Worldwide Emissions Standards

Passenger Cars & Light Duty Trucks

DELPHI

Innovation for the Real World

2009

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We've engineered a revolutionary breed of diesel injection technology.

Delphi's all-new Direct Acting Diesel Common Rail System is a faster, more fuel-efficient species.

The revolutionary direct acting piezo injector opens and closes up to three times faster than current systems. It also has zero backleak and rail pressure capability of 2,000 bar. These features can result in a three to four percent decrease in CO_2 emissions. Providing premium performance, more power and more torque with reduced fuel consumption and lower emissions.

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Our one-of-a-kind Multec® 20 fuel injector with solenoid technology delivers outstanding spray performance and better fuel economy, while reducing emissions and engine noise. All the performance you need at a significantly lower cost than piezo injectors. Genius.

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Many thanks to the people around the world who helped to put this book together!

The information contained in this booklet is general in nature. Although Delphi believes the information provided is accurate as of its date of publication, the applicable laws and regulations in this area are complex and subject to change, and Delphi makes no representation or warranty regarding the information and assumes no obligation to update or revise this information. Please consult the full text of all applicable government laws, rules and regulations prior to taking any action in respect of the matters described in this booklet.

Delphi is pleased to offer free of charge to our Customers our Worldwide Emissions Standards Booklets:

- Passenger Cars & Light Duty Trucks

- Heavy Duty & Off-Road Vehicles

Electronic versions of the booklets are also available on our website:
www.delphi.com/pdf/emissions/2009_Delphi_PC.pdf
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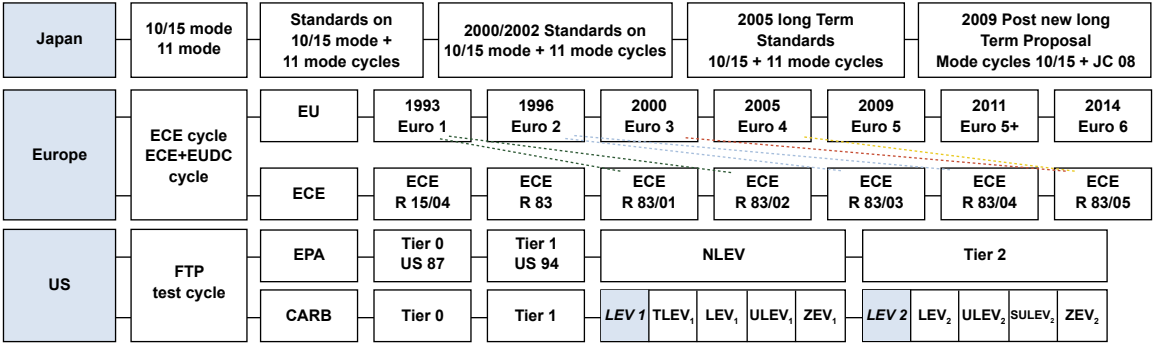
WORLDWIDE TESTING PROCEDURES AND STANDARDS



European Union countries: Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.
Candidate Members: Croatia, Former Yugoslav Republic of Macedonia, Island, Turkey

ECE

ECE regulations are similar to EU directives. A base regulation is updated with a consecutive series of amendments. Dates of implementation differ from country to country, depending on the approval status of the respective amendment in that country.

ECE-R15/04 and ECE-R83/00-05 Leaded Gasoline (= Approval A)

TEST	EMISSIONS	UNIT	Ref. mass in kg, TA (COP)						
			≤ 1020	≤ 1250	≤ 1470	≤ 1700	≤ 1930	≤ 2150	> 2150
Urban cycle	HC+NOx	g/test	19 (23.8)	20.5 (25.6)	22 (27.5)	23.5 (29.4)	25 (31.3)	26.5 (33.1)	28 (35)
	CO		58 (70)	67 (80)	76 (91)	84 (101)	93 (112)	101 (121)	110 (132)

ECE-R83/01 Unleaded Gasoline (Approval B)

TEST	EMIS-SIONS	UNIT	Engine Displacement		
			< 1.4 L [1)]	≥ 1.4 L, ≤ 2 L [1)]	> 2 L [1)]
Urban cycle	HC+NOx	g/test	15 (19)	8 (10)	6.5 (8.1)
	CO		45 (54)	30 (36)	25 (30)
	NOx		6 (7.5)	-	3.5 (4.4)

ECE-R83/01 Diesel (Approval C)

TEST	EMIS-SIONS	UNIT	Engine Displacement		
			< 1.4 L [1)]	≥ 1.4 L, ≤ 2 L [1)]	> 2 L [1)]
Urban cycle	HC+NOx	g/test	15 (19)	8 (10)	
	CO		45 (54)	30 (36)	
	NOx		6 (7.5)	-	

[1)] These are manual transmission limits. Automatic transmission limits are multiplied by 1.3 (NOx) and 1.2 (HC+NOx).

ECE

ECE-R83/01 includes requirements for approval A (leaded gasoline, = ECE-R-15/04), B and C, as well as optional certification to US 87.

Vehicles certified to group A and B also need to run Idle CO test (≤ 3.5 vol.%) and crankcase emissions test.

ECE-R-83/00 ⇒ Content equivalent to 88/76/EEC European Directive, Regulation ECE-R15/04 (approval A) and Annex XXIII of StVZO German Road Code.

ECE-R-83/01 ⇒ Content equivalent to 91/441/EEC European Directive = EC 93 for passenger cars.

ECE-R-83/02 ⇒ Content equivalent to 93/59/EEC European Directive = EC 93 for passenger cars AND large passenger cars AND light duty trucks.

ECE-R-83/03 ⇒ Content equivalent to 94/12/EC European Directive = EC 96 for passenger cars plus LPG/NG vehicles

ECE-R-83/04 ⇒ Content equivalent to 96/69/EC European Directive = EC 96 for PC & LCV and 98/77/EC (LPG/NG emissions & replacement catalytic converters).

ECE-R-83/05 ⇒ Content equivalent to 98/69/EC European Directive = EC 00 & 05

ECE-R-83/05 supplement 1 to 7

- ⇒ Contains provisions for OBD and access to repair information
- ⇒ Contains the emission test procedure for periodically regeneration exhaust aftertreatment systems (e.g. particulate trap, DeNOx catalyst)
- ⇒ Contains provisions for hybrid vehicles type approval
- ⇒ Contains specific provisions for gaseous LPG/NG vehicles
- ⇒ Contains provisions for modified particulate mass measurement procedures in line with the conclusions of the Particle Measurement Program
- ⇒ Contains provisions for particle number measurement procedures in line with the conclusions of the Particulate Measurement Program

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EU type Approval

A European type approval is granted after compliance with tests and requirements:

Test	Description	Requirement
Type I	Tailpipe Emissions after a cold start	See pages 9-16 Test cycle: see page 24
Type II	CO Emission test at idling speed	Determination of reference value for I/M [1] & COP. See page 66
Type III	Emissions of crankcase gases	Standard: zero emission
Type IV	Evaporative Emissions	See page 87
Type V	Durability of anti-pollution devices	See pages 9-11-13-18
Type VI	Low temperature test	See page 13
-	OBD	See pages 53-55

[1] I/M: Inspection & Maintenance

European Vehicle Categories

Directive 70/156/EC, as amended by Directive 2007/46/EC

Category	Description	Sub-category	Number of Persons	Mass Limit	
M	Carriage of Passengers Min. 4 wheels	M1	Up to 9 Persons	GVW ≤ 3,500 kg*	
		M2	Over 9 Persons	GVW ≤ 5,000 kg	
		M3		5,000 kg < GVW	
N	Carriage of Goods Min. 4 wheels	N1 Cl 1	N.A.	Max GVW ≤ 3,500 kg	RM ≤ 1,305 kg
		N1 Cl 2			1,305 kg < RM ≤ 1,760 kg
		N1 Cl 3			1,760 kg < RM ≤ 3,500 kg
		N2		3,500 kg < GVW ≤ 12,000 kg	
		N3		12,000 kg < GVW	

* Until EU4: Two subgroups: M1 with GVW ≤ 2,500 kg and M1 with 2500 kg < GVW ≤ 3,500 kg

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EC 93 and EC 96 (Euro 1 and Euro 2)

PASSENGER CARS (≤ 2.5 t GVW, ≤ 6 seats)

Directives 91/441/EEC or 93/59/EEC (“EC 93”) - Directives 94/12/EC or 96/69/EC (“EC 96”)

			EC 93 [2]	EC 96	
TEST	**EMISSIONS**	**UNIT**	**TA - FR 7/92 - 1/93**	**TA - FR 1/96 - 1/97**	
			Gasoline = Diesel	**Gasoline**	**Diesel***
Urban	HC+NOx	g/km	0.97 (1.13)	0.5	0.7
+	CO		2.72 (3.16)	2.2	1.0
EUDC	PM [1]		0.14 (0.18)	-	0.08

Assigned multiplicative deterioration factors for 80.000 km limits:

Gasoline: CO, HC+NOx: 1.2

Diesel: CO: 1.1, HC+NOx: 1.0, PM: 1.2

* Limits for IDI diesel. For DI diesel until 30/9/99: HC+NOx: 0.9 g/km, CO: 1.0 g/km, PM: 0.1 g/km

[1] Diesel vehicles [2] In brackets = COP values

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EC 93 and EC 96 (Euro 1 and Euro 2)
LARGE PASSENGER CARS AND LIGHT DUTY TRUCKS
(7-9 seats, > 2.5t GVW, LDT ≤ 3.5t GVW – Directive 96/69/EC)

Step I: TA: 10/93, FR 10/94

TEST	EMIS-SIONS	UNIT	Class I [2] ≤ 1250 kg [3]	Class II [2] > 1250 kg ≤ 1700 kg [3]	Class III [2] > 1700 kg [3]
Urban	HC+NOx	g/km	0.97 (1.13)	1.4 (1.6)	1.7 (2.0)
+	CO		2.72 (3.16)	5.17 (6.0)	6.9 (8.0)
EUDC	PM [1]		0.14 (0.18)	0.19 (0.22)	0.25 (0.29)

[1] Diesel vehicles [2] In brackets = COP values [3] Reference weight in running order plus 25 kg

EC 93 – Euro 1:

⇒ 91/441/EEC Directive defines “EC 93” requirements for normal passenger cars. 93/59/EEC includes 91/441/EEC plus “EC 93” requirements for large passenger cars and light duty trucks.

⇒ Evaporative emissions requirements, 80.000 km durability

Step II: TA 1/97 (Cl. I), 1/98 (Cl. II, III), FR 10/97 (I), 10/98 (II, III)

TEST	EMIS-SIONS	UNIT	Class I [2] ≤ 1250 kg [3]	Class II [2] > 1250 kg ≤ 1700 kg [3]	Class III [2] > 1700 kg [3]
Urban	HC+NOx	g/km	0.5	0.6	0.7
+	CO		2.2	4.0	5.0
EUDC	HC+NOx [1]	g/km	0.7/0.9	1.0/1.3	1.2/1.6
	CO [1]		1.0	1.25	1.5
	PM [1]		0.08/0.1	0.12/0.14	0.17/0.2

EC 96 – Euro 2:

⇒ COP limits = TA limits.

⇒ No change in exhaust/evaporative procedure or durability requirements

⇒ 96/44/EC is equivalent to 94/12/EC, tighter inertia weight classes in line with Directive 93/116/EEC (fuel consumption)

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EC 2000 and EC 2005 ("Euro 3" and "Euro 4")
Directive 70/220/EEC, as amended by Directive 98/69/EC and 2003/76/EC

⇒ Exhaust and evaporative emissions testing revisions for passenger cars and light duty trucks

⇒ Quality of market gasoline and diesel fuels (Directive 98/70/EC, as amended by 2003/17/EC)

Passenger cars (≤ 2.5 t GVW)			EC 2000 / Euro 3		EC 2005 / Euro 4	
TEST	EMIS-SIONS	UNIT	TA - FR 1/2000 - 1/2001		TA - FR 1/2005 - 1/2006	
			Gasoline, LPG, NG	Diesel [1)]	Gasoline, LPG, NG	Diesel
Rev.	HC		0.20	-	0.10	-
Urban	NOx		0.15	0.50	0.08	0.25
+	HC+NOx	g/km	-	0.56	-	0.30
EUDC	CO		2.3	0.64	1.0	0.50
	PM		-	0.05	-	0.025

Assigned multiplicative deterioration factors for 80.000 km limits (Euro 3) or 100.000 km limits (Euro 4):
Gasoline: CO, HC, NOx:1.2
Diesel: CO: 1.1, NOx,HC+NOx: 1.0, PM: 1.2

[1)] Until 12/2002, diesel cars with GVW > 2 t, and
a) > 6 seats or
b) off-road vehicles were considered as N1 vehicles.

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EC 2000 and EC 2005 ("Euro 3" and "Euro 4")

LARGE PASSENGER CARS (> 2.5 t GVW) AND LIGHT DUTY TRUCKS (≤ 3.5t GVW)

Light Duty Trucks			Class I				Class II				Class III*			
TEST	EMIS-SIONS	UNIT	EC 2000 / Euro 3 TA: 01/00 FR: 01/01		EC 2005 / Euro 4 TA: 01/05 FR: 01/06		EC 2000 / Euro 3 TA: 01/01 FR: 01/02		EC 2005 / Euro 4 TA: 01/06 FR: 01/07		EC 2000 / Euro 3 TA: 01/01 FR: 01/02		EC 2005 / Euro 4 TA: 01/06 FR: 01/07	
			SI	CI	SI	CI	SI	CI	SI	CI	SI	CI	SI	CI
Rev.	HC		0.20	-	0.10	-	0.25	-	0.13	-	0.29	-	0.16	-
Urban	NOx		0.15	0.50	0.08	0.25	0.18	0.65	0.10	0.33	0.21	0.78	0.11	0.39
+	HC+NOx	g/km	-	0.56	-	0.30	-	0.72	-	0.39	-	0.86	-	0.46
EUDC	CO		2.3	0.64	1.0	0.50	4.17	0.80	1.81	0.63	5.22	0.95	2.27	0.74
	PM		-	0.05	-	0.025	-	0.07	-	0.04	-	0.10	-	0.06

* Included Large Passenger Cars (> 2.5 t GVW)

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- **More stringent exhaust limits for Euro3 and Euro4**
  - Separation of HC and NOx
- **Modified exhaust emissions test cycle (MVEG B)**
  - Deletion of first 40 s idle, start of bag sampling at engine crank.
- **Onboard diagnostics requirements for gasoline, LPG, NG and diesel**
- **Enhanced evaporative emissions requirements**
- **Low temperature test for gasoline vehicles:**

Cat M_1 and N_1 Cl I ≤ 2.5t GVW and/or ≤ 6 seats	CO	15 g/km
New types from 1 January 2002	HC	1.8 g/km
Cat N_1 Cl. II, M_1 > 6 seats, 2.5 t < GVW ≤ 3.5 t	CO	24 g/km
New types from 1 January 2003	HC	2.7 g/km
Cat N_1 Cl. III	CO	30 g/km
New types from 1 January 2003	HC	3.2 g/km

- Measurement of HC and CO at -7°C (266K) during four Rev. urban driving cycles (780 seconds - Urban/ECE portion)
- Deterioration factors are **not** applied
- Reference Fuel option with higher RVP and density
- Gaseous Fuel (LPG or NG) vehicles are exempt from the low temperature test.
- **Stricter in-use durability requirements**
  - Euro 3: 80.000 km or 5 years, ass. deterioration factors in place.
  - Euro 4: 100.000 km or 5 years.
  - Newly required recording of in-use durability.

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SMOKE - Diesel Only

Directive 72/306/EEC amended by Dir 2005/21/EC

Two tests are required:

- **Speed Stabilised under full load:**

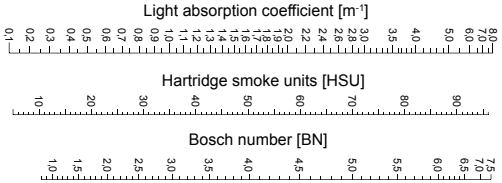
  6 measurements shall be made at engine speeds spaced out uniformly between that corresponding to maximum power and the higher of the following two engine speeds: 45 % of the engine speed corresponding to maximum power; and 1000 rpm. For each measuring point, the smoke measured should not exceed the limit values (SL) specified in the directive, which are a function of the air flow rate. The value selected will be the measured (SM) nearest the relevant limit value.

- **Free acceleration:**

  With warm engine from idle to maximum engine speed giving an average (XM) of 4 consecutive non-dispersed values.

  Calculated according both tests:
  XL1= (SL/SM)*XM and XL2 = XM + 0.5
  The lowest numerical XL value will be marked on the vehicle and will be used as a reference for checking production which should not be greater than this value more than 0.5 m^{-1}.
  Additional requirement for turbo engines: XM ≤ SL (corresponding to max SM) +0.5 m^{-1}.

- **Conversion of Diesel Smoke values**



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Euro 5 & 6 Regulation

Split level Approach: Co-decision Regulation EC 715/2007 - June 20, 2007
Comitology Regulation EC 692/2008 - July 18, 2008

Repeal of Dir 70/220 and related amendments

Vehicle Scope: M1 and M2, N1 and N2 vehicles as defined in Dir 70/156/EC with reference mass ≤ 2,610 kg
Extension possible at the manufacturer's request to M1, M2, N1, N2 with reference mass ≤ 2,840 kg

Exempted Vehicles at EU5 stage:
Diesel M1 Vehicles designed to fulfill specific social needs:
- Special purpose vehicles with Ref Mass > 2000kg (Ambulance, hearse, motor caravan…)
- Vehicles w/ Ref Mass > 2,000 kg and designed to carry at least 7 occupants. From 01Sept12, no more valid for "true' off-road vehicle
- Vehicles w/ Ref Mass > 1,760 kg and built specifically for commercial purposes to accommodate wheelchair use inside the vehicle

No more exemption for passenger cars from Euro 6

Test Cycle: similar to EU4: Revised Urban + EUDC

New Reference Fuels (See page 84):
For Type 1 test: Gasoline: E5; Flex fuel: E85; Diesel: B5
For Type 6 test: Gasoline E5, Flex fuel E75 (TBD)

Unrestricted and standardized access to vehicle repair and maintenance information

CO_2 and Fuel Consumption:
Current Dir 80/1268/EC is merged into Euro 5&6 regulations
CO_2 is replaced by Greenhouse Gas; Test procedure not changed

Implementation Schedule:

	EU5a		Euro 5b		Euro 5b,+		Euro 6	
	TA	FR	TA	FR	TA	FR	TA	FR
M N1 Cl I	01Sep09	01Jan11	01Sep11	01Jan13	01Sep11	01Jan14	01Sep14	01Sep15
N1Cl II N1Cl III N2	01Sep10	01Jan12	01Sep11	01Jan13	01Sep11	01Jan14	01Sep15	01Sep16

Diesel voluntary EU6 certification possible in advance of TA dates. See page 22

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Euro 5&6 Spark Ignition Emission Limits

Emissions	Unit	PC M[1], LDT N1 CL 1			LDT N1 Cl 2			LDT N1 Cl 3, N2		
		Euro 5a	Euro 5b/b+	Euro 6	Euro 5a	Euro 5b/b+	Euro 6	Euro 5a	Euro 5b/b+	Euro 6
THC	mg/km	100	100	100	130	130	130	160	160	160
NMHC		68	68	68	90	90	90	108	108	108
NOx		60	60	60	75	75	75	82	82	82
CO		1000	1000	1000	1810	1810	1810	2270	2270	2270
PM[2) 3)]		5.0	4.5	4.5	5.0	4.5	4.5	5.0	4.5	4.5
PN #[3) 4)]	Nb/km	-	-	TBD	-	-	TBD	-	-	TBD

[1)] No exemption for gasoline Passenger Car
[2)] Applicable to gasoline DI engines only
[3)] Test procedure defined in UN Reg 83 Suppl 7
[4)] Applicable to all Spark Ignition engines

Euro 5&6 Compression Ignition Emission Limits

Emissions	Unit	PC M[1], LDT N1 CL 1			LDT N1 Cl 2			LDT N1 Cl 3, N2		
		Euro 5a	Euro 5b/b+	Euro 6	Euro 5a	Euro 5b/b+	Euro 6	Euro 5a	Euro 5b/b+	Euro 6
NOx	mg/km	180	180	80	235	235	105	280	280	125
HC+NOx		230	230	170	295	295	195	350	350	215
CO		500	500	500	630	630	630	740	740	740
PM [2)]		5	4.5	4.5	5	4.5	4.5	5	4.5	4.5
PN # [2)]	Nb/km	-	6.0×10^{11}	6.0×10^{11}	-	6.0×10^{11}	6.0×10^{11}	-	6.0×10^{11}	6.0×10^{11}

