2001; ICS 75.160.20.

(2) As per government requirement.

(3) Free from water and suspended matter.

(4) MON (for blends containing more than 2% (v/v) alcohol) = 83 (min). For Octane Rating only one of the three parameters needs to be satisfied.

(5) Summer = 1 September to 30 April (inclusive); Winter = 1 May to 31 August (inclusive).

(6) Any alcohol blended into the fuel shall contain a minimum of 85% (m/m) ethanol with the balance i-propanol and n-propanol, and only trace quantities of other alcohols. Ethers containing five or more carbon atoms per molecule may be included up to a maximum concentration as indicated in the standard. The oxygen content of the blend will be determined by method ASTM D 4815 (MTBE) and such other methods that may be developed for other C5 esters. For fuels containing oxygenates a total acidity limit of 0.03 mg KOH/g also applies.

Table 10.2 Africa Leaded Gasoline Grade Structure - Summary

Country	Regular or Premium	RON	Lead content (mg Pb/l)	Colour	Vapour pressure (kPa)	Distillation	
						T10E (ºC)	FBP (ºC)
Algeria	R	89	500				
	P	96	600				
Angola	P	90	800	red	63	70	204
Benin	P	90	500	yellow	60		205
Burkina	R	87	400	red	77.3		204
	P	93	400	yellow	77.3	70	205
Cameroon	R	85	800	red	63.5	70	204
	P	95	840	yellow	63.5	70	204
Congo	P	95	750	yellow	64.0	70	205
Egypt	R	81-83	230-280				
	P	90	230-280				
Equatorial Guinea	P	93	800	yellow	65.0	70	210
Gabon	R	85	200				
	P	93	800	yellow	63.5	70	204
Gambia	P	93	800	red	63.0	70	210
Ghana	P	92	600	red	74.0	70	210
Guinea Bissau	P	95	800	yellow	65.0	75	210
Guinea	P	93	800	red	650	75	210
Ivory Coast	R	87	800	red	63.0	75	210
	P	95	800	yellow	63.0	75	210
Kenya	R	87	600				
	P	93	600				
Liberia	P	93	800	red	63.0	70	204
Madagascar	R	87	500-600				
	P	95	500-600				
Malawi	P	93	600				
Mauritania	R	88	550	pink	62.0	70	205
	P	92	850	undyed	62.0	70	205
Mauritius	P	95	400				
Morocco	R	87	40-500				
	P	95	40-500				
Mozambique	P	93	400				
Namibia	R	83	400	orange	73.0	65	210
	P	93	400	orange	73.0	65	210
Nigeria	R	90	700				
	P	90	700	red	90	70	215

Table 10.2 Africa Leaded Gasoline Grade Structure – Summary (continued)

Country	Regular or Premium	RON	Lead content (mg Pb/l)	Colour	Vapour pressure (kPa)	Distillation	
						T10E (ºC)	FBP (ºC)
Senegal	R	87	800	undyed	63.5	70	204
	P	95	800	undyed	63.5	70	204
Sierra Leone	P	93	900	red	70.0	70	205
South Africa (2005)	Note (1)	97	400		75.0	65	215
		93	13		75.0	65	215
		95	400		75.0	65	215
		93	13		75.0	65	215
Tanzania	R	83	71.0				
	P	93	71.0				
Togo	R	87	600	red	63.0	70	205
	P	93	400	red	63.0	70	205
Tunisia	R	89	500				
	P	96	500				
Zaire	P	93	630				
Zambia	R	87	710		60.0		
	P	93	710		60.0		
Zambia	R	87	0.60				
Zimbabwe	P	93	840				

(1) See the **Appendix to Part 1**, **Section A.10.2.2** for full details. In South African coastal areas leaded RON 97 and unleaded RON 95 are currently marketed. Inland leaded RON 93 and unleaded RON 93 are available. Alcohol is blended into the leaded grade of fuel in certain inland supply areas – the alcohol is manufactured in the SASOL oil-from-coal process. The specification of the alcohol and the permissible concentrations varies by both gasoline grade and location. The octane structure will change from 2006, along with total lead phase out, to the following:

Coast:	Inland:
RON	RON
95	95
93	93
91	91
95*	93*

* Lead replacement grades

Table 10.3 Middle East Gasoline Grade Structure - Summary

Country	Octane (RON/MON)	Type	Sulphur content (mg/kg)	Lead content (g Pb/l) - Max.
Bahrain	91/NA	U/L	1500	0.013 (1)
	95/84	U/L	1500	0.013
Iran	87/NA	U/L	1000	0.013 (2)
	95/87	U/L	1000	0.013
Iraq	92/NA	L	500	0.1 - 0.3
	90/NA	L	500	0.1 - 0.3
	82/NA	L	500	0.1 - 0.3
Israel	95/85 (EN 228:1999)	U/L	50 (2003) 10 (2004)	0.005
Jordan	88/NA	L	2000	0.28
	96/NA	L	2000	0.28
	95/NA	U/L	2000	0.05
Kuwait	93/82	U/L	500	0.005 (3)
	96/85 (4)	U/L	500	0.005
	98/87 (5)	U/L	500	0.013
Lebanon	92/NA	L	1500	0.4
	98/NA	L	1500	0.25
	95/85	U/L	1000	0.013
Oman	90/NA	U/L	1000	0.013
	95/NA	U/L	1000	0.013
Qatar	97/NA	U/L	100	(6)
	90/NA	U/L	300	(6)
Saudi Arabia	95/NA	U/L	1500 (7)	0.013 (8)
Syria	90/NA	L	1500	0.4
	90/NA	U/L	1000	0.013
UAE	90/NA	L	1000	0.4
	97/NA	L	1000	0.4
	95/85	U/L	500	0.013
	97/87	U/L	500	0.013
	98/87	U/L	500	0.013
Yemen	NA/83	L	200 (9)	0.4

(1) Leaded gasoline phased out July 2000.

