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Item 12 of the provisional agenda

Fuel Quality (FQ)**Proposal for amendments to the Consolidated Resolution on the Construction of Vehicles (R.E.3)****Submitted by the experts from the Association for Emissions Control by Catalyst, the European Association of Automotive Suppliers, the European Association of Internal Combustion Engine Manufacturers and the International Organization of Motor Vehicle Manufacturers***

The purpose of this proposal, tabled by the experts from the Association for Emissions Control by Catalyst (AECC), the European Association of Automotive Suppliers (CLEPA), the European Association of Internal Combustion Engine Manufacturers (EUROMOT) and the International Organization of Motor Vehicle Manufacturers (OICA), is to propose amendments to the recommendation on market fuel quality, contained in the Consolidated Resolution on the Construction of Vehicles (R.E.3).

* In accordance with the programme of work of the Inland Transport Committee for 2012–2016 (ECE/TRANS/224, para. 94 and ECE/TRANS/2012/12, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.

I. Proposal

Annex 4, delete and replace by:

"Annex 4

Recommendation on market fuel quality

1. Purpose of the recommendation

This recommendation has been developed to inform governments about the appropriate market fuel quality that is protective of vehicle emission control technologies. The regulated vehicle emissions limits and associated market fuel qualities should be consistent with local air quality expectations.

2. Scope of the recommendation

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

3. Abbreviations

AQIRP	Air Quality Improvement Research Programme
CEN	European Committee for Standardization
CCR	Conradson Carbon Residue (indication of fuel tendency to form carbon deposits)
CFPP	Cold Filter Plugging Point (measure for lowest temperature at which a fuel will give trouble-free flow)
FAME	Fatty Acid Methyl Esters
FBP	Final Boiling Point
DPF	Diesel Particulate Filter
HC	Hydrocarbons
JCAP	Japan Clean Air Programme
OBD	On-board diagnostics
MON	Motor Octane Number
PAH	Polycyclic Aromatic Hydrocarbons
PM	Particulate matter
RON	Research Octane Number
RVP	Reid Vapour Pressure
TEL	Tetra Ethyl Lead
VLI	Vapour Lock Index

In this annex and its appendixes, for simplifying the format of the tables, the UN Regulations and their series of amendments are noted in a short form as follow: the *YY* series of amendments to UN Regulation No. *XX* is noted "*RXX.YY*".

4. 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

within a given 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 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 UN Regulations Nos. 83 and 49 up to R83.05 (row B) and R49.03 (row B1) and UN Regulation No. 96 up to R96.02. An extension to cover more recent and more stringent emission limits may be needed in due time to keep this recommendation updated to technical progress.

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.

5. Appendix content

Appendix 1 shows the historical development of on-road and non-road emission standards and fuel quality (based on CEN standards).

Appendix 2 details the fuel parameters aligned with the progression of the UN emission standards that require the use of more advanced exhaust after-treatment control technology that are affected by market fuel quality.

Appendix 3 shows the correlation between the series of UN Regulations Nos. 83, 49 and 96 and the parallel Euro standards.

Appendix 4 indicates a guideline document on good practice for fuel housekeeping.

6. Market fuel quality

The clearly demonstrated link between emission standards and market fuel quality – which the European Union, Japan and the United States of America have all followed - should be 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 (NRMM).

6.1. Gasoline – on road vehicles

<i>Unleaded Gasoline</i>	<i>R83.03</i>	<i>R83.05 (row A)</i>	<i>R83.05 (row B)</i>	<i>Test method</i>
Lead [g/l]	No intentional addition, with a max ≤ 0.013	No intentional addition, with a max ≤ 0.005	No intentional addition, with a max ≤ 0.005	EN 237
Sulphur [mg/kg]	≤ 500	≤ 150	≤ 50 ¹	EN ISO 20846 EN ISO 20884
Metal Additives [mg/l]	----- Not permitted -----			
Oxygen [%m/m]	≤ 2.7	≤ 2.7	≤ 2.7	EN 1601 EN 13132
Oxygenates [%v/v]				
- methanol	≤ 3.0 ²	≤ 3.0 ²	≤ 3.0 ²	
- ethanol	≤ 5.0	≤ 5.0	≤ 5.0	
- iso-propyl alcohol	≤ 10.0	≤ 10.0	≤ 10.0	
- iso-butyl alcohol	≤ 10.0	≤ 10.0	≤ 10.0	
- tert-butyl alcohol	≤ 7.0	≤ 7.0	≤ 7.0	
- ethers	≤ 15.0	≤ 15.0	≤ 15.0	
- other oxygenates	≤ 10.0	≤ 10.0	≤ 10.0	EN 1601 EN 13132
RVP [kPa]	35 - 100	45 – 100	45 – 100	EN 13016/1 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]	-	≤ 18	≤ 18	EN 14517 EN15553
VLI (10VP + E70)	-	1 050 – 1 250	1 050 – 1 250	
Residue [%v/v]	< 2	< 2	< 2	EN ISO 3405

¹ Corresponds to the United Nations Environment Programme (UNEP) decision taken at the fourth global meeting of the Partnership for Clean Fuels and Vehicles (PCFV), held on 14 and 15 December 2005 in Nairobi, Kenya.

