Worldwide Emissions Standards
Passenger Cars and Light Duty Vehicles

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2011 / 2012

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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 torque with reduced fuel consumption and lower emissions.

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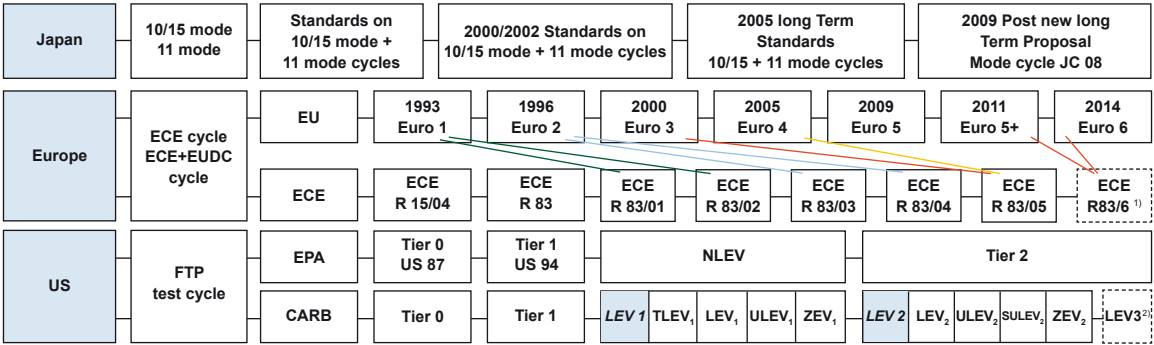
WORLDWIDE TESTING PROCEDURES AND STANDARDS



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, Iceland, Turkey

1) to be issued in spring 2011 2) proposed

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 9

- ⇒ 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

ECE-R-83/06 ⇒ to be issued in spring 2011

⇒ content to be equivalent to 715/2007/EC

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EUROPEAN UNION

TYPE APPROVAL

Test	Description	Requirement
Type I	Tailpipe Emissions after a cold start	See pages 8-21 Test cycle: see page 22
Type II	CO Emission test at idling speed	Determination of reference value for I/M [1] & COP.
Type III	Emissions of crankcase gases	Standard: zero emission
Type IV	Evaporative Emissions	See page 83
Type V	Durability of anti-pollution devices	See pages 8,10,12
Type VI	Low temperature test	See pages 12, 20-21
-	OBD	See pages 56-58

[1] I/M: Inspection & Maintenance

Note: Type Approval is granted after compliance with tests and requirements:

VEHICLE CATEGORIES

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

<table>
<tr><th>Category</th><th>Description</th><th>Sub-category</th><th>Number of Persons</th><th colspan="2">Mass Limit</th></tr>
<tr><td rowspan="3">M</td><td rowspan="3">Carriage of Passengers
Min. 4 wheels
PC</td><td>M1</td><td>Up to 9 Persons</td><td colspan="2">GVW ≤ 3,500 kg [2]</td></tr>
<tr><td>M2</td><td rowspan="2">Over 9 Persons</td><td colspan="2">GVW ≤ 5,000 kg</td></tr>
<tr><td>M3</td><td colspan="2">5,000 kg < GVW</td></tr>
<tr><td rowspan="6">N</td><td rowspan="6">Carriage of Goods
Min. 4 wheels</td><td>N1 Cl 1</td><td rowspan="4">N.A.</td><td rowspan="3">Max GVW ≤ 3,500 kg</td><td>RM ≤ 1,305 kg</td></tr>
<tr><td>N1 Cl 2</td><td>1,305 kg < RM ≤ 1,760 kg</td></tr>
<tr><td>N1 Cl 3</td><td>1,760 kg < RM ≤ 3,500 kg</td></tr>
<tr><td>N2</td><td colspan="2">3,500 kg < GVW ≤ 12,000 kg</td></tr>
<tr><td>N3</td><td colspan="2">12,000 kg < GVW</td></tr>
</table>

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

EUROPEAN UNION

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 [3]
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

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

[3] 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

EUROPEAN UNION

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	Emissions	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	Emissions	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	Emissions	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

EUROPEAN UNION

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 [1]			
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

[1] 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.

EUROPEAN UNION

SMOKE - DIESEL ONLY

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

2 tests are required:

1 Speed stabilised under full load

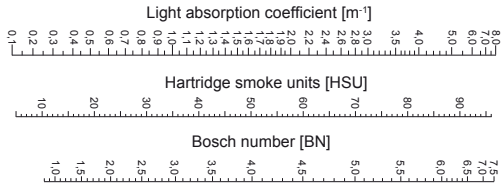
6 measurements shall be made at engine speeds spaced out uniformly between that corresponding to maximum power and the higher of the following two engine speeds: 45 % of the engine speed corresponding to maximum power; and 1000 rpm. For each measuring point, the smoke measured should not exceed the limit 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.

2 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



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 deliver a highly atomized spray in small quantities, with minimal separation. And new generation pumps provide pressures of 2,000 bar, with the capability of 2,400. No wonder our diesel technology is really going places. Visit: **delphi.com/eb-solenoid**

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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 Directive 70/220 and related amendments

Vehicle Scope: M1 and M2, N1 and N2 vehicles as defined in Directive 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 Euro 5 stage:
Diesel M1 Vehicles designed to fulfill specific social needs:
- Special purpose vehicles with Ref Mass > 2,000 kg (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

These vehicles still have to meet the N1 Class III limits for Euro 5.
No more exemption for passenger cars from Euro 6.

Test Cycle: similar to Euro 4: Revised Urban + EUDC

New Reference Fuels (See page 80):
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 regulation (EC) 443/2009 is merged into Euro 5 & 6 regulations
CO_2 is replaced by Greenhouse Gas; Test procedure not changed

Implementation Schedule:

	Euro 5a		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 Euro 6 certification possible in advance of TA dates. See page 21

EUROPEAN UNION

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)] PN valve for Euro 6 is planned to be adopted in a comitology proposal by the Commission 2nd semester 2011

