
AECC, CLEPA, EUROMOT and OICA proposal

Recommendation concerning Guidelines for Market Fuel Quality

in R.E.3 and/or S.R.1

Justification

The objective of this document is to provide recommendations for the **minimum quality of market fuels** (i.e. gasoline and diesel) **that should be introduced in parallel, and at the same time, to complement the level of motor vehicle and non-road mobile machinery pollutant emission standards that a country or region may be considering to introduce.**

For the purpose of these recommendations, the motor vehicle and non-road mobile machinery pollutant emissions standards are those identified in the various series of UNECE Regulation No 83, UNECE Regulation No 49 and UNECE Regulation No 96⁽¹⁾ that might be considered by countries or regions introducing for the first time, or strengthening, motor vehicle emission standards.

Scope of the recommendation

This Recommendation applies to fuel quality parameters that directly affect the performance and durability of engine and exhaust emission control equipment and influence the content of exhaust emissions.

Definitions and Abbreviations

AQIRP	Air Quality Improvement Research Program
CEN	European Committee for Standardization
DPF	Diesel Particulate Filter
HC	Hydrocarbons
JCAP	Japan Clean Air Programme
OBD	On-board diagnostics
PM	Particulate matter
TEL	Tetra Ethyl Lead

⁽¹⁾ See Annex C for the correlation between the series of Regulation No 83, Regulation No 49 and Regulation No 96 and the respective European emission standards.

Introduction

It is acknowledged that market fuel quality plays a key role in the level and type of pollutant emissions from motor vehicles. Regulations and specifications for market fuel quality are not yet well harmonized (even in the same region) and they are not always fully aligned with the needs of engine technology to help meet pollutant emission regulations in force. As many world regions and cities suffer from poor air quality and move towards more stringent motor vehicle emission regulations, this requires the use of more advanced emission control technology on engines - which drives the crucial need for improved market fuel quality.

This recommendation defines a list of key fuel parameters linked to legally required emissions levels and suggests the minimum fuel quality requirements corresponding to vehicle technologies necessary to help achieve and maintain such emission levels. It has to be recognised that other parameters can influence tailpipe pollutant emissions and thus adherence to this list may not be sufficient to enable durable compliance to the relevant emissions standards for all vehicle concepts.

The list of parameters has been herewith linked to emission limits set in the various series of UNECE Regulations No 83 and No 49 up to the versions of R83.05 (row B) and R49.03 (row B1) and UNECE Regulation No 96 up to the version R96.02. An extension to cover more recent and more stringent emission limits may be needed in due time in order to keep this recommendation updated to technical progress.

Considering that the annex to the Consolidated Resolution on the Construction of Vehicles (R.E.3)⁽²⁾ set, as a first step, limited recommendations concerning lead and sulphur in gasoline and sulphur, ash and total contamination in diesel, a fuller set of fuel parameters should now be included that impact:

- a) On the performance and durability of engines and emission control equipment and,
- b) Parameters that have an impact on human health and the environment.

The position of OICA, EUROMOT, CLEPA and AECC is, in general, that a recommendation to WP29 to definitively link emissions standards and necessary fuel quality should be based on the World Wide Fuel Charter (WWFC) which, in the 5th version being completed now, sets 5 categories of petrol and 5 categories of diesel fuel characteristics that are appropriate for various emission control technology mixes.

However, international fuel standards (e.g. CEN) have been developed from the emission technology-fuel specifications that have been driven by European legislation. These CEN standards, developed on a technical basis between the various stakeholders in CEN, provide for European market fuels that are, essentially, fit for purpose.

The parallel application of appropriate market fuel standards must be an important part of an integrated approach by Contracting Parties to enable improved and long-lasting emission reductions during the lifetime of all motor vehicles.