[1)] Exempted M1 vehicles have to comply with N1Cl3 test I emissions limits, TA 01 Sep 2009, FR 01 Jan 2011 - No more exemption for passenger cars from Euro 6
[2)] Test procedure defined in UN Reg 83 Suppl 7

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Euro 5 & 6 Implementation Roadmap - Mandatory Certification Process

Spark Ignition Vehicles		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
M, N1 Cl I	Type approval	EU4			EU5a 01Sep09		EU5b OR EU5b+ 01Sep11			EU6 01Sep14		
	First registration	EU4				EU5a 01Jan11		EU5b 01Jan	EU5b+ 01Jan14		EU6 01Sep15	
N1 Cl II, III, N2	Type approval	EU4				EU5a 01Sep	EU5b OR EU5b+ 01Sep11				EU6 01Sep15	
	First registration	EU4					EU5a 01Jan	EU5b 01Jan	EU5b+ 01Jan14			EU6 01Sep16
Compression Ignition Vehicles												
M, N1 Cl I	Type approval	EU4			EU5a 01Sep09		EU5b OR EU5b+ 01Sep11			EU6 01Sep14		
	First registration	EU4				EU5a 01Jan11		EU5b 01Jan	EU5b+ 01Jan14		EU6 01Sep15	
Exempted M1 off-road	Type approval	EU4			EU5a as N1 Cl III		EU5b OR EU5b+ 01Sep11			EU6 01Sep14		
	First registration	EU4					EU5a N1	*	EU5b as M	EU5b+ 01Jan14	EU6 01Sep15	
Exempted non off-road	Type approval	EU4			EU5a as N1 Cl III		EU5b OR EU5b+ 01Sep11			EU6 01Sep14 as M		
	First registration	EU4 as N1 Cl III					EU5a 01Jan	EU5b 01Jan	EU5b+ 01Jan14		EU6 01Sep15 as M	
N1 Cl II, III, N2	Type approval	EU4				EU5a 01Sep	EU5b OR EU5b+ 01Sep11				EU6 01Sep15	
	First registration	EU4					EU5a 01Jan	EU5b 01Jan	EU5b+ 01Jan14			EU6 01Sep16

* EU5a as M as of 01Sep12

List of requirements at the different stages can be found on pages 20 - 21

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Euro 5 & 6 Regulation

Main additional requirements EU5a / EU5b / EU5b+ / EU6 - Spark Ignition Vehicles

	Euro 5a	Euro 5b	Euro 5b+	Euro 6
TA [1)]	01Sep09	01Sep11	01Sep11	01Sep14
FR [1)]	01Jan11	01Jan13	01Jan14	01Sep15
Emissions Limits	See page 16			See page 16
PM	5.0 mg/km Current method	4.5 mg/km Revised method		
PN	Not required			TBD
Tyres	Euro 4 rules	Highest or 2nd highest rolling resistance ISO 28580		
DFs	CO:1,5; THC/NMHC:1,3; NOx: 1,6; PM/PN: 1,0			
Low temp test for flex-fuel vehicle	Test on gasoline only	Test on both gasoline and E75 (E75 TBD)		
OBD thresholds	EU5			TBD
OBD: monitoring of catalytic conv.	Against NMHC	Against NMHC and NOx		
OBD: IUPR	Not required		IUPR ≥ 0.1 [2)]	IUPR ≥ 0.336 [2)]

[1)] M Vehicle only. See page 15 for complete implementation schedule

[2)] Detailed IUPR see on page 55

Delphi Gasoline Engine Management Systems optimize control of the engine for emissions, fuel economy and performance to meet wide-ranging and highly specific OE requirements

Delphi's ability to offer full gasoline engine management systems capabilities and powertrain control strategies is what sets us apart. In many ways.

Our system-level analysis and understanding not only means we can provide integrated systems, including algorithms and calibration, it also enables us to develop components that are optimized to deliver the required performance, cost-effectively.

So whether you choose our complete modules or our individual components, our systems expertise is built into every product.

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Euro 5 & 6 Regulation

Main additional requirements EU5a / EU5b / EU5b+ / EU6 - Compression Ignition

	Euro 5a	Euro 5b	Euro 5b+	Euro 6
TA[1)]	01Sep09	01Sep11	01Sep11	01Sep14
FR[1)]	01Jan11	01Jan13	01Jan14	01Sep15
Exempted M vehicles	See page 15			No more exemption
Emissions Limits	See page 16			See page 16
PM	5.0 mg/km Current method	4.5 mg/km Rev. method		
PN	Not required	6 x10[11]		
Tyres	Euro 4 rules	Highest or 2nd highest rolling resistance ISO 28580		
DFs	CO:1,5; NOx / NOx+THC: 1,1; PM/PN: 1,0			TBD [3)]
OBD Thresholds	EU5			TBD [3)]
OBD: relaxed PM thres. for veh. w/ RM > 1,760 kg	Yes (PM thres. 80 mg/km)	No (PM threshold 50 mg/km)		
OBD: IUPR	Not required		IUPR ≥ 0.1 [2)]	IUPR ≥ 0.336 [2)]

[1)] M Vehicle only. See page 15 for complete implementation schedule

[2)] Detailed IUPR see on page 55

[3)] For veh. certified EU 6 in advance of date: real DFs used; interim EU 6 OBD thresholds. See page 55

Well adjusted. Good listener. Works well under pressure. No wonder our common rail system is so popular.

Delphi's diesel common rail system has many attractive features: an Accelerometer Pilot Control that "listens" to every cylinder, to adjust the drive pulse as conditions change, enabling better performance and reduced emissions over time. State-of-the-art injectors, capable of delivering a highly atomized spray, injected in small quantities, in extremely close proximity. And next-generation pumps that provide pressures of 1,800 bar, with the inherent capability of 2,000. It's elegantly packaged and backed by customer-dedicated teams. No wonder our diesel technology is really going places.

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Euro 5 & 6 Regulation - Voluntary Certification Process
Diesel Vehicles in advance of EU6 TA can be certified as:

- Emissions EU 6a (current PM test procedure 5 mg/km, no PN); OBD EU 6- (interim EU6 OBD thresholds)
- Emissions EU 6b (revised PM 4.5 mg/km; PN 6x10^{11}/km); OBD EU 6- (interim EU6 OBD thresholds)
- Emissions EU 6b; OBD EU 6- plus IUPR (≥ 0.1)

Last date for first registration		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
M, N1 Cl I	EU6a / EU6-						31Dec12				
	EU6b / EU6-							31Dec13			
	EU6b / EU6- plus IUPR								31Aug15		
N1 Cl II, III; N2	EU6a / EU6-						31Dec12				
	EU6b / EU6-							31Dec13			
	EU6b / EU6- plus IUPR									31Aug16	

Durability Requirements starting EU5: 160.000 km

Assigned EU5 DFs: SI: CO: 1.5; THC and NMHC: 1.3; NOx: 1.6; PM: 1.0
CI: CO: 1.5; NOx and THC+NOx: 1.1; PM/PN: 1.0

Alternatives: Calculated DFs based on Standard Road Cycle (SRC)
Test ageing bench: SI based on Standard Bench Cycle (SBC)
CI based on Standard Diesel Bench Cycle (SDBC)

Assigned EU6 DFs: spark ignition: no change compression ignition: TBD

In-Service Conformity
Up to 100.000 km or 5 years

Low Temperature Test (- 7° C)
No change for spark ignition
Compression ignition: Demonstration at TA of

- performance of NOx aftertreatment device reaching sufficiently high temperature for efficient operation within 400 sec after a cold start (- 7° C)
- Operation strategy of the EGR including its functioning at low temperature

Evaporative emissions: no change (2 g/test)

SCR Provisions (Selective Catalyst Reduction with reagent)
Reagent Indication
Identification of incorrect reagent
Reagent consumption monitoring
NOx emissions monitoring
Driver warning strategy and inducement system
Operating conditions of the aftertreatment
Storage of failure information

EUROPEAN UNION

Amendments Proposal to Reg 692/2008 and 715/2007 (23 Feb 2009)

- Particulate Mass and Particulate Number test procedure according to UN Reg 83, series of Amendments 05, supplement 7
- Mandatory use of Daylight Driving Lamps during test cycle from 07Feb11 TA; 07 Aug 12
- OBD requirements:
  * Mandatory DPF total failure monitoring
  * Exemption for monitoring of short/open circuit failure
  * IUPR: Denominator for monitors requiring a cold start
  * IUPR: Denominator for boost pressure control
  * IUPR: Statistical test procedure and in-service conformity check
- SCR requirements:
  * Activation of SCR driving warning system for Euro 6- CI vehicles
  * Record of activation of SCR driver inducement system

EU Commission Communication (01 October 2007) on fields subject to future review:

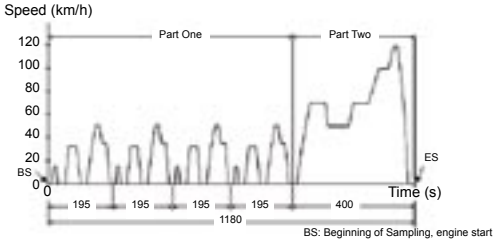
The commission intends to refine the following requirements to be applicable at mid-way through EU5/EU6 or at EU6 stage:

- Particle Number emission limit for Spark Ignition Vehicles
- Durability: EU 6 deterioration factors for diesel vehicles
- Reference Fuel E75 specifications
- Emissions test procedure: Objective: to reflect real world emissions
  » New test driving cycle under progress at UNECE - WLTP
  » Off-cycle requirement?
- Low temperature test: new emission limits: HC, CO for SI vehicles, NOx for CI vehicles
- Evaporative emissions test procedure subject to review because of wider use of biofuels: alignment on US test procedure? Durability requirements? In-service conformity requirements?
- New reference mass limit for a vehicle to be considered as LDT
- Mass neutral emission standards
- CH_4 (or even a wider range of GHG) in CO_2 calculation
- Not yet regulated emissions (Aldehyde, PAH, NO_2/NO,...)
- New requirements for TA procedure for replacement of pollution control devices
- EU 6 OBD thresholds proposal. See page 55

EUROPEAN UNION

DRIVING CYCLE FOR EUROPEAN UNION

Urban (“ECE”) + extra-urban cycle (“EUDC”)



Length : 11.007 km Total duration : 1180 s (ECE+EUDC)

Max. speed : 120 km/h Average speed : 33.6 km/h

Cycle revision for **Euro 3** onwards:

Modification of the start-up phase: deletion of the 40 seconds idle period prior to bag sampling start. Simultaneous engine crank and bag sampling start.

11 sec idle after crank.

Cycle named revised urban + extra-urban cycle or MVEG-B.

Prior to Euro 3, start and 40 sec idle period prior to bag sampling start

US FEDERAL

LDV ≤ 12 PASSENGERS

LIMITS IN GRAMS/MILE						
TEST	EMIS-SIONS	DURA-BILITY (mile)	MY91→ (Tier 0) (US 87)	MY 94→ (Tier I) (US 94)	MY 01→ NLEV	MY 04→ (TIER II)
US FTP	HC	50.000	0.41	0.41	0.41	See Page 28
	NMHC	50.000		0.25	0.075 [3]	
		100.000		0.31	0.090 [3]	
	CO	50.000	3.4	3.4	3.4	
		100.000		4.2	4.2	
	CO (-7°C)	50.000		10	10	
	NOx [1] [2]	50.000	1.0	0.4	0.2	
		100.000		0.6	0.3	
	PM	50.000	0.2	0.08	0.08	
		100.000		0.10	0.08	

LIMITS IN GRAMS/KILOMETER						
TEST	EMIS-SIONS	DURA-BILITY (km)	MY91→ (Tier 0) (US 87)	MY 94→ (Tier I) (US 94)	MY 01→ NLEV	MY 04→ TIER II
US FTP	HC	80.000	0.25	0.25	0.25	See Page 28
	NMHC	80.000		0.16	0.047 [3]	
		160.000		0.19	0.056 [3]	
	CO	80.000	2.1	2.1	2.1	
		160.000		2.6	2.6	
	CO (-7°C)	80.000		6.2	6.2	
	NOx [1] [2]	80.000	0.62	0.25	0.124	
		160.000		0.37	0.186	
	PM	80.000	0.124	0.05	0.05	
		160.000		0.06	0.05	

[1] Diesel vehicles allowed 1.0 / 1.25 g/mi NOx until MY2003

[2] NOx (Highway)-standard: 1.33 X NOx (City)-standard as listed above

[3] NMOG measurement instead of NMHC

US FEDERAL

Implementation Plan for Clean Air Act Amendments

	Model Year																
Phase-in (%)	**94**	**95**	**96**	**97**	**98**	**99**	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**
Exhaust emissions																
Tier I Phase-in	40	80	100													
Cold CO Standard	40	80	100													
Tier II											25	50	75	100		
NLEV						No.Ea.		Nationwide								
Evap. emissions																
Enh.EVAP (US Fed)			20	40	90	100										
Enh.EVAP (Cal.)		10	30	50	100											
ORVR					40	80	100									
Testing procedures																
Suppl. FTP (Cal./NLEV)								25	50	85	100					
Revised durability	old+altern.						CAP2000+altern.									
Others																
OBD II		100														
Clean fuel veh. fleets																

US FEDERAL

Exhaust Emissions Standards

⇒ Cold CO: Standard must be met at all altitudes.

⇒ Tier II standards, see page 28.

NLEV

⇒ Requires phase-in of LEVs and TLEVs in northeast US in 1999 and 2000. Requires 100% LEVs or equivalent in all states in 2001.

⇒ NLEV will be in place until MY2004, at which time Tier II standards will take effect.

Revised Durability Schedule

⇒ Manufacturer specific durability schedule allowed as an alternative to AMA schedule.

⇒ Durability shown through bench aging of components

⇒ Requires in-use reality check performed by manufacturer. Reality check procedures become more stringent 2000 onwards.

⇒ No more carry-over of durability data from AMA schedule after MY2000.

Certification Streamlining (Compliance Assurance Plan 2000)

⇒ US & Calif. certification process changed in 2000 time frame. Focus moved from upfront self certification toward manufacturer performed in-use checks.

Others

⇒ Clean fuel vehicle fleets: Starting in 1999, in certain US cities fleets of ≥ 10 vehicles and central fuelling are required to purchase vehicles certified on federal test fuel to LEV or cleaner standards.

Tier II Standard

⇒ Same standards applicable to cars and trucks up to 8500 lbs GVWR (most sport utility vehicles, pick up trucks and vans)

⇒ Emissions limits are fuel neutral, i.e. applicable to gasoline, diesel and all other fuels.

⇒ Vehicles also have to meet new Tier II limits on Supplemental Federal Test Procedure.

⇒ New evaporative emissions standards (see page 89).

⇒ 0.07 g/mi NOx fleet average at 120,000 mi/ 10 y phased-in 25/50/75/100% from 2004-2007 for cars and trucks < 6000 lbs GVWR, and 50/100% in 2008-2009 for heavier trucks.

⇒ 8 standards “bins” are available as long as the manufacturer’s fleet averages 0.07 g/mi NOx. Bin 1 corresponds to 0.0 g/mi of all emission categories.

⇒ One new bin for MDPV. “Tier II” MDPV must be included in 0.07 g/mi NOx fleet average.

US FEDERAL

Tier II Standard (cont'd)

Two temporary options available for MY2007-09 diesel powered veh.

- US06 opt: Relaxed 4k NOx+NMHC std in exchange for 30% stricter composite SFTP NOx+NMHC std.
  Also extends SFTP useful life to 150k.
- High Alt. Option; Bin 7/8 veh. Allowed in-use NOx std of 1.2x the FTP std., when at high alt. In exchange, must meet Bin 5 PM std.
  Also extends the useful life to 150k for ALL FTP based tests.

New fleet average requirement for NMHC:

- Provisions for carry forward and carry-back of credits
- Prov. for carry-over programs with respect to in-use testing
- Test is on FTP cycle at 20 deg F
- Flex fueled vehicles only required to provide assurance that the same emission reduction systems are used on non-gasoline fuel as on gasoline
- LDV < 6000 GVWR:
  Meet sales weighted fleet average of 0.3 g/mi at 120k mi
  Phase in 25/50/75/100 from MY2010 - 2013
- 6000 ≤ LDV < 8500 GVWR and MDPV < 10,000 lbs
  Meet sales weighted fleet average of 0.5 g/mi at 120k mi
  Phase in 25/50/75/100 from MY2012 - 2015

0.07 g/mi NOx fleet average

g/mi	Durab	Bin 8	Bin 7	Bin 6	Bin 5	Bin 4	Bin 3	Bin 2
NMOG	50 k	0.100	0.075	0.075	0.075			
	120 k	0.125	0.090	0.090	0.090	0.070	0.055	0.010
CO	50 k	3.4	3.4	3.4	3.4			
	120 k	4.2	4.2	4.2	4.2	2.1	2.1	2.1
NOx	50 k	0.14	0.11	0.08	0.05			
	120 k	0.20	0.15	0.10	0.07	0.04	0.03	0.02
PM	120k	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HCHO	50 k	0.015	0.015	0.015	0.015			
	120 k	0.018	0.018	0.018	0.018	0.011	0.011	0.004

Tier II Phase-In Schedule in % (Vehicles < 6000 lbs GVWR)

%	'01	'02	'03	'04	'05	'06	'07	'08
NLEV	100	100	100					
(Interim Non-)Tier II, 0.3 NOx avg				75	50	25	0	0
Tier II, 0.07 NOx avg				25	50	75	100	100

US FEDERAL

During phase-in period 2004-2006, vehicles up to 6000 lbs GVWR that do not follow 0.07 NOx fleet average must meet 0.3 NOx fleet average. In addition to bins 1-8, a manufacturer may choose, for that period, to certify to bins 9 or 10 as shown in the table below as long as the 0.3 NOx fleet average is met. Different interim standards and phase-ins apply to trucks for 6001-8500 lbs GVWR, as well as heavier trucks.

Relaxed Bins available for 0.3 g/mi NOx fleet average

g/mi	Durability	Bin 9	Bin 10	Bin 11 (MDPV)
NMOG	50 k	0.075	0.125	0.195
	120 k	0.090	0.156	0.280
CO	50 k	3.4	3.4	5.0
	120 k	4.2	4.2	7.3
NOx	50 k	0.2	0.4	0.6
	120 k	0.3	0.6	0.9
PM	120k	0.06	0.08	0.12
HCHO	50 k	0.015	0.015	0.022
	120 k	0.018	0.018	0.032

During phase-in period 2004-2008, HLDT vehicles (> 6000 lbs GVWR) that do not follow 0.07 NOx fleet average (see phase in) must meet 0.2 NOx fleet average with a 0.6 g/mi maximum.

Optional Bins for Interim HLDT & MDPV (until 2008)

g/mi	Durability	Bin 10	Bin 9	Bin 8
NMOG	50 k	0.160	0.140	0.125
	120 k	0.230	0.180	0.156
CO	50 k	4.4	3.4	3.4
	120 k	6.4	4.2	4.2
NOx	50 k	0.4	0.2	0.14
	120 k	0.6	0.3	0.20
PM	120k	0.08	0.06	0.02
HCHO	50 k	0.018	0.015	0.015
	120 k	0.027	0.018	0.018

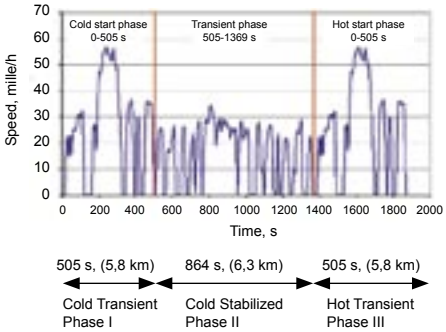
Tier II Phase-In Schedule HLDT (Veh. > 6000 lbs GVWR) & MDPV in %

%	'03	'04	'05	'06	'07	'08	'09
(Interim Non-)Tier II; 0.2 avg, 0.6 max NOx		25	50	75	100	50	0
Tier II, 0.07 NOx avg						50	100

US FEDERAL TEST PROCEDURE

DRIVING SCHEDULES

CITY CYCLE [1)]



Length : 11.04 mi. (17,86 km)
Total duration : 1874 s (+ hot soak: 540 s min; 660 s max)
Simultaneous engine crank and bag sampling start.
Initial idle is 20 sec.
Max. speed : 56.68 mph (91,2 km/h)
Average speed : 21.19 mph (34,2 km/h - stop excluded)

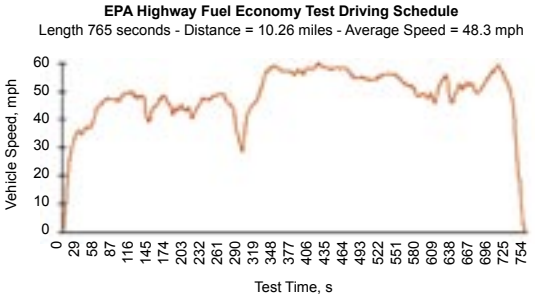
Between Phase II and Phase III, Hot Soak (9-11 min)

[1)] Also known as: FTP 75, EPA III
Phase I + II also known as: FTP 72, EPA II, UDDS, LA-4

US FEDERAL TEST PROCEDURE

DRIVING SCHEDULES

HIGHWAY CYCLE [1)]



Length	: 10.26 mi. (16.5 km)
Total duration	: 765 s (765 s)
Max. speed	: 59.91 mph (96.4 km/h)
Average speed	: 48.30 mph (77.7 km/h)

[1)] Also known as Highway Fuel Economy Test – HWFET

CALIFORNIA

LDV ≤ 12 PASSENGERS

LEV 1 emissions categories phasing out 2004 - 2007

In g/mi	Durab.	$TLEV_1$	LEV_1	$ULEV_1$	ZEV_1
NMOG	50 k	0.125	0.075	0.040	0
	100 k	0.156	0.090	0.055	0
CO [1)]	50 k	3.4	3.4	1.7	0
	100 k	4.2	4.2	2.1	0
NOx	50 k	0.4	0.2	0.2	0
	100 k	0.6	0.3	0.3	0
PM	50 k	-	-	-	0
	100 k	0.08	0.08	0.04	0
HCHO [2)]	50 k	0.015	0.015	0.008	0
	100 k	0.018	0.018	0.011	0

Definition of emission classes

⇒ TLEV Transitional Low Emission Vehicle
⇒ LEV Low Emission Vehicle (LEV_1, LEV_2)
⇒ ULEV Ultra Low Emission Vehicle ($ULEV_1$, $ULEV_2$)
⇒ SULEV Super Ultra Low Emission Vehicle
⇒ ZEV Zero Emission Vehicle
⇒ Additional testing at 10°C/50°F for gasoline and alcohol vehicles.
Same CO, NOx, 2 x standard for NMOG, HCHO.