(2) Leaded gasoline phased out March 2003.

(3) Leaded gasoline phased out 1998.

(4) MON adjusted in late 2002 from 83.5 to 85.

(5) Introduced late 2002.

(6) Leaded gasoline phased out in 1996. Plans to introduce gasoline with max. 10 mg/kg sulphur by 2010.

(7) A reduction of sulphur in gasoline is planned to commence in 2006 in two phases. Phase I – introduction of gasoline with max. 500 mg/kg sulphur content in major cities, such as Mecca, Jeddah and Riyadh. Phase II – introduction in entire Kingdom.

(8) Leaded gasoline phased out January 2001.

(9) Actual fuel market average (November 2002): 200 mg/kg S; 0.4 g Pb/l.

- Much of this information represents typical marketed quality, rather than specification limits.

10.2.2. Regional Diesel Fuel Summary

The following data were gathered over the years 2000 to 2005. No information is available for countries omitted from the table. Specifications for Israel and South Africa are included in the **Appendix to Part 1**, **Sections A.10.2.3** and **A.10.2.4** respectively.

Table 10.4 Africa Diesel Fuel Sulphur Contents - Summary

Property	Units	Angola (1)	Eritrea (3)	Ethiopia	Ghana	Madagascar (5)	Malawi
Cetane Number	(min)		46				
Cetane index	(min)	45	50	48	45	48	45
Density @ 15°C	kg/m^3	820 (min)	820-870	830-870	830-870	810-890	820-840
Sulphur content	mg/kg (max)	3000	7500	10000	5000	5000	5500
Flash point	°C	66		66	55	55	60
Carbon residue (on 10% distillation residue)	%m/m	0.15	0.15	0.2	0.2	0.15	0.2
Ash content	%m/m	0.01	0.01	0.01	0.1	0.01	0.01
Water content	mg/kg	30-500	500	500	500	500	500
Sediment	%v/v		0.01	0.03	0.1	0.01	0.03
Copper strip corrosion (3 h @ 50°C)	rating		1	2		1	2
Strong acid number	mg KOH/g					Nil	
Total acid number	mg KOH/g	1	1		1	0.5	
Lubricity, corrected wear scar diameter (wsd 1,4) @ 60°C	µm						
Viscosity @ 40°C	mm^2/s	2.1-5.5	2.0-5.5	2.0-5.5	6.5 (max) (4)	1.6-5.5 (4)	1.8-6.0 (4)
Colour		2.5	3.5		3.0	3.0	
Appearance			Clear				
Cloud Point	C (max)		4.5	5.0			5
Pour Point	C (max)	(2)			15	0	
Distillation							
IBP	C	Report					
% recovered @ 360°C	%v/v				85	90	
% recovered 240 – 310 C	%v/v		50				
90%v/v recovered	°C	365-370	360	362			362
FBP	°C					385	

(1) Annexo VII a que refere Artigo 10.

(2) 15/12 – 15/04: + 9 C; 15/04 – 15 07: + 3 C; 15/07 – 15/12: +6 C

(3) The requirements of Low Sulphur Gas oil are as specified for Automotive Gas oil except for the Cetane index and the Sulphur content which are as indicated below:
Sulphur, mg/kg, (max): 5000
Cetane Index, (min): 40

(4) Viscosity @ 37.8 C.

(5) Arrêté No. 24.538 of 21 December 2004.

Property	Units	Mauritania	Mauritius	Mozambique [3]	Niger [5]	Nigeria	Sao Tome & Principe [8]
Cetane Number	(min)						
Cetane index	(min)	50		45	48	47 [7]	50
Density @ 15°C	kg/m^3	810-860	820-860	820-869 [4]	810-890	820 (min)	820 (min)
Sulphur content	mg/kg (max)	5000	2500	5500	10000	5000/ 3000 [6]	1500
Flash point	°C	55-120	66	60	61-120	65	66
Carbon residue (on 10% distillation residue)	%m/m		0.2 [2]	0.2 [2]	0.15	0.15	0.15
Ash content	%m/m	Not detectable		0.01	0.01	0.01	
Water content	mg/kg	Not detectable	500	500	Trace	500	
Sediment	%v/v	Nil	0.01	0.01	0.01		
Copper strip corrosion (3 h @ 50°C)	rating		1	1	1b	1	1
Strong acid number	mg KOH/g	Nil	Nil	Nil	Nil	Nil	
Total acid number	mg KOH/g		0.25	0.5	1.0	0.5	
Viscosity @ 40°C	mm^2/s	9.5 [1]	2.0-4.5	1.6-5.3	9.5 [1]		2.2-5.8 [9]
Conductivity @ 20 C	ps/m		75-350				
Colour		1.5	2.5		3.0		
Appearance			Clear & Bright	Clear & Bright			
Cloud Point	C (max)	2	60 F			4	
Pour Point	C (max)	-7	50 F	5			
CFPP	C (max)		0				
Distillation							
% recovered @ 250°C	%v/v	< 65			< 65		
% recovered @ 350°C	%v/v (min)	85			85		
50%v/v recovered	°C		290	240			
90%v/v recovered	°C		366	362		357	
95%v/v recovered	°C		385				
FBP	°C				390	385	

(1) Viscosity @ 20 C.
(2) Ramsbottom method.
(3) Specification PMO/550 (Issue 9, 31/10/1994).
(4) Report API gravity.
(5) Specification dated 2 February 2001.
(6) With effect from June 2005.
(7) Diesel index.
(8) Specification dated January 2005.
(9) Viscosity @ 37.8 C.