For information:

⁽²⁾ ECE-TRANS-WP29-2011-127e.pdf

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- Annex A shows the historical development of on-road and non-road emission standards and fuel quality (based on CEN standards).
 - Annex B details the fuel parameters that have been changed in alignment with the progression of the UNECE emission standards that require the use of more advanced exhaust after-treatment control technology that are affected by market fuel quality.
 - Annex C shows the correlation between the series of UNECE Regulation No 83, UNECE Regulation No 49 and UNECE Regulation No 96 and the parallel Euro standards.
 - Annex D gives details of gasoline parameters – extract of the latest draft of the 5th edition of the World Wide Fuel Charter (published September 2013).
 - Annex E gives details of diesel parameters - extract of the latest draft of the 5th edition of the World Wide Fuel Charter (published September 2013).
 - Annex F gives details of recommended housekeeping for fuel management.

Recommendation

The clearly demonstrated link between emission standards and market fuel quality – which the European Union, Japan and the USA have all followed - should followed in those world areas that are now introducing for the first time, or adopting more stringent emission standards, for on-road motor vehicles and non-road mobile machinery.

The short-list of parameters outlined in annex to the Consolidated Resolution on the Construction of Vehicles (RE3) and in SR1 is insufficient for this purpose and for ensuring in-service performance and durability of emission control systems. Therefore, OICA proposes that the list of fuel parameters be extended.

In this respect, OICA, EUROMOT, CLEPA and AECC propose that the parameters shown in the following tables (gasoline and diesel for on-road engines and diesel for non-road mobile machinery) be included in RE3 and SR1.

Fuel Quality Recommendations – on road vehicles:

Unleaded Gasoline:	R83.03	R83.05 (row A)	R83.05 (row B)	Test method
Lead [g/l] ⁽¹⁾	No intentional addition, with a max $\leq 0,013^{(1)}$	No intentional addition, with a max $\leq 0,005^{(1)}$	No intentional addition, with a max $\leq 0,005^{(1)}$	EN 237
Sulphur [mg/kg] ⁽¹⁾	$\leq 500^{(1)}$	$\leq 150^{(1)}$	$\leq 50^{(1)}$	EN ISO 20846 EN ISO 20884
Metal Additives [mg/l]	----- Not permitted -----			
Oxygen [%m/m]	[$\leq 2,7$]	$\leq 2,7$	$\leq 2,7$	EN 1601 EN 13132
Oxygenates [%v/v]				EN 1601 EN 13132
- methanol	$\leq 3,0^{(2)}$	$\leq 3,0^{(2)}$	$\leq 3,0^{(2)}$	
- ethanol	$\leq 5,0$	$\leq 5,0$	$\leq 5,0$	
- iso-propyl alcohol	$\leq 10,0$	$\leq 10,0$	$\leq 10,0$	
- iso-butyl alcohol	$\leq 10,0$	$\leq 10,0$	$\leq 10,0$	
- tert-butyl alcohol	$\leq 7,0$	$\leq 7,0$	$\leq 7,0$	
- ethers	$\leq 15,0$	$\leq 15,0$	$\leq 15,0$	
- other oxygenates	$\leq 10,0$	$\leq 10,0$	$\leq 10,0$	
RVP [kPa]	35 - 100	45 – 100	45 – 100	EN 13016/ DVPE
Density [kg/m ³]	725 – 780	720 – 775	720 – 775	EN ISO 3675 EN ISO 12185
RON	[≥ 95]	[≥ 95]	[≥ 95]	EN ISO 5164
MON	[≥ 85]	[≥ 85]	[≥ 85]	EN ISO 5163
Benzene [%v/v]	≤ 5	≤ 1	≤ 1	EN 238 EN 14517
Aromatics [%v/v]	-	≤ 42	≤ 35	EN 14517 EN15553
Olefins [%v/v]	-	≤ 21 & 18	≤ 18	EN 14517 EN15553
VLI (10VP + E70)	-	1050 – 1250	1050 - 1250	
Residue [%v/v]	< 2	<2	<2	EN ISO 3405

⁽¹⁾ Already agreed in annex to the Consolidated Resolution on the Construction of Vehicles (RE3). Industry recommends maximum 50ppm sulphur.