LEV 1 standards

- 4 emissions categories $TLEV_1$, LEV_1, $ULEV_1$, ZEV_1
- Application according to NMOG fleet average

[1)] MY 96 onwards: Non-Diesel vehicles also need to meet cold CO limit: 10 g/mile at -7°C

[2)] HCHO = Formaldehyde; Statement of compliance allowed

CALIFORNIA

LDV ≤ 12 PASSENGERS

LEV 2 emissions limits phasing in 2004 onwards

In g/mi	Durab.	LEV_2	$ULEV_2$	$SULEV_2$	ZEV_2
NMOG	50 k	0.075	0.040	-	0
	120 k	0.090	0.055	0.010	0
CO [1)]	50 k	3.4	1.7	-	0
	120 k	4.2	2.1	1.0	0
NOx	50 k	0.05	0.05	-	0
	120 k	0.07	0.07	0.02	0
PM	50 k	-	-	-	0
	120 k	0.01	0.01	0.01	0
HCHO [2)]	50 k	0.015	0.008	-	0
	120 k	0.018	0.011	0.004	0

LEV 2 standards

- New stringent NOx and PM limits plus additional SULEV category
- Same emissions limits for passenger cars and trucks < 8500 lbs GVWR (most sport utility vehicles, vans, pick up trucks)
- LEV 2 standards phase-in 25/50/75/100 % from 2004 - 2007
- Durability limit extended to 120,000 mi
- Dual Fuel PZEVs must meet SULEV standards on both fuels
- NMHC to NMOG certification factor of 1.04 allowed.
- Additional NMOG credits possible for 150,000 mi durability certification
- NMOG fleet average limits defined through MY2010
- Mandatory phase-out of TLEV limits by MY2004
- Partial ZEV credits for vehicles certified to SULEV at 150,000 mi, zero evaporative standard, and 150,000 mi emissions warranty/OBD

[1)] MY 96 onwards: Non-Diesel vehicles also need to meet cold CO limit: 10 g/mile at -7°C

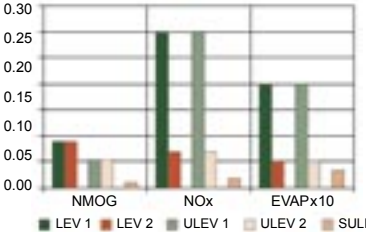
[2)] HCHO = Formaldehyde; Statement of compliance allowed

CALIFORNIA

LEV 2 standards (cont'd)

- ZEV subcategories: NEV, PZEV, AT-PZEV, CEV, FFEV, HEV:
  - NEV (Neighborhood Electrical Vehicle)
  - PZEV (Partial Zero-Emission Vehicle)
  - AT-PZEV (Advanced Technology PZEV)
  - CEV (City Electric Vehicle)
  - FFEV (Full-Function Electric Vehicle)
  - HEV (Hybrid Electric Vehicle)
- Less stringent in-use NOx standard applies initially.
- Additionally, new, less stringent standards for trucks 8,500 – 14,000 lbs GVWR
- More stringent enhanced evaporative emissions requirements. See page 88

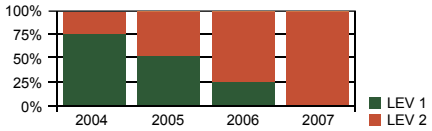
Comparison of LEV emissions standards ("full useful life")



Green = LEV 1 standards: LEV 1, ULEV 1

Red = LEV 2 standards: LEV 2, ULEV 2, SULEV 2

Certification Phase-in of CARB LEV standards



CALIFORNIA

NMOG (Non-methane Organic Gases) measurement

⇒ Reactivity-adjusted hydrocarbon mass concept

⇒ For individually determined Reactivity Adjustment Factors (RAFs), masses of HC compounds incl. aldehydes, ketones, and alcohols are separately measured. The reactivity and mass of each compound are taken into account in determining the RAF for the engine family.

⇒ Manufacturer may choose between individually determined RAFs or generic RAFs defined by CARB:

⇒ Generic RAF for LEV/ULEV: 0.94 (phase 2 fuel), 0.41 (M85), 0.43 (CNG), 0.50 (LPG)

⇒ Reactivity Adjusted NMOG = NMOG mass X RAF

⇒ Eliminated gasoline generic RAF for MY04. The rest are unchanged.

⇒ As an alternative to empirical determination of RAF, manufacturer may use a NMHC to NMOG adjustment factor of 1.04 for gasoline.

NMOG fleet average

⇒ Manufacturers have to certify their vehicle fleet each model year such that the sales-weighted NMOG fleet average is below the mandatory limits. The calculation is based on 50k standards for TLEV, LEV and ULEV, and 120k standards for SULEV. Manufacturers can obtain credits for better fleet average or buy credits from another manufacturer to balance possible emission deficits. There are also provisions for carry forward and carry back of credits. Determination of introduction rate of TLEV, LEV, ULEV or SULEV is up to the manufacturer.

⇒ Less stringent fleet average applies to trucks > 3,750 lbs LVW

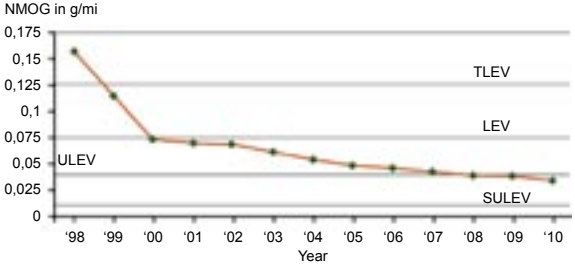
⇒ 10% ZEV mandate starts MY 2003. CARB and manufacturers have come to agreement on a modified ZEV plan. Plan provides flexibility and places emphasis on hybrid technology (AT-PZEVs) and fuel cells.

⇒ ZEV Mandate Percentage Requirements

Model Years	Minimum ZEV Requirements
2009 through 2011	11%
2012 through 2014	12%
2015 through 2017	14%
2018 and subsequent	16%

CALIFORNIA

NMOG Fleet Average (cars and trucks 0 – 3750 lbs LVW)



Year	1999	2000	2001	2002	2003	2004
g/mi	0.113	0.073	0.07	0.068	0.062	0.053
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
g/mi	0.049	0.046	0.043	0.04	0.038	0.035

California is in the process of drafting standards to include hybrid and electric vehicles

The following US States have also adopted CARB Standards:

(Dates shown are LEV II)

- Arizona MY 2011
- Connecticut MY 2008
- Maine MY 2009
- Maryland MY 2011
- Massachusetts MY 2004
- New Jersey MY 2008
- New Mexico MY 2011
- New York MY 2004
- Oregon MY 2009
- Pennsylvania MY 2008
- Rhode Island MY 2008
- Vermont MY 2004
- Washington MY 2009

The following US States are considering adopting CARB Standards:

- Colorado
- Florida
- Montana
- North Carolina
- Utah
- Wisconsin

CALIFORNIA

States Adopting California Vehicle emission Standards

- **US States having adopted CARB Standards**
- **US States considering adopting CARB Standards**

US FEDERAL / CALIFORNIA

US - Supplemental Federal Test Procedure
CARB LEV1 + ULEV1 – EPA NLEV, EPA Tier I, II Standard

In parallel to the FTP (EPA III), an additional test procedure with separate emissions standards is phased in for passenger cars and light duty trucks.

⇒ 2 portions: Air conditioning cycle (SC03) + High speed/high load cycle (US06). Both tests are hot starts.

⇒ AC cycle run in full environmental test cell. Alternative: Standard test cell using simulation procedure. Correlation of simulation to environmental cell required in MY 2004.

CARB

⇒ Separate 4,000 mi standards apply to each test cycle only
Phase-in for LEV1+2: complete in MY04. Different timing/limits for heavier trucks.

EPA

⇒ NLEV -> follow CARB LEV 1 limits and phase-in for LDV/LDT1+2. Different timing for heavier trucks.

⇒ Tier II standard -> CARB 4000 mi standards plus 100/120,000 mi standards. 50k mi. intermediate standard available in lieu of 4k std.

⇒ Phase-in: Passenger cars MY 2004 onwards with stringency levels depending on Tier II FTP standard bin selected. (see next page)
Full life-time standards for NMHC+NOx are weighted (CO/ PM weighting optional):
0.35x (FTP) + 0.28x (US06) + 0.37x (SC03)

US Supplemental Federal Test Procedure (SFTP)

Applicable for both CARB LEV1 + LEV2 and EPA NLEV, EPA Tier I, II Standard

SFTP		SC03	US06
Test conditions: Prep scenarios		10 min soak, 95°F ambient, 40% rel. humidity, 850 W/m² solar load, prop. air flow, AC max. cooling	1-2 min idle, ambient test temp.
LDV & LDT 1 limits in g/mi			
CARB LEV1+ULEV1, EPA NLEV, EPA SFTP Tier II			
NMHC+NOx	4 k	0.20	0.14
CO	4 k	2.7	8.0
LDT 2 limits in g/mi			
NMHC+NOx	4 k	0.27	0.25
CO	4 k	3.5	10.5

Details on EPA SFTP Tier II standard

In addition to satisfying 4 k CARB standard, vehicles must certify to standards at 100/120 k mi. Limits are calculated based on formula:

SFTP Tier II std = SFTP Tier I std – [0.35 x (Tier I FTP std – Tier II FTP std bin)]

Consequently Tier II SFTP standards differ depending on Tier II standard bin selected. For details see page 27 for phase-in schedule.

LDV & LDT1&2 limits in g/mi – SFTP Tier I

Limits in g/mi	Cat.	Dur.	SC03	US06
NMHC+NOx weighted	LDV/LDT1	100 k	0.91	
	LDT2		1.37	
CO	LDV/LDT1	100 k	3.7	11.1
	LDT2		4.9	14.6

Optional Tier I CO weighted std. is 4.2 (LDV/LDT1) and 5.5 (LDT2)

Temporary option available for diesel powered vehicles

MY2007 – 09 -> see Tier 2 section for additional details

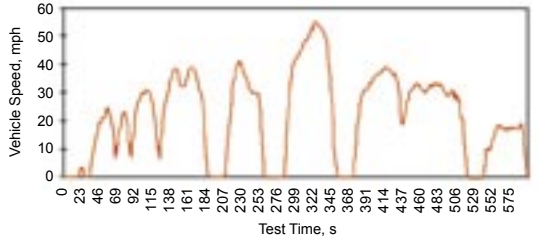
CALIFORNIA

SUPPLEMENTAL FEDERAL TEST PROCEDURE – DRIVING SCHEDULES

SC03 Air Conditioning Cycle

SC03 – Speed Correction Driving Schedule

Length 598 seconds - Distance = 3.58 miles - Average Speed = 21.55 mph



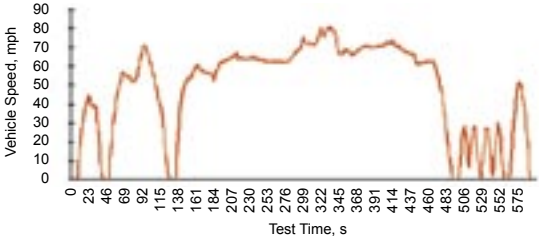
Total duration: 598 s
Length: 3.58 mi. (5,76 km)
Average speed: 21.55 mph (34,9 km/h)

Initial Idle: 18 s
Max. speed: 54.8 mph (88 km/h)

US 06 High speed/High load cycle

US 06 or Suplemental FTP Driving Schedule

Length 596 seconds - Distance = 8.01 miles - Average Speed = 48.37 mph



Total duration: 596 s
Length: 8.01 mi. (15,86 km)
Average speed: 48.37 mph (77,2 km/h)

Initial Idle: 5 s
Max. speed: 80.3 mph (129 km/h)
Max.acceleration: 8 mph/second

JAPAN

Exhaust Emission Limit – Gasoline and LPG fuelled vehicles

	Test Mode [1]	Unit	CO	HC	NOx	PM [2]	New Model	All prod. / Imported veh.
New Short Term (Mean / Max)								
PC	10-15 Mode	g/km	0.67/1.27	0.08/0.17	0.08/0.17	-	Oct. 2000	Sep. 2002
	11 Mode	g/test	19.0/31.1	2.20/4.42	1.40/2.50	-		
Mini Com Veh	10-15 Mode	g/km	3.30/5.11	0.13/0.25	0.13/0.25	-	Oct. 2002	Sep. 2003
	11 Mode	g/test	38.0/58.9	3.50/6.40	2.20/3.63	-		
Light CV	10-15 Mode	g/km	0.67/1.27	0.08/0.17	0.08/0.17	-	Oct. 2000	Sep. 2002
	11 Mode	g/test	19.0/31.1	2.20/4.42	1.40/2.50	-		
Medium CV	10-15 Mode	g/km	2.10/3.36	0.08/0.17	0.13/0.25	-	Oct. 2001	Sep. 2003
	11 Mode	g/test	24.0/38.5	2.20/4.42	1.60/2.78	-		
New Long Term (Mean / Max)				**NMHC**				
PC	10-15 Mode + 11 Mode	g/km	1.15/1.92	0.05/0.08	0.05/0.08	-	Oct. 2005	Sep. 2007
Mini Com Veh			4.02/6.67	0.05/0.08	0.05/0.08	-	Oct. 2007	Sep. 2008/ Sep. 2007
LCV			1.15/1.92	0.05/0.08	0.05/0.08	-	Oct. 2005	Sep. 2007
Medium LCV			2.55/4.08	0.05/0.08	0.07/0.10	-	Oct. 2005	Sep. 2007
Post New Long Term [3] - 8th Recommendation from the Central Environmental Counsel - Amended in November 2007 **(Mean/Max)**								
PC	JC08H + JC08C	g/km	1.15/1.92	0.05/0.08	0.05/0.08	0.005/0.007	Oct. 2009	Oct. 2009/ Sep. 2010
Light LCV			1.15/1.92	0.05/0.08	0.05/0.08	0.005/0.007	Oct. 2009	Oct. 2009/ Sep. 2010
Medium LCV			2.55/4.08	0.05/0.08	0.07/0.10	0.007/0.009	Oct. 2009	Oct. 2009/ Sep. 2010

[1] Test mode: see pages 45-46 [2] PM limit applied to direct injection gasoline engine to which NOx absorber
[3] New PM measurement method; technically modified methods for CO and other gases

JAPAN

Exhaust Emission Limit – Diesel vehicles

	Test Mode[1]	Unit	CO	HC	NOx	PM	New Model	All prod. / Imported veh.
New Short Term (Mean / Max)								
PC ≤ 1265 kg	10-15 Mode	g/km	0.63/0.98	0.12/0.24	0.28/0.43	0.052/0.11	Oct. 2002	Sep. 2004
PC > 1265 kg			0.63/0.98	0.12/0.24	0.30/0.45	0.056/0.11	Oct. 2002	Sep. 2004
Light Com Veh			0.63/0.98	0.12/0.24	0.28/0.43	0.052/0.11	Oct. 2002	Sep. 2004
Med. Com Veh			0.63/0.98	0.12/0.24	0.49/0.68	0.06/0.12	Oct. 2003	Sep. 2004
New Long Term (Mean / Max)				**NMHC**				
PC ≤ 1265 kg	10-15 Mode + 11 Mode	g/km	0.63/0.84	0.024/0.032	0.14/0.19	0.013/0.017	Oct. 2005	Sep. 2007
PC > 1265 kg			0.63/0.84	0.024/0.032	0.15/0.20	0.014/0.019	Oct. 2005	Sep. 2007
Light Com Veh			0.63/0.84	0.024/0.032	0.14/0.19	0.013/0.017	Oct. 2005	Sep. 2007
Med. Com Veh			0.63/0.84	0.024/0.032	0.25/0.33	0.015/0.020	Oct. 2005	Sep. 2007
Post New Long Term [4] - 8th Recommendation from the Central Environmental Counsel - Amended in November 2007 **(Mean/Max)**								
PC	JC08H + JC08C	g/km	0.63/0.84	0.024/0.032	0.08/0.11 [3]	0.005/0.007	Oct. 2009	Oct 2009/ Sep 2010
Light LCV			0.63/0.84	0.024/0.032	0.08/0.11	0.005/0.007	Oct. 2009	Oct 2009/ Sep 2010
Medium LCV			0.63/0.84	0.0240.032	0.15/0.20	0.007/0.009	Oct. 2010 [2]	Oct 2009/ Sep 2010 [2]

[1] Test mode: see pages 45-46
[2] Oct 2010 for Medium Commercial Vehicle w/ 1.7 t < GVW ≤ 2.5 t or Oct 2009 for Medium Commercial Vehicle w/ 2.5 t < GVW ≤ 3.5 t
[3] For vehicles not exceeding 1.265 kg. For vehicles > 1.265 kg: 0.15/0.20
[4] New PM measurement method; technically modified methods for CO and other gases

JAPAN

Other Requirements:

From 2005.

HC is measured as NMHC
Light Weight Commercial Vehicles ≤ 1.7 t GVW (diesel and gasoline)
Medium Weight Commercial Vehicles: 1.7 < GVW ≤ 3.5 t (diesel and gasoline)

For vehicles powered by fuels other than gasoline, LPG or diesel:

- Test method is 10.15 mode + JC08C until 31 March 2011 (28 Feb 2013 for imported vehicle); after: JC08H + JC08C
- Emission limits are similar to the relevant 2009 vehicle regulation (see pages 41 & 42)
- Application date: domestic vehicle: 01 Oct 2009; imported vehicle: 01 Sep 2010

Test Mode:

Exhaust Emission Level will be calculated as below:

From Oct 2005: 10-15 mode hot start x 0.88 + 11 mode cold start x 0.12
From Oct 2008: 10-15 mode hot start x 0.75 + JC08 mode cold start x 0.25
From Oct 2009: JC08 mode hot start x 0.75 + JC08 mode cold start x 0.25

Mean / Max:

Mean: to be met as a type approval limit and as a production average
Max: to be met as type approval limit if sales are less than 2000 per vehicle model per year and generally as an individual limit in series production

Idle CO & HC – Gasoline and LPG: Idle CO: 1%, Idle HC: 300 ppm

Durability: PC, truck and bus GVW < 3.5t: 80,000 km
PC, truck and bus GVW > 3.5t: 250,000 km

DF: 10-15 Mode: CO: 0.15; HC: 0.15; NOx: 0.25
11 Mode: CO: 2.0; HC: 0.15; NOx: 0.20
JC08 mode: CO: 0.11; NMHC: 0.12; NOx: 0.21

Evaporative Emissions – Gasoline and LPG:

Test similar to EC 2000 Evap test
(1 h hot soak at 27± 4°C + 24 h diurnal (20-35°C)),

test limit: 2.0 g/test, run on 10-15 Mode (three times).