Property	Units	Senegal	Sierra Leone	Tanzania [2]	Zambia [3]
Cetane Number	(min)	45		51	46
Cetane index	(min)		45	48	50
Density @ 15°C	kg/m^3	820-880	820-875	820-870	820-870
Sulphur content	mg/kg (max)	5000	5000	5000	7500
Flash point	°C	61	140 F	65.5	60
Carbon residue (on 10% distillation residue)	%m/m	0.15	0.15	0.15	0.15
Ash content	%m/m	0.01	0.1	0.01	0.01
Water content	mg/kg	500	500	500	500
Sediment	%v/v	0.01	0.01	0.01	0.01
Copper strip corrosion (3 h @ 50°C)	rating	1	1		1
Oxidation stability	mg/100 ml			2.0	
Strong acid number	mg KOH/g	Nil	Nil		
Total acid number	mg KOH/g	1.0	1.0		1.0
Viscosity @ 40°C	mm^2/s	1.6-5.9 [1]	1.6-3.8 [1]	1.6-4.5	2.0-5.5
Colour		3.0	2.5	3.5	3.5
Appearance				Clear	Clear
Cloud Point	C (max)	7		4.5	4.5
Pour Point	C (max)	5	10		
CFPP	C (max)				
Distillation					
% recovered @ 360°C	%v/v				90
% recovered 240 – 310 C	%v/v				50
90%v/v recovered	°C	362	370	357	
FBP	°C	Report			

(1) Viscosity @ 37.8 C.

(2) Specification TZS 674:2001.

(3) The requirements of Low Sulphur Gas oil are as specified for Automotive Gas oil except for the Cetane index and the Sulphur content which are as indicated below:
Sulphur, mg/kg, (max): 5000
Cetane Index, (min): 40

Table 10.5 Middle East Diesel Fuel Quality - Summary

Country	Cetane Number (min.)	Cetane index (min.)	Sulphur content (mg/kg)
Bahrain	N/A	50	5000
Israel (1)	51	46	50
Iran	NA	50	7000 - 8000 (2)
Iraq	53	55	2000
Jordan	51	46	12 000
Kuwait	N/A	48	5000
Lebanon	46	49	350
Oman	N/A	47	1000
	N/A	47	500
	N/A	47	50
Qatar	N/A	50	500
Saudi Arabia	N/A	45	10 000 (3)
Syria	N/A	58-65	7000
UAE	N/A	50	5000
	N/A	45	500
Yemen	54	N/A	10 000

(1) Israel has adopted EN 590:1999 but the sulphur content is limited to 50 mg/kg.

(2) From market survey. Specification is 10 000 mg/kg maximum. Iran plans to segregate diesel fuel into on-road and non-road grades; no dates are given.

- Much of this information represents typical marketed quality, rather than specification limits.

10.2.3. 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 Table 1.28**), attracts a tax incentive.

10.3. EMISSIONS AND FUEL ECONOMY TEST PROCEDURES

CONCAWE have no information available.

10.4. REFERENCE FUELS

CONCAWE have no information available.

10.5. FUEL CONSUMPTION AND CO_2 REGULATIONS

CONCAWE are not aware of any regulations in the region.

10.6. IN-SERVICE EMISSIONS LEGISLATION AND ON-BOARD DIAGNOSTIC SYSTEMS

10.6.1. Egypt

In-service control of diesel engined vehicle emissions are in place and the authorities are considering introducing EU limit values.

10.6.2. Israel

The following regulations are in place:

Table 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

10.6.3. Saudi Arabia

Annual inspections of vehicle emission control systems are required in Jeddah, Riyadh and Dammam.

11. WORLDWIDE HARMONISATION OF TEST CYCLES

11.1. HEAVY-DUTY EMISSIONS CERTIFICATION PROCEDURE PROPOSAL

11.1.1. Introduction

This proposal was tabled as Informal document No. GRPE-50-4-Rev.1 at the 50th GRPE, 30 May - 3 June 2005. Its full title is "World-Wide Heavy-Duty Emissions Certification Procedure Proposal for New Draft Global Technical Regulation (GTR)". This document covers the general technical contents of the GTR procedure, as approved by the 48th GRPE on 03.06.2004, comments from the WHDC Drafting Committee, and cold start provisions as proposed by the USA at the 49th GRPE on 13.01.2005.

The proposed regulation is based on new research into the world-wide pattern of real heavy commercial vehicle use. From the collected data, two representative test cycles, one transient test cycle (WHTC) and one steady state test cycle (WHSC), have been created, covering typical driving conditions in the European Union, the United States of America, Japan and Australia. Alternative emission measurement procedures have been developed by an expert committee in ISO and have been published in ISO 16183. This standard reflects the state-of-the-art in exhaust emissions measurement technology with the potential for accurately measuring the pollutant emissions from future low emission engines.

The WHTC and WHSC test procedures reflect world-wide on-road heavy-duty engine operation as closely as possible and provide a marked improvement in the realism of the test procedure for measuring the emission performance of existing and future heavy-duty engines. In summary, the test procedure was developed so that it would be:

- representative of world-wide on-road vehicle operation,
- able to provide the highest possible level of efficiency in controlling on-road emissions,
- corresponding to state-of-the-art testing, sampling and measurement technology,
- applicable in practice to existing and foreseeable future exhaust emissions abatement technologies, and
- capable of providing a reliable ranking of exhaust emission levels from different engine types.

As a first step, the GTR is being presented without limit values. In this way the test procedure can be given a legal status which also requires the Contracting Parties to start the process of implementing it into their national law.