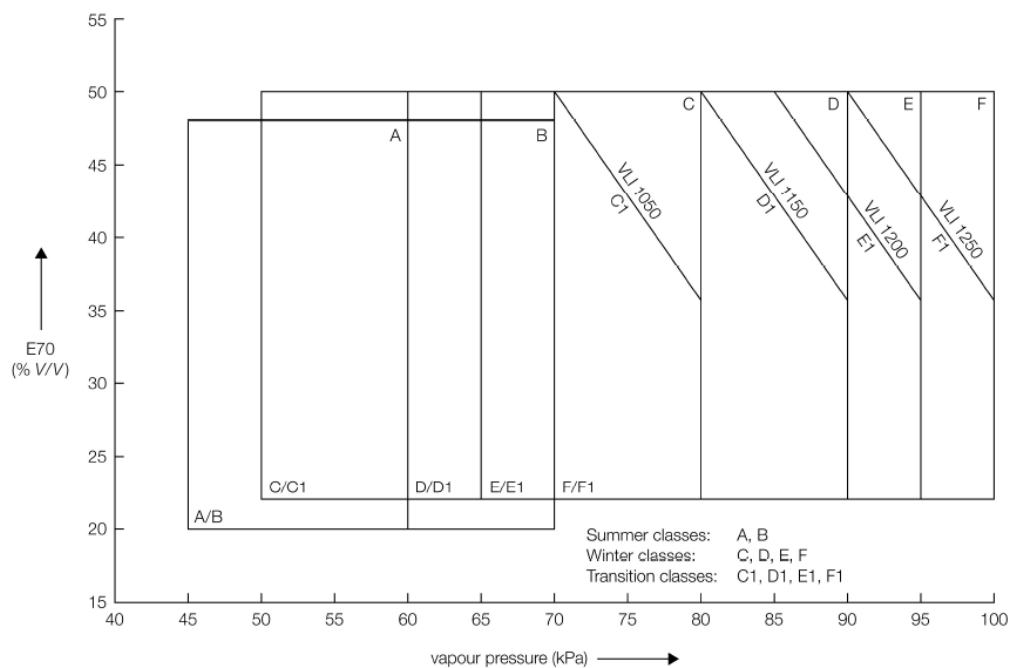
⁽²⁾ Industry recommends no methanol content (non-detectable).

Volatility Classes for Unleaded Gasoline:

Class (*)	A	B	C/C1	D/D1	E/E1	F/F1
Vapour pressure (kPa)	45 – 60	45 - 70	50 - 80	60 - 90	65 - 95	70 - 100
E70 (%) ⁽¹⁾	20 - 48	20 - 48	22 - 50	22 - 50	22 – 50	22 – 50
E100 (%) ⁽¹⁾	46 - 71	46 - 71	46 - 71	46 - 71	46 - 71	46 - 71
E150 (% min) ⁽¹⁾	75	75	75	75	75	75
Final boiling point (°C max) ⁽¹⁾	210	210	210	210	210	210
T10 (°C, max) ⁽¹⁾	65	60	55	50	45	45
T50 (°C, max) ⁽¹⁾	77-100	77-100	75-100	70-100	65-100	65-100
T90 (°C, max) ⁽¹⁾	130-175	130-175	130-175	130-175	130-175	130-175
Distillation residue (% V/V)	2	2	2	2	2	2
Vapour Lock Index (VLI) (10 VP + 7 E70) (index max)	-	-	C	D	E	F
Vapour Lock Index (VLI) (10 VP + 7 E70) (index max)			C1 1050	D1 1150	E1 1200	F1 1250

(*) 'Class' is based on the minimum expected ambient temperature of the market and will vary by season.

(1) E-values or T-values as alternatives.



