

English version

## Automotive fuels - Diesel - Requirements and test methods

Carburants pour automobiles - Carburant pour moteur  
diesel (gazole) - Exigences et méthodes d'essai

Kraftstoffe für Kraftfahrzeuge - Dieseldieselkraftstoff -  
Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 24 December 2003.

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## Foreword

This document EN 590:2004 has been prepared by Technical Committee CEN/TC 19 "Petroleum products, lubricants and related products", the secretariat of which is held by NEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2004, and conflicting national standards shall be withdrawn at the latest by July 2004.

This document supersedes EN 590:1999.

Significant technical changes between this European Standard and the previous edition are:

- The requirements of the European Fuels Directive 98/70/EC [1], including amendment 2003/17/EC [2] have been included, supporting early national introduction of maximum 10 mg/kg sulfur automotive diesel fuel.
- Provision is made for a maximum of 5 % (V/V) of fatty acid methyl esters (FAME) to be included in automotive diesel fuel.
- Dates have been included with all normative test method references in order to comply with the requirements of the European Commission, with the accompanying assurance that updated versions will always give similar accuracy and the same or better precision.
- Table 1 explicitly differentiates between requirements included in the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2], and other requirements.
- Many of the test methods included in this standard were the subject of inter-laboratory testing to determine the applicability of the method and its precision in relation to blends of automotive diesel fuel containing 5 % (V/V) of different sources of fatty acid methyl esters (FAME). These fatty acid methyl esters were produced from rapeseed and sunflower oil.

Annex A is normative and contains the precision data generated on the test methods which are the result of the inter-laboratory testing as mentioned above, carried out by working groups of CEN/TC19. This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

## **1 Scope**

This European Standard specifies requirements and test methods for marketed and delivered automotive diesel fuel. It is applicable to automotive diesel fuel for use in diesel engine vehicles designed to run on automotive diesel fuel.

**NOTE** For the purposes of this European Standard, the terms “% (m/m)” and “% (V/V)” are used to represent respectively the mass fraction and the volume fraction.

## **2 Normative references**

This European Standard incorporates by dated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 116:1997, *Diesel and domestic heating fuels - Determination of cold filter plugging point.*

EN 12662:1998, *Liquid petroleum products – Determination of contamination in middle distillates.*

EN 12916:2000, *Petroleum products – Determination of aromatic hydrocarbon types in middle distillates – High performance liquid chromatography method with refractive index detection.*

EN 14078:2003, *Liquid petroleum products – Determination of fatty acid methyl ester (FAME) content in middle distillates – Infrared spectrometry method.*

EN 14214:2003, *Automotive fuels – Fatty acid methyl esters (FAME) for diesel engines – Requirements and test methods.*

EN ISO 2160:1998, *Petroleum products - Corrosiveness to copper - Copper strip test (ISO 2160:1998).*

EN ISO 2719:2002, *Determination of flash point - Pensky-Martens closed cup method (ISO 2719:2002).*

EN ISO 3104:1996, *Petroleum products - Transparent and opaque liquids - Determination of kinematic viscosity and calculation of dynamic viscosity (ISO 3104:1994).*

prEN ISO 3170:2002, *Petroleum liquids – Manual sampling.*

EN ISO 3171:1999, *Petroleum liquids – Automatic pipeline sampling (ISO 3171:1988).*

EN ISO 3405:2000, *Petroleum products - Determination of distillation characteristics (ISO 3405:2000).*

EN ISO 3675:1998, *Crude petroleum and liquid petroleum products - Laboratory determination of density - Hydrometer method (ISO 3675:1998).*

EN ISO 4259:1995, *Petroleum products - Determination and application of precision data in relation to methods of test (ISO 4259:1992, including Cor.1: 1993).*

EN ISO 4264:1996, *Petroleum products - Distillate fuels - Calculation of cetane index (ISO 4264: 1995).*

EN ISO 5165:1998, *Diesel fuels - Determination of ignition quality - Cetane method (ISO 5165:1998).*

EN ISO 6245:2002, *Petroleum products - Determination of ash (ISO 6245:2001).*

EN ISO 10370:1995, *Petroleum products - Determination of carbon residue (micro method)*. (ISO 10370:1993).

EN ISO 12156-1:2000, *Diesel fuels - Assessment of lubricity by HFRR* (ISO 12156-1:1997, including Cor.1:1998).

EN ISO 12185:1996/C1:2001, *Crude petroleum and petroleum products - Determination of density - Oscillating U-tube method* (ISO 12185:1996, including Cor.1:2001).

EN ISO 12205:1996, *Petroleum products - Determination of the oxidation stability of distillate fuels* (ISO 12205:1995).

EN ISO 12937:2000, *Petroleum products - Determination of water - Coulometric Karl Fisher titration method* (ISO 12937:2000).

EN ISO 13759:1996, *Petroleum products - Determination of alkyl nitrate in diesel fuels - Spectrometric method* (ISO 13759:1996).