When implementing the test procedure contained in this GTR as part of their national legislation or regulation, Contracting Parties are invited to use limit values which represent at least the same level of severity as their existing regulations, pending the development of harmonized limit values under the 1998 Agreement administered by the World Forum for Harmonization of Vehicle Regulations (WP.29). The performance levels (emissions test results) to be achieved in the GTR will therefore be discussed on the basis of the most recently agreed legislation in the Contracting Parties, as required by the 1998 Agreement.

11.1.2. Scope

This Regulation applies to the emission of gaseous and particulate pollutants from compression ignition engines and positive-ignition engines fuelled with natural gas and LPG, used for propelling heavy duty motor vehicles having a design speed exceeding 25 km/h and having a maximum mass exceeding 3.5 tonnes.

11.1.3. Engine Family

General

An engine family is characterized by design parameters. These shall be common to all engines within the family. In some cases there may be interaction of parameters. The engine manufacturer may decide, which engines belong to an engine family, as long as the membership criteria listed in the regulation are respected.

Choice of the Parent Compression Ignition Engine

The parent engine of the family shall be selected using the primary criterion of the highest fuel delivery per stroke at the declared maximum torque speed. In the event that two or more engines share this primary criterion, the parent engine shall be selected using the secondary criterion of highest fuel delivery per stroke at rated speed.

Choice of the Parent Spark Ignition Engine

The parent engine of the family shall be selected using the primary criterion of the largest displacement. In the event that two or more engines share this primary criterion, the parent engine shall be selected using the secondary criterion in the following order of priority:

1. the highest fuel delivery per stroke at the speed of declared rated power
2. the most advanced spark timing
3. the lowest EGR rate

Remarks on the Choice of Parent Engine

Under certain circumstances, the approval authority may conclude that the worst case emission rate of the family can best be characterized by testing a second engine. Thus, the approval authority may select an additional engine for test based upon features which indicate that it may have the highest emission level of the engines within that family. In this case, the parties involved shall have the appropriate information to determine the engine within the family likely to have the highest emissions level. If engines within the family incorporate other variable features which may be considered to affect exhaust emissions, these features shall also be identified and taken into account in the selection of the parent engine. If engines within the family meet the same emission values over different useful life periods, this shall be taken into account in the selection of the parent engine.

11.1.4. Test Procedures

Principles of Emissions Measurement

In this regulation, two measurement principles are described that are functionally equivalent: Both principles may be used for both the WHTC and the WHSC cycle:

- the gaseous components are measured in the raw exhaust gas on a real time basis, and the particulates are determined using a partial flow dilution system;
- the gaseous components and the particulates are determined using a full flow dilution system (CVS system).
- any combination of the two principles (e.g. raw gaseous measurement and full flow particulate measurement) is permitted.

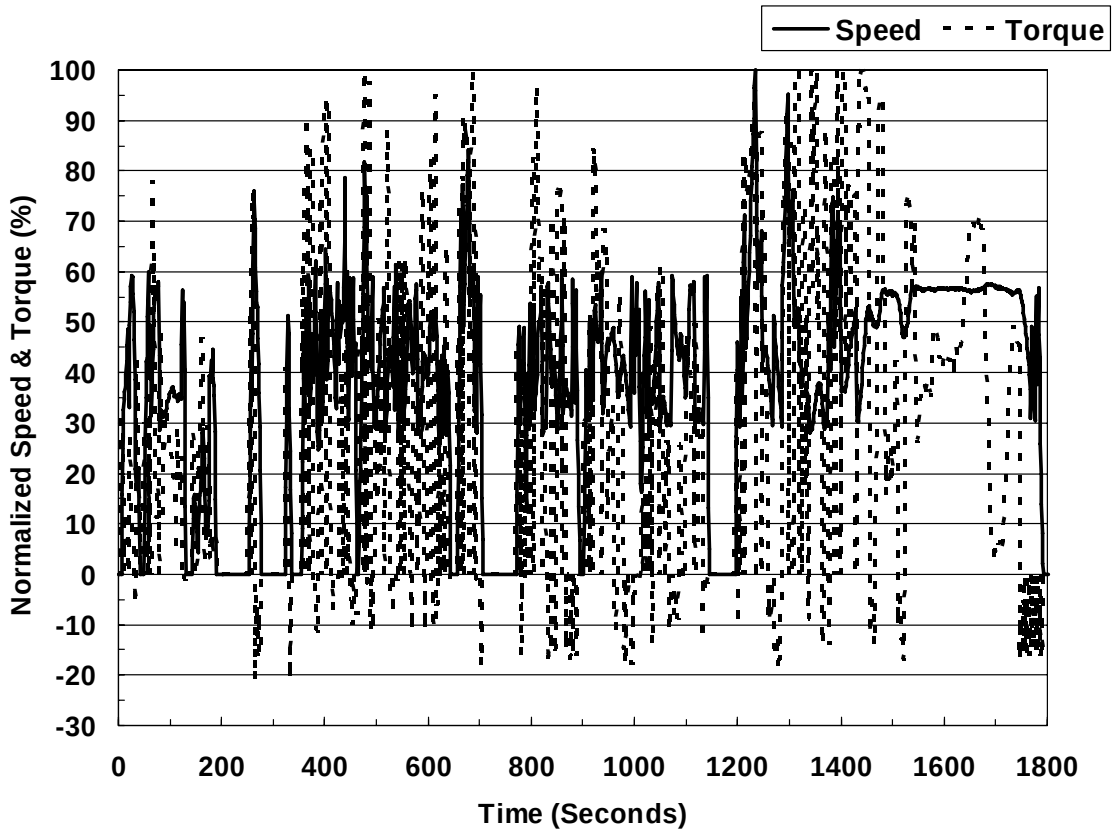
The engine shall be subjected to the tests specified below.