Preparation driving cycle for EVAP:
25 sec. Idle + 11 mode x4 + ((24 sec. Idle + 10 mode x3 + 15 mode) x3)

OBD – Diesel, Gasoline and LPG:

J-OBDII: Enhanced OBD requirement for Passenger Cars and Commercial Vehicles with GVW ≤ 3.5 ton from October 2008
EU/US OBD standards to be accepted as equivalent

Smoke – Diesel: 4-mode: opacity limit 25%; free acceleration limit 25%; Max PM: 0.8 m^{-1}
From 2009: diesel 4-mode is abolished.; Max PM: 0.5 m^{-1}

Fuel quality – Sulfur content: Diesel: from Jan 2007: 10 ppm
Gasoline: current: 50 ppm; from Jan 2008: 10 ppm

JAPAN

NOx – PM Law

Applicable in following metropolis: Tokyo, Saitama, Chiba, Kanagawa, Aichi, Mie, Osaka, Hyogo

	Weight category	NOx	PM
Diesel PC	-	0.25 g/km	0.026 g/km
Bus & truck	GVW ≤ 1.7 ton	0.25 g/km	0.026 g/km
	1.7 < GVW ≤ 2.5 ton	0.4 g/km	0.03 g/km
	2.5 < GVW ≤ 3.5 ton	4.5 g/kWh	0.09 g/kWh

If a vehicle does not satisfy the regulation limit it cannot be registered in the applicable area after grace period.

Grace period from 1st registration:

Diesel PC: 9 years
Small truck: 8 years
Small bus: 10 years

Local Ordinance on Diesel Vehicles – PM Emission Regulation

Applicable in whole area of Tokyo (exclude island area), Saitama, Chiba, Kanagawa

Diesel truck & bus	From Oct 2003	From April 2006*
GVW ≤ 1.7 ton	0.08 g/km	0.052 g/km
1.7 < GVW ≤ 2.5 ton	0.09 g/km	0.06 g/km
2.5 ton < GVW	0.25 g/kWh	0.18 g/kWh

* In case of Tokyo and Saitama only

Vehicles from outside the mentioned area will not be able to operate within the cities unless of equal standard to city vehicles.

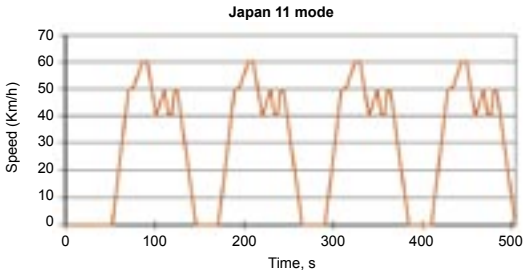
Two exemptions:

- Vehicles less than 7 years old (which must meet new vehicle emissions for 7 years from registration)
- Vehicles fitted with a PM filter

JAPAN

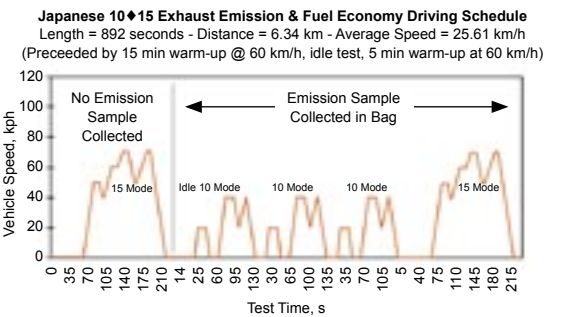
Driving Cycles

11 MODE COLD CYCLE



Length: 4.084 km Max. Speed: 60 km/h
Duration: 480 s Average speed: 30.6 km/h

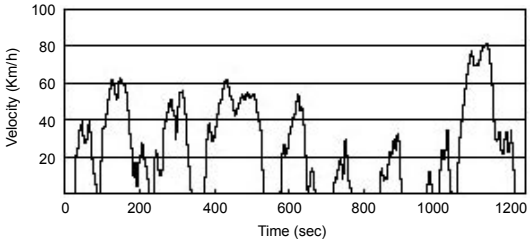
10♦15 MODE HOT CYCLE



Emissions are measured during the last four segments:
Length: 4.16 km Duration: 660 s Max. Speed: 70 km/h Average speed: 22.7 km/h

JAPAN

New Driving Cycle JC 08



Length: 8.2 km
Duration: 1205 s

Max. Speed: 80 km/h
Average speed: 24.4 km/h

REQUIREMENTS IN OTHER AREAS OF THE WORLD

Country	Requirement
Algeria	M1: Gasoline/LPG/NG: CO:2.3; HC:0.2; NOx: 0.15 g/km Diesel: CO:1; NOx: 0.50; PM:0.05 g/km N1: Gasoline/LPG/NG: CO:5.5; HC:0.31; NOx:0.25 g/km Diesel: CO:1; HC:1; NOx:0.90; PM:0.15 g/km
Argentina	Euro 3: New model: 01 Jan 2007 - EOBD not required Gasoline: low temp test not required 01 Jan 2008 – EOBD required - Gasoline: VT-SHED test required All model: 01 Jan 2009 Euro 4: New model: 01 Jan 2009 Gasoline: low temp test not required * All model: 01 Jan 2011
Australia	Gasoline - LPG /NG: ADR 79/01 Euro 3 for new vehicles (model) from 01 Jan 05 for all new registered vehicles from 01 Jan 06 Euro 4 ADR 79/02: From 01 Jul 2008 for new models - From 01 Jul 2010 for all production Diesel: ADR 79/01 Euro 4 for new vehicles (model) from 01 Jan 06 for all production from 01 Jan 07
	Gasoline 50 ppm Sulfur from 01Jan 08 10 ppm Sulfur from 01 Jan 12 (proposal) Diesel 10 ppm Sulfur from 01 Jan 09 Certificate of Conformity required according to EU, US or Japan in force legislation
Bermuda	Since Jan 2006, diesel engines and LCV w/ displacement ≤ 4.000 cc are forbidden
Bolivia	Imported vehicles to be fitted w/ a catalytic converter Decree 29836: ban of diesel vehicles ≤ 4.000 cc
Brazil	1/97: ≈ US 83 standrad, icl. Aldehyde limit (0.03 g/km), Fixed DF's from Jan 2002: CO and HC 20%, NOx and CHO 10 % only valid if annual production is < 15.000 vehicles Durability: 80.000 km or 5 years SHED: 2 g/test> Proposal Proconve L6: 1.5 g/test Certification required with E22 fuel for E22 vehicle, E22/E60/E100 for a flexfuel vehicle, E22/E60/E100 and CNG for a "tri" fuel vehicle Diesel passenger cars not allowed at this stage Wide range of fuels available on the market E100 (93% ethanol + 7% water) E22 (22% ± 2% ethanol + gasoline) Natural gas: CNG

REQUIREMENTS IN OTHER AREAS OF THE WORLD

Brazil

On Board Diagnostics:
- Br-1: Continuity Monitoring Only - Main actuators and sensors
- Br-2: Similar to EOBD (Approved by Gov't Technical Chamber. Awaiting final legislative approval)
  Drive Cycle: FTP75
  No Fuel System Diagnostics
  O_2 Response & Cat Mon required only in % ethanol ranges of 19-30% and 90-100%

Phase In Requirements (% of Total PC + Lt. Comm):

	CY2007	CY2008	CY2009	CY2010	CY2011
Br-1	40%	70%	100%	100%	100%
Br-2				60%	100%

Br-2 OBD Emission Thresholds:

	THC [1] (g/km)	NMHC [2] (g/km)	CO (g/km)	NOx (g/km)
PC	0.75	0.30	4.11	0.75
LDT ≤ 1700 kg [3]	0.75	0.30	4.11	0.75
LDT > 1700 kg [3]	1.25	0.50	8.22	1.50

[1] Only for vehicles moved by LPG
[2] Only for Spark Ignition vehicles except LPG
[3] Mass of the vehicle for the emission test

From 01/01/07, stricter standards for gasoline and diesel PC and LCV Proconve L6 is still in proposal phase

	CY		NMHC [1]	CO	NOx [3]	HCHO	PM [4]
PC	2007+	PROCONVE L4	0.16	2.0	0.25	0.03	
	2009+	PROCONVE L5	0.05	2.0	0.12	0.02	
	2012+	PROCONVE L6	0.05	1.3 [6]	0.08	0.02	
LCV (< = 1700 kg)	2007+	PROCONVE L4	0.16	2.0 [2]	0.25 (0.60)	0.03	0.08
	2009+	PROCONVE L5	0.05	2.0 [2]	0.12 (0.25)	0.02	0.05
	2012+	PROCONVE L6	0.05	1.3 [6]	0.08 (0.08)	0.02	0.025
Lt. Comm (> 1700 kg)	2007+	PROCONVE L4	0.20 [5]	2.7 [2]	0.43 (1.00)	0.06	0.10
	2009+	PROCONVE L5	0.06 [5]	2.7 [2]	0.25 (0.43)	0.04	0.06
	2012+	PROCONVE L6	0.06 [5]	2.0 [6]	0.25 (0.25)	0.03	0.03

[1] THC Reqmt of 0.30 [1] g/km and 0.50 [5] g/km for Nat.Gas engines
[2] Idle CO: 0.50%[2] and 0.30% [6] of volume for Otto Cycle Engines
[3] Diesel limits in ( ) [4] Diesel Only

Phase In Requirements (% of Total PC + Lt. Comm):

	CY05	CY06	CY07	CY08	CY09	CY10	CY11	CY12
PROCONVE L4	40%	70%	100%	100%				
PROCONVE L5					100%	100%	100%	
PROCONVE L6 (proposal)								100%

REQUIREMENTS IN OTHER AREAS OF THE WORLD

Canada	US Tier 2 starting from 2004 MY. - OBD II required Fleet average NOx standard from 2007: 0.07 g/mi Fuel economy: Corporate Average Fuel Consumption (CAFC): 8.6 l/100 km for PC; 10.6 l/100 km for LDT
Chile	Gasoline: From Jan 2005, for Santiago and from Sep 2006 nationwide: US Tier 1 – FTP 75 – applicable for all PC and LDV Evap: SHED, 2g/ test Alternative: Euro 3 No crankcase emissions allowed for gasoline vehicles From 2010: Santiago: Euro 4 or US Tier 2 bin 8 with OBD Diesel: From March 2006: Euro 4 or CARB Tier I From 2011: Santiago: Euro 5 or US Tier 2 bin 5 with OBD
Colombia	US-87 Tier I (FTP75 cycle) or Euro 1 (EDC cycle) EVAP: US or EU SHED at sea level, 2g/test From June 2008: Euro 3 or US Tier1
Costa Rica	US 87 (Tier 0) or EC 93 (Euro 1) accepted.
Croatia	EU legislation in force
Egypt	Imported gasoline cars to be equipped with catalytic converters. Emissions at idling speed (600-900 rpm): CO 4.5% Volume & HC: 900 ppm Proposal: Euro 2 for new vehicle
Ecuador	US 87 or Euro 1

El Salvador	US 87 in place. Gasoline vehicles must be equipped with a 3-way catalytic converter
Hong Kong	Gasoline: From Jan 2006, new registered vehicles: Euro 4 or CARB LEV II or Japan 2005 standards Diesel: Current, PC: CARB LEV II + EU smoke test LDV: Euro 4 or CARB LEV II OBD: EOBD or CARB OBD or J-OBD Proposal: Euro 5: implementation calendar similar to EU (2011)
Kazakhstan	Jan 2009: Euro 2 Jan 2011: Euro 3 Jan 2014: Euro 4
Iceland	EU legislation in force
India	From 04/2005 11 cities: Bharat Stage III equivalenet to Euro 3 w/ deviation in test procedure (Max speed limited to 90 km/h as against 120 km/h in Europe) Rest of India: Bharat Stage II (Euro 2) From 04/2010 11 cities: Bharat Stage IV (Euro 4 – Max speed 120 km/h) OBD I from 04/2010; OBD II from 04/2013 Rest of India: Bharat Stage III (Euro 3 w/ deviation in test procedure as above)

REQUIREMENTS IN OTHER AREAS OF THE WORLD

India (2)	Fuel specification change is also to be implemented with emission level changes 10% ethanol blended gasoline proposal as pilot in some states
Indonesia	ECE R 83.4 (Euro2) applicable From 01 Jan 05 for new type motor vehicles From 01 Jan 07 for motor vehicles in current production Euro 4 from 2012
Iran	Gasoline and diesel: From 21 Mar 2008: Euro 3 From 21 Mar 2012: Euro 4
Israel	From MY2002, Euro 3. US cars with equiv. US stand. are accepted From model year 2003 imported M1 & N1 gasoline vehicles must meet complete OBD requirements. From MY2007, Euro 4 Euro 5 from Jan 2009 (?)
Malaysia	Euro 2 from 01 Jan 03 Euro 4 from 2012
Malawi	All imported vehicle to be equipped with cat. converter by 2008
Mexico	Since MY 2004: Standard A based on US 94. US – FTP 75 Test OBD II EPA / EOBD from 2006 Tier 2 (Euro 4 option) phase in 25% in 2007; 100% in 2009 Sulfur: Gasoline: 30-80 ppm Premium from 2006 Magna from 2008 in Mexico city from 2009 in rest of country Diesel: 300 ppm from 2006; 15 ppm from 2008, 2007 along the US border

Mozambique	All imported vehicle to be equipped with cat. converter by 2008
New Zealand	Same vehicle categories as Australia Gasoline: ADR79/01 or Euro 3 or US 2001 or Japan 00/02 Diesel: ADR79/01 and 30/01 or Euro 4 or US 2004 or Japan 02/04 Diesel Sulfur: max 50 ppm from Jan 2006 As of 2006: Euro 2 for diesel and CNG vehicles Proposal: EU 5 TA from 01 Jan 2011; FR from 01 Jan 2012 (or US 2007 or Japan 2009)
Norway	EU legislation in force
Pakistan	From 2006: Euro 2 diesel and CNG vehicles
Philippines	Euro 2 from December 2006 Euro 4 target in 2012
PR of China	All China: Euro 3 (included -7°C test): TA: 01 Jul 2007; FR: 01 Jul 2008 OBD: type I veh: from 01 Jul 2008 – Other types: from 01 Jul 2010 Euro 4: TA: 01 Jul 2010; FR: 01 Jul 2011 Proposal Euro 5 in 2012 Durability requirement: EU 3: 80.000 km; EU 4: 100.000 km Low sulfur diesel (500 ppm) from 2004 **Beijing:** Gasoline: from Mar 2008: Euro 4 Diesel: from January 2007: Euro 4 CNG/LPG: veh. public transport + post: Euro 4 from 01 Jul 2008; Other veh.: Euro 3 with EOBD Max Sulfur both diesel and gasoline: 50 ppm: 01 Jan 08 **Guangzhou:** From 01 Sep 2006, Euro 3 with EOBD

REQUIREMENTS IN OTHER AREAS OF THE WORLD

PR of China(2)	Shanghai: From 01 Jan 2007: Euro 3 with EOBD From 01 Oct 2009: Euro 4 Proposal: Introduction of Euro 4 emission phase in advance of the Nationwide is foreseen in the Zhu River Delta
Russia	Euro 2 (ECE R83.03): from 01 Apr 06 Euro 3 (ECE R83.05 Stage III): Jan 2011 Euro 4 (ECE R83.05 Stage IV): Jan 2012 Proposal Euro 5: 2015
Saudi Arabia	As of MY 2004: PC: Euro 2 - LCV: Euro 1 Proposal: Euro 3 from MY 2010 (UN ECE Reg 83/05)
Singapore	Gasoline: Euro 2 from 01Jan 01. Proposal to adopt Euro 4 Diesel: from 01 Oct 06: Euro 4 Discussion for adoption of Euro 5
South Africa	Car & LCV (category M1/N1): Effective: Euro 2: TA 01/2006; FR 01/2008 Proposal: Euro 4: TA 01/2010; FR 01/2012 HCV (category M2/M3/N2/N3): Effective: Euro 2 (ECE R49.02): TA 01/2006; FR 01/2010 Proposal: Euro 4 (ECE R49.03): TA 01/2010; FR 01/2012 Leaded gasoline phase out effective 01/2006
South Korea	Vehicle Categories: Category 1: Mini-Car < 800 cc Category 2: Small PC 800cc<PC, GVW ≤ 3.5t, 8 seats Category 3: Mid PC 800cc<PC, GVW ≤ 3.5t, 9-15 seats

South Korea (cont'd)	Category 4: 800cc< Small commercial car, GVW ≤2t Category 5: 800cc< Mid Commercial Car (Van), GVW ≤3.5t New vehicle categories from 01 Jan 2009: Mini PC: < 1.000 cc Small PC: ≥ 1.000 cc, GVW < 4 tons, 8 seats max Medium PC: ≥ 1.000 cc, GVW < 4 tons, 9 seats min Small commercial car: ≥ 1.000 cc, GVW < 2 tons Medium commercial car: ≥ 1.000 cc, 2 tons ≤ GVW < 4 tons 01Jul02: NLEV + OBD II gasoline: Phase-in 2003-2006 (25% - 100%) Gasoline limits PC from 07/2002: CO:2.61; Cold CO: 6.3; NOx: 0.19; NMHC: 0.056 g/km HC SHED US: 1 g/test Diesel limits PC from 07/2002: CO: 0.5; NMHC: 0.01; NOx: 0.02; PM: 0.01 g/km **K-ULEV Gasoline Applications:** Mini-Car and PC Phase-In 2006-2009 (25% - 100%) Evap: 1 g/test Limits at 80.000 km: CO: 1.06; NOx: 0.031; NMHC: 0.025; HCHO: 0.0059 g/km PC only: Limits at 160.000 km: CO: 1.31; NOx: 0.044; NMHC: 0.034; HCHO: 0.007 g/km **K-ULEV Diesel Applications** for not more than GVWR 2.5 tons: Euro 4 from 01Jan 06 (All Model) **K-OBD for passenger car** Gasoline Category 1, 3, 4, 5: 01Jan06 (New Model), 01Jan07 (All Model)

REQUIREMENTS IN OTHER AREAS OF THE WORLD

South Korea (cont'd)	Gasoline Category 2: 10%(CY05), 30%(CY06), 100%(CY07) Diesel Category 1, 2: 01Jan06 (New model) , 01Jan 07 (All model) Diesel Category 3, 4, 5: 01Jan07 (New Model), 01Jan08 (All Model) **K-CAFE**: from March 2004, PC only w/ gasoline engine and < 10 seats Group 1(< 1500cc): 12,4 km/l Group 2 (≥ 1500 cc): 9,6 km/l **Next emission regulation:** Diesel: Euro 5 Mini PC, small PC and small commercial vehicle: New model: 01 Sep 2009; all model: 01 Jan 2011 Mid PC, mid commercial car: New model: 01 Sep 2010; all model: 01 Jan 2012 Gasoline: CARB LEV 2 from Jan 2009 (phase-in until 2013) Introduction of NMOG FAS (fleet average system) for PC and truck ≤ 1.7 ton 2009 FAS: 0.025; from Dec 2012: 0.024; from 2015: 0.022 Evaporative emission: 1 hr hot soak + 1 Day DBL: 2 g/test Durability: Diesel: should follow Euro 5 Gasoline: extension to 10 years or 192.000 km
Switzerland	Has harmonised national requirements on EU requirements
Taiwan	From Jan 08 Gasoline: based on US 04 (Tier 2 Bin 7): CO: 2.1; NMHC: 0.045; NOx:0.07 g/km; Idle: CO:0.5 %; HC: 100 ppm

	Or on Euro 4 OBD required - Durability: 5 years / 80.000 km Diesel: PC: US Tier 1 or Euro 4 Com veh: Tier 2 bin 5 or Euro 4 Proposal: Euro 5 introduction with same schedule than EU
Tanzania	All imported vehicle to be equipped with cat. converter by 2008
Thailand	From Jan 06: Gasoline Euro 3 (TISI2160-2546) w/out OBD Diesel Euro 3 (TISI2155-2546) w/out OBD Euro 4 in Jan 2012 for new model; Jan 2013 all model. with EOBD, without in-use conformity
Turkey	Imported vehicles to comply with the last EU Amend. of 70/220/EEC Euro 4 diesel and gasoline from 01.2008/01.2009 (TA/FR) w/ EOBD
Ukraine	Proposal: from 01 Jul 2009: Euro 3 from 01 Jul 2011: Euro 4 from 01 Jul 2014: Euro 5
Venezuela	From 2000: US 87 limits on US FTP 75 cycles or EC 93 PV and EC 95 CV on MVEG cycle
Vietnam	Gasoline: from 2001: ECE-Reg 83.03 - From 01 Jul 2007: Euro 2 Diesel: 2005: Euro 1 - Euro 2 from 01 Jul 2007 Proposal: 2009: Euro 3 - 2010: Euro 4
Zimbabwe	All imported vehicle to be equipped with cat. converter by 2008

EUROPEAN ON BOARD DIAGNOSTICS (EOBD)

Identifies malfunctions and deterioration that cause emissions to exceed thresholds, based European revised urban + extra urban cycle. Driver is notified upon detection.