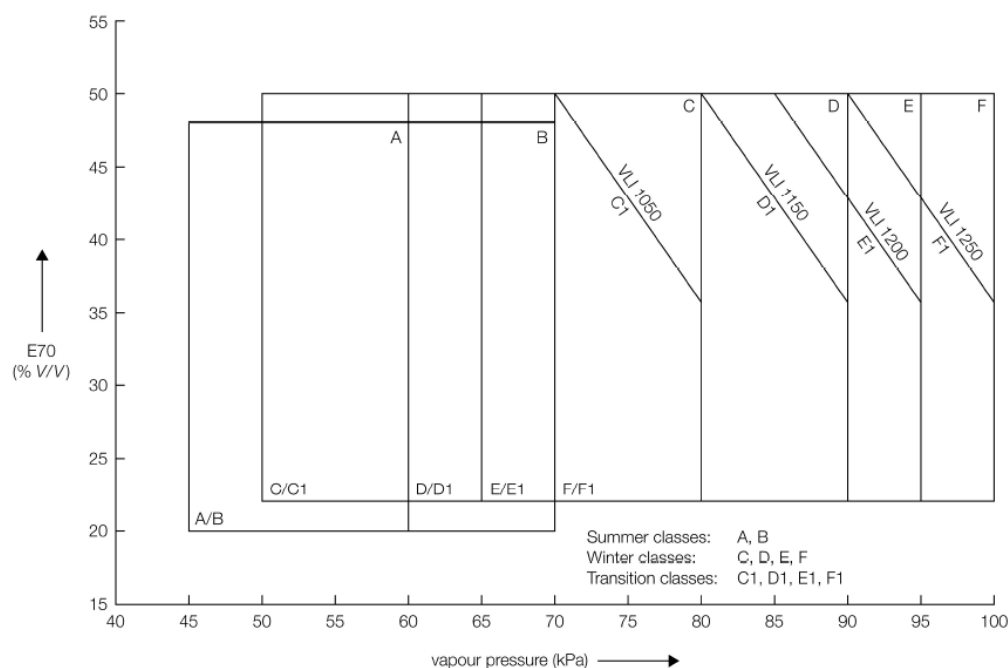
² Industry recommends no methanol content (non-detectable).

6.2. 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 1 050	D1 1 150	E1 1 200	F1 1 250

* "Class" is based on the minimum expected ambient temperature of the market and will vary by season. Implementing country to choose volatility class or classes appropriate to their yearly ambient temperature conditions.

¹ E-values or T-values as alternatives.



Relation between vapour pressure (VP), E70 and VLI for the ten different volatility classes for unleaded gasoline

6.3. Diesel – on-road vehicles

	<i>R83 - 03series and R49.02 (Stage II)</i>	<i>R83.05 (row A) and R49.03 (row A)</i>	<i>R83.05 (row B) and R49.03 (row B)</i>	<i>Test method</i>
Sulphur [mg/kg]	≤ 500	≤ 350	≤ 50 ¹	EN ISO 20846 EN ISO 20884
Ash [%m/m]	≤ 0.01	≤ 0.01	≤ 0.01	EN/ISO 6245
Total Contamination [mg/kg]	≤ 24	≤ 24	≤ 24	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 Corresponds to the United Nations Environment Programme (UNEP) decision taken at the fourth global meeting of the Partnership for Clean Fuels and Vehicles (PCFV), held on 14 and 15 December 2005 in Nairobi, Kenya.

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 per cent v/v FAME.

⁴ Up to 5 per cent v/v FAME permitted if FAME complies with ASTM D6751. Up to 7 per cent 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.

6.4. Diesel – NRMM

	<i>R96</i> Power bands A to C	<i>R96.01</i> Power bands D to G	<i>R96.02</i> Power bands H to K	Test method
Sulphur [mg/kg]	≤ 2 000	≤ 2 000	≤ 300 ¹	ASTM D5453
Ash [%m/m]	≤ 0.01	≤ 0.01	≤ 0.01	EN/ISO 6245
Total Contamination [mg/kg]	≤ 24	≤ 24	≤ 24	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 (R.E.3) for on-road engines only. Industry recommends maximum 50 ppm 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 per cent v/v FAME.