Transient Test Cycle WHTC

The transient test cycle WHTC is illustrated in **Figure 11.1** and represents a second-by second sequence of normalized speed and torque values applicable to all engines covered by this GTR. In order to perform the test on an engine test cell, the normalized values shall be converted to the actual values for the individual engine under test based on the engine mapping curve. The conversion is referred to as denormalisation, and the test cycle so developed as the reference cycle of the engine to be tested.

With those reference speed and torque values, the cycle shall be run on the test cell, and the feedback speed, torque and power values shall be recorded. In order to validate the test run, a regression analysis between reference and feedback speed, torque and power values shall be conducted upon completion of the test. For calculation of the brake specific emissions, the actual cycle work shall be calculated by integrating actual engine power over the cycle. For cycle validation, the actual cycle work must be within prescribed limits of the cycle work of the reference cycle (reference cycle work). The gaseous pollutants may be recorded continuously or sampled into a sampling bag. The particulate sample shall be diluted with conditioned ambient air, and collected on a single suitable filter.

Figure 11.1 World Harmonized Transient Test Cycle (WHTC)



Steady State Test Cycle WHSC

The steady state test cycle WHSC consists of a number of speed and power modes which cover the typical operating range of heavy duty engines. During each mode, and the ramps between the modes, the concentration of each gaseous pollutant, exhaust flow and power output shall be determined, and the measured values weighted. The particulate sample shall be diluted with conditioned ambient air. One sample over the complete test procedure shall be taken, and collected on a single suitable filter.

The WHSC is shown schematically in **Table 11.1**.

Table 11.1 World Harmonized Steady State Test Cycle (WHSC)

Mode No	Speed (%)	Load (%)	W F (1) (%)	Sample Time (s)	Mode Length (s)
0	Motoring		24		
1	0	0	17	340	370
2	55	100	2	40	70
3	55	25	10	200	230
4	55	70	3	60	90
5	35	100	2	40	70
6	25	25	8	160	190
7	45	70	3	60	90
8	45	25	6	120	150
9	55	50	5	100	130
10	75	100	2	40	70
11	35	50	8	160	190
12	35	25	10	200	230
Sum			100	1520	1880

(1) WF = Weighting Factor

Notes:

Total PM sampling time close to WHTC = 1520 sec

Mode length dependent on WF

Mode stabilization time = 30 sec

Idle mode determines length of other modes due to the highest WF (ca. 5 to 7 minutes)

Total cycle length is 31.3 minutes

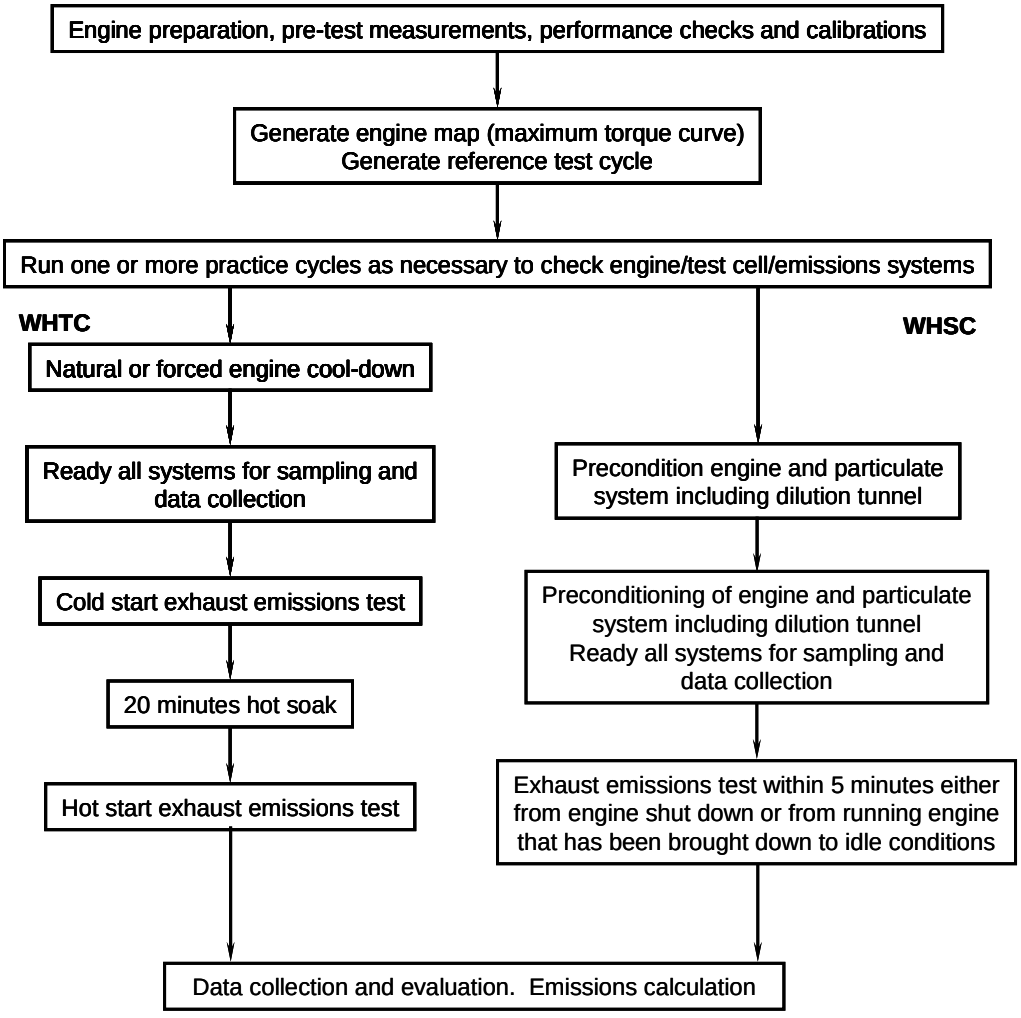
Motoring is accounted for mathematically by a WF of 0.24 and zero emissions/zero power

Motoring does not add to sample time, mode length and cycle length

General Test Sequence

The following flow chart (**Figure 11.2**) outlines the general guidance that should be followed during testing. The details of each step are described in the relevant paragraphs of the regulation. Deviations from the guidance are permitted where appropriate, but the specific requirements are mandatory.