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

EUROPEAN UNION

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	Euro 4			Euro 5a 01Sep09		Euro 5b OR Euro 5b+ 01Sep11			Euro 6 01Sep14		
	First registration	Euro 4				Euro 5a		Euro 5b	Euro 5b+		Euro 6 01Sep15	
N1 Cl II, III, N2	Type approval	Euro 4			Euro 5a 01Sep		Euro 5b OR Euro 5b+ 01Sep11				Euro 6 01Sep15	
	First registration	Euro 4					Euro 5a	Euro 5b	Euro 5b+			Euro 6 01Sep16
Compression Ignition Vehicles												
M, N1 Cl I	Type approval	Euro 4			Euro 5a 01Sep09		Euro 5b OR Euro 5b+ 01Sep11			Euro 6 01Sep14		
	First registration	Euro 4				Euro 5a		Euro 5b	Euro 5b+		Euro 6 01Sep15	
Exempted M1 off-road	Type approval	Euro 4			Euro 5a as N1 Cl III		Euro 5b OR Euro 5b+ 01Sep11			Euro 6 01Sep14		
	First registration	Euro 4					Euro 5a N1	* Euro 5b as M	Euro 5b+		Euro 6 01Sep15	
Exempted non off-road	Type approval	Euro 4			Euro 5a as N1 Cl III		Euro 5b OR Euro 5b+ 01Sep11			Euro 6 01Sep14 as M		
	First registration	Euro 4 as N1 Cl III					Euro 5a	Euro 5b	Euro 5b+		Euro 6 01Sep15 as M	
N1 Cl II, III, N2	Type approval	Euro 4				Euro 5a 01Sep	Euro 5b OR Euro 5b+ 01Sep11				Euro 6 01Sep15	
	First registration	Euro 4					Euro 5a	Euro 5b	Euro 5b+			Euro 6 01Sep16

* Euro 5a as M as of 01Sep12

List of requirements at the different stages can be found on pages 18-19

EUROPEAN UNION

EURO 5 & 6 REGULATION

Main additional requirements Euro 5a / Euro 5b / Euro 5b+ / Euro 6 - Spark Ignition Vehicles

	Euro 5a	Euro 5b	Euro 5b+	Euro 6
TA [1)]	01Sep09	01Sep11	01Sep11	01Sep14
FR [1)]	01Jan11	01Jan13	01Jan14	01Sep15
Gaseous 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 [3)]
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	Euro 5			TBD [4)]
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 58
[3)] PN limits to be adopted through a comitology proposal 2nd semester 2011
[4)] OBD limits; special work group established intermediate proposal expected in 2011

EUROPEAN UNION

EURO 5 & 6 REGULATION

Main additional requirements Euro 5a / Euro 5b / Euro 5b+ / Euro 6 - 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
Gaseous 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	Euro 5			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 58
[3)] For veh. certified EU 6 in advance of date: real DFs used

EUROPEAN UNION

EURO 5 & 6 REGULATION - VOLUNTARY CERTIFICATION PROCESS
Diesel Vehicles in advance of Euro 6 TA can be certified as:

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

Last date for first registration		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
M, N1 Cl I	Euro 6a / Euro 6-						31Dec12				
	Euro 6b / Euro 6-							31Dec13			
	Euro 6b / 6- plus IUPR								31Aug15		
N1 Cl II, III; N2	Euro 6a / Euro 6-						31Dec12				
	Euro 6b / Euro 6-							31Dec13			
	Euro 6b / 6- plus IUPR									31Aug16	

Durability Requirements starting Euro 5: 160.000 km

Assigned Euro 5 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 Euro 6 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

- 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 (25Jan11)

"Future emission strategy for Euro 6 vehicles"

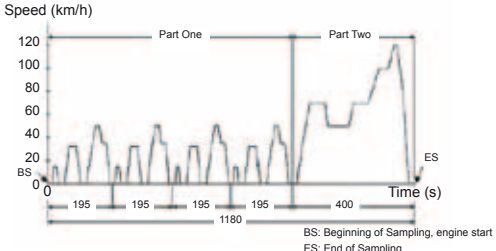
The commission intends to define/review the following items for introduction with Euro 6 (TA 01Sep14) or at a later date:

- Revised low temperature emission limits for Euro 6.
  EC decision end of 2012, implementation date TBD
- Particulate number limits for Euro 6 petrol vehicles.
  EC decision end of 2011, implementation date Euro 6
- Definition of the OBD limits.
  EC decision end of 2012 / intermediate decision possible 1st semester 2011 to allow TA of early Euro 6 vehicles (proposed values see page 58)
- NO_2 emission limits (WLTP test procedure)
  EC decision end of 2012, implementation TBD
- Definition of the THC (Total HydroCarbon) limits including Methane as CO_2 equivalents in the green house gas balance of vehicles
  EC decision end of 2012, implementation TBD
- Revised evaporative emissions test procedure and limits
  EC decision end of 2012, implementation TBD
- Procedures for the assessment of real driving emissions of vehicles
  EC decision end of 2012, implementation TBD (is not linked to Euro 6)

EUROPEAN UNION

DRIVING CYCLE

URBAN (ECE) + EXTRA-URBAN CYCLE (EUDC)



Urban cycle = 820 seconds

Urban + extra-urban cycle = 1220 seconds ("MVEG-A")

Euro 3 onw.

Rev. urb + extra-urban cycle = 1180 seconds ("MVEG-B")

Rev. urban cycle = 780 s (-7°C test)

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

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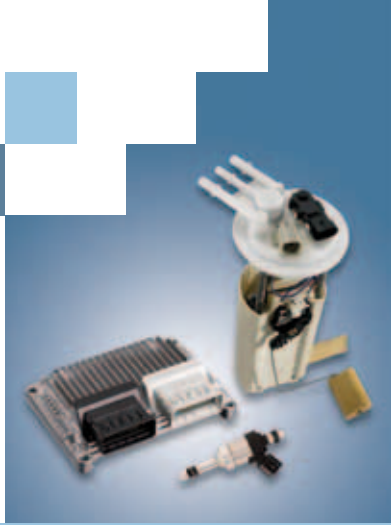

US FEDERAL

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 27
	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 27
	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

CLEAN AIR ACT AMENDMENTS - IMPLEMENTATION PLAN

	Model Year															
	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Phase-In (%)																
Exhaust Emissions																
Tier II				25	50	75	100									
NLEV	Nationwide															
Evap. Emissions																
Enh. EVAP																
ORVR																
Testing Procedures																
Suppl. FTP (Cal./NLEV)	25	50	85	100												
Revised durability																
g CO_2/mile																
Fleet Wide Emissions																
PC												261	253	246	235	224
Light Trucks												352	341	332	317	302
Combined												295	286	276	263	250

US FEDERAL

Exhaust Emissions Standards

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

⇒ Tier II standards, see page 27.

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 85.

⇒ 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.

