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| --- | --- | --- | --- |
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**Economic Commission for Europe**

Inland Transport Committee

**World Forum for Harmonization of Vehicle Regulations**

**179th session**

Geneva, 12-14 November 2019

Item 4.14.2 of the provisional agenda

**1958 Agreement:**

**Proposal for amendments to the Consolidated Resolution  
on the Construction of Vehicles (R.E.3) submitted by   
the Working Parties to the World Forum for consideration**

Proposal for an amendment to Annex 4 to the Consolidated Resolution on the Construction of Vehicles (R.E.3)

Submitted by the Working Party on Pollution and Energy[[1]](#footnote-2)\*

The text reproduced below was adopted by the Working Party on Pollution and Energy (GRPE) at its seventy-ninth session (ECE/TRANS/WP.29/GRPE/79, para. 72). It is based on ECE/TRANS/WP.29/GRPE/2019/13. It is submitted to the World Forum for Harmonization of Vehicle Regulations (WP.29) and to the Administrative Committee AC.1 for consideration at their November 2019 sessions.

Amendment to Annex 4 to the Consolidated Resolution on the Construction of Vehicles (R.E.3)Proposal

*Annex 4,* amend to read:

"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. Exclusions

This recommendation imposes no obligation on Contracting Parties to the 1958 Agreement to accept in their territory fuels complying with the parameters outlined in this recommendation that may have been introduced by other Contracting Parties or other countries. Compliance with applicable fuel quality legislation and standards is required in respect of fuels offered for sale in Contracting Parties.

4. 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 appendices, 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 "R*XX*.*YY*"*.*

5. 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 R83.07 (row B) and R49.06 (row B1). For the moment, this amendment will make no change in relation to NRMM. An extension to cover future 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.

6. Appendices 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.

7. 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).

7.1. Gasoline – on road vehicles

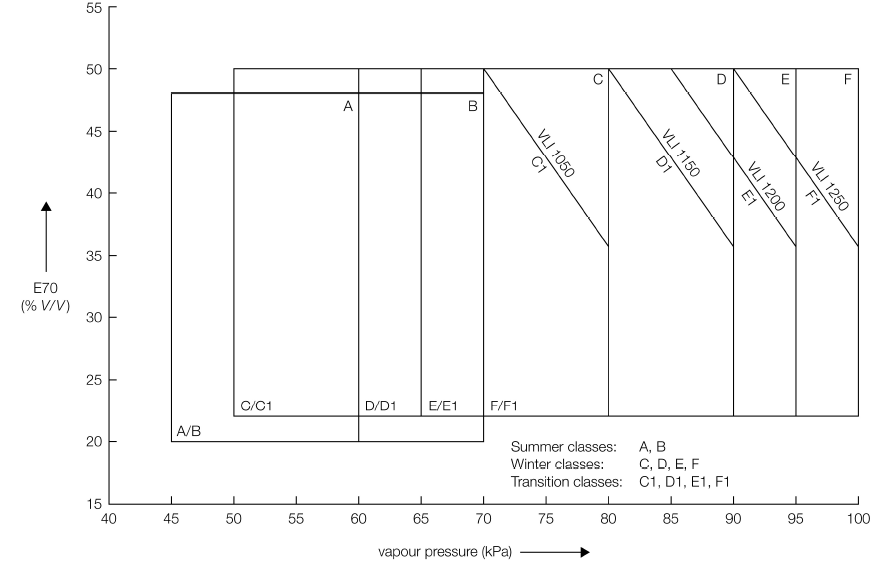
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *Unleaded Gasoline* | *R83.03* | *R83.05 (row A)* | *R83.05 (row B)* | *R83.06* | *R83.07* | | *Test method* |
| *E5* | *E10* |
| Lead [g/l] | No intentional addition,  with a max ≤ 0.013 | No intentional addition,  with a max ≤ 0.005 | No intentional addition,  with a max ≤ 0.005 | No intentional addition,  with a max ≤ 0.005 | No intentional addition,  with a max ≤ 0.005 | | EN 237 |
| Sulphur [mg/kg] | ≤ 500 | ≤ 150 | ≤ 50 | ≤ 10 | ≤ 10 | | EN ISO 20846 EN ISO 20884 |
| Metal Additives [mg/l] | ----------------- Not permitted ----------------- | | | | | |  |
| Oxygen [%m/m] | ≤ 2.7 | ≤ 2.7 | ≤ 2.7 | ≤ 2.7 | ≤ 2.7 | ≤ 3.7 | EN 1601 EN 13132 |
| Oxygenates [%v/v] |  |  |  |  |  |  |  |
| - methanol | ≤ 3.01 | ≤ 3.0 1 | ≤ 3.0 1 | ≤ 3.0 1 | ≤ 3.0 1 | | EN 1601 EN 13132 |
| - ethanol | ≤ 5.0 | ≤ 5.0 | ≤ 5.0 | ≤ 5.0 | ≤ 5.0 | ≤ 10.0 |
| - iso-propyl alcohol | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | |
| - iso-butyl alcohol | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | |
| - tert-butyl alcohol | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | ≤ 7.0 | |
| - ethers | ≤ 15.0 | ≤ 15.0 | ≤ 15.0 | ≤ 15.0 | ≤ 15.0 | ≤ 22.0 |
| - other oxygenates | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | ≤ 10.0 | |
| RVP [kPa] | 35 - 100 | 45 – 100 | 45 – 100 | 45 – 100 | 45 – 100 | | EN 13016/l DVPE |
| Density [kg/m3] | 725 – 780 | 720 – 775 | 720 – 775 | 720 – 775 | 720 – 775 | | EN ISO 3675 EN ISO 12185 |
| RON | ≥ 95 | ≥ 95 | ≥ 95 | ≥ 95 | ≥ 95 | | EN ISO 5164 |
| MON | ≥ 85 | ≥ 85 | ≥ 85 | ≥ 85 | ≥ 85 | | EN ISO 5163 |
| Benzene [%v/v] | ≤ 5 | ≤ 1 | ≤ 1 | ≤ 1 | ≤ 1 | | EN 238 EN 14517 |
| Aromatics [%v/v] | - | ≤ 42 | ≤ 35 | ≤ 35 | ≤ 35 | | EN 14517 EN15553 |
| Olefins [%v/v] | - | ≤ 18 | ≤ 18 | ≤ 18 | ≤ 18 | | EN 14517  EN15553 |
| VLI (10VP + E70) | - | 1 050 – 1 250 | 1 050 – 1 250 | 1 050 – 1 250 | 1 050 –  1 250 | 1 064 –  1 264 |  |
| Residue [%v/v] | < 2 | < 2 | < 2 | < 2 | < 2 | < 2 | EN ISO 3405 |
| 1 Industry recommends no methanol content in gasoline (non-detectable). | | | | | | | | |