Figure 11.2 General Test Sequence –
Worldwide Harmonized Heavy-Duty Engine Procedure



For the WHTC, the test procedure consists of a cold start test following either natural or forced cool-down of the engine, a 20 minutes hot soak period and a hot start test. For the WHSC, the test procedure consists of a hot start test following engine preconditioning. One or more practice cycles may be run as necessary to check engine, test cell and emissions systems before the measurement cycle.

11.2. PROPOSED EMISSIONS TEST CYCLE FOR TWO-WHEELED MOTORCYCLES

11.2.1. Introduction

This proposal was tabled at the UN World Forum for Harmonization of Vehicle Regulations (WP.29), One-hundred-and-thirty-sixth session, 21-24 June 2005. Its full title is "World-Wide Emissions Test Cycle for Two-Wheeled Motorcycles - Proposal for New Draft Global Technical Regulation (GTR)". The test procedure was developed so that it would be:

- representative of world-wide on-road vehicle operation,
- able to provide the highest possible level of efficiency in controlling on-road emissions,
- corresponding to state-of-the-art testing, sampling and measurement technology,
- applicable in practice to existing and foreseeable future exhaust emissions abatement technologies,
- capable of providing a reliable ranking of exhaust emission levels from different engine types,
- consistent with the development of appropriate emission factors, and
- inclusive of adequate cycle-bypass prevention provisions.

A number of existing regulations contain relevant applications of exhaust-emissions requirements for motorcycles which are available for technical reference in developing a new GTR. Most of these regulations have been in existence for many years and the methods of measurement vary significantly. The technical experts were familiar with these requirements and discussed them in their working sessions. The group considered that to be able to determine a vehicle's real impact on the environment, in terms of its exhaust emissions and fuel consumption, the test procedure and consequently the GTR needed to represent modern, real-world vehicle operation. Consequently, the proposed regulation is based on new research into the worldwide pattern of real motorcycle use.

The issues addressed by the test procedure development group are discussed in detail in the reference technical report. The process used to develop this GTR can be broken down into four basic steps:

- the basis of the cycle development was the collection and analysis of driving behaviour data and statistical information about motorcycle use for the different regions of the world.
- in a second step the in-use driving behaviour data were combined with the statistics on vehicle use in order to create a reference database that is representative for worldwide motorcycle driving behaviour.
- the next step was to compact this reference cycle into a test cycle of the desired length. A computer search programme then selected a number of modules (speed/time sequences between two stops) to represent by approximation this "ideal" length.
- finally, a first draft of the World-wide Motorcycle Test Cycle (WMTC) was produced. It was foreseen that this first draft needed to be modified on the basis of an evaluation concerning driveability and practical points concerning the measurement procedure. Since this process is iterative by nature, several

adaptation rounds including the driveability tests were carried out. In each of these steps, specific technical issues were raised, discussed, and resolved.

11.2.2. General Requirements

The GTR contains:

1. a main cycle in three parts, which is applied to three different categories of motorcycle according to their typical use
2. an alternative cycle, which is to be used by low-powered motorcycles
3. a specific gear shift procedure (see original document for details)
4. the general laboratory conditions (see original document for details)

The question of harmonized off-cycle emissions requirements will be considered and appropriate measures introduced in due course.

11.2.3. Performance Requirements

As a first step, the GTR is being presented without limit values. In this way the test procedure can be given a legal status which also requires the Contracting Parties to start the process of implementing it in their national law. When implementing the test procedure contained in this as part of their national legislation or regulation, Contracting Parties are invited to use limit values which represent at least the same level of severity as their existing regulations, pending the development of harmonized limit values under the 1998 Agreement of the World Forum for Harmonization of Vehicle Regulations (WP.29).

11.2.4. Vehicle classification

Table 11.2 gives an overview of the vehicle classification in terms of engine capacity and maximum vehicle speed. The numerical values of the engine capacity and maximum vehicle speed shall not be rounded up or down.

Table 11.2 Motorcycle classification

Class	Sub-Class	Engine Capacity (cm^3)	Maximum Speed (v_{max} km/h)
1	1-1	≤ 50	$50 < v_{max} \leq 60$
	1-2	50 < capacity < 150	< 50
	1-3	< 150 (1)	$50 \leq v_{max} < 100$ (1)
2	2-1	< 150	$100 \leq v_{max} < 115$
		≥ 150	< 115
	2-2		$115 \leq v_{max} < 130$
3	3-1		$130 \leq v_{max} < 140$
	3-2		≥ 140

(1) Excluding subclass 1-1.