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

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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

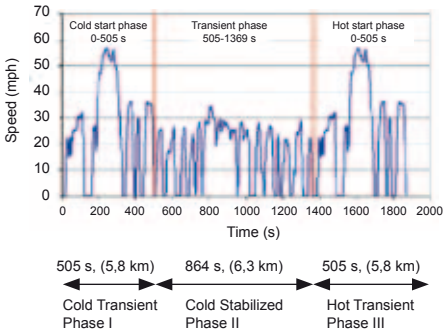
Tier II Phase-In Schedule HLDT (Veh. > 6000 lbs GVWR) & MDPV in %

%	'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

DRIVING SCHEDULES

CITY CYCLE [1)]



Length : 11.04 mi. (17,77 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)

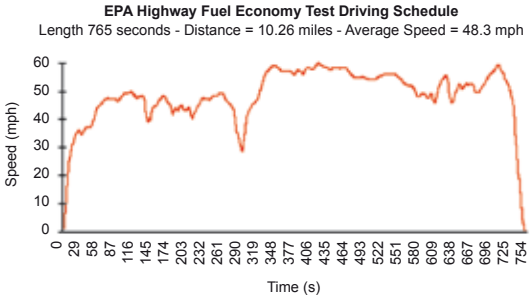
Between Phase II and Phase III, Hot Soak (9-11 min)

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

US FEDERAL

DRIVING SCHEDULES

HIGHWAY CYCLE [1)]



Length	: 10.26 mi. (16.5 km)
Total duration	: 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

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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

[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

Definition of emission classes

⇒ LEV Low Emission Vehicle (LEV_1, LEV_2)

⇒ TLEV Transitional Low Emission Vehicle

⇒ 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

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

[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

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

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LEV 2 standards (cont'd)

- ZEV subcategories:
  - ⇒ 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

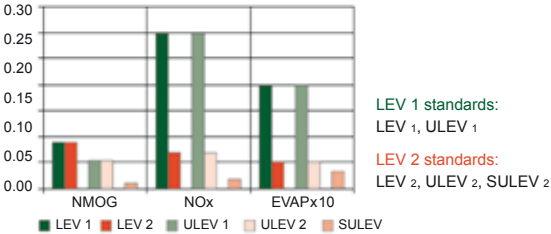
LEV 3 Proposal issued November 16th 2010

CARB's primary objective is to require fleet average SULEV-level emissions performance from new vehicles by MY 2022. Proposed modifications from 2014 include:

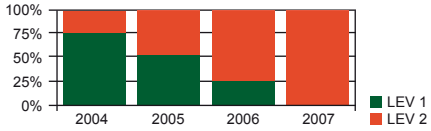
- NMOG and NOx will be combined and in a single tighter limit;
- tighter PM standards;
- durability increased to 150.000 miles (241.402 km);
- reference fuel to include up to 10% ethanol;
- revised evaporative emission limits;
- new full useful life requirements for the supplemental test procedure (SFTP);
- increased 50°F test limit when run on E85 fuel.

The 3 emissions categories will be extended to 6. These are to be used for fleet average compliance with the new standards. Annual fleet average limits have yet to be defined.

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



Certification Phase-in of CARB LEV standards



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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
⇒ HEV NMOG Factor. The HEV NMOG factor for light duty vehicles is calculated as follows:

LEV HEV Contribution Factor = 0.075 - [(Zero-emission VMT Factor) x 0.035]
ULEV HEV Contribution Factor = 0.040 - [(Zero-emission VMT Factor) x 0.030]
where Zero-emission VMT Factor for HEVs is determined in accordance with section 1962.

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%

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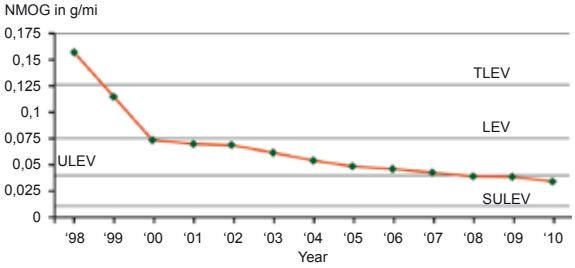
NMOG FLEET AVERAGE (Cars and Trucks 0 – 3750 lbs LVW)



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 has modified the standards to include hybrid - electric vehicles (HEVs)

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

SUPPLEMENTAL FEDERAL TEST PROCEDURE (SFTP)

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)

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 28 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

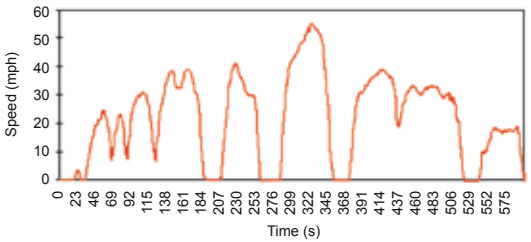
CALIFORNIA

DRIVING CYCLES

SC03 AIR CONDITIONING CYCLE

SC03 – Speed Correction Driving Schedule

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



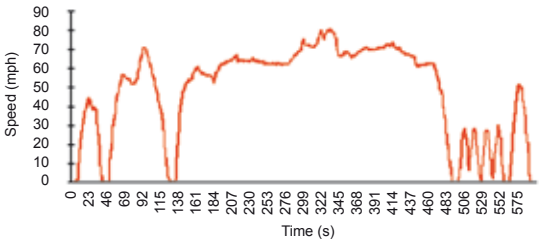
Total duration: 598 s
Length: 3.58 mi. (5,76 km)
Average speed: 21.55 mph (34,9 km/h)

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

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



Total duration: 596 s
Length: 8.01 mi. (12,86 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

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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	Combined Mode [4]	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] (Mean/Max) 8th Recommendation from the Central Environmental Counxel – Amended in Nov07 **(Mean/Max)**								
PC	Combined Mode [4]	g/km	1.15/1.92	0.05/0.08	0.05/0.08	0.005/0.007	Oct 2009	Oct 2009 / Sep 2010
Mini Com Veh			4.02/6.67	0.05/0.08	0.05/0.08	0.005/0.007	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 page 46-47 [2] PM limit applied only to direct injection gasoline engines equipped with NOx adsorber
[3] New PM measurement method; technically modified methods for CO and other gases [4] Combined Mode: see page 44

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	Combined Mode [5]	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	Combined Mode [5]	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	0.024/0.032	0.15/0.20	0.007/0.009	Oct 2009 Oct 2010 [2]	Sep 2010 / Sep 2011 [2]

[1] Test mode: see pages 46-47
[2] Oct 2009 for Medium Commercial Vehicle w/ 1.7 t < GVW ≤ 2.5 t or Oct 2010 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
[5] Combined Mode: see page 44

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 31Mar11 (28Feb13 for imported vehicle); after: JC08H + JC08C
- Emission limits are similar to the relevant 2009 vehicle regulation (see pages 42 & 43)
- Application date: domestic vehicle: 01Oct09; imported vehicle: 01Sep10

Combined 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 2011: 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 Oct08
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 07: 10 ppm
Gasoline: from Jan 08: 10 ppm

JAPAN

OTHER REQUIREMENTS – contd.

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.