7.2. Volatility Classes for Unleaded Gasoline

7.2.1.Volatility Classes for Unleaded Gasoline (R83.03, R83.05, R83.06, R83.07 – E5 gasoline blend)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *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) 1 | 65 | 60 | 55 | 50 | 45 | 45 |
| T50 (°C) 1 | 77 - 100 | 77 - 100 | 75 - 100 | 70 - 100 | 65 - 100 | 65 - 100 |
| T90 (°C) 1 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 |
| Distillation residue (% V/V, max) | 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. | | | | | | |

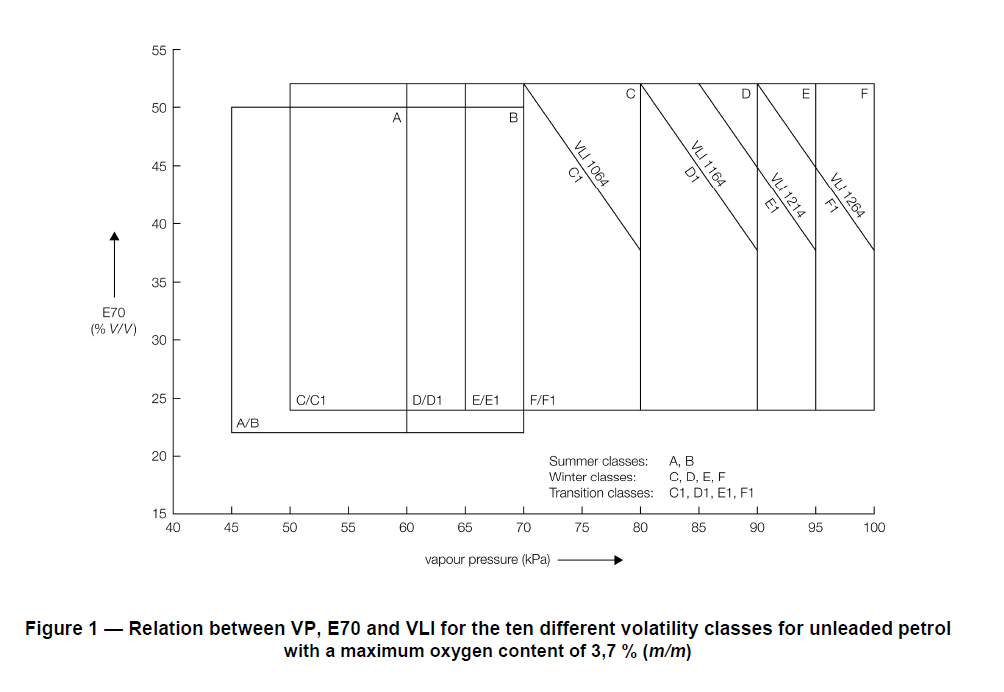
Figure A4-1:   
**Relation between vapour pressure (VP), E70 and VLI for the ten different volatility classes for unleaded petrol with a maximum oxygen content of 2.7% (m/m).**