11.2.5. Test Cycles

Test cycles (vehicle speed patterns), for the Type I test consist of up to three parts, as shown in **Figure 11.3**. Depending on the vehicle class (see **Table 11.2**) the following test cycle parts have to be run:

Table 11.3 Required Test Cycle Segments

Class	Sub-Class	Cycle Segment	Test Conditions
1	1-1 & 1-2	Part 1	Reduced speed in cold condition
		Part 1	Reduced speed in hot condition
	1-3	Part 1	Cold condition
		Part 1	Hot condition
2	2-1	Part 1	Cold condition
		Part 2	Reduced speed in hot condition
	2-2	Part 1	Cold condition
		Part 2	Hot condition
3	3-1	Part 1	Cold condition
		Part 2	Hot condition
		Part 3	Reduced speed in hot condition
	3-2	Part 1	Cold condition
		Part 2	Hot condition
		Part 3	Hot condition

Figure 11.3 Parts of the World-Wide Motorcycle Test Cycle

Part 1

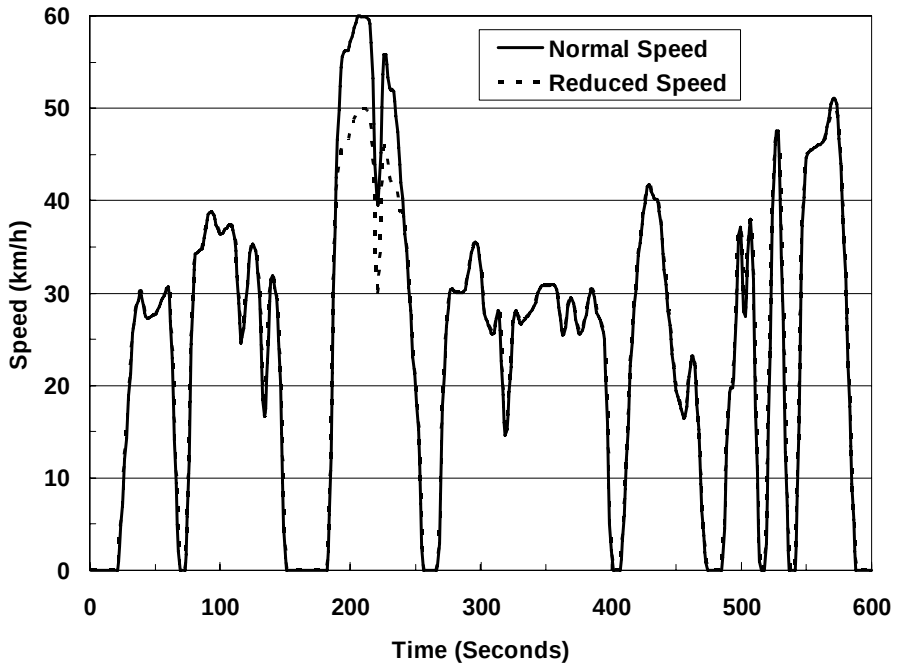
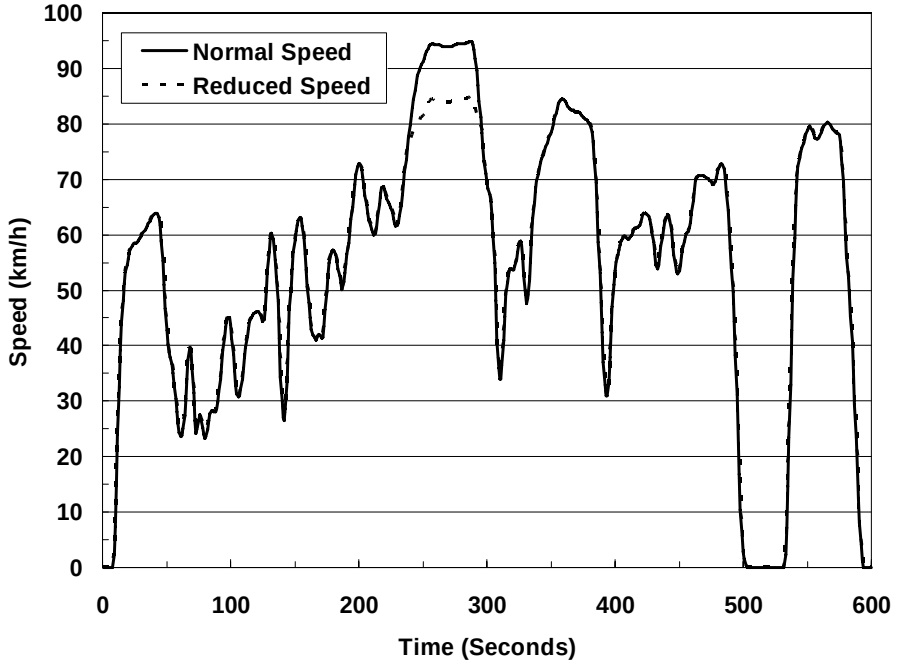
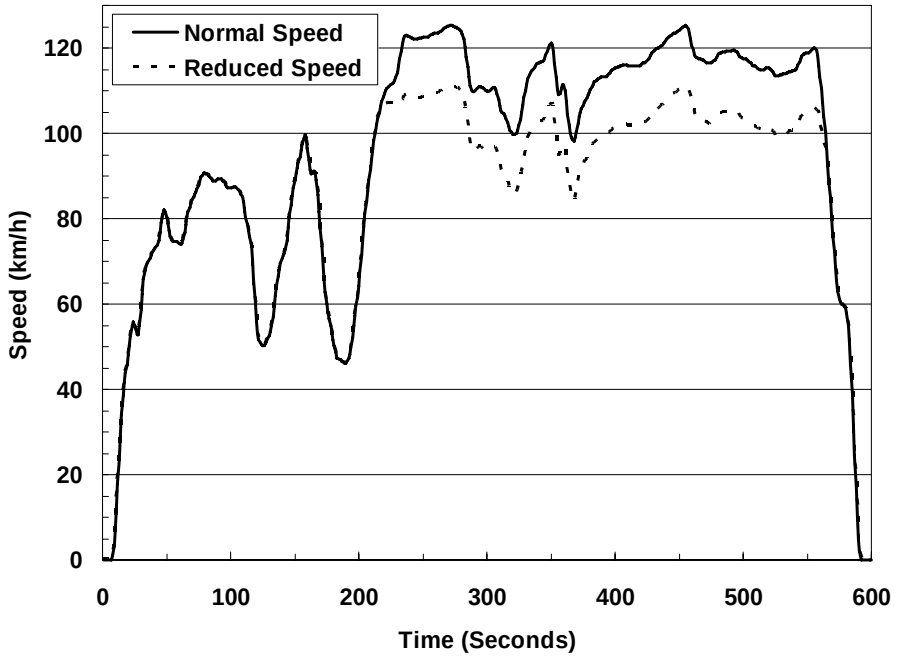