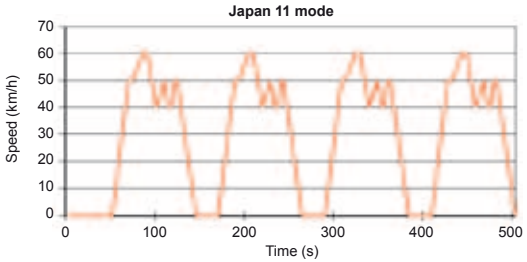
2 exemptions:

- 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

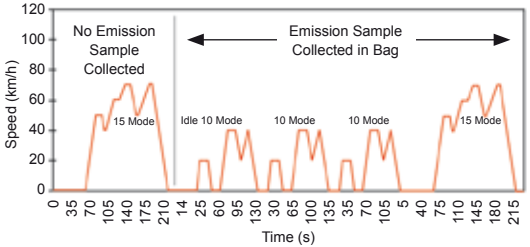
11 MODE COLD CYCLE



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

10♦15 MODE HOT CYCLE

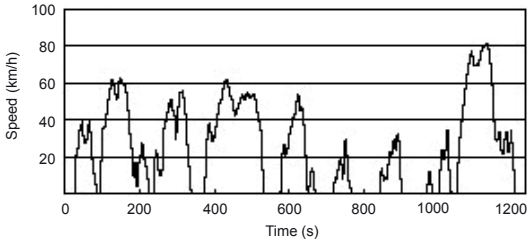
Japanese 10♦15 Exhaust Emission & Fuel Economy Driving Schedule
Duration = 892 seconds - Distance = 6.34 km - Average Speed = 25.61 km/h
(Preceeded by 15 min warm-up @ 60 km/h, idle test, 5 min warm-up at 60 km/h)



Emissions are measured during the last 4 segments:
Distance: 4.16 km Duration: 660 s Max. Speed: 70 km/h Average speed: 22.7 km/h

JAPAN

NEW DRIVING CYCLE JC 08



Distance: 8.2 km
Duration: 1205 s

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

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SOUTH KOREA

VEHICLE CATEGORIES

Category 1: Mini-car < 800cc
Category 2: Small PC 800cc < PC, GVW ≤ 3.5t, 8 seats
Category 3: Mid PC 800cc < PC, GVW ≤ 3.5t, 9-15 seats
Category 4: 800cc < Small commercial car, GVW ≤ 2t
Category 5: 800cc < Mid commercial car (Van), GVW ≤3.5t

From 01JAN2009, new vehicle categories:
Mini PC < 1.000cc
Small PC ≥ 1.000cc, GVW < 3.5t, 8 seats max.
Medium PC ≥ 1.000cc, GVW < 3.5t, 9 seats min.
Small commercial car ≥ 1.000cc, GVW < 2t
Medium commercial car ≥ 1.000cc, 2t ≤ GVW < 3.5t

From 01JUL2002
NLEV + OBD II gasoline: phase-in 2003-2006 (25-100%)
Gasoline limits PC: CO: 2.61, Cold CO: 6.3, NOx: 0.19, NMHC: 0.056 g/km
HC SHED US: 1 g/test
Diesel limits PC: 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 : 1g/test
Limits at 80.000 km: CO: 1.06, NOx: 0.031, NMHC: 0.025, HCHO: 0.005 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: GVWR ≤ 2.5t
Euro 4 from 01SEP2009
K-OBD for PC:
Gasoline Category 1,3,4,5: 01JAN06 (New Model), 01JAN07 (All Model)
Gasoline Category 2: 10% (CY05), 30% (CY06), 100% (CY07)
Diesel Category 1,2: 01JAN06 (New Model), 01JAN07 (All Model)
Diesel Category 3,4,5: 01JAN07 (New Model), 01JAN08 (All Model)
K-CAFÉ: from MAR2001, PC only with gasoline engine and < 10 seats
Group 1 (< 1.600 cc): 12.4 km/l, Group 2 (≥ 1.600 cc): 9.6 km/l

Next emission regulation:
Mini-PC, small PC and small commercial vehicle
01SEP14 (New Model), 01JAN15 (All Model)
Mid PC, mid commercial car
01SEP15 (New Model), 01JAN16 (All Model)
Gasoline: CARB LEV 2 from JAN2009 (phase-in until 2015)
Introduction of NMOG FAS (Fleet Average System) for PC and Truck ≤ 1.7t
2009 FAS: 0.025, from JUL2012: 0.024, from 2015: 0.022
Evaporative emission: 1hr hot soak + 1 day DBL: 2 g/test
Durability: Diesel should follow EU 5 / EU 6
Gasoline extension to 10 years or 192,000 km

BRAZIL

Jan 1997: ≈ US 83 standard, incl. 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

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

BRAZIL

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%

OTHER AREAS OF THE WORLD

Argentina	M1 & N1 vehicles Gasoline: Euro 4˚ since 2009 Diesel: Euro 4 since 2009 ˚ Low temperature tests not required
Australia	Euro 4 Diesel: all new registrations since Jan. 2006 Euro 4 Gasoline: all new registrations since Jul. 2010 Euro 5 targeted for 2012 Euro 6 targeted for 2016
Bermuda	Ban of diesel engines and LCV w/ displacement ≤ 4,000cc
Bolivia	Imported vehicles to be fitted w/ a catalytic converter Decree 29836: ban of diesel vehicles ≤ 4,000cc
Canada	PC & LDV: US Tier 2 Canada regulations for new on-road vehicle emissions are harmonized with US-EPA since 2004. Fuel economy: Corporate Average Fuel Consumption (CAFC): 8.6l/100km for PC; 10.6l/100km for LDT GHG limitations planned to be introduced MY 2011. Proposed programme is aligned to the US and included separate limits for NO_2 and methan emissions
Chile	Passenger Cars Gasoline: US Tier 1 – FTP 75 – applicable for PC & LDV Evap: Shed, 2g/test Alternative Euro 3 No crankcase emissions allowed Diesel: Euro 4 or Carb Tier 1
	Santiago: Gasoline: Euro 4 or US Tier 2 , bin 8 since 2010 Diesel: Euro 5 or US Tier 2, bin 5 in 2011
PR of China	Nationwide: Euro 3 (incl. -7°C test): TA: 01 Jul 2007; FR: 01 Jul 2008 (N1 category LD Diesel vehicle: postponed to 01 Jul 2009) OBD: Type I Gasoline vehicle: from 01 Jul 2008 Other types: from 01 Jul 2010 Euro 4: TA: 01 Jul 2010; FR: 01 Jul 2011 (N1 category LD Diesel vehicle: postponed very likely; date TBD) Durability requirement: Euro 3: 80,000 km; Euro 4: 100,000 km Euro 3 Diesel (350 ppm sulfur): before 30 Jun 2011 Euro 4 Diesel (50 ppm sulfur): before 30 June 2013 (proposed) Beijing: Euro 4 Gasoline: from 01 Mar 2008 Euro 4 Diesel LDV: not allowed at the moment Euro 4 Fuel: max. sulfur (both diesel & gas) 50 ppm, from 01 Jan 2008 Guangzhou/ Zhujiang Delta: Euro 4: Gasoline: from 01 Sep 2010 Diesel: TBD Euro 4: Gasoline: from 01 Aug 2010 Diesel: supply date to be announced