⁴ Up to 5 per cent v/v FAME permitted if FAME complies with ASTM D6751. Up to 7 per cent 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 4 - Appendix 1

Evolution of the UNECE emission limits

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

On-road standards

UN 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

UN 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

<i>UN Emission Levels</i>	<i>Power band</i>	<i>Net power (P) (kW)</i>	<i>CO (g/kWh)</i>	<i>HC (g/kWh)</i>	<i>NOx (g/kWh)</i>	<i>PM (g/kWh)</i>	<i>Date of application</i>
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	

<i>UN Emission Levels</i>	<i>Power band</i>	<i>Net power (P) (kW)</i>	<i>CO (g/kWh)</i>	<i>HC + NOx (g/kWh)</i>	<i>PM (g/kWh)</i>	<i>Date of application</i>
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 4 - Appendix 2

Evolution of stringency of gasoline market fuel quality standards

On-road vehicles

Gasoline	<i>R83.03</i>	<i>R83.05 (row A)</i>	<i>R83.05 (row B)</i>
RON	95	95	95
MON	85	85	85
Lead	0.013	0.005	0.005
Sulphur	500	150	50 / 10 ¹
Benzene	5	1	1
Aromatics	-	42	35
Olefins	-	21	18
Oxygen	-	2.7	2.7
RVP	35 - 100	45 - 100	45 - 100
VLI	-	1 050 – 1 250	1 050 – 1 250
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

¹ For the EU, maximum 10 ppm sulphur content is mandatory since 1 January 2009.

On-road vehicles

<i>Diesel</i>	<i>R83.03 R49.03</i>	<i>R83.05 (level A) R49.05 (level A)</i>	<i>R83.05 (level B) R49.05 (level B1)</i>
Cetane Number	49	51	51
Cetane Index	46	46	46
Sulphur	500	350	50 / 10 ²
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

² For the EU, maximum 10 ppm sulphur content is mandatory since 1 January 2009.

Annex 4 - Appendix 3

Correlation between UN Regulations and Euro standards

On-road vehicles

Correlation between the series of amendments of Regulations Nos. 83 and 49 and Euro emission standards

<i>UN Regulation No. 49</i>	<i>Euro standard</i>
R49.02 level B	Euro II
R49.03 level A	Euro III
R49.03 level B1	Euro IV

<i>UN Regulation No. 83</i>	<i>Euro standard</i>
R83.03	Euro 2
R83.05 level A	Euro 3
R83.05 level B	Euro 4

Non-road vehicles

Correlation between the series of amendments to Regulation No. 96 and Euro emission standards

<i>UN Regulation No. 96</i>	<i>NRMM Directive 97/68/EC</i>
R96	Stage I
R96.01	Stage II
R96.02	Stage IIIA

Annex 4 - Appendix 4

Housekeeping

Some problems encountered by vehicles linked to fuel quality can be caused by adulteration of the fuel in the fuel distribution system, after the fuel has left the refinery gate. Failure to invest in adequate pipeline as well as storage facilities and failure to maintain the equipment can lead to volatility losses, fuel leakage, and contamination by particulates and water. These, in turn, can lead to many of the vehicle problems mentioned previously. Poor maintenance practices at the service station, such as too infrequent replacement of fuel dispenser filters or "dipping" of tanks to check for water, can magnify these problems, including corrosion problems within vehicles. CEN has issued a useful guideline document on good practice for fuel housekeeping: CEN TR/15367.³

II. Justification

1. 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, with the corresponding emissions standards. They complement the motor vehicle and NRMM pollutant emission standards that a country or a region may be considering to introduce.

2. Considering that the current Annex 4 of the Consolidated Resolution on the Construction of Vehicles (R.E.3) set basic recommendations (concerning lead and sulphur in gasoline and sulphur, ash and total contamination in diesel), an additional set of fuel parameters is proposed, to impact:

- (a) the performance and durability of engines and emission control equipment and;
- (b) the parameters that have an impact on human health and the environment, should now be included.

3. For the purpose of these recommendations, the motor vehicle and NRMM pollutant emissions standards are those identified in the various series of amendments to UN Regulations Nos. 83, 49 and 96.⁴

4. Earlier series of these UN Regulations on engine pollutant emissions may already have been implemented by many countries and such countries may now be considering strengthening their pollutant emission standards. Other countries may be considering, for the first time, introducing such pollutant emission regulations.

5. Countries or regions that have, so far, not implemented a well-formulated relationship between pollutant emissions standards and high quality market fuels are the focus of these recommendations.

³ See Annex C for the correlation between the series of amendments to UN Regulations Nos. 83, 49 and 96 and the respective European emission standards.

⁴ See Appendix 3 to Annex 4 for the correlation between the series of amendments to UN Regulations Nos. 83, 49 and 96 and the respective European emission standards.