7.2.2.Volatility Classes for Unleaded Gasoline (R83.07 - E10 gasoline blend)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *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 | 22 - 50 | 22 - 50 | 24 - 52 | 24 - 52 | 24 - 52 | 24 - 52 |
| E100 (%) 1 | 46 - 72 | 46 - 72 | 46 - 72 | 46 - 72 | 46 - 72 | 46 - 72 |
| E150 (% min) 1 | 75 | 75 | 75 | 75 | 75 | 75 |
| Final boiling point (°C max) 1 | 210 | 210 | 210 | 210 | 210 | 210 |
| T10 (°C) 1 | 65 | 60 | 55 | 50 | 45 | 45 |
| T50 (°C) 1 | 65 - 100 | 65 - 100 | 65 - 100 | 65 - 100 | 65 - 100 | 65 - 100 |
| T90 (°C) 1 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 | 130 - 175 |
| Distillation residue (% V/V max) | 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  1 064 | D1  1 164 | E1  1 214 | F1  1 264 |
| \* "*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. | | | | | | |

Figure A4-2:  
**Relation between vapour pressure (VP), E70 and VLI for the ten different volatility classes for unleaded petrol with a maximum oxygen content of 3.7% (m/m)**.



7.3. Diesel – on-road vehicles

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *R83 - 03series and  R49.02 (Stage II)* | *R83.05 (row A) and R49.03 (row A)* | *R83.05 (row B) and  R49.03 (row B)* | *R83.06*  *R49.03 B2, 04 B2, 05 B2* | *R83.07*  *R49.06* | *Test method* |
|  | ≤ 500 | ≤ 350 | ≤ 50 | ≤ 10 | ≤ 10 | EN ISO 20846 EN ISO 20884 |
| Ash [%m/m] | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | ≤ 0.01 | EN/ISO 6245 |
| Total Contamination [mg/kg] | ≤ 24 | ≤ 24 | ≤ 24 | ≤ 24 | ≤ 24 | EN 12662 |
| Cetane Number 1 | ≥ 49 | ≥ 51 | ≥ 51 | ≥ 51 | ≥ 51 | EN ISO 5165 |
| Cetane Index 1 | ≥ 46 | ≥ 46 | ≥ 46 | ≥ 46 | ≥ 46 | EN ISO 4264 |
| Density [kg/m3] 1 | 820 - 860 | 820 - 845 | 820 - 845 | 820 - 845 | 820 - 845 | EN ISO 3675 EN ISO 12185 |
| Viscosity [mm2/s] 1 | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 | EN ISO 3104 |
| Flash Point [°C] | > 55 | > 55 | > 55 | > 55 | > 55 | EN ISO 2719 |
| T50 [°C] | - | T65 = 250 min | T65 = 250 min | T65 = 250 min | T65 = 250 min | EN ISO 3405 |
| T85 [°C] | ≤ 350 | ≤ 350 | ≤ 350 | ≤ 350 | ≤ 350 | EN ISO 3405 |
| T95 [°C] | ≤ 370 | ≤ 360 | ≤ 360 | ≤ 360 | ≤ 360 | EN ISO 3405 |
| PAH [%m/m] | ≤ 11 | ≤ 11 | ≤ 11 | ≤ 11 | ≤ 11 | EN 12916 |
| Carbon residue [%m/m] | ≤ 0.3 | ≤ 0.3 | ≤ 0.3 | ≤ 0.3 | ≤ 0.3 | EN ISO 10370 |
| CFPP [°C] 1 | -44 to +5 | -44 to +5 | -44 to +5 | -44 to +5 | -44 to +5 | EN 116 |
| Cloud Point [°C] (severe winter conditions) 1 | -34 to -10 | -34 to -10 | -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 | ≤ 200 | ≤ 200 | EN ISO 12937 |
| Lubricity [micron] | ≤ 460 | ≤ 460 | ≤ 460 | ≤ 460 | ≤ 460 | EN ISO 12156-1 |
| Oxidation stability [hours] 2 | > 20 | > 20 | > 20 | > 20 | > 20 | EN15751 |
| FAME [%v/v] | 3 | 3 | 3 | 3 | 3 | EN14214  ASTM D6751 |
| Appearance | Clear and bright, no free water or particulates | | | | | D4176 visual inspection |
| Ethanol/Methanol [%v/v] | Non-detectable 4 | | | | |  |
| 1 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.  2 Applicable for diesel containing more than 2 per cent v/v FAME.  3 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.  4 At or below detection limit of method used. | | | | | | |