EOBD Thresholds	CO		HC		NOx		PM
Euro 3 / Euro 4 (g/km)	Gasoline LPG/NG	Diesel	Gasoline LPG/NG	Diesel	Gasoline LPG/NG	Diesel	Diesel
M1 ≤ 2.5t GVW, LDT N1 Cl 1	3.20	3.20	0.40	0.40	0.60	1.20	0.18
LDT N1 Cl 2	5.80	4.00	0.50	0.50	0.70	1.60	0.23
LDT N1 Cl 3, M1 > 2.5t GVW	7.30	4.80	0.60	0.60	0.80	1.90	0.28

No OBD Euro 4 step was foreseen. More stringent OBD thresholds limits will be applied with Euro 5 (see page 54)

Vehicle Class	Gasoline		LPG/NG		Diesel	
	TA	FR	TA	FR	TA	FR
M1 ≤ 2.5t GVW, LDT N1 Cl 1	01 Jan 00	01 Jan 01	01 Jan 03	01 Jan 04	-	-
M1 ≤ 6 seats and ≤ 2.5t GVW	-	-	-	-	01 Jan 03	01 Jan 04
M1 > 6 seats and ≤ 2.5t GVW, LDT N1 Cl 1	-	-	-	-	01 Jan 05	01 Jan 06
M1 > 2.5t GVW, LDT N1 Cl 2, 3	01 Jan 01	01 Jan 02	01 Jan 06	01 Jan 07	01 Jan 06	01 Jan 07

Monitoring area	Gasoline	Diesel
Catalyst converter (gasoline THC only)	X	X
Engine misfire	X	
Oxygen sensor deterioration	X	
Particulate trap		X

Monitoring area	Gasoline	Diesel
Fuel injection system	X	X
Circuit continuity of all emission-related powertrain components	X	X

Monitoring area	Gasoline	Diesel
Any other emis. Rel. comp. or syst. (air flow, EGR,eg) if malfunction causes increase above thresholds	X	X

EUROPEAN ON BOARD DIAGNOSTICS

EU5 OBD requirements:

UN Reg 83, Annex 11 requirements are applicable, in addition to following points:

EOBD Thresholds	Implementation Dates		CO		NMHC		NOx		PM	
Euro 5 (mg/km)	TA	FR	PI	CI	PI	CI	PI	CI	PI [1]	CI [2]
M, LDT N1 CL 1	01Sep09	01Jan11	1900	1900	250	320	300	540	50	50
LDT N1 Cl 2	01Sep10	01Jan12	3400	2400	330	360	375	705	50	50
LDT N1 Cl 3, N2	01Sep10	01Jan12	4300	2800	400	400	410	840	50	50

[1] For GDI engines only [2] 80 mg/km until 01Sep2011 for M and N vehicles with RM > 1,760 kg

Expanded Monitoring area starting EU5
EGR system
EGR flow and cooler monitoring
Catalyst against NMHC
Catalyst against NOx (> EU5+)
NOx aftertreatment device with or without reagent
All O_2 Sensors to monitor cat (in addition to front sensor)
PM monitoring
IUPR (> EU 5+)

Access to OBD information:

- Similar to UN Reg 83 requirements
- Access with generic scan tool, complying with ISO 15031-5 document

Functional Aspects of OBD systems:

- Technical requirements are similar to UN Reg 83
- Starting EU6, on-board and off-board communication standard: ISO 15765-4 (CAN)

EUROPEAN ON BOARD DIAGNOSTICS

Interim EU6 OBD Thresholds for CI vehicles in advance of EU6

EOBD Thresholds – Interim Euro 6 (mg/km)	CO	NMHC	NOx	PM
M, LDT N1 CL 1	1900	320	240	50
LDT N1 CI 2	2400	360	315	50
LDT N1 CI 3, N2	2800	400	375	50

Proposed EU6 OBD thresholds (to be confirmed before 01Sep2010)

PROPOSED EOBD Thresholds Euro 6 (mg/km)	Implementation Dates		CO		NMHC		NOx		PM		PN	
	TA	FR	PI	CI	PI	CI	PI	CI	PI [1)]	CI	PI [2)]	CI
M, LDT N1 CL 1	01Sep14	01Sep15	1500	750	100	140	90	140	9	9		$1,2x10^{12}$
LDT N1 CI 2	01Sep15	01Sep16	2700	940	130	140	110	180	9	9		$1,2x10^{12}$
LDT N1 CI 3, N2	01Sep15	01Sep16	3400	1100	160	140	120	220	9	9		$1,2x10^{12}$

[1)] For PI vehicles, PM threshold applies only to direct injection engines [2)] Threshold to be determined once emission limit is set

Additional requirement starting EU5+:
In Use Performance Ratio Monitoring (IUPR)

IUPR indicates how often a specific monitor is operating relative to vehicle operation.

$$IUPR = \frac{Numerator_M}{Denominator_M}$$

$Numerator_M$ measures number of times a fault could have been detected

$Denominator_M$ measures vehicle activity

EU 5+: IUPR ≥ 0,1 for all monitors

EU6: IUPR ≥ 0,260 for secondary air system monitors and other cold starts related monitors
≥ 0,520 for evaporative purge control monitor
≥ 0,336 for all other monitors

Separate IUPR reporting for:

- Catalysts
- EGR system
- Particulate filter
- VVT system
- Evap system
- Exhaust sensors
- Secondary air system
- NOx aftertreatment
- Boost pressure control system

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US ON BOARD DIAGNOSTICS

US EPA OBD II - EPA "Harmonization" Final Rule MY 2001 onwards

Monitoring area	Condition for malfunction
Catalyst, engine misfire,O2 sensor	OBD threshold = 1.5x standard measured on FTP test
EVAP system	Leakage equivalent to a 0.040 inch hole
Other emis. rel. components	Monitoring for continuity, rationality and functionality

• Option to comply with CARB OBD II instead of EPA OBD II

US CARB OBD II (Regulation Approved 9 November, 2007) - Requirements for ALL Vehicles

Monitor area	Condition for malfunction
Cooling System	Thermostat: within 20 deg F of normal operating temp (may use higher threshold if less than 50% emissions increase) - May disable thermostat monitoring at ambient temperatures below 20 deg F Unable to reach the enable temperature for other monitors: - Stuck in range below the highest minimum enable temperature - Stuck in range above the lowest maximum enable temperature Time to reach Closed Loop fuel control enable (exemption if coolant temperature not used for closed-loop enable) - Time threshold must be approved by the Executive Officer, and must be a function of intake air temperature or start-up ECT - Maximum of 2 minutes allowed for engine start temperature up to 15 degrees below closed-loop enable temperature - Maximum of 5 minutes allowed for engine start temperature between 15 and 35 degrees below closed-loop enable temperature
Crankcase Ventilation System	Disconnection of any portion of CV system exemption possible for system design, w/ Exec. Officer approval)

US ON BOARD DIAGNOSTICS

US CARB OBD II (Regulation Approved 9 November, 2007) - Requirements for ALL Vehicles

Monitor area	Condition for malfunction
Comprehensive Components	Monitoring required for any component that can impact emissions (by any amount) under any reasonable driving condition Those components/systems that affect only engine mechanical or electrical load (not related to fuel, air, or emissions control) are only to be monitored if they are used by any other system or component monitor. Hybrid monitoring requires Executive Officer approval: at a minimum, must monitor components used by any other system or component monitor, energy input devices, battery and charging system performance, electric motor performance, and regenerative braking performance. Continuous monitoring required for circuit and out of range failures. MIL not required to be illuminated if the component is not used for any other monitoring strategy AND the malfunctioning component cannot, under any driving condition or cycle, cause emissions to increase by: - 25% or more for PC/LDT SULEV II vehicles - 15% or more for all other vehicles
Input Components	Lack of circuit continuity Signal out of range: signal is too high or too low given the expected maximum signal range Irrational signal (tw□ VVT (and other precise cam/crank alignment systems) requires cam and crank sensor failure detection for a single tooth/cog error, or error that causes a measurable increase in emissions Executive Officer approval required to disable circuit continuity and out of range monitoring
Output Components / Systems	Proper functional response to computer command - If not feasible, then detection of lack of continuity and circuit faults is required Proper functional response of the idle speed control - For target error-based control strategies, must detect inability to control within 100 rpm below the target speed and within 200 rpm above the target speed - Must ad□ Executive Officer approval required to disable circuit continuity and circuit fault monitoring

US ON BOARD DIAGNOSTICS

US CARB OBD II - Requirements for SI GASOLINE Vehicles

Monitor area	Condition for malfunction
Fuel System – Control	1.5 x standard (primary and secondary sensor-based controls)
Fuel System - Cylinder Imbalance	Air-fuel ratio for one or more cylinders is different than the others due to a cylinder specific malfunction (e.g. intake manifold leak, fuel injector, individual EGR runner flow, individual variable cam lift, etc.) Phase-in: 2011: 25%; 2012: 50%; 2013: 75%; 2014+: 100% Emission Thresholds: - 2011 through 2013: 3 x Standard (SULEV: 4.0 x Standard) - 2014+: 1.5 x Standard (may carry-over prior MY threshold for 2014 only)
Misfire: Continuous Monitoring for all positive engine torque speeds/loads	1.5 x standard and catalyst damage misfire thresholds Specific cylinder DTC required when > 90% misfires are occurring on a single cylinder
EGR (low and high flow rate)	1.5 x standard
Secondary Air	1.5 x standard, based on reduction in Secondary airflow - monitoring required while control strategy is normally activated
Variable Valve Timing (target Error, Slow response)	1.5 x standard
Evaporative System	No purge flow Cumulative evaporative system leak ≥ 0.020” orifice - For tanks with > 25 gallon capacity, may monitor larger leakage with Executive Officer approval - Executive Officer shall exclude leakage sizes that do not result in 1.5 x standard evaporative and running loss emissions

US ON BOARD DIAGNOSTICS

US CARB OBD II - Requirements for SI GASOLINE Vehicles

<table>
<tr><th>Monitor area</th><th colspan="6">Condition for malfunction</th></tr>
<tr><td>Exhaust Gas Sensors (primary and secondary)</td><td colspan="6">1.5 x standard
Monitoring of lack of circuit continuity and out of range faults
Monitoring of sensor deterioration or failure that renders the sensor insufficient for use as a monitoring device
Primary Sensors: Monitoring of:
- Voltage, response rate, and any additional parameters that affect emissions
- Symmetric and asymmetric failure modes
- Sensor failure or deterioration that causes the fuel control system to open loop operation.
Secondary Sensors: Monitoring of voltage, activity, and response rate</td></tr>
<tr><td>Exhaust Gas Sensor Heaters</td><td colspan="6">Heater current or voltage insufficient for manufacturer specified limit
(unable to maintain sufficient sensor temperature)
Open or shorted circuit failures that conflict with the commanded heater state</td></tr>
<tr><td rowspan="4">Catalyst</td><td>MY</td><td colspan="3">LEV II, ULEV II, MDV SULEV II</td><td colspan="2">SULEV II</td><td></td></tr>
<tr><td></td><td>NMOG</td><td>NOx</td><td>Conversion Efficiency</td><td>NMOG</td><td>NOx</td><td>Conversion Efficiency</td></tr>
<tr><td>2008</td><td>1.75x</td><td>3.5x</td><td>50%</td><td>2.5x</td><td>3.5x</td><td>50%</td></tr>
<tr><td>2009+</td><td>1.75x</td><td>1.75x</td><td>50%</td><td>2.5x</td><td>2.5x</td><td>50%</td></tr>
<tr><td colspan="6">For threshold testing purposes, the catalyst system is to be aged simultaneously (full catalyst volume)
- If fuel is shut off for misfiring cylinder, the monitored volume catalyst(s) must be aged simultaneously to the threshold limit, while unmonitored volume must be aged to the end of the vehicle’s full useful life</td></tr>
</table>

US ON BOARD DIAGNOSTICS

US CARB OBD II - Requirements for SI GASOLINE Vehicles

Monitor area	Condition for malfunction
Cold Start Emission Reduction Strategy	1.5 x standard Monitoring of individual control strategy input error(s) and/or individual or combined functional output error - monitoring required while control strategy is normally activated
Air Conditioning System	1.5 x standard Monitoring required when off-idle fuel and/or spark modified when A/C system is on Monitoring of all A/C components that may cause the system to invoke incorrect control
Direct Ozone Reduction (DCR)	For vehicles with NMOG credit ≤ 50%:Monitor for no detectable amount of ozone reduction For vehicles with NMOG credit > 50%:Monitor for loss in NMOG performance > 50% NMOG standard DOR NMOG credit modifies malfunction criteria for other components/systems by the NMOG credit - Example: Malfunction Threshold = (1.5 x standard + DOR NMOG Credit)
Cooling System; Crankcase Ventilation; Comprehensive Components	Refer to General OBD II requirements (top of CARB OBD II section)
Other Emission Related Components or Systems	Must request Executive Officer approval prior to introduction on a particular vehicle For air flow modifying devices (swirl, runner length, etc.), monitoring of the shaft(s) may suffice - Non-metal or segmented shafts require segment monitoring (verification that the furthest segment properly functions) - If more than one shaft to operate valves in multiple banks, not required to add more than one set of detection hardware
Exceptions to Monitoring Requirements	PC/LDT SULEV II: Executive Officer shall approve Malf. Criterion of 2.5 x Std. in lieu of 1.5 x Std. With data and/or engineering evaluation, may disable monitoring for battery voltage below 11.0 Volts upon Executive Officer approval (high-side voltage disablement also possible, with high-side voltage monitor)

US ON BOARD DIAGNOSTICS

US CARB OBD II for DIESEL Vehicle Certifications

Monitor area	Condition for malfunction
Reductant Injection System (Incl. SCR) Continuous monitoring required	A) Reductant System Failure – Same Fault Criteria as NOx converting catalyst (see p 61) B) If reductant is NOT engine fuel, must additionally diagnose empty reductant tank C) Improper Reductant
Misfire: Continuous Monitoring for all positive engine torque speeds/loads	'04+: one or more misfiring cylinders '10+: veh. w/ comb. sensor: LDV: NMHC, NOx, CO, PM: 1.5x st; MDV: NMHC, CO, NOx: 2.0x St, PM +0.03
Particulate Matter System	A) Incomplete regeneration; B) Missing substrate; C) Active/intrusive injection
Exhaust Gas Sensor Heater	Current or voltage outside manufacturer specification (requires CARB thresholds approval)
Feedback control	Monitoring of proper feedback control to diagnose
Reductant injection, Fuel system, Exhaust gas sensors, Boost press., EGR, NOx adsorber, PM system	A) Delayed entrance to feedback control B) Failure or deterioration causes open loop or default operation C) Feedback control adjustment at maximum authority
Cooling System; Crankcase Ventilation; Comprehensive Components	Refer to General OBD II requirements (top of CARB OBD II section)
Other emission related components or systems	Must request Executive Officer approval prior to introduction on a particular vehicle
Exceptions to monitoring requirements	A) Emis. Thresholds may be modif. by Executive Officer, dependent on upon most reliable monitoring method capab. B) 2007-09MY: Partic.matter filter malfunction criteria may be revised by Executive Officer to exclude cert. fail. Modes C) PC/LDT SULEV II: Executive Officer shall approve Malf. Criterion of 2.5 x Std. in lieu of 1.5 x Std. D) Engine cert. MDV: Executive Officer shall approve Malf. Criterion of (PM Std. +0.02) in lieu of 0.03. Additionally, (PM Std. +0.04) in lieu of 0.05 E) Engine cert. MDV: 2007-09MY: Executive Officer shall approve PM malfunction criterion of 1.5 x standard in lieu of PM ≥ 0.08

US CARB II (updated December 21, 2006) for DIESEL Vehicle Certification (Cont'd)

Monitor Area If standard is given, unit is g/bhp-hr	LDV Diesel Threshold					MDV Diesel Threshold				
	MY	NMHC	CO	NOx	PM	MY	NMHC	CO	NOx	PM
NMHC cat	2007-2009	5.0x	-	-	-	2007-2009	2.5x	-	-	-
	2010-2012	3.0x	-	-	-	2010-2012	2.5x	-	-	-
	2013+	1.75x	-	-	-	2013+	2.0x	-	-	-
NOx Converting Catalyst	2007-2009	3.0x	-	3.0x	-	2007-2009	3.5x	-	+0.5	-
	2010-2012	2.5x	-	2.5x	-	2010-2012	2.5x	-	+0.3	-
	2013+	1.75x	-	1.75x	-	2013+	2.0x	-	+0.2	-
NOx Adsorber	2007-2009	3.0x	-	3.0x	-	2007-2009	3.5x	-	+0.5	-
	2010-2012	2.5x	-	2.5x	-	2010-2012	2.5x	-	+0.3	-
	2013+	1.75x	-	1.75x	-	2013+	2.0x	-	+0.2	-
Exhaust Gas Sensor Performance NOx and PM sensors	2007-2009	3.5x	3.5x	3.5x	5.0x	2007-2009	2.5x	-	+0.5	0.05
	2010-2012	2.5x	2.5x	2.5x	4.0x	2010-2012	2.5x	-	+0.3	0.05
	2013+	1.5x	1.5x	1.75x	2.0x	2013+	2.0x	-	+0.2	0.03
EGR Low Flow, High Flow, Response Cooler Performance	2007-2009	3.0x	3.0x	3.0x	3.0x	2007-2009	2.5x	2.5x	+0.3	0.03
	2010-2012	2.5x	2.5x	2.5x	2.5x	2010-2012	2.5x	2.5x	+0.3	0.03
	2013+	1.5x	1.5x	1.5x	2.0x	2013+	2.0x	2.0x	+0.2	0.03
Boost Pressure Ctrl (under & over) VGT Resp., Charge Air Undercool.	2010-2012	2.0x	2.0x	2.0x	2.0x	2010-2012	2.5x	2.5x	+0.3	0.03
	2013+	1.5x	1.5x	1.5x	2.0x	2013+	2.0x	2.0x	+0.2	0.03

US ON BOARD DIAGNOSTICS

US CARB II (updated December 21, 2006) for DIESEL Vehicle Certification (Cont'd)

Monitor Area If standard is given, unit is g/bhp-hr	LDV Diesel Threshold					MDV Diesel Threshold				
	MY	NMHC	CO	NOx	PM	MY	NMHC	CO	NOx	PM
Cold start Emission Reduction Strategy		Fault due to control strategy input error(s) and/or output error								
	2010-2012	2.5x	2.5x	2.5x	2.5x	2010-2012	-	-	-	-
	2013+	1.5x	1.5x	1.5x	2.0x	2013+	2.0x	2.0x	+0.2	0.03
VVT Target Error Slow Response	2006-2009	3.0x	3.0x	3.0x	3.0x	2006-2009	2.5x	2.5x	+0.3	0.03
	2010-2012	2.5x	2.5x	2.5x	2.5x	2010-2012	2.5x	2.5x	+0.3	0.03
	2013+	1.5x	1.5x	1.5x	2.0x	2013+	2.0x	2.0x	+0.2	0.03
Particulate Matter Filter	2004-2009	-	-	-	5.0 x	2004-2009	-	-	-	0.09
	2010-2012	-	-	-	4.0 x	2010-2012	-	-	-	0.05
	2013+	-	-	-	1.75 x	2013+	-	-	-	0.03
Particulate Matter Filter System	2007-2009	Regen. Freq. Exceeds Manuf. Design Limit				2007-2009	Regen. Freq. exceeds Manuf. Design Limit			
- Frequent Regeneration	2010-2012	3.0 x	3.0 x	3.0 x	-	2010-2012	2.5 x	-	+0.3	-
- NMHC Conversion (2010-2013+ only)	2013+	1.5 x	1.5 x	1.5 x	-	2013+	2.0 x	-	+0.3	-
Aftertreatment Assistance Function	2010 + loss function					2010 + loss of function				

US ON BOARD DIAGNOSTICS

US CARB II (updated December 21, 2006) for DIESEL Vehicle Certification (Cont'd)

Monitor Area If standard mentioned, unit is g/bhp-hr	MY	LDV Diesel Threshold				MDV Diesel Threshold NOx cert. > 0.50 g/bph-hr				MDV Diesel Threshold NOx cert. ≤ 0.50 g/bph-hr			
		NMHC	CO	NOx	PM	NMHC	CO	NOx	PM	NMHC	CO	NOx	PM
Fuel System Pressure Control	2007-2009	3.0 x	3.0 x	3.0 x	3.0 x	1.5 x	1.5 x	1.5 x	0.03	2.5 x	2.5 x	+0.3	0.03
	2010-2012	2.0 x	2.0 x	2.0 x	2.0 x	1.5 x	1.5 x	1.5 x	0.03	2.5 x	2.5 x	+0.3	0.03
	2013+	1.5 x	1.5 x	1.5 x	2.0 x	1.5 x	1.5 x	1.5 x	0.03	2.0 x	2.0 x	+0.2	0.03
Fuel System Injection Quality / Timing	2010-2012	3.0 x	3.0 x	3.0 x	3.0 x	Same Fault Criteria as Fuel System Pressure Control							
	2013+	1.5 x	1.5 x	1.5 x	2.0 x	Same Fault Criteria as Fuel System Pressure Control							
Downstream Exhaust Gas Sensor Performance A/F Sensors	2007-2009	3.5 x	3.5 x	3.5 x	5.0 x	2.5 x	2.5 x	+0.5	0.05	2.5 x	2.5 x	+0.3	0.05
	2010-2012	2.5 x	2.5 x	2.5 x	4.0 x	?	?	?	?	2.5 x	2.5 x	+0.3	0.05
	2013+	1.5 x	1.5 x	1.75 x	2.0 x	?	?	?	?	2.0 x	2.0 x	+0.2	0.03
Upstream Exhaust Gas Sensor Performance A/F Sensors	2007-2009	2.5 x	2.5 x	2.5 x	2.5 x	1.5 x	1.5 x	1.5 x	0.03	2.5 x	2.5 x	+0.3	0.03
	2010-2012	2.0 x	2.0 x	2.0 x	2.0 x	1.5 x	1.5 x	1.5 x	0.03	2.5 x	2.5 x	+0.3	0.03
	2013+	1.5 x	1.5 x	1.5 x	2.0 x	1.5 x	1.5 x	1.5 x	0.03	2.0 x	2.0 x	+0.2	0.03

INSPECTION / MAINTENANCE PROGRAMS (I/M)

EUROPE

European Union: 96/96/EC as amended by 2003/27/EC

Application	1/94 for gasoline cars w/o cat. Converter 1/96 for diesel cars (FR after 1/80) 1/97 for gasoline cars with cat. Converter 3/01 for gasoline cars with OBD in acc. with 98/69/EC
Checks	Every 2 years. Start 4 years after FR
Gasoline vehicles	The maximum permissible CO content in the exhaust gases is that stated by the vehicle manufacturer. Where this information is not available the CO content must not exceed the following: Idle speed test: ≤ 4.5 vol%, w/o converter, FR before 10/86 [1] ≤ 3.5 vol%, w/o converter, FR after 10/86 [1] ≤ 0.5 vol%, with converter [1] ≤ 0.3 vol%, with converter [2] If **OBD** is fitted gas test not required, alternatively correct functioning of emission system through reading by the OBD device and simultaneous checking of proper functioning of OBD system shall be carried out
	Increased idle speed test (> 2000 RPM): CO: ≤ 0.3 vol%, λ = 1 ± 0.03 [1] CO: ≤ 0.2 vol%, λ = 1 ± 0.03 [2]
Diesel vehicles	Free acceleration from idling to cut off speed: Smoke opacity: naturally aspirated: ≤ 2.5 m^{-1} turbo-charged: ≤ 3.0 m^{-1} Smoke opacity for all [3]: ≤ 1.5 m^{-1}

[1] Alternatively manufacturer's type approval figures accepted

⇒ Germany and Scandinavian countries have similar programs already in place, varying slightly in testing/application parameters.