OTHER AREAS OF THE WORLD

	Hong Kong: Passenger Cars (< 2,500kg) Gasoline: Euro 4; CARB Lev 2 or Jap. 2005 since 2006 Euro 5 planned for 2011 Diesel: Euro 5 or Jap. 2009 since 2009 Light Duty Commercial vehicles Euro 4 since 2007 Shanghai: Euro 4 Gasoline from 01 Nov 2009 Euro 4 Diesel: max sulfur 50 ppm: from 01 Sep 2009 Euro 4 Gasoline:max sulfur 50 ppm: from 01 Oct 2009
Columbia	US-87 Tier I (FTP 75 cycle) or Euro 1 (EDC cycle) EVAP: US or EU SHED at sea level, 2 g/test Since June 2008: Euro 3 or US Tier 1
Costa Rica	US 87 (Tier 0) or Euro 1
Croatia	EU legislation applied
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 vehicles
Ecuador	US 87 or Euro 1
El Salvador	US 87 3 way catalytic converter required for gas vehicles
Kazakhstan	Jan 2009: Euro 2 / Jan 2011: Euro 3 / Jan 2014: Euro 4

Iceland	EU legislation applied
India	Since Apr 2010 13 cities: Bharat Stage IV (Euro 4 – max speed 90 km/h) OBD I from 04/2010: OBD II from 04/2013 Since Oct 2010 Rest of India: Bharat Stage III (Euro 3 w/ deviation in test procedure as above) Fuels Bharat III fuel (Diesel 350 ppm sulfur; gasoline 150 ppm Sulfur) Available across the country since Oct 2010 Bharat IV (50 ppm sulfur) Gasoline and Diesel available in 13 cities
Indonesia	ECE R83.4 (Euro 2) applicable 01 Jan 05 for new type motor vehicles 01 Jan 07 for motor vehicles in current production Euro 4 2012
Iran	Gasoline: M1 & N1 Euro 3 since 2008 Diesel: M1 not authorized in Iran N1 Euro 3 smoke ECE R24/03
Israel	MY 2002, Euro 3. US cars with equivalent US standards From MY 2003 imported M1 & N1 Gasoline vehicles must meet complete OBD MY 2007, Euro 4 Euro 5 from Jan 2009

OTHER AREAS OF THE WORLD

Malaysia	Gasoline: M1 Euro 2 Euro 4 in 2012 Diesel: M1 Euro 1
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
New Zealand	Same vehicle categories as Australia Gasoline: ADR79/01 or Euro 3 or US 20001 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 20065 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 applied
Philippines	Euro 2: Dec 2006 Euro 4: target in 2012
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

Saudia Arabia	As of MY 2004 : PC: Euro 2; LCV Euro 1 Proposal Euro 3 from MY 2010 (UN ECE Reg 83/05)
South Africa	Car & LCV (category M1/N1) Effective: Euro 2 Proposal: Euro 4 for 2012
Switzerland	Has harmonised national requirements on EU requirements
Taiwan	Jan 08 Gasoline: US 04 (Tier 2 bin 7): CP 2.1 NMHC: 0.045; NOx: 0.07 g/km; Idle CO 0.5%; HC 100 ppm or Euro 4 Diesel: PC: US Tier 1 or Euro 4 Commercial Vehicles: Tier 2 bin 5 or Euro 4
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: 01 Jul 2011: Euro 4 01 Jul 2014: Euro 5

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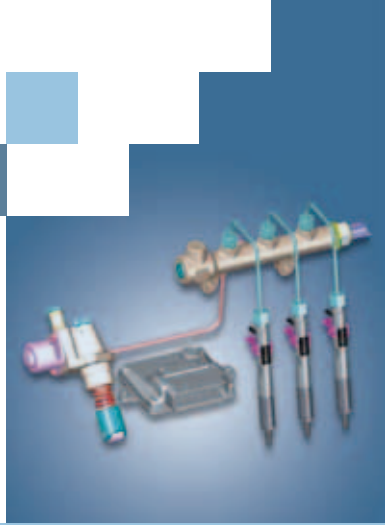

EUROPEAN ON-BOARD DIAGNOSTICS

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 57)

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

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

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

Monitor 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

Euro 5 OBD requirements:

UN Reg 83, Annex 11 requirements are applicable, in addition to following points: as outlined in 70/220EC; 715/2007EC and 692/2008EC:

EOBD Thresholds Euro 5 (mg/km)	Implementation Dates		CO		NMHC		NOx		PM	
	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 Euro 5
EGR system efficiency monitoring
EGR flow and cooler monitoring
Catalyst against NMHC
Catalyst against NOx (> Euro 5+)
NOx aftertreatment device with or without reagent efficiency monitoring
All O_2 Sensors to monitor cat (in addition to front sensor)
PM monitoring
IUPR (> Euro 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 Euro 6, on-board and off-board communication standard: ISO 15765-4 (CAN)

EUROPEAN ON-BOARD DIAGNOSTICS

EOBD Thresholds – Euro 6 (mg/km) for CI vehicles in advance of Euro 6	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

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

Proposed EOBD Thresholds Euro 6 (mg/km) (to be confirmed in Sep 10)	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		$1,2x10^{12}$

Additional requirement starting Euro 5+:
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 monitoring function has run and a malfunction could have been detected. $Denominator_M$ measures the number of vehicle driving events taking into account special conditions.