7.4. Diesel – NRMM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *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] | ≤ 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/m3] 2 | 835 - 845 | 835 - 845 | 833 - 837 | EN ISO 3675 ASTM D4052 |
| Viscosity [mm2/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*  *(g/km)* | *NOx*  *(g/km)* | *PM*  *(g/km)* | *PN*  *(♯/km)* | *Fuel standard* | *CO*  *(g/km)* | *HC+NOx*  *(g/km)* | *NOx*  *(g/km)* | *PM*  *(g/km)* | *PN*  *(♯/km)* | *Fuel standard* |
| R83.03 | 2.2 | 0.5 (HC+NOx) | | - | - | 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 | 0.56 | 0.5 | 0.05 | - | EN590:2000 | 2000 |
| R83.05 (level B) | 1.0 | 0.1 | 0.08 | - | - | EN228:2004 | 0.5 | 0.30 | 0.25 | 0.025 | - | EN590:2004 | 2005 |
| R83.06 | 1.0 | 0.1 | 0.06 | 0.0045 | - | EN228:2008 | 0.5 | 0.23 | 0.18 | 0.0045 | - | EN590:2008 | 2009 |
| R83.07 | 1.0 | 0.1 | 0.06 | 0.0045 | 6 ×1011 | EN228:2012 | 0.5 | 0.17 | 0.08 | 0.0045 | 6 ×1012 /  6 ×1011 | EN590:2014 | 2014 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *UN Emission Levels* |  |  | | *Diesel* | | | | | *Date of application* |
| *CO*  *(g/kWh)* | *NMHC*  *(g/kWh)* | *THC*  *(g/kWh)* | | *NOx*  *(g/kWh)* | *PM*  *(g/kWh)* | *PN*  *((♯/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 - 05 (level B2) 2 | 5.45 | 0.78 | - | | 5.0 | 0.03 | - | EN590:2008 | 2008 |
| R49.06 3 | 4.0 | - | 0.16 | | 0.46 | 0.01 | 6 ×1011 | EN590:2014 | 2012 |
| Limits shown for the 13-mode test.  2 Limits shown for the ETC test only.  3 Limits shown for the WHTC only. | | | | | | | | | |

**Non-road standards**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *UN 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 ≥ 130 | 5 | 1.3 | 9.2 | 0.54 | 1995 |
| B | 75 ≤ P < 130 | 5 | 1.3 | 9.2 | 0.7 |
| C | 37 ≤ P < 75 | 6.5 | 1.3 | 9.2 | 0.85 |
| R96.01 | E | 130 ≤P ≤560 | 3.5 | 1.0 | 6.0 | 0.2 | 2001 |
| F | 75 ≤ P < 130 | 5.0 | 1.0 | 6.0 | 0.3 |
| G | 37 ≤ P < 75 | 5.0 | 1.3 | 7.0 | 0.4 |
| D | 18 ≤ P < 37 | 5.5 | 1.5 | 8.0 | 0.8 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *UN 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 ≤ P ≤ 560 | 3.5 | 4.0 | 0.2 | 2008 |
| I | 75 ≤ P < 130 | 5.0 | 4.0 | 0.3 |
| J | 37 ≤ P < 75 | 5.0 | 4.7 | 0.4 |
| K | 19 ≤ P < 37 | 5.5 | 7.5 | 0.6 |