⇒ In addition, Germany's «AU» requires a closed-loop check through manipulation of the incoming air/fuel ratio. Since 1 April 2002 for gasoline vehicles with OBD a check on any malfunctions stored in the OBD memory is also required

[2] For petrol vehicles approved to EURO 3 (98/69**A**) or later amendments

[3] For diesel vehicles approved to EURO 4 (98/69**B**) or later amendments

INSPECTION / MAINTENANCE PROGRAMS (I/M)

UNITED STATES

⇒ Inspection/maintenance testing requirements vary per state.

⇒ Areas with the worst air quality use enhanced, more stringent tests.
Areas with moderate air quality use basic, less stringent tests.

⇒ Standards vary based on model year and vehicle types.

Test	Enhanced	Basic	Type	Emissions
Idle & 2 speed idle	No	Yes	Static	HC, CO
IM 240	Yes	No	Loaded, Transient	HC, CO, NOx
ASM	Yes	No	Loaded, Steady speed	HC, CO, NOx

Certification Short Test

⇒ Applies to gasoline passenger cars/ light duty trucks 1996 onwards

⇒ Conducted during certification, SEA and recall testing.

⇒ Laboratory simulation of worst case conditions encountered during any typical I/M testing (i.e. wait times, fuel RVP and ambient temperatures)

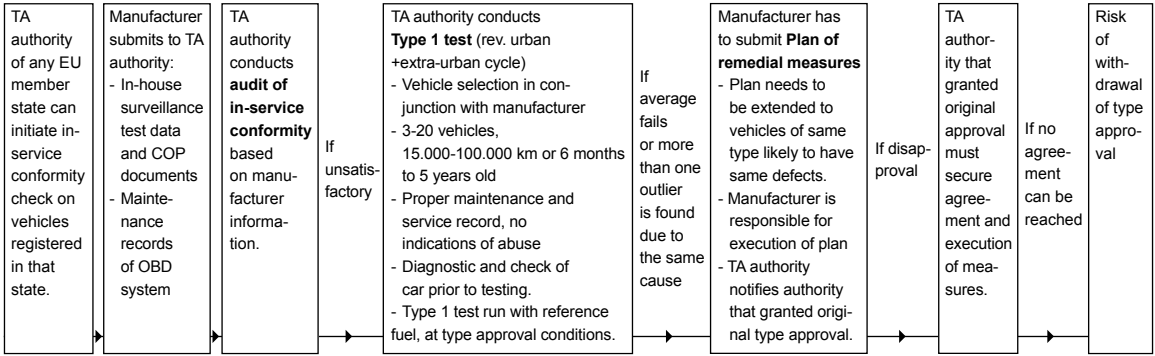
⇒ Standards - Idle test: (Cert & SEA) 0.5 vol% CO, 100 ppm HC,
In-use (recall) 1.2 vol% CO, 220 ppm HC.

Only idle test standards are currently available.

IN-USE COMPLIANCE TESTING

⇒ Audits of in-use emissi□ .

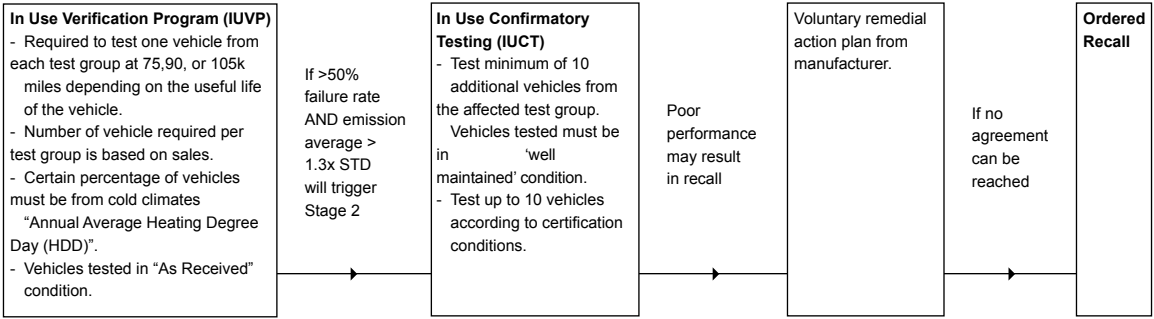
European Union Directive 98/69/EC and 2002/80/EC. From Euro 5 EU Reg 715/2007 and Reg 692/2008



Implementation Euro 4 step: FR 01/2006

IN-USE COMPLIANCE TESTING

In-use compliance testing sequence (US)
CAP 2000



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FUEL CONSUMPTION - FUEL ECONOMY

EUROPEAN UNION

ECE-R84 and Directive 80/1268/EEC, as amended by 89/491/EE

European Union: TA up to 31 DEC 1995. FR up to 31 DEC 1996.

Average fuel consumption is determined in a test made up of 3 parts:

1. Urban cycle simulating urban driving
2. Constant speed at 90 km/h
3. Constant speed at 120 km/h

Test results are averaged and expressed in l/100 km.

For volumetric measurement fuel consumption (FC) is calculated:

$$FC = \frac{V\,(1 + a\,(T0 - Tf))}{D} \times 100 \text{ l/100 km}$$

V = Volume in litres of fuel consumed
a = Coefficient of volumetric expansion of fuel
T0 = Reference temperature (°C)
Tf = Fuel temperature (°C) measured at volume measuring point
D = Distance covered during the test (km)

ECE-R101 and Directive 80/1268/EEC, as amended by 93/116/EEC

Implementation: TA mandatory:1/96, FR mandatory: 1/97

Fuel consumption is determined according to the carbon balance method from the CO_2, CO and HC emissions measured in g/km during the urban/extra-urban cycle.

$$FC \text{ (gasoline)} = \frac{0.1154\ ^{1)}}{D}\,[(0.866\times HC) + (0.429\times CO) + (0.273\times CO_2)]$$

[1)] Diesel:0.1155, FC = Fuel consumption in l/100 km, D = Fuel density

Directive 80/1268/EEC, as amended by 1999/100/EC and by 2004/3/EC

Adaptation to driving cycle of Euro3 (deletion of the first 40sec idle).

Scope extended to LPG and NG fuelled M1 vehicles.

Impl. M1 ≤ 2,5t GVW TA:1/00, FR: 1/01
M1 > 2,5t GVW TA:1/01, FR: 1/02

Scope extended to N1 vehicles.

Impl. N1 Cl 1 ≤ 1305 kg TA:1/05, FR: 1/06
1305 kg < N1 Cl 2 ≤ 1760 kg TA:1/07, FR: 1/08
N1 Cl 3 > 1760 kg TA:1/07, FR: 1/08

Why is Delphi's diesel technology better? It's very simple.

Sophisticated doesn't have to mean complicated. Case in point Delphi's diesel injector. This intelligent injector is capable of consistently delivering small quantities of atomized spray, with minimal separation, for unsurpassed performance. Yet its efficient design results in the industry's smallest injector package and reduces or eliminates the need for coolers or oversized pumps. For accuracy, each injector has a data matrix code, which specifies individual characteristics. And our Accelerometer Pilot Control optimizes combustion for clean, quiet operation throughout the engine's life.

To find out more, simply visit
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DELPHI

Innovation for the Real World

European Union - EU regulation on CO_2 Emission Reduction for Passenger Car

Adopted by EP on 17 Dec 2008 – Doc. 2007/0297 (COD) – EU Council still to endorse decision

- Average CO_2 emissions from new PC: 120 g/km by 2012
  - + max 130 g CO_2/km based on improvements in vehicle motor technologies
  - + complementary measures to deliver a further 10 g/km reduction (tires, air conditioning, greater use of alternative energy)
- Phase-in period: 2012- 2015

  Manufacturers to be given interim targets ensuring average CO_2 emission of:
  - + 65% of their fleet in Jan 2012
  - + 75% of their fleet in Jan 2013
  - + 80% of their fleet in Jan 2014
  - + 100% of their fleet from Jan 2015
- For each manufacturer, individual targets based on average mass of their EU car fleet, based on an emission limit curve
- Eco-innovation credit: Valid until 2014

  Innovative CO_2 reducing technologies are technologies not included in test cycle CO_2 measurement, nor included in complementary measures

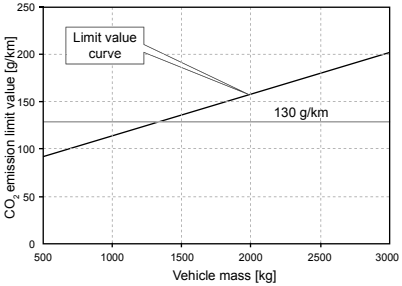
  Total contribution of eco-innovation limited to max 7 g CO_2/km in each manufacturer's average specific target
- Excess emissions premium will be applied. The premium will be based on the # of g/km above the curve multiplied by the number of vehicles sold by the manufacturer.
  - + From 2012 to 2018: 5 € for 1st g; 15 € for 2nd g; 25 € for 3rd g; 95 € 4th g onwards exceeding the target (per vehicle sold)
  - + From 2019: 95 €/g exceeding the target (per vehicle sold)
- Long term target: 95 g CO_2/km in 2020

Proposal for regulation on CO_2 reduction for LDT (M2, N1 and N2 vehicles)

Proposed target: 175 g CO_2/km in 2012; 160 g CO_2/km in 2015

Regualtion proposal should be similar to the PC regulation

Emission limit curve:



Formula for the limit value curve is:

Permitted specific emissions of $CO_2 = 130 + a \times (M - M_0)$

Where: M = mass in kg

$M_0 = 1372.0$

$a = 0.0457$

FUEL CONSUMPTION - FUEL ECONOMY

US - FUEL ECONOMY MEASUREMENT METHOD (40 CFR Part. 600.113)

Fuel consumption is determined in miles/US gallon according to the carbon balance method with CO_2, CO and HC measured in g/mile.

$$\text{FE (gasoline)} = \frac{5174\times10^4\times CWF\times SG}{[(CWF\times HC)+(0.429\times CO)+(0.273\times CO_2)]\times[(0.6\times SG\times NHV)+5471]}$$

$$\text{FE (diesel)} = \frac{2778}{(0.866\times HC) + (0.429\times CO) + (0.273\times CO_2)}$$

CWF = carbon weight fraction, SG = specific gravity of fuel, NHV = net heating value of fuel

Combined fuel economy value is calculated in miles/gallon by applying the results from US EPA III and Highway (HWFET) Cycle:

$$\text{HWFET [mpg]} = \frac{1}{0.55 / \text{EPA III} + 0.45 / \text{HFE}}$$

Conversion: Fuel consumption in l/100 km to fuel economy in mi/gal

$$\text{FC (l/100 km)} = \frac{235.215}{\text{FE (mi/gal)}}$$

US VEHICLE FUEL ECONOMY LABEL REQUIREMENTS

Current to MY 2010: City and Highway values calculated based upon FTP75 and HWFET results.

New 5 cycle calculation is optional 2008-2010

MY 2011 and beyond:

- 5 cycle formulae based upon combination of FTP75, FTP20, US06, SC03, HWFET
- MDPV (8.500 - 10.000 GVWR) require FE label for first time
- Option remains to use old calculation method, but manufacturer must show proof of accuracy

US - CAFE STANDARD (CORPORATE AVERAGE FUEL ECONOMY)

The sales weighted average fuel economy limit of a car manufacturer's vehicle fleet shall meet 27.5mpg LDV; 20.7 LDT. Debit/Credit balancing available +/- 3 yrs. A penalty to be paid by the manufacturer will result, if the average falls below the specified limits.

Current Standard:

LDT standards increased to 21 mpg in MY05; 21.6 in MY06; 22.2mpg in MY07+.

Manufacturer may choose between Unreformed (current) and Reformed (new) Calculation Method

Reformed Path

- SUVs, Light Pickups, Mini-Vans would be classified based upon wheelbase x track
- Limit for indiv. Models based upon a continuous function
- Manufacturer compliance based upon cumulative fleet performance

Unreformed Path

- Manufacturer will use the current CAFE calculation method
- Limits would increase for Unreformed Path

FUEL CONSUMPTION - FUEL ECONOMY

US - CAFE STANDARD (cont'd)

Renewable Fuels, Consumer Protection, Energy Independence & Security Act of 2007

- Groups PC and Trucks < 8500 lbs into a single fleet
- Sets new fuel economy goals for combined PC and LDT fleet
  - Sets a 35mpg US fleet average (all manufacturers) for MY2020
  - Fleet fuel economy goals for MY2011 – 2019 shall be 'maximum feasible average fuel economy standards'
  - MY2021 – 2030 fuel economy goals also required to be 'maximum feasible' standard
  - Waivers possible until MY2015
  - Each manufacturer will have indiv. goals that consider their fleet mix of vehicle footprints
  - Small Volume Manufacturer provisions exist
  - Credit trading provisions exist
- Federal fleets required to meet 'low greenhouse gas' emission requirements
- Requires NHTSA and EPA to develop proposed regulations by Dec2008 and final regulations by June 2009.
- Bill has advanced battery initiatives, alternative fuel incentives and provisions to support development of high efficiency technologies

California CO_2 Reduction Regulation (California AB 1493)

- State of California has enacted limits on CO_2 emissions.
- Limits are broken down into two phases: (2009-2012) and (2013-2016)

	CO_2-equiv. limit (g/mi)							
	2009	2010	2011	2012	2013	2014	2015	2016
Phase-In (%)	20	40	70	100	20	40	70	100
PC / LDT1	323	301	267	233	227	222	213	205
LDT2 / MDPV	439	420	390	361	355	350	341	332

- Credits for early compliance available over the 2000-2008 timeframe.
- EPA has denied California's CAA waiver request. Several lawsuits pending.
- If regulation stands, several additional states are expected to adopt the limits.

Canada is also considering such regulations: Mandatory fuel consumption standards for LDT to be published by end of 2008. Applicable from MY 2011

FUEL CONSUMPTION - FUEL ECONOMY

JAPAN CO_2 Reduction Regulation

Fuel Efficiency Targets

- Each manufacturer has to achieve the fuel efficiency as a weighted average in each weight class.
- Consumption determined on 10-15 cycle

Vehicle weight in kg – Fuel Efficiency in km/l

Gasoline Passenger Cars – Targets for 2010								
< 702	703 - 827	828 - 1015	1016 - 1265	1266 - 1515	1516 - 1765	1766 - 2015	2016 - 2265	2266 - 2500
21.1	18.8	17.9	16.0	13.0	10.5	8.9	7.8	6.4
Diesel Passenger Cars – Targets from 2005								
		≤ 1015	1016 - 1265	1266 - 1515	1516 - 1765	1766 - 2015	2016 - 2265	2266 - 2500
		18.9	16.2	13.2	11.9	10.8	9.8	8.7
LPG Passenger Cars – Targets for 2010								
< 702	703 - 827	828 - 1015	1016 - 1265	1266 - 1515	1516 - 1765	1766 - 2015	2016 - 2265	2266 - 2500
15.9	14.1	13.5	12.0	9.8	7.9	6.7	5.9	4.8

2015 Fuel Economy for all fuels

New Regulation will consider diesel and gasoline vehicles together

Test cycle: JC08 (cold and hot), applicable from March 2013

Average:

Vehicle Class	2004 Avg value - km/l	2015 Avg value - km/l	Change %
PC	13.6	16.8	23.5
Small buses	8.3	8.9	7.2
LCV	13.5	15.2	12.6

Vehicle weight in kg – Fuel Efficiency in km/l

Gasoline Passenger Cars – Target for 2015								
≤ 600	601 - 740	741 - 855	856 - 970	971 - 1080	1081 - 1195	1195 - 1310	1311 - 1420	1421 - 1530
22.5	21.8	21.0	20.8	20.5	18.7	17.2	15.8	146.4
1531 - 1650	1651 - 1760	1761 - 1870	1871 - 1990	1991 - 2100	2101 - 2270	≥ 2271		
13.2	12.2	11.1	10.2	9.4	8.7	7.4		

FUEL CONSUMPTION - FUEL ECONOMY

PR of China

Fuel economy Regulation (GB 20997-2007)

Phase I TA: 01Jul05; FR: 01Jul06

Phase II TA: 01Jul08; FR: 01Jul09

PC GVW < 3.500 kg / PC for automatic AT, 3 line seats or off-road

Curb weight (kg)	Phase I (l/100km)	Phase II (l/100km)
G ≤ 750	7.2/7.6	6.2/6.6
750< G ≤ 865	7.2/7.6	6.5/6.9
865< G ≤ 980	7.7/8.2	7.0/7.4
980< G ≤ 1090	8.3/8.8	7.5/8.0
1090< G ≤ 1205	8.9/9.4	8.1/8.6
1205 < G ≤ 1320	9.5/10.1	8.6/9.1
1320 < G ≤ 1430	10.1/10.7	9.2/9.8
1430 < G ≤ 1540	10.7/11.3	9.7/10.3
1540 < G ≤ 1660	11.3/12.0	10.2/10.8
1660 < G ≤ 1770	11.9/12.6	10.7/11.3
1770 < G ≤ 1880	12.4/13.1	11.1/11.8
1880 < G ≤ 2000	12.8/13.6	11.5/12.2
2000 < G ≤ 2110	13.2/14.0	11.9/12.6
2110 < G ≤ 2280	13.7/14.5	12.3/13.0
2280 < G ≤ 2510	14.6/15.5	13.1/13.9
2510 < G	15.5/16.4	13.9/14.7

South Korea

From 2010, for gasoline engines ≤ 1500 cc: 12.4 km/l

> 1500 cc: 9.6 km/l

No penalties foreseen if no compliance but publication of the achievements

Taiwan

Fuel economy standards for PC, LDT ≤ 2.5 t

Class of vehicle (kg)	Under FTP 75 (km/l)	Under EU Dir 1999/100 (km/l)
< 1.200	16.2	14.1
1.200 to 1.800	13.0	11.3
1.800 to 2.400	11.4	9.9
2.400 to 3.000	10.0	8.7
3.000 to 3.600	9.2	8.0
3.600 to 4.200	8.5	7.4
4.200 to 5.400	7.2	6.3
> 5.400	6.5	5.7