Relation between VP, E70 and VLI for the ten different volatility classes for unleaded gasoline

Diesel – on-road vehicles:

	R83.03 and R49.02 (Stage II)	R83.05 (row A) and R49.03 (row A)	R83.05 (row B) and R49.03 (row B)	Test method
Sulphur [mg/kg] ⁽¹⁾	≤ 500 ⁽¹⁾	≤ 350 ⁽¹⁾	≤ 50 ⁽¹⁾	EN ISO 20846 EN ISO 20884
Ash [%m/m] ⁽¹⁾	≤ 0,01 ⁽¹⁾	≤ 0,01 ⁽¹⁾	≤ 0,01 ⁽¹⁾	EN/ISO 6245
Total Contamination [mg/kg] ⁽¹⁾	≤ 24 ⁽¹⁾	≤ 24 ⁽¹⁾	≤ 24 ⁽¹⁾	EN 12662
Cetane Number ⁽²⁾	[≥ 49]	[≥ 51]	[≥ 51]	EN ISO 5165
Cetane Index ⁽²⁾	[≥ 46]	[≥ 46]	[≥ 46]	EN ISO 4264
Density [kg/m ³] ⁽²⁾	820 – 860	820 – 845	820 – 845	EN ISO 3675 EN ISO 12185
Viscosity [mm ² /s] ⁽²⁾	2,0 - 4,5	2,0 - 4,5	2,0 – 4,5	EN ISO 3104
Flash Point [°C]	> 55	> 55	> 55	EN ISO 2719
T50 [°C]	-	T65 = 250 min	T65 = 250 min	EN ISO 3405
T85 [°C]	≤ 350	≤ 350	≤ 350	EN ISO 3405
T95 [°C]	≤ 370	≤ 360	≤ 360	EN ISO 3405
PAH [%m/m]	≤ 11	≤ 11	≤ 11	EN 12916
Carbon residue [%m/m]	≤ 0,3	≤ 0,3	≤ 0,3	EN ISO 10370
CFPP [°C] ⁽²⁾	-44 to +5	-44 to +5	-44 to +5	EN 116
Cloud Point [°C] (severe winter conditions) ⁽²⁾	-34 to -10	-34 to -10	-34 to -10	EN 23015
Copper strip corrosion (3h at 50°C) [rating]	Class 1			EN ISO 2160
Water [mg/kg]	≤ 200	≤ 200	≤ 200	EN ISO 12937
Lubricity [micron]	≤ 460	≤ 460	≤ 460	EN ISO 12156- 1
Oxidation stability [hours] ⁽³⁾	> 20	> 20	> 20	EN15751
FAME [%v/v]	(4)	(4)	(4)	EN14214 ASTM D6751
Appearance	Clear and bright, no free water or particulates			D4176 visual inspection
Ethanol/Methanol [%v/v]	Non-detectable ⁽⁵⁾			

(1) Already agreed in annex to the Consolidated Resolution on the Construction of Vehicles (RE3). Industry recommends maximum 50ppm sulphur.

(2) Implementing country to choose value appropriate within range for arctic or severe winter conditions. More detailed arctic or severe winter specifications for these parameters to be considered.

(3) Applicable for diesel containing more than 2%v/v FAME.

(4) Up to 5%v/v FAME permitted if FAME complies with ASTM D6751. Up to 7%v/v FAME permitted if FAME complies with EN14214. Industry recommends that vehicle owners refer to their vehicle handbook.

(5) At or below detection limit of method used.

Diesel – non-road mobile machinery:

	R96 Power bands A to C	R96.01 Power bands D to G	R96.02 Power bands H to K	Test method
Sulphur [mg/kg] ⁽¹⁾	≤ 2000 ⁽¹⁾	≤ 2000 ⁽¹⁾	≤ 300 ⁽¹⁾	ASTM D5453
Ash [%m/m] ⁽¹⁾	≤ 0,01 ⁽¹⁾	≤ 0,01 ⁽¹⁾	≤ 0,01 ⁽¹⁾	EN/ISO 6245
Total Contamination [mg/kg] ⁽¹⁾	≤ 24 ⁽¹⁾	≤ 24 ⁽¹⁾	≤ 24 ⁽¹⁾	EN 12662
Cetane Number ⁽²⁾	[≥ 45]	[≥ 45]	[≥ 52]	EN ISO 5165
Density [kg/m ³] ⁽²⁾	835 – 845	835 – 845	833 – 837	EN ISO 3675 ASTM D4052
Viscosity [mm ² /s] ⁽²⁾	2,0 - 4,5	2,0 - 4,5	2,0 – 4,5	EN ISO 3104
Flash Point [°C]	> 55	> 55	> 55	EN ISO 2719
T50 [°C]	-	-	> 250	EN ISO 3405
T95 [°C]	≤ 370	≤ 370	345-350	EN ISO 3405
Final boiling point [°C]	-	-	≤ 370	EN ISO 3405
PAH [%m/m]	≤ 11	≤ 11	≤ 11	EN 12916
Carbon residue [%m/m]	≤ 0,3	≤ 0,3	≤ 0,3	EN ISO 10370
CFPP [°C] ⁽²⁾	-44 to +5	-44 to +5	-44 to +5	EN 116
Cloud Point [°C] (severe winter conditions) ⁽²⁾	-34 to -10	-34 to -10	-34 to -10	EN 23015
Copper strip corrosion (3h at 50°C) [rating]	Class 1			EN ISO 2160
Water [mg/kg]	≤ 500	≤ 500	≤ 500	EN ISO 12937
Lubricity [micron]	≤ 460	≤ 460	≤ 460	EN ISO 12156-1
Oxidation stability [hours] ⁽³⁾	> 20	> 20	> 20	EN15751
FAME [%v/v]	(4)	(4)	(4)	EN14214 ASTM D6751
Appearance	Clear and bright, no free water or particulates			D4176 visual inspection
Ethanol/Methanol [%v/v]	Non-detectable ⁽⁵⁾			

(1) Already agreed in annex to the Consolidated Resolution on the Construction of Vehicles (RE3) for on-road engines only. Industry recommends maximum 50ppm sulphur.

(2) Implementing country to choose value appropriate within range for arctic or severe winter conditions. More detailed arctic or severe winter specifications for these parameters to be considered.

(3) Applicable for diesel containing more than 2%v/v FAME.

(4) Up to 5%v/v FAME permitted if FAME complies with ASTM D6751. Up to 7%v/v FAME permitted if FAME complies with EN14214. Industry recommends that vehicle owners refer to their vehicle handbook.

(5) At or below detection limit of method used.

ANNEX A - Evolution of the UNECE emission standards:

Emission standards have been linked with a revision of the respective European market fuel standards (EN228 and EN590):

On-road standards:

UNECE Emission Levels	Gasoline				Diesel				Date of application	
	CO (g/km)	HC+NOx (HC/NOx) (g/km)		PM (g/km)	Fuel standard	CO (g/km)	HC+NOx (HC/NOx) (g/km)	PM (g/km)		Fuel standard
R83.03	2.2	0.5		-	EN228: 1993	1.0	0.7	0.08	EN590: 1993	1996
R83.05 (level A)	2.3	0.2	0.15	-	EN228: 1999	0.64	0.50	0.05	EN590: 2000	2000
R83.05 (level B)	1.0	0.1	0.08	-	EN228: 2004	0.5	0.30	0.025	EN590: 2004	2005
R83.06	1.0	0.1	0.60	0.0045	EN228: 2008	0.5	0.23	0.0045	EN590: 2008	2009

UNECE Emission Levels	Diesel						Date of application
	CO (g/kWh)	NMHC (g/kWh)	THC (g/kWh)	NOx (g/kWh)	PM (g/kWh)	Fuel standard	
R49.02 (level B) ⁽¹⁾	4.0	-	1.1	7.0	0.15	EN590: 1993	1995
R49.03 (level A) ⁽²⁾	5.45	0.78	1.6	5.0	0.03	EN590: 2000	2000
R49.03 (level B1) ⁽²⁾	4.0	0.55	1.1	3.5	0.03	EN590: 2004	2005
R49.03 (level B2) ⁽²⁾	4.0	0.55	1.1	2.0	0.02	EN590: 2008	2008

⁽¹⁾ Limits shown for the 13-mode test.