Figure 11.3 Parts of the World-Wide Motorcycle Test Cycle (Continued)

Part 2



Part 3



11.2.6. Reference Fuels

Reference Gasoline

Parameter	Unit	Limits (1)		Test method	Publication
		Min	Max		
RON		95.0		EN 25164	1993
MON		85.0		EN 25163	1993
Density at 15 °C	kg/m^3	748	762	ISO 3675	1995
Reid vapour pressure	kPa	56.0	60.0	EN 12	1993
Distillation:				EN-ISO 3205	1988
initial boiling point	°C	24	40		
evaporated at 100 °C	%v/v	49.0	57.0		
evaporated at 150 °C	%v/v	81.0	87.0		
final boiling point	°C	190	215		
Residue	%v/v		2		
Hydrocarbon analysis:					
olefins	%v/v		10	ASTM D 1319	1995
Aromatics (3)	%v/v	28.0	40.0	ASTM D 1319	1995
benzene	%v/v		1.0	pr. EN 12177	1998 (2)
saturates	%v/v		balance	ASTM D 1319	1995
Carbon/hydrogen ratio		report	report		
Oxidation stability (4)	min.	480		EN-ISO 7536	1996
Oxygen content (5)	%m/m		2.3	EN 1601	1997 (2)
Existent gum	mg/ml		0.04	EN-ISO 6246	1997 (2)
Sulphur content (6)	mg/kg		100	pr.EN-ISO/ DIS 14596	1998 (2)
Copper corrosion at 50 °C			1	EN-ISO 2160	1995
Lead content	mg/l		5	EN 237	1996
Phosphorus content	mg/l		1.3	ASTM D 3231	1994

(1) The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test,' have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The month of publication will be completed in due course.

(3) The reference fuel used shall have a maximum aromatics content of 35 per cent v/v.

(4) The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilise refinery gasoline streams, but detergent/dispersive additives and solvent oils shall not be added.

(5) The actual oxygen content of the fuel for the tests shall be reported. In addition the maximum oxygen content of the reference fuel shall be 2.3%.

(6) The actual sulphur content of the fuel used for the tests shall be reported. In addition the reference fuel shall have a maximum sulphur content of 50 mg/kg.

Reference Diesel Fuel

Parameter	Unit	Limits (1)		Test method	Publication
		Min	Max		
Cetane number (2)		52.0	54.0	EN-ISO 5165	1998 (3)
Density at 15°C	kg/m³	833	837	EN-ISO 3675	1995
Distillation:				EN-ISO 3405	1988
50%	°C	245	-		
95%	°C	345	350		
final boiling point	°C	-	370		
Flash point	°C	55	-	EN 22719	1993
CFPP	°C	-	-5	EN 116	1981
Viscosity at 40 °C	mm²/s	2.5	3.5	EN-ISO 3104	1996
Polycyclic aromatic hydrocarbons	%m/m	3.0	6.0	IP 391	1995
Sulphur content (4)	mg/kg	-	300	pr. EN-ISO/ DIS 14596	1998 (3)
Copper corrosion		-	1	EN-ISO 2160	1995
Conradson carbon residue (10 %t DR)	%m/m	-	0.2	EN-ISO 10370	1995
Ash content	%m/m	-	0.01	EN-ISO 6245	1995
Water content	%m/m	-	0.05	EN-ISO 12937	1998 (3)
Neutralisation strong acid number	mg KOH/g	-	0.02	ASTM D 974-95	1998 (3)
Oxidation stability (5)	mg/ml	-	0.025	EN-ISO 12205	1996

(1) The values quoted in the specification are "true values". In establishment of their limit values the terms of ISO 4259 "Petroleum products - Determination and application of precision data in relation to methods of test,' have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for statistical reasons, the manufacturer of fuels should nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the question as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

(2) The range for the cetane number is not in accordance with the requirement of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms in ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

(3) The month of publication will be completed in due course.

(4) The actual sulphur content of the fuel used for the Type I test shall be reported. In addition the reference fuel shall have a maximum sulphur content of 50 mg/kg.

(5) Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life.

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 association for Environment, Health and Safety in refining and distribution)
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)
$TP_{(cold)}$	Transition Period (cold and hot) (part of Federal city cycle)
$TP_{(hot)}$	
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 $\leq$8500 lb, curb weight $\leq$6000 lb and frontal area $\leq$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 $\leq$6000 lb
Heavy Light Duty Trucks	Light duty trucks with GVWR $\geq$6000 lb
Heavy Duty Vehicles	Vehicle with GVWR >8500 lb or curb weight >6000 lb or frontal area >45 ft^2

13. ACKNOWLEDGEMENT

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