Global Fuel Economy Initiative (GFEI): “50 by 50”

Initiative jointly launched by UNEP (UN Environment Program), IEA (International Energy Agency), ITS (International Tranport Forum), FIA Foundation

Call for cars worldwide to be made 50 % more fuel efficient by 2050, along with interim targets

ENVIRONMENTALLY RELATED INITIATIVES FOR PASSENGER CARS

Austria	Bonus for new cars emitting < 120 g CO_2/km; Malus for veh emitting > 180 g CO_2/km; from Jan 2010: > 160 g CO_2/km Old vehicle scrappage incentive
Belgium	Special deduction from personal income tax when installing DFP (from 2006) Registration tax reduction for low CO_2 emitter vehicles From 01 Jul 2007: if CO_2 < 105 g/km, purchase price of veh. reduced by 15% If 105 < CO_2 ≤ 15 g/km, purchase price of veh. is reduced by 3% Additional specific regional incentive for eco-vehicle purchase (Wallonia) Flanders: incentives for retrofit DPF on diesel EU3 veh
Brazil	Registration tax based on engine cubic capacity and fuel type
Canada	Rebates of up to C$ 2000 for purchase or long-term lease fuel efficient Veh. > 36 mpg US cars or > 28.3 mpg US for light trucks
Chile	Santiago: incentives for zero and ultra-low emission vehicles
China	Tax based on engine displacement from 3% for a max 1.5 l up to 20% for a 4.0 l
Cyprus	Old vehicle scrappage incentive
Denmark	Subsidy for fitting particulate filters; Circulation tax based on fuel efficiency From 01 Jan 06: registration tax reduction for diesel PC with DPF Driving charge phase-in from 2011: based on vehicle mileage and location

EU	Member states are allowed to grant tax incentives on the basis of future EU Directives, starting after the publication of the next step limits. CO_2 fleet average goal for 2005/2012: 120 g CO_2/km (≈ 5 l/100 km for gasoline, 4.5 l/100 km for diesel) EU suggestion: EU-wide automotive taxation system: by 2009, min 25% of tax should be based on CO_2 emissions and 50% by 2010 Registration tax should be abolished over 5 to 10 years
Finland	Proposal from 2010: Cars registered after 2001: taxation linked to CO_2 emission Cars registered before 2001: taxation based on vehicle curb weight
France	Registration tax related to CO_2 emissions, engine power, and region/province Bonus-malus incentive program for new low CO_2 emitting cars purchase (bonus up to 5.000 € - malus up to 2.600 €); until 2012 Old vehicle scrappage incentive until Dec 2009
Germany	Annual tax based on engine capacity and exhaust emissions Tax incentives for fitting DPF to existing diesel cars. From 01 Jan 06 to 31 Dec 09 one time credit on vehicle licence fee for fitting DPF on LDT (300 €)

ENVIRONMENTALLY RELATED INITIATIVES FOR PASSENGER CARS

Germany (2)	Measures for PM emissions-based traffic restrictions in big cities: Vehicle labelling depending on Euro level Proposal for tax exemption for veh w/ CO_2 ≤ 100 g/km from Jan 09 and for higher tax rates for old vehicles From 2011: tax to be based on CO_2 emissions Old vehicle scrappage incentive – Tax bonus for purchase of veh min Euro 4
Greece	New road tax system: 4 classes tax based on emissions produced.
Hungary	New registration tax system based on engine volume
Iceland	Registration and circulation taxes related to CO_2 emissions
Ireland	From 01 Jul 08: registration tax linked to CO_2: from 100€ for 120g/km veh up to 2000 € for veh > 225 g/km Annual tax: engine < 2.5 l: increase of 9.5%; engine ≥ 2.5 l: increase of 15% Tax incentives for flex-fuel and hybrid veh - From 01 Jan 08: tax exemption for electrical cars and mopeds Sticker on vehicle depending on its energy efficiency
Italy	Power output and emissions based vehicle taxes – Additional tax for cars exceeding CO_2 limit of 170 g/km from 2008 and 120 g/km from 2010 Old vehicle scrappage incentive
Japan	Reduction of the vehicle tax and vehicle acquisition tax depending on vehicle category

	J-ULEV: 50% below the 2005 NOx/HC emission standard J-SULEV: 75% below the 2005 NOx/HC emission standard Additional automobile tax on old cars (13 yrs for gasoline and 11 yrs for diesel) 2009: incentives for purchase of new clean diesel w/ NOx < 0.08 and PM< 0.005 g/km
Luxembourg	01 June 07 - 31 Dec 09: incentives (750€) for purchase of low CO_2 emissions Veh (≤ 120g/km or in spec cond. ≤ 160 g/km) - Old vehicle scrappage incentive
Netherlands	Incentive purchase for diesel equipped w/ DPF until 31 Dec 2010 From 01 Jul 06: car registration tax based on vehicle environmental Performance. 7 categories based on fuel consumption, CO_2 emission and efficiency indicator proportional to other cars of similar size 01 Feb 08: tax based on CO_2 emissions: penalties: 100€/g above 232 g/km (Gasoline) and 192 g/km (diesel) Veh tax as a function of CO_2 emission in relation to their catalogue price from 2010 Tax exemption for very clean technologies (CO_2 ≤ 110 g for gasoline, 95 g for diesel) Extra tax on company veh > 140 g CO_2 for gasoline, > 115g for diesel 2009-2010: vehicle tax reduction for diesel PC and LDT w/ PM ≤ 5 mg/km Subsidies for DPF in 2009-2011 Proposal: road pricing system based on driven km and abandon of veh purchase tax
Norway	Vehicles are taxed according to their weight, engine displacement, engine power and price

ENVIRONMENTALLY RELATED INITIATIVES FOR PASSENGER CARS

Norway (2)	From 2008: Tax incentives for fitting particulate filter Bonus (640€) for scrapping older diesel vehicles Environmental incentives for low and zero CO_2 emissions vehicles Green national vehicle taxation: from Jan08, ratio of purchase tax based on CO_2 emissions to rise from 30% to 60%
Poland	Ecological tax for cars ≤ 3.5 t payable on 1st registration of vehicle Rates proportional to engine capacity and EU standards
Portugal	From 01 Jan 09: emission based annual taxes Old vehicle scrappage incentives
Romania	Old vehicle scrappage incentives. Pre-euro, Euro 1-2 no change in tax schema. Circulation tax based 30 % on CO_2 and 70% on pollutant for Euro 3⁄4 veh. Specific rates for Euro 5, hybrid and electric cars.
Singapore	Revised special tax structure for diesel PC Euro 4 based on engine capacity
Slovakia	Old vehicle scrappage incentives
Spain	From 2007: Scrapping incentives for cars > 2.5 l and > 10 years From Jan 2008: veh w/ CO_2 < 120 g/km: no registration tax 120-140 g/km: 4.75% tax; 160-200 g/km: 9.75% tax; > 200 g/km: 14.75 % tax
Sweden	Sales tax varying acc. to curb weight and emissions std. class 1 or 2. Tax incentive for diesel PC with low PM emissions until 31 Dec 2012

Switzerland	From 01/01/04 supplementary tax on gasoline and diesel fuels > 10 ppm Sulfur Canton specific tax reductions for fuel efficient vehicles Purchasing and tax programs or driving bans based on new criteria (fuel consumption, PM, NOx, HC and CO_2 emissions and noise) Proposal: 2010: car labelling depending on emission level & fuel efficiency
Thailand	Tax incentives for manufacturer of EFV (EU 4 and fuel consumption ≤ 5l/100km) tax rate of 17% in place of 30-50%
UK	Since 3/01 graduated excise duty for passenger cars based on their CO_2 emission value according to 80/1268/EEC Proposal for a reform of vehicle excise duty tax based: introduction of a top-land for the most CO_2 polluting vehicles
UK (London)	Low emission zone proposal: applicable from 2008 for HD, buses and coaches and from 2010 for diesel LDT
US	CAFE (corporative avg fuel economy) standard: 27.5 mpg (8.55 l/100km) Passenger Cars only; LDT 20.7 mpg Penalty assessed per vehicle for every 0.1 mpg fleet is over standard Federal Tax Credits: Up to $ 3000 on US hybrids but none on Japanese hybrids (credits phased out); up to $ 1800 on diesel (Mercedes-Benz or VW); up to $ 4000 on AFVs (CNG fuel). Only Colorado still has tax credit on AFVs and HEVs. Gas guzzler tax: Sales tax payable on each vehicle: FE < 22.5 mpg (10.45 l/km)

MARKET FUELS EUROPE

EU - Unleaded Gasoline Market Fuel

NEW DIN EN 228 standard harmonised with 98/70/EC (2003/17/EC)

Parameter	Unit	Min Limit	Max Limit	Test Methods
Research Octane N°	RON	95.0	-	EN ISO 5164
Motor Octane N°	MON	85.0	-	EN ISO 5163
Density at 15º	kg/l	720	775	EN ISO 3675 EN ISO 12185
Oxydation Stability	Minutes	360	-	EN ISO 7536
Existent Gum Content	mg/100 ml	-	5	EN ISO 6246
Copper Corrosion at 50°C	-	Class I		EN ISO 2160
Appearance	-	Clear and bright		Visual Control
Aromatics	max % vol	-	42 Until 31-12-04 Or 35.0	ASTM D 1319 EN 14517
Olefins	max % vol	-	18	ASTM D 1319 EN 14517
Benzene	max % vol	-	1	EN 12177 EN 238, EN 14517
Oxygen	% mass	-	2.7	EN 1601, EN 13132
Oxygenates	max % vol			EN 1601, EN 13132
Methanol		-	3	
Ethanol		-	5	
Iso-propyl alcohol		-	10	
Tert-propyl alcohol		-	7	
Iso-butyl alcohol		-	10	
Ethers w/ ≥ 5 C atoms		-	15	
Other oxygenates		-	10	
Sulfur	mg/kg		10.0	EN ISO 20846 EN ISO 20884
Lead	mg/l	-	5	EN 237

Climatic Specifications for Class A RVP: 45-60 kPa
% Evaporated at 70°C: 20.0-48.0 % (V/V)
% Evaporated at 100°C: 46.0-71.0 % (V/V)
% Evaporated at 150°C: 75.0 % (V/V)
Final Boiling Point: 210°C

Dir 98/70 amendment adopted by EU Parliament on 17 Dec 08 (to be endorsed by EU Council):

- Until 2013, gasoline with max 2.7% oxygen and max 5% ethanol to be available on the market
- Countries w/ low ambient summer temperatures: max RVP of 70 kPa allowed
- MMT: 01 Jan 2011: max 6 mg/l; 01 Jan 2014: max 2 mg/l; limit review by end of 2012 (MMT: methylcyclopentadienyl manganese tricarbonyl)
- New gasoline quality with max ethanol: 10%, max oxygen: 3.7% allowed

MARKET FUELS EUROPE

EU - Diesel Market Fuel

Parameter	Unit	DIN EN 590 standard harmonised with 98/70/EC (2003/17/EC)
Cetane number	-	≥ 51
Density at 15ºC	kg/m^3	820-845
Distillation T 95	ºC	≤ 360
Polycyclic aromatics	% (m/m)	≤ 11
Viscosity at 40°C	mm^2/s	2.0-4.5
Sulfur	ppm	50 [1)]
FAME [2)]	% (v/v)	≤ 5

[1)] Sulfur-free (<10 ppm) diesel: Mandatory from 1 January 2009

[2)] FAME (fatty acid methyl esters) must be in accordance with EN 14214

Dir 98/70 amendment adopted by EU Parliament on 17 Dec 08
(to be endorsed by EU Council):

- Max FAME: 7%
- Countries w/ severe winter conditions: possibility of max distillation T10: 180°C
- Polycyclic aromatics: Max 8%
- New diesel quality with FAME > 7%, with information on biofuel content allowed

REFERENCE/TEST FUELS EUROPE

These specifications apply to reference fuel used during certification/type approval.

Eu - Unleaded Gasoline Reference Fuel

Values for Euro 3 and Euro 4 are part of European Directive 98/69/EC and 2002/80/EC. For implementation timing see pages 11 - 12

Parameter	Unit	ECE, EC 93,96	Euro 3	Euro 4
Octane	RON/MON	95/85	95/85	95/85
RVP	kPa	56-64	56-60 [1)]	56-60 [1)]
Density at 15ºC	kg/l	0.748-0.762	0.748-0.762 [1)]	0.740-0.754 [1)]
T 10	ºC	42-58		
T 50	ºC	90-110		
T 90	ºC	155-180		
Dist. at 100ºC	% vol		49-57	50-58
at 150ºC	% vol		81-87	83-89
FBP	ºC	190-215	190-215	190-210
Aromatics	% vol	45	28-40	29-35
Olefins	% vol	20	≤ 10	≤ 10
Benzene	% vol	5	≤ 1	≤ 1
Oxygen	% mass		≤ 2.3	≤ 1

Parameter	Unit	ECE, EC 93,96	Euro 3	Euro 4
Sulfur	ppm	400	100	10
Lead	g/l	0.005	0.005	0.005
Phosphorus	g/l	0.0013	0.0013	0.0013

[1)] Different values for cold temperature test fuel: RVP: 56-95 kPa, Density at 15°C: 748-775 kg/m^3

Eu - Diesel Reference Fuel

Parameter	Unit	ECE, EC 93,96	Euro 3,4
Cetane		49-53	52-54
Density at 15ºC	kg/l	0.835-0.845	0.833-0.837
Distillation T 50	ºC	≥ 245	≥ 245
T 95	ºC	320-340	345-350
FBP	ºC	≤ 370	≤ 370
Flash point	ºC	≥ 55	≥ 55
Viscosity at 40°C	mm^2/s	2.5-3.5	2.5-3.5 [2)]
Polycyclic aromatics	% mass		3-6.0
Sulfur	ppm	≤ 3000	≤ 300 [3)]

[2)] For Euro 4: 2.3-3.3 [3)] Mandatory diesel sulfur level for Euro 4: ≤ 10 ppm

REFERENCE/TEST FUELS EUROPE

Values for Euro 5 and Euro 6 are part of Comitology Reg 2008/692

EU - Unleaded Gasoline Reference Fuel

Parameter	Unit	Euro 4	Euro 5&6
Octane	RON/MON	95/85	95/85
RVP	KPa	56-60 [1)]	56-60 [1)]
Density at 15ºC	kg/m^3	748-775	743-756
Dist. at 100ºC	% vol	50-58	48-60
at 150ºC	% vol	83-89	82-90
FBP	ºC	190-210	190-210
Aromatics	% vol	29-35	29-35
Olefins	% vol	≤ 10	3-13
Benzene	% vol	≤ 1	≤ 1
Oxygen	% mass	≤ 1	Ethanol only
Sulfur	ppm	≤ 10	≤ 10
Lead	mg/l	≤ 5	≤ 5
Phosphorus	g/l	≤ 1.3	≤ 1.3
Ethanol	% vol	-	4.7-5.3

[1)] Different values for cold temperature test fuel: RVP: 56-95 KPa

EU - Diesel Reference Fuel

Parameter	Unit	Euro 4	Euro 5&6
Cetane		52-54	52-54
Density at 150°C	kg/m^3	833-837	833-837
Distillation T50	ºC	≥ 245	≥ 245
T95	ºC	345-350	345-350
FBP	ºC	≤ 370	≤ 370
Flashpoint	ºC	≥ 55	≥ 55
Viscosity at 400°C	mm^2/s	2.3-3.3	2.3-3.3
Polycyclic aromatics	% mass	3.0-6.0	2.0-6.0
Sulfur	ppm	≤ 10	≤ 10
FAME	% vol	-	4.5-5.5
Oxydation stability	mg/ml	≤ 0.025	≤ 0.025
Oxydation stability @ 110ºC	hr	-	≥ 20

REFERENCE/TEST FUELS US

These specifications apply to reference fuel used during certification/type approval.

US - Unleaded Gasoline Reference Fuel

Parameter	Unit	EPA			CARB Phase 3
		Ambient	Cold CO low oct.	Cold CO high oct.	
Octane	(R+M)/2	93	87.8±3	92.3±0.5	91
RVP [1]	psi (kPa)	8.0-9.2 (55.2-63.4)	11.5±3	11.5±3	6.7-7.0 (46.8-48.3)
RVP Evap	psi (kPa)	8.7-9.2 (60-63.4)			7 (48.3)
T10	ºF	120-135	98-118	105-125	130-150
T50	ºF	200-230	179-214	195-225	200-210
T90	ºF	300-325	316-346	316-346	290-300
FBP	ºF	415	413	413	390
Aromatics	% vol	35	26.4±4	32±4	22-25
Olefins	% vol	10	12.5±5	10±5	4-6
Benzene	% vol				0.8-1

Parameter	Unit	EPA			CARB Phase 3
		Ambient	cold CO low oct.	cold CO high oct.	
Sulfur	ppm	15-80 [2]	15-80 [2]	15-80 [2]	30-40
Lead	g/gal (g/l)	0.05 (0.013)	0.01 (0.0026)	0.01 (0.0026)	0.01
Phosphorus	g/gal (g/l)	0.005 (0.0013)	0.005 (0.0013)	0.005 (0.0013)	0.005

[1] RVP for altitude testing: 7.6-8.0 psi or 52-55 kPa

[2] The road fuel will be 30 ppm avg. 80 ppm max.

Note: CARB Phase 3 fuel may use ethanol as alternative oxygenates; phase-in 2003.
Nationwide requirement for 2% oxygen content repealed.

Benzene limit for road fuel: 0.62% by vol. on an annual refinery average beginning in 2012.

REFERENCE/TEST FUELS US

US and California Certification Diesel Fuel for 2007 and later MY Vehicles

Fuel Property	Unit	Federal Specifications		California Specifications	Test [3]
		1-D [2]	2-D		
Cetane Number (natural)		40-54	40-50	47-55	D-613
Distillation Range	°F (°C)				D-86; 13 CCR section 2282(g)(3)
Initial Boiling Point	°F (°C)	330-390 (166-199)	340-400 (171-204)	340-420 (171-216)	
10% Point	°F (°C)	370-430 (188-221)	400-460 (204-238)	400-490 (204-254)	
50% Point	°F (°C)	410-480 (210-249)	470-540 (243-282)	470-560 (243-293)	
90% Point	°F (°C)	460-520 (238-271)	560-630 (293-332)	550-610 (288-321)	
End Point	°F (°C)	500-560 (260-293)	610-690 (321-366)	580-660 (304-349)	
API Gravity		40 - 44	32 - 37	33 - 39	D-287
Total Sulfur	ppm (wt.)	7 - 15	7 - 15	7 - 15	D-2622; 13 CCR section 2282(g)(3)
Nitrogen Content (max.)	ppm (wt.)			100 - 500	13 CCR section 2282(g)(3)
Total Aromatic Hydrocarbons	% (vol.)	8 (min.) [1]	27 (min.) [1]	8 - 12	D-1319; 13 CCR section 2282(g)(3)
Polycyclic Aromatic Hydrocarbons	% (wt.)			1.4 (max.)	
Flashpoint (min.)	°F (°C)	120 (49)	130 (54)	130 (54)	D-93
Viscosity @ 40°F (4°C)	mm^2/sec	1.6 - 2.0	2.0 - 3.2	2.0 - 4.1	D-445

[1] Remainder shall be paraffins, naphthenes, and olefins

[2] Basic Certification fuel is the grade 2-D diesel. Grade 1-D is allowed only if the engine manufacturer demonstrates that this fuel will be the predominant in-use fuel.

[3] ASTM standards and/or California Title 13, CCR procedures.