**Annex 4 - Appendix 2**

**Evolution of stringency of market fuel quality standards**

**On-road vehicles**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gasoline | *R83.03* | *R83.05 (row A)* | *R83.05 (row B)* | *R83.06* | *R83.07* | |
| *E5* | *E10* |
| RON | 95 | 95 | 95 | 95 | 95 | 95 |
| MON | 85 | 85 | 85 | 85 | 85 | 85 |
| Lead [g/l] | 0.013 | 0.005 | 0.005 | 0.005 | 0.005 | 0.005 |
| Sulphur [mg/kg] | 500 | 150 | 50 / 10 1 | 10 | 10 | 10 |
| Benzene [%v/v] | 5 | 1 | 1 | 1 | 1 | 1 |
| Aromatics [%v/v] | - | 42 | 35 | 35 | 35 | 35 |
| Olefins [%v/v] | - | 21 | 18 | 18 | 18 | 18 |
| Oxygen [%m/m] | - | 2.7 | 2.7 | 2.7 | 2.7 | 3.7 |
| RVP [kPa] | 35 - 100 | 45 - 100 | 45 - 100 | 45 - 100 | 45 - 100 | 45 - 100 |
| VLI | - | 1 050 - 1 250 | 1 050 - 1 250 | 1 050 - 1 250 | 1 050 - 1 250 | 1064 - 1264 |
| Density [kg/m3] | 725 - 780 | 720 - 775 | 720 - 775 | 720 - 775 | 720 - 775 | 720 - 775 |
| FBP [°C] | 215 | 210 | 210 | 210 | 210 | 210 |
| E70 (%) | 15 - 47 | 20 - 50 | 20 - 50 | 20 - 50 | 20 - 50 | 22 - 52 |
| E100 (%) | 40 - 70 | 46 - 71 | 46 - 71 | 46 - 71 | 46 - 71 | 46 - 72 |
| E150 (%) | - | - | - | - | > 75 | > 75 |
| E180 (%) | 85 | - | - | - | - | - |
| Residue [%v/v] | 2 | 2 | 2 | 2 | 2 | 2 |
| 1 For the EU, maximum 10 ppm sulphur content is mandatory since 1 January 2009. | | | | | | |

**On-road vehicles**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| *Diesel* | *R83.03*  *R49.02* | *R83.05 (level A)*  *R49.03 (level A)* | *R83.05 (level B)*  *R49.05 (level B1)*  *R49.03 (level B1)*  *R49.04 (level B1)* | *R83.06*  *R49.03 (level B2)*  *R49. 04 (level B2),*  *R49. 05( level B2)* | *R83.07*  *R49.06* |
| Cetane Number | 49 | 51 | 51 | 51 | 51 |
| Cetane Index | 46 | 46 | 46 | 46 | 46 |
| Sulphur [mg/kg] | 500 | 350 | 50 / 10 1 | 10 | 10 |
| Density [kg/m3] | 820 - 860 | 820 - 845 | 820 - 845 | 820 - 845 | 820 - 845 |
| Viscosity [mm2/s] | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 | 2.0 - 4.5 |
| T50 [°C] | Report | T65 = 250 min | T65 = 250 min | T65 = 250 min | T65 = 250 min |
| T85 [°C] | 350 max | 350 max | 350 max | 350 max | 350 max |
| T95 [°C] | 360 max | 360 max | 360 max | 360 max | 360 max |
| PAH [%m/m] | 11 | 11 | 11 | 11 | 11 |
| Flash Point [°C] | 55 | 55 | 55 | 55 | 55 |
| CCR [%m/m] | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| CFPP [°C] | -44 to +5 | -44 to +5 | -44 to +5 | -44 to +5 | -44 to +5 |
| Cloud Point [°C] | -34 to -10 | -34 to -10 | -34 to -10 | -34 to -10 | -34 to -10 |
| Water [mg/kg] | 200 | 200 | 200 | 200 | 200 |
| Ash [%m/m] | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| Lubricity [micron] | - | 460 | 460 | 460 | 460 |
| 1  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[[2]](#footnote-3)\***

**On-road vehicles**

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

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *UN Regulation No. 49* | *Euro standard* |  | *UN Regulation No. 83* | *Euro standard* |
| R49.02 level B | Euro II |  | R83.03  R83.04 | Euro 2 |
| R49.03 level A | Euro III |  | R83.05 level A | Euro 3 |
| R49.03 level B1  R49.04 level B1  R49.05 level B1 | Euro IV |  | R83.05 level B | Euro 4 |
| R49.03 level B2  R49.04 level B2  R49.05 level B2 | Euro V | R83.06 | Euro 5 |
| R49.06 | Euro VI | R83.07 | Euro 6 |

**Non-road vehicles**

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

|  |  |
| --- | --- |
| *UN Regulation No. 96* | *NRMM Directive 97/68/EC* |
| 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]](#footnote-4)

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1. \* In accordance with the programme of work of the Inland Transport Committee for 2018–2019 (ECE/TRANS/274, para. 123 and ECE/TRANS/2018/21, Cluster 3.1), the World Forum will develop, harmonize and update UN Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate. [↑](#footnote-ref-2)
2. \* *Note by the secretariat*: The recommendation of fuel quality is only applicable to the listed emission levels; more stringent emission standards may likely require more stringent fuel requirements. [↑](#footnote-ref-3)
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. [↑](#footnote-ref-4)