Euro 5+: IUPR ≥ 0,1 for all monitors
Euro 6- plus IUPR: IUPR ≥ 0,1 for all monitors
Euro 6: 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 - Exhaust gas sensors - Particulate filter - VVT system - Evap system
- EGR system - Secondary air system - NOx aftertreatment - Boost pressure control system

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Delphi offers a wide portfolio of transmission management technologies to help vehicle manufacturers around the world meet emissions requirements, improve performance and increase fuel economy. We have controllers, sensors and actuators. We can provide software and algorithms. We also offer a global network of resources and a flexible engineering approach. And, we complement our transmission management products with engine management technologies which enables us to provide manufacturers with complete powertrain management capabilities. Visit: **delphi.com/eb-trans**

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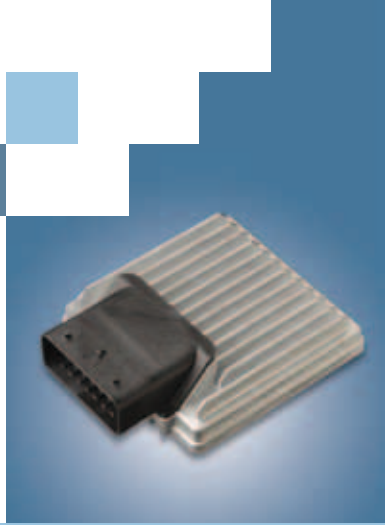

US ON-BOARD DIAGNOSTICS

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

Monitor area	Condition for malfunction
Catalyst, engine misfire, O_2 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 - ALL Vehicles (approved 09 Nov 07)

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 - ALL VEHICLES (approved 09 Nov 07)

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 (two-sided rationality): given other system performance parameters, the component signal is outside the expected operating envelope 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 additionally detect inability to control within the smallest engine speed range required by any other monitor in the OBD II system Executive Officer approval required to disable circuit continuity and circuit fault monitoring

US ON-BOARD DIAGNOSTICS

US CARB OBD II - 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 - SI GASOLINE VEHICLES

<table>
<tr><th>Monitor area</th><th>Condition for malfunction</th></tr>
<tr><td>Exhaust Gas Sensors (primary and secondary)</td><td>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>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>Catalyst</td><td>
<table>
<tr><td>MY</td><td colspan="3">LEV II, ULEV II, MDV SULEV II</td><td colspan="3">SULEV II</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>
</table>
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 - 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 (DOR)	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 - DIESEL VEHICLES (CCR TITLE 13, SECTION 1968.2)

Monitor area	Condition for malfunction
Reductant Injection System (Incl. SCR) Continuous monitoring required Selective Catalytic reduction	A) Reductant System Failure – Same Fault Criteria as NOx converting catalyst (see p 63) B) If reductant is NOT engine fuel, must additionally diagnose empty reductant tank C) Improper Reductant
Misfire: Monitoring during idle (systems w/o combustion pressure sensors). Continuous monitoring for all positive engine torque speed/loads (systems w. combustion pressure sensors)	'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 ON-BOARD DIAGNOSTICS

US CARB OBD II - DIESEL VEHICLES

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) Variable Geometry Turbocharger (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 OBD II - DIESEL VEHICLES

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
Variable Valve Train (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 - Frequent Regeneration - NMHC Conversion (2010-2013+ only)	2007-2009	Regen. Freq. Exceeds Manuf. Design Limit				2007-2009	Regen. Freq. exceeds Manuf. Design Limit			
	2010-2012	3.0 x	3.0 x	3.0 x	-	2010-2012	2.5 x	-	+0.3	-
	2013+	1.5 x	1.5 x	1.5 x	-	2013+	2.0 x	-	+0.3	-
Aftertreatment Assistance Function	2010 + loss function					2010 + loss function				

US ON-BOARD DIAGNOSTICS

US CARB OBD II - DIESEL VEHICLES

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							
Fuel Control System using Tolerance compensation features	2013+	Detect if compensation does not match				Detect if compensation does not match							
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

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Delphi is the first to develop an ammonia sensor for the automotive industry. It allows closed-loop control of the selective catalytic reduction process enabling higher conversion efficiency at lower overall system cost.

Delphi's new particulate matter sensor offers low cost, easy system integration. Our new differential pressure sensor is a cost-effective solution for diesel particulate trap monitoring.

Delphi's wide range O_2 sensors have a poison-resistant coating to help improve accuracy and durability in harsh environments. And our turbo pressure sensors offer affordability for high output diesel engines. Learn more about technology that makes good sense for you at: **delphi.com/eb-sensors**

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FUEL CONSUMPTION - CO_2 EMISSIONS

EUROPEAN UNION

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

Directive 80/1268/EEC shall be repeated with effect 02 Jan 13

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

FUEL CONSUMPTION - CO_2 EMISSIONS

EUROPEAN UNION - EU REGULATION ON CO_2 EMISSION REDUCTION FOR PASSENGER CAR

Regulation (EC) 443/2009

- Fleet 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 (called eco-innovations) are technologies not included in test cycle CO_2 measurement, nor included in complementary measures

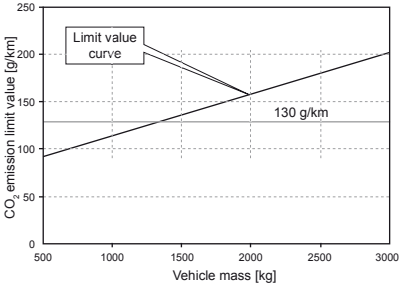
  Total contribution of eco-innovation limited to max 7 g CO_2/km in each manufacturer's average specific target
- 1 g CO_2/km is the minimum a single eco-innovation can contribute. Eco-innovations are approved as part of the vehicle TA procedure
- Excess emissions premium will be applied. The premium 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

Regulation 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 × (M – M_0)

Where: M = mass in kg

M_0 = 1372.0

a = 0.0457

FUEL CONSUMPTION - CO_2 EMISSIONS

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

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

Label requirements

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

5 cycle calculation is optional 2008-2010

MY 2011 and beyond:

- 5 cycle formulae based upon combination of FTP75, cold FTP (20F), 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

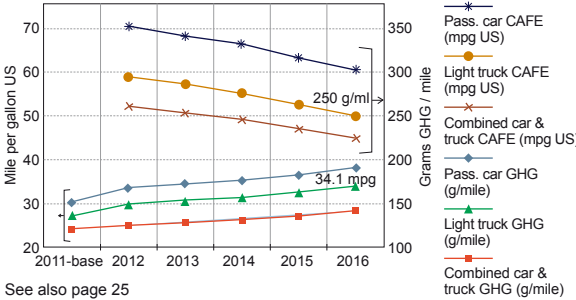
Unreformed Path

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

FUEL CONSUMPTION - CO_2 EMISSIONS

US - CAFE STANDARD (cont'd)
Renewable Fuels, Consumer Protection, Energy Independence & Security Act of 2007

EPA and NHTSA proposed new fuel economy and GHG regulations for vehicles on 15Sep09.



See also page 25

- Groups PC and Trucks < 8500 lbs into a single fleet
- Sets new fuel economy goals for combined PC and LDT fleet.

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 granted California's CAA waiver request.
- Several additional states are adopting 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 - CO_2 EMISSIONS

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	4.8t

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	14.4
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		

In June 2010, the Japanese governement started a study of further CO_2 requirements for 2020 and plans to announce a proposal in the second half of 2011.