⁽²⁾ Limits shown for the ETC test only.

Non-road standards:

UNECE Emission Levels	Power band	Net power (P) (kW)	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	PM (g/kWh)	Date of application
R96	A	$P \geq 130$	5	1,3	9,2	0,54	1995
	B	$75 \leq P < 130$	5	1,3	9,2	0,7	
	C	$37 \leq P < 75$	6,5	1,3	9,2	0,85	
R96.01	E	$130 \leq P \leq 560$	3,5	1,0	6,0	0,2	2001
	F	$75 \leq P < 130$	5,0	1,0	6,0	0,3	
	G	$37 \leq P < 75$	5,0	1,3	7,0	0,4	
	D	$18 \leq P < 37$	5,5	1,5	8,0	0,8	

UNECE Emission Levels	Power band	Net power (P) (kW)	CO (g/kWh)	HC + NOx (g/kWh)	PM (g/kWh)	Date of application
R96.02	H	$130 \leq P \leq 560$	3,5	4,0	0,2	2008
	I	$75 \leq P < 130$	5,0	4,0	0,3	
	J	$37 \leq P < 75$	5,0	4,7	0,4	
	K	$19 \leq P < 37$	5,5	7,5	0,6	

ANNEX B

Evolution of stringency of gasoline market fuel quality standards:

On-road standards:

Gasoline	R83.03	R83.05 (row A)	R83.05 (row B)
RON	95	95	95
MON	85	85	85
Lead	0,013	0,005	0,005
Sulphur	500	150	50 [10]
Benzene	5	1	1
Aromatics	-	42	35
Olefins	-	21 & 18	18
Oxygen	-	2,7	2,7
RVP	35 - 100	45 - 100	45 - 100
VLI	-	1050 - 1250	1050 - 1250
Density	725 - 780	720 - 775	720 - 775
FBP	215	210	210
E70	15 - 47	20 - 50	20 - 50
E100	40 - 70	46 - 71	46 - 71
E180	85	-	-
Residue	2	2	2

Evolution of stringency of diesel market fuel quality standards:

On-road standards:

Diesel	R83.03 R49.03	R83.05 (level A) R49.05 (level A)	R83.05 (level B) R49.05 (level B1)
Cetane Number	49	51	51
Cetane Index	46	46	46
Sulphur	500	350	50 & 10
Density	820 - 860	820 - 845	820 - 845
Viscosity	2,0 - 4,5	2,0 - 4,5	2,0 – 4,5
T50	Report	T65 = 250 min	T65 = 250 min
T85	350 max	350 max	350 max
T95	360 max	360 max	360 max
PAH	11	11	11
Flash Point	55	55	55
CCR	0,3	0,3	0,3
CFPP	[-44] to +5	[-44] to +5	[-44] to +5
Cloud Point	-34 to -10	-34 to -10	-34 to -10
Water and sediment	-	0,0024	0,0024
Water	0,02	0,02	0,02
Ash	0,01	0,01	0,01
Lubricity	-	460	460

ANNEX C

On-road:

Correlation between the series of Regulation 83 and Regulation 49 and Euro emission standards.

UNECE Regulation 49	Euro standard
R49.02 level B	Euro II
R49.03 level A	Euro III
R49.03 level B1	Euro IV

UNECE Regulation 83	Euro standard
R83.03	Euro 2
R83.05 level A	Euro 3
R83.05 level B	Euro 4

Non-road:

Correlation between the series of Regulation 96 and Euro emission standards.

UNECE Regulation 96	NRMM Directive 97/68/EC
R96	Stage I
R96.01	Stage II
R96.02	Stage IIIA