CONVENTIONAL US TEST / EU TEST FOR EC 93, EC 96

Test sequence

Preconditioning	Fill to 40% with test fuel (US: 8.7-9.2 RVP, EU: 8.1-9.3 RVP) US: EPA II (18 cycles) EU: Purge canister by driving or air purge 2X diurnal heat build, (heat fuel 16° to 30°C), 1 ECE + 2 EUDC cycles
Soak	12-36 hours (68°-86°F/20°-30°C ambient)
Fuel drain / fill	Drain tank, Fill 40 ± 2% with test fuel (US: fuel 45°-60°F / EU: fuel 10°-14°C)
Diurnal test (SHED)	Heat fuel tank for 1 hour (US: from 60° to 84°F) / (EU: from 16° to 30°C)
Exhaust test	US: EPA III (Emissions measured for TA) EU: ECE + EUDC cycle (Emissions not measured for TA)
Hot Soak Test	US/EU: 1 hour at 68°-86°F/23°-31°C ambient
Emissions standard: Diurnal test + Hot Soak test: 2 grams	
Implementation	EU: EC 93, EC 96

EURO 3 / EURO 4 EVAPORATIVE TEST SEQUENCE

(Directive 1999/102/EC = EC 2000/2005)

Test sequence

Fuel drain/ fill	Fill to 40% with test fuel
Canister Preconditioning	Canister loading: Repeated diurnal heat builds or Butane/N_2 loading to 2 g breakthrough
Fuel drain/ fill	Drain tank, Fill to 40% with test fuel
Vehicle Preconditioning	Preconditioning Drive at 20°-30°C: 1 ECE + 2 EUDC cycles
Soak	12-36 hours (20°-30°C ambient)
Exhaust test	ECE + EUDC at 20°-30C
Evap Cond. Drive	Urban cycle max. 2 min later
Hot Soak Test	1 hour at 23°-31°C ambient
Soak	6-36 h (min 6 h at 20 ± 2°C ambient)
Real Time Diurnal Test	1 heat build in 24 hours in VT SHED Cycle from 20°- 35°C, Δ T = 15 K
Emissions standard: Diurnal test + Hot Soak test: 2 grams	
Implementation	As part of Euro3/4, TA: 01 JAN 2000

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ENHANCED EVAPORATIVE EMISSIONS

US FEDERAL AND CALIFORNIA REQUIREMENTS

TEMP.	US FEDERAL / CALIFORNIA TEST SEQUENCE	
	3-day diurnal	Supplemental 2-day
68-86°F (20-30°C)	Fuel drain / fill	Fuel drain / fill
	6- hour minimum Soak	6- hour minimum Soak
	Preconditioning: 1 EPA II. Fuel drain/fill. 12-36 hr soak ⇒ Canister purge: 300 BV at 0.8 cfm with 25-75 gr/lb dry air ⇒ Canister load: 1.5 X WC at 15 g butane/hr with 50/50 butane/N_2 mix	Preconditioning: 1 EPA II. Fuel drain/fill. 12-36 hr soak ⇒ Canister load: Load to 2 g breakthrough at 40 g butane/hr with 50/50 butane/N_2 mix
	Exhaust test: EPA III	Exhaust test: EPA III
EPA: 90-100°F CARB: 100-110°F	1-6 hr Soak **Running loss test** EPA II,2x NYCC,EPA II	Not required

TEMP.	US FEDERAL / CALIFORNIA TEST SEQUENCE	
	3-day diurnal	Supplemental 2-day
EPA: 90-100°F CARB: 100-110°F	**1 hr Hot Soak Test (EPA 95 / CARB 105°F)**	**1 hr Hot Soak Test (68-86°F)**
	Stabilize Temp: 6-36 hr (EPA 72 / CARB 65 °F)	Stabilize Temp: 6-36 hr (EPA 72 / CARB 65 °F)
	Diurnal emission test 3 heat builds in 72 hr EPA: Cycle 72-96°F CARB: Cycle 65-105°F	**Diurnal Emission Test** 2 heat builds in 48 hr EPA: Cycle 72-96°F CARB: Cycle 65-105°F
	Running Loss: 0.05 g/mi	-
	Standard for Hot Soak + Highest Diurnal (grams)	
EPA/ CARB LEV I	2.0 g/test	2.5 g/test
CARB LEV II	0.50 g/test	0.65 g/test
EPA Tier II	0.95 g/test	1.2 g/test

Note: Vehicle certification requires the 3-day diurnal, in-use vehicles the supplemental 2-day diurnal test.

ENHANCED EVAPORATIVE EMISSIONS

EPA and California now accept certification data generated using the other agency's test procedure.

New EPA Evaporative Emission requirements

- Harmonizes federal limits with CARB LEV II requirements
  - 3-Day diurnal = 0.5 g/test for LDV
  - Supplemental 2-day = 0.85 g/test for LDV
  - LLDT/HLDT/MDPV have less stringent requirements
- Now allows CARB LEV II certification data to be used for EPA cert. without prior approval
- Implemented in MY2009 for LDV/LLDT and in MY2010 for HLDT/MDPV

Alternate phase in for FFV when operating on non-gasoline

Further CARB LEV II requirements:

- Useful life for standards extended to 150,000 mi or 15 years
- 1.75x higher in-use standard for 3 model years for LEV II families introduced prior to 2007
- Optional "Zero-Evap" standard is available to earn NMOG credits or partial ZEV credits, 0.35 g/test for hot soak + highest diurnal (2 or 3 days) & 0.0 g (< 0.054 g) from fuel system.

Further EPA Tier 2 requirements:

"Useful life" for standards extended to 120,000 mi.
Ethanol and HEV/ZEV vehicles regulated for first time

	EPA Enhanced & Tier 2	CARB Enhanced & LEV II
Test temp.	95 ± 5°F	105 ± 5°F
Fuel	9 psi RVP, 7.8 psi for altitude testing	7 psi RVP
Phase-in	Enhanced: 1996-1999: 20/40/90/100% Tier 2: 2004-2007: 25/50/75/100%	Enhanced: 1995-1998: 10/30/50/100% LEV II: 2004-2006: 40/80/100%

California is in the process of drafting standards to include hybrids and electric vehicles

ONBOARD REFUELLING VAPOUR RECOVERY (ORVR)

- Applicable in all US Federal States. CARB adopted EPA regulation.

Phase-in with 40/80/100% over 3 years.
Passenger cars: MY 1998/1999/2000
LDT ≤ 6000 lbs GVW: MY 2001/2002/2003
LDT > 6000 lbs GVW: MY 2004/2005/2006
Small volume manufacturers for passenger cars do not need to follow phase-in, but have to comply for 100% in MY 2000.

- No changes to ORVR procedures for CARB LEV II and EPA Tier 2.
- Measurement of emissions that escape from the vehicle during a refuelling emissions event. Stand-alone test in addition to enhanced EVAP tests. Fuel used: US Federal Cert. fuel: 8.7-9.2 RVP

Vehicle Pre-conditioning	Fuel drain + fill to 40% 6 hours min. soak at 68-86°F (20-30°C) 1 x EPA II Preconditioning Drive
Canister Pre-conditioning	⇒ Fuel drain + fill to 40% ⇒ 12-36 hours soak. Load canister with HC vapours until 2 g breakthrough at 40g/h 50% butane/N_2 ⇒ Exhaust test: EPA III (record emissions) 0-1 hr soak at 68-86°F ⇒ Canister purge drive at 68-86°F: EPA II, 2x NYCC, EPA II

Refuelling Event	⇒ Disconnect canister(s) ⇒ Fuel drain + fill to 10% ⇒ 6-24 hours Soak at 80 ± 3°F (27°C) ⇒ Reconnect canister(s) ⇒ Dispense fuel at 10 gal/min until automatic shut-off. If < 85% of total tank capacity is dispensed, continue auto refuelling until fuel dispensed is ≥ 85%. The Administrator may use 4 gal/min rate (15 l/min). Dispense fuel temp: 67°F ±1.5°F(19°C)
HC standard: 0.20 grams/gallon (0.053 grams/litre)	

EPA FUEL DISPENSING SPITBACK TEST

⇒ Applicable in all US Federal States for vehicles ≤ 14,000 GVW. Spitback phase-in same as enhanced EVAP (100% phase-in by 1999)

⇒ Measurement of liquid fuel spitback from the fuel filler inlet during a refuelling event. Stand-alone test in addition to enhanced EVAP tests. If ORVR compliant, manufacturer can request spitback test waiver

⇒ Fuel used: US Federal Certification fuel: 8.7-9.2 RVP

⇒ Spitback standard: 1.0 g/test

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MOTORCYCLES

Europe Dir 97/24/EC, as amended by Dir 2003/77/EC, Dir 2005/30/EC, Dir 2006/27/EC and Dir 2006/72/EC

Mopeds

Type I test	Emission Limits for TA and COP		Test Cycle
	CO (g/km)	HC+NOx (g/km)	
Euro 1 (17-06-1999)	6 [1]	3 [1]	UN-ECE Reg 47
Euro 2 (17-06-2002)	1 [2]	1.2	UN-ECE Reg 47

[1] The limit value for the masses of CO and HC+Nox are multiplied by a factor of 2 in the case of 3 wheeled mopeds and light quadricycles.

[2] The limit value for the mass of CO must be 3.5 g/km in the case of 3 wheeled mopeds and light quadricycles.

Type II test: measure of CO and HC at idling speed

Two-stroke Motorcycles and tricycles

Stage	Emission Limits for TA and COP [1]			Test Cycle
	CO (g/km)	HC (g/km)	NOx (g/km)	
Euro 1 (17-06-1999)	8	4	0.1	UN-ECE Reg. 40

[1] However, for tricycles and quadricycles, the limit values must be multiplied by a factor of 1.5.

Four-stroke motorcycles and tricycles

Stage	Emission Limits for TA and COP [1]			Test Cycle
	CO (g/km)	HC (g/km)	NOx (g/km)	
Euro 1 (17-06-1999)	13	3	0.3	UN-ECE Reg. 40

[1] However, for tricycles and quadricycles, the limit values must be multiplied by a factor of 1.5.

Note: National TA granted prior of the implementation of Dir remain valid for a max of 4 years.

MOTORCYCLES

Europe - Euro 2 & Euro 3 emission limits for 2 and 3- wheeled vehicles and quadricycles

		Class	CO (g/km)	HC (g/km)	NOx (g/km)
Limit values for motorcycles (2-wheels) for TA and COP					
A (2003)	TA: 01 Apr 04	I (< 150 cc)	5.5	1.2	0.3
Euro 2	FR: 01 Jul 05	II (≥ 150 cc)	5.5	1.0	0.3
B (2006) Euro 3	TA: 01 Jan 06 FR: 01 Jan 07	I (< 150 cc) UDC cold [1]	2.0	0.8	0.15
		II (≥ 150 cc) UDC + EUDC cold [2]	2.0	0.3	0.15
C (2006)	Alternative	V max < 130 km/h	2.62	0.75	0.17
GTR 2 [3]	TA: 01 Jul 07	V max ≥ 130 km/h	2.62	0.33	0.22
Limit values for tricycles and quadricycles for TA and COP					
A (2003)	TA: 01 Jan 03	All Gasoline	7.0	1.5	0.4
Euro 2	FR: 01 Jul 04	All Diesel	2.0	1.0	0.65
Proposal	TBD	Gasoline	4.0	1.0	0.25
		Diesel	1.0	0.15	0.65

Other items: In-Use Compliance: 30.000 km (Euro 3 stage)
CO_2 and Fuel consumption measurement required from Euro 3 stage

TA of replacement and retrofit of catalytic converter as separate technical units

Public consultation on proposal for new regulation for mopeds, motorcycles, tricycles and quadricyles – Formal proposal expected mid-2009

- Referencing of UN-ECE regulations should be used
- New emissions limits for motorcycles, mopeds,and quadricyles similar to Euro 5 car limits
- Durability requirements
- Evaporative emission requirements
- Measurement of CO_2 emissions
- Revised test procedure for Mopeds
- Test cycle: WMTC
- Additional legislation for four-wheel mini-cars, off-road quads, hydrogen-powered motorcycles, tricycles and quadricyles
- Hybrid motorcycle provisions should be considered as well

[1] Test cycle = ECE R40 (with emissions measured for all 6 modes – sampling starts at T=0)
[2] Test cycle = ECE R40 + EUDC (emissions measured for all modes – sampling starts at T=0), with a max speed of 120 km/h
[3] UN/ECE GTR2 is an alternative TA procedure for Euro 3 stage (Dir 2002/51/EC), based on harmonized WMTC test cycle

MOTORCYCLES

US Federal Motorcycle Limits (CFR 40 Part. 86.401)

1980 and later vehicles: 5.0 g/km HC; 12 g/km CO on FTP-75 test.
No crankcase emissions allowed. No evaporative emission regulations for MY2005 and prior. EPA has adopted new regulations in line with CARB regulations with implementation delayed by two years.

EPA New Motorcycle Standards (LIMITS IN GRAMS/KILOMETER)

Year	Class	Disp. (cc)	HC corp. ave	CO	HC+NOx	
					corp. ave	max
06+	I	50-169	1.0	12		
06+	II	170-279	1.0	12		
06-09	III	≥ 280	1.0	12	1.4	5.0
10+	III	≥ 280		12	0.8	5.0

Regulations are fuel neutral.
Class I: 0 to 169 cc Class II: 170 to 279 cc Class III: ≥ 280 cc
Banking and early introduction credits available.
Three wheels vehicles included if they meet the On-Highway Motorcycle criteria.
Mopeds and scooters covered under Non-Road Recreational standards.

California Motorcycle Limits

California Motorcycle Standards (LIMITS IN GRAMS/KILOMETER)

Year	Class	Disp.	HC		CO	HC+NOx	
			corp. ave	max		corp. ave	max
88-03	I & II	50-279	1.0	2.5	12		
88-03	IIIa	280-699	1.0	2.5	12		
	IIIb	700+	1.4	2.5	12		
04-07	III	≥ 280			12	1.4	2.5
08+	III	≥ 280			12	0.8	2.5

Early Introduction Incentive program avail for 2008 standard.
Evap: 2.0 g beginning 1986.
Small volume manufacturers:
Until 2007 need only meet HC+NOx stand. as HC only.
2008+: HC+NOx stand. at 1.4 g/km level.

MOTORCYCLES

Country	Requirements
Brazil	Mopeds: Vehicle with two wheels or similar equipped with three or four wheels. Engine capacity < 50 cc and top speed < 50 km/h Motorcycles: Vehicle with two wheels or similar equipped with three or four wheels. Engine capacity > 50 cc and top speed > 50 km/h Small volume manufacturer provisions available **Emissions Limits in grams/kilometer**

Class	Application Date	Displacement (cc)	Equivalent to	Cycle	HC	NOx	HC+NOx	CO
Mopeds	CY 03+	All	Euro 1	UN-ECE Reg 47	-	-	3.0	6.0
	CY 05+	All	Euro 2	UN-ECE Reg 47	-	-	1.2	1.0
Motorcycle [1)]	CY 03+	All	Euro 1	UN-ECE Reg 40	3.0	0.30	-	13.0
	CY 06+	< 150 cc	Euro 2	UN-ECE Reg 40	1.2	0.30	-	5.5
		≥ 150 cc	Euro 2	UN-ECE Reg 40	1.0	0.30	-	5.5
	From April 09 [2)]	< 150 cc	Euro 3	UN-ECE Reg 40	0.8	0.15	-	2.0
		≥ 150 cc	Euro 3	UN-ECE Reg 40 + EUDC	0.3	0.15	-	2.0

[1)] Vehicles with 3 or 4 wheels CY 05+: HC+NOx 1.5 g/km; CO: 7.0 g/km; NOx: 0.4 g/km

[2)] Min diameter for emissions rolls: 40”

MOTORCYCLES

Country	Requirements
Chile	Santiago: 2009: Euro 2 or US06 2010: Euro 3 or US10
India	All motorcycles: India Drive Stage 2; CO: 1.5; HC+NOx: 1.5g/km Durability: 30.000km or DFs: 1.2 Bharat Stage III: from 01Apr2010 Gasoline: 2-wheel: CO: 1.0; HC+NOx: 1.0 g/km 3-wheel: CO: 1.25; HC+NOx: 1.25 g/km Gasolilne DFs: 1.2 Diesel: 2- and 3-wheel: CO: 0.50; HC+NOx: 0.50; PM: 0.05 g/km Diesel DFs: CO: 1.1; HC+NOx: 1.0; PM: 1.2
Indonesia	UN-ECE Reg 40 Step 3: HC: 3 g/km; CO: 4.5 g/km
Japan	Motorcycle ≤ 125cc: ISO 6460 (ECE R40-cold start): HC: 0.5; CO: 2; NOx: 0.15 g/km Durability: 15.000 km Motorcycle > 125 cc: ISO 6460 (ECE R40- cold + EUDC cold start): HC: 0.3; CO: 2; NOx: 0.15 g/km Durability: 24.000 km
PR of China	China Stage III (GB-14622-2207): similar to EU Stage 3 TA: 01 Jul 08; FR: 01 Jul 09 With specific stage III for 3-wheelers

Country	Requirements
PR of China	Without WMTC provisions, idle CO test, different max speed (all bikes > 150 c: max speed 90 km/h) and diff. reference fuel Applicable to SI motorcycles of classes L3, L4 and L5 (2 or 3 wheelers of engine displacement > 50cc and max speed > 50 km/h fuelled by gasoline, LPG or NG)

Classification		Limits for emission (g/km)		
		CO	HC	NOx
2-wheel	< 150 cc (UDC)	2.0	0.8	0.15
	≥ 150 cc (UDC + EUDC)	2.0	0.3	0.15
3-wheel	All (UDC)	4.0	1.0	0.25

Durability: < 150 cc: 12.000 km
≥ 150 cc: < 130 km/h: 18.000 km
≥ 130 km/h: 30.000 km
Durability test: 11-mode procedure adapted to engine capacity
Mode 1-9: speed of 45 to 70 km/h; Mode 10-11: speed of 70, 90 Or 110 km/h
No assigned DF; min test mileage: 1⁄2 durability requirement
Evaporative requirements (GB-20998-2008)
Requirements for Mopeds (GB-18716-2007)
Beijing: 2 and 4-stroke motorcycles: CO: 3.5; HC+NOx: 2 g/km
Durability: 15.000 km
Test cycle: UN-ECE Reg 40

MOTORCYCLES

Country	Requirements
Singapore	All motorcycles: FTP: CO: 12 g/km; HC+NOx: 5 g/km
South Korea	≤ 50 cc: Euro 1 – Test cycle: ECE R47 > 50 cc 2-stroke: Euro 1 – Test cycle: ECE R40 > 500cc 4-stroke: Euro 1 – Test cycle: ECE R40 Durability for all: 6.000 km
Switzerland	Euro 3
Taiwan	CNS cold start (ECE R40 cold start test excl. 0-40 sec idle) ≤ 700 cc 2-stroke: CO: 7 g/km; HC+NOx: 1 g/km ≤ 700 cc 4-stroke: CO: 7 g/km; HC+NOx: 2 g/km > 700 cc 2 or 4-stroke: CO: 12 g/km; HC+NOx: 2 g/km Durability: all: 15.000 km 2-stroke motorcycle phase-out project by incentives over next 3 Years (2008-2010) Fuel economy standards required, based on eng. displacement
Thailand	From end of 2008: Euro III
Vietnam	Moped: ECE R47 CO: 1 g/km; HC+NOx: 1.2 g/km Motorcycle: ECE R40 CO: 3.5 g/km; HC+Nox: 2 g/km

GLOSSARY

ACEA	European Car Manufacturer Association
AMA	Accelerated Mileage Accumulation
ASM	Acceleration Simulation Mode
BV	Bed Volume
CAFE	Corporate Average Fuel Economy (US)
COP	Conformity of Production
CWF	Carbon Weight Fraction (US Fuel Economy Meas. Method)
DF	Deterioration Factor
ECE	Economic Commission for Europe, European subgroup of United Nations
EOBD	European Union On Board Diagnostic
EPA	US Environmental Protection Agency
EU	European Union, formally called EEC or EC
EUDC	Extra Urban Driving Cycle
Evap	Evaporative Emissions
FC	Fuel Consumption (EU)
FE	Fuel Economy (US)
FR	First Registration, entry into service
FTP	Federal Test Procedure
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating
LBS	Pounds (1 lb = 454 g)
LDT	Light Duty Truck
LDT1	Goods transport with LVW ≤ 3750 lbs
LDT2	Goods transport with 3751 ≤ LVW ≤ 5750 lbs
LDV	Light Duty Vehicle = Passenger car ≤ 12 passengers
LEV	Low Emission Vehicle (LEV1, LEV2)
LLDT	Light Light Duty Trucks (US) GVW ≤ 6000 lbs
LVW	Loaded Vehicle Weight (curb weight + 300 lbs)
MTBE	Methyl Tertiary Butyl Ether
MVEG	Motor Vehicle Emissions Group, advisory expert committee to the EU Commission
MY	Model Year
NHV	Net Heating Value of Fuel (US Fuel Economy Meas. Method)
NLEV	National Low Emission Vehicle
NMHC	Non-Methane Hydrocarbons
NMOG	Non-Methane Organic Gases
NYCC	New York City Cycle
OBD	On Board Diagnostic
ORVR	On Board Refuelling Vapor Recovery
PM	Particulate Matter
ppm	Parts per million
PZEV	Partial Zero Emission Vehicle
RAFs	Reactivity Adjustment Factors
RM	Reference Mass
SEA	Selective Enforcement Audit (= conformity of production testing)
SG	Specific Gravity of Fuel (US Fuel Economy Meas. Method)
SHED	Sealed House for Evaporation Determination
SULEV	Super Ultra Low Emission Vehicle
TA	Type Approval
TLEV	Transitional Low Emission Vehicle
UDDS	Urban Dynamometer Driving Schedule
ULEV	Ultra Low Emission Vehicle (ULEV1, ULEV2)
VT SHED	Variable Temperature SHED
WC	Working Cycle
ZEV	Zero Emission Vehicle

Yes, emissions standards are becoming tougher
Yes, the price of fuel is a constant concern
Yes, drivers demand more power and performance

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