FUEL CONSUMPTION - CO_2 EMISSIONS

PR OF CHINA

1) Fuel consumption standard for Passenger Cars
(GB 19578-2004) Applicable for M1 vehicles (GVW ≤ 3500 kg)
Implementation dates for:

new certific. veh.:	Phase 1: 01Jul05	Phase 2: 01Jan08
veh. in production:	Phase 1: 01Jul06	Phase 2: 01Jan09

FC Limit Table L/100km

Curb Mass (CM), kg	Phase 1	Phase 2
CM≤750	7.2 (7.6)	6.2 (6.6)
750<CM≤865	7.2 (7.6)	6.5 (6.9)
865<CM≤980	7.7 (8.2)	7.0 (7.4)
980<CM≤1090	8.3 (8.8)	7.5 (8.0)
1090<CM≤1205	8.9 (9.4)	8.1 (8.6)
1205<CM≤1320	9.5 (10.1)	8.6 (9.1)
1320<CM≤1430	10.1 (10.7)	9.2 (9.8)
1430<CM≤1540	10.7 (11.3)	9.7 (10.3)
1540<CM≤1660	11.3 (12.0)	10.2 (10.8)
1660<CM≤1770	11.9 (12.6)	10.7 (11.3)
1770<CM≤1880	12.4 (13.1)	11.1 (11.8)
1880<CM≤2000	12.8 (13.6)	11.5 (12.2)
2000<CM≤2110	13.2 (14.0)	11.9 (12.6)
2110<CM≤2280	13.7 (14.5)	12.3 (13.0)
2280<CM≤2510	14.6 (15.5)	13.1 (13.9)
2510<CM	15.5 (16.4)	13.9 (14.7)

( ) Applicable for automatic transmission (AT), ≥ 3 rows of seats or category G (M1) off-road vehicles

2) Fuel consumption standard for Light Duty Commercial Vehicles (GB 20997-2007)
Applicable for N1 and M2 vehicles (GVW ≤ 3500 kg)
Implementation dates from:
01Feb08 Phase 2 for new certific. veh.
01Jan09 Phase 1 for in-prod veh. (certif. before 01Feb08)
01Jan11 Phase 2 for all veh.

FC Limit Table 3 for cat N1 gasoline veh. L/100km

Gross Vehicle Mass (M) kg	Engine Displacem. (V), L	Phase 1	Phase 2
M≤2000	All	8.0	7.8
2000<M≤2500	V≤1.5	9.0	8.1
	1.5<V≤2.0	10.0	9.0
	2.0<V≤2.5	11.5	10.4
	V>2.5	13.5	12.5
2500<M≤3000	V≤2.0	10.0	9.0
	2.0<V≤2.5	12.0	10.8
	V>2.5	14.0	12.6
M>3000	V≤2.5	12.5	11.3
	2.5<V≤3.0	14.0	12.6
	V>3.0	15.5	14.0

FC Limit Table 4 for cat N1 diesel veh. L/100km

Gross Vehicle Mass (M) kg	Engine Displacem. (V), L	Phase 1	Phase 2
M≤2000	All	7.6	7.0
2000<M≤2500	V≤2.5	8.4	8.0
	2.5<V≤3.0	9.0	8.5
	V>3.0	10.0	9.5
2500<M≤3000	V≤2.5	9.5	9.0
	2.5<V≤3.0	10.0	9.5
	V>3.0	11.0	10.5
M>3000	V≤2.5	10.5	10.0
	2.5<V≤3.0	11.0	10.5
	3.0<V≤4.0	11.6	11.0
	V>4.0	12.0	11.5

FC Limit Table 5 for cat M2 gasoline veh. (GVW ≤ 3500 kg) L/100km

Gross Vehicle Mass (M) kg	Engine Displacem. (V), L	Phase 1	Phase 2
M≤3000	V≤2.0	10.7	9.7
	2.0<V≤2.5	12.2	11.0
	2.5<V≤3.0	13.5	12.2
	V>3.0	14.5	13.1
M>3000	V≤2.5	12.5	11.3
	2.5<V≤3.0	14.0	12.6
	V>3.0	15.5	14.0

FUEL CONSUMPTION - CO_2 EMISSIONS

FC Limit Table 6 for cat. M2 diesel veh.
(GVW ≤ 3500 kg) L/100km

Gross Vehicle Mass (M) kg	Engine Displacem. (V), L	Phase 1	Phase 2
M≤3000	V≤2.5	9.4	8.5
	V>2.5	10.5	9.5
M>3000	V≤3.0	11.5	10.5
	V>3.0	12.5	11.5

SOUTH KOREA
From 2010, for gasoline & diesel engines ≤ 1.600 cc: 12.4 km/l
> 1.600 cc: 9.6 km/l
From 2012: ≥ 17 km/l and ≤ 140 G GHG/km fleet average
Introduction 30% in 2012; 60% in 2013; 80% in 2014;100% in 2015

TAIWAN
Fuel economy standards for PC, LDT ≤ 2.5 t

Class of Vehicle (kg)	Under FTP 75 (km/l)	Under EU Dir 199/100 (km/l)
< 1200	16.2	14.1
1200 to 1800	13.0	11.3
1800 to 2400	11.4	9.9
2400 to 3000	10.0	8.7
3000 to 3600	9.2	8.0
3600 to 4200	8.5	7.4
4200 to 5400	7.2	6.3
> 5400	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 Transport Forum), FIA Foundation. Call for cars worldwide to be made 50% more fuel efficient by 2050, along with interim targets

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

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DELPHI

Innovation for the Real World

EU MARKET FUELS

UNLEADED GASOLINE FUEL

EN 228 standard harmonised with 98/70/EC (2003/17/EC) + (2009/30/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
Oxidation 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	-	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

Directive 98/70 amendment adopted by EU Parliament on 17 Dec 08:

- 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

EU MARKET FUELS

DIESEL FUEL

Parameter	Unit	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	< 10
FAME [1)]	% (v/v)	< 7

[1)] FAME (Fatty Acid Methyl Esters) must be in accordance with EN 14214

Directive 98/70 amendment adopted by EU Parliament on 17 Dec 08:

- Max FAME: 7%
- Countries with 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 required.

EU REFERENCE TEST FUELS

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

UNLEADED GASOLINE 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 10-11

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
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

DIESEL 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

EU REFERENCE TEST FUELS

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

UNLEADED GASOLINE 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

DIESEL 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

US REFERENCE TEST FUELS

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

UNLEADED GASOLINE 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.

US REFERENCE TEST FUELS

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 / EU TEST PROCEDURES

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

Co-decision Regulation EC715/2007. Comitology Regulation EC692/2008 Annex VI. UN/ECE Regulation No. 83 Annex 7

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 / CALIFORNIA REQUIREMENTS

TEMP.	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.	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 LEV III standards and test procedures to include plug-in hybrids

Proposed LEV III Evap Standards:

- Lower whole vehicle diurnal + hot soak zero evaporative standards (g/test) for all vehicles < 14K GVWR
- Extend current zero evap technology to all vehicle categories
- Same standards for both 3 days + hot soak and 2 days + hot soak
- Eliminate the "rig" test
- Change the cert fuel to E10

ON-BOARD REFUELLING VAPOUR RECOVERY

- 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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EUROPEAN UNION

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

EUROPEAN UNION

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: 01Apr04	I (< 150cc)	5.50	1.20	0.30
Euro 2	FR: 01Jul05	II (≥ 150cc)	5.50	1.00	0.30
B (2006) Euro 3	TA: 01Jan06 FR: 01Jan07	I (< 150cc) UDC cold [1]	2.00	0.80	0.15
		II (≥ 150cc) UDC+EUDC cold [2]	2.00	0.30	0.15
C (2006) GTR 2 [3]	Alternative TA: 01Jul07	V max < 130 km/h	2.62	0.75	0.17
Euro 4	TBD	V max < 130 km/h	1.97	0.25	0.17
Limit values for tri- and quadricycles for TA and COP					
A (2003)	TA: 01Jan03		7.00	1.50	0.40
Euro 2	FR: 01Jul04		2.00	1.00	0.65
Proposal	TBD			1.00	0.25
			1.00	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

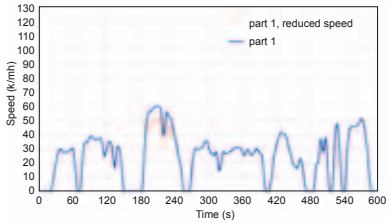
Proposal for new regulation for mopeds, motorcycles, tri- and quadricycles:
Intended 1st application 01Jan13

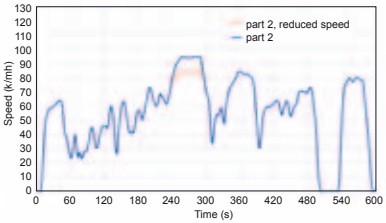
- Referencing of UN-ECE regulations should be used
- Stepped introduction of new emissions limits for motorcycles, Euro 4 in 2012,Euro 5 in 2017, Euro 6 in 2020
- Single emissions test cycle (WMTC) applicable for all L-category vehicles
- Anti tampering measures introduced
- Mandatory introduction of OBD Stage I
- Evaporative emissions requirements defined
- Measurement of CO_2 emissions
- Revised test procedure for mopeds, Euro 3 in 2012 and Euro 4 in 2015
- Durability requirements
- Additional legislation for 4-wheel mini-cars, off-road quads, hydrogen-powered motorcycles, tri- and quadricycles
- Hybrid motorcycle provisions should be considered as well
- Off-road quads are excluded from this regulation

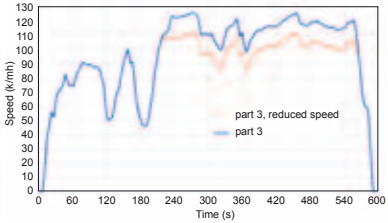
[1] Test cycle = ECE R40 (with emissions measured for all 6 modes – sampling starts at T=0)
[2] Test cycle = ECE R40 + EUDC (emissions measured for all modes – sampling starts at T=0) with a max speed of 120 km/h
[3] UN/ECE GTR2 is an alternative TA procedure for Euro 3 stage (Directive 2002/51/EC),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

WORLDWIDE REQUIREMENTS

PROPOSED WMTC DRIVING CYCLE







CLASS 1

Engine capacity ≤ 50 cm^3 and 50 km/h < v_{max} ≤ 60 km/h	subclass 1-1
50 cm^3 < engine capacity < 150 cm^3 and v_{max} < 50 km/h	subclass 1-2
Engine capacity < 150 cm^3 and 50 km/h ≤ v_{max} 100 km/h but not including subclass 1-1	subclass 1-3

CLASS 2

Engine capacity < 150 cm^3 and 100 km/h ≤ v_{max} < 115 km/h or Engine capacity ≥ 150 cm^3 and v_{max} < 115 km/h	subclass 2-1
115 km/h ≤ v_{max} < 130 km/h	subclass 2-2

CLASS 3

130 km/h ≤ v_{max} < 140 km/h	subclass 3-1
v_{max} ≥140 km/h	subclass 3-2

US FEDERAL / CALIFORNIA

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 2 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.

OTHER AREAS OF THE WORLD

Country: Brazil

Requirements

Mopeds: Vehicle with 2 wheels or similar equipped with 3 or 4 wheels. Engine capacity < 50 cc and top speed < 50 km/h

Motorcycles: Vehicle with 2 wheels or similar equipped with 3 or 4 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”

OTHER AREAS OF THE WORLD

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 Gasoline 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

OTHER AREAS OF THE WORLD

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

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)
DF	Deterioration Factor
DI	Direct Injection
EOBD	European Union On-board Diagnostic
EUDC	Extra Urban Driving Cycle
Evap	Evaporative Emissions
FAME	Fatty Acid Methyl Esters
FC	Fuel Consumption (EU)
FE	Fuel Economy (US)
FR	First Registration, entry into service
FTP	Federal Test Procedure
GHG	Greenhouse Gas
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating
IDI	Indirect Diesel Injection
IUPR	In-Use Performance Ratio
LBS	Pounds (1 lb = 454 g)
LDT	Light Duty Trucks
LLDT	Light Light Duty Trucks
LVW	Loaded Vehicle Weight
MDPV	Medium Duty Passenger Vehicle
MIL	Malfunction Indication Lamp
MTBE	Methyl Tertiary Butyl Ether
NHV	Net Heating Value of Fuel (US)
NMHC	Non-Methane Hydrocarbons
NMOG	Non-Methane Organic Gases
NYCC	New York City Cycle
OBD	On-board Diagnostic
ORVR	On-board Refuelling Vapour Recovery
PM	Particulate Matter
RAFs	Reactivity Adjustment Factors
RM	Reference Mass
SEA	Selective Enforcement Audit
SG	Specific Gravity of Fuel (US)
SI	Spark Ignition
SHED	Sealed House for Evaporation Determination
TA	Type Approval
UDDS	Urban Dynamometer Driving Schedule
VT SHED	Variable Temperature SHED
WC	Working Cycle

EXPLANATION OF ABBREVIATIONS

PAGE 32	LEV, TLEV, ULEV, SULEV, ZEV
PAGE 34	NEV, PZEV, AT-PZEV, CEV, FFEV, HEV

ADMINISTRATIONS & ASSOCIATIONS

ACEA	European Car Manufacturer Association
CARB	California Air Resources Board
ECE	Economic Commission for Europe
EPA	US Environmental Protection Agency
EU	European Union
MVEG	Motor Vehicle Emissions Group, advisory expert committee to the EU commission

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