EN ISO 20846:xxxx, *Petroleum products – Determination of sulfur content of automotive fuels – Ultraviolet fluorescence method*.

EN ISO 20847:xxxx, *Petroleum products – Determination of sulfur content of automotive fuels – Energy-dispersive X-ray fluorescence spectrometry*.

EN ISO 20884:xxxx *Petroleum products – Determination of sulfur content of automotive fuels – Wavelength-dispersive X-ray fluorescence spectrometry*.

EN 23015:1994, *Petroleum products - Determination of cloud point* (ISO 3015:1992).

### 3 Sampling

Samples shall be taken as described in prEN ISO 3170 or EN ISO 3171 and/or in accordance with the requirements of national standards or regulations for the sampling of automotive diesel fuel. The national requirements shall be set out in detail or shall be referred to by reference in a national annex to this European Standard.

In view of the sensitivity of some of the test methods referred to in this European Standard, particular attention shall be paid to compliance with any guidance on sampling containers which is included in the test method standard.

### 4 Pump marking

Information to be marked on dispensing pumps used for delivering automotive diesel fuel, and the dimensions of the mark shall be in accordance with the requirements of national standards or regulations for the marking of pumps for automotive diesel fuel. Such requirements shall be set out in detail or shall be referred to by reference in a national annex to this European Standard.

NOTE It is recommended to set marking for sulfur in a National Annex to this European Standard. The recommended designation for maximum 10 mg/kg sulfur content is "sulfur-free" in national language.

## 5 Requirements and test methods

### 5.1 Dyes and markers

The use of dyes or markers is allowed.

### 5.2 Additives

In order to improve the performance quality, the use of additives is allowed. Suitable fuel additives without known harmful side-effects are recommended in the appropriate amount, to help to avoid deterioration of driveability and emissions control durability. Other technical means with equivalent effect may also be used.

NOTE Deposit forming tendency test methods suitable for routine control purposes have not yet been identified and developed.

### 5.3 Fatty acid methyl ester (FAME)

Diesel fuel may contain up to 5 % (V/V) of FAME complying with EN 14214.

NOTE A suitable method for the separation and identification of FAME is given in EN 14331 [3].

### 5.4 Generally applicable requirements and related test methods

**5.4.1** When tested by the methods indicated in Table 1, automotive diesel fuel shall be in accordance with the limits specified in Table 1.

**5.4.2** The limiting value for the carbon residue given in Table 1 is based on product prior to addition of ignition improver, if used. If a value exceeding the limit is obtained on finished fuel in the market, EN ISO 13759 shall be used as an indicator of the presence of a nitrate-containing compound. If an ignition improver is thus proved present, the limit value for the carbon residue of the product under test cannot be applied. The use of additives does not exempt the manufacturer from meeting the requirement of maximum 0,30 % (m/m) of carbon residue prior to addition of additives.

Table 1 - Generally applicable requirements and test methods

Property	Unit	Limits		Test method <sup>a</sup> (See 2. Normative references)
		minimum	maximum	
<b>Cetane number</b> <sup>b</sup>		<b>51,0</b>	–	EN ISO 5165
Cetane index		46,0	–	EN ISO 4264
<b>Density at 15 °C</b> <sup>c</sup>	<b>kg/m<sup>3</sup></b>	820	<b>845</b>	EN ISO 3675 EN ISO 12185
<b>Polycyclic aromatic hydrocarbons</b> <sup>d, e</sup>	<b>% (m/m)</b>	–	<b>11</b>	EN 12916
<b>Sulfur content</b> <sup>f</sup>	<b>mg/kg</b>	–	<b>350</b> (until 2004-12-31) or <b>50,0</b>	EN ISO 20846 EN ISO 20847 EN ISO 20884
			<b>10,0</b>	EN ISO 20846 EN ISO 20884
Flash point	°C	Above 55	–	EN ISO 2719
Carbon residue <sup>g</sup> (on 10 % distillation residue)	% (m/m)	–	0,30	EN ISO 10370
Ash content	% (m/m)	–	0,01	EN ISO 6245
Water content	mg/kg	–	200	EN ISO 12937
Total contamination	mg/kg	–	24	EN 12662
Copper strip corrosion (3 h at 50 °C)	rating	class 1		EN ISO 2160
Oxidation stability	g/m <sup>3</sup>	–	25	EN ISO 12205
Lubricity, corrected wear scar diameter (wsd 1,4) at 60 °C	µm	–	460	EN ISO 12156-1
Viscosity at 40 °C	mm <sup>2</sup> /s	2,00	4,50	EN ISO 3104
<b>Distillation</b> <sup>h, i</sup> % (V/V) recovered at 250 °C % (V/V) recovered at 350 °C <b>95 % (V/V) recovered at</b>	% (V/V) % (V/V) °C	85	< 65 <b>360</b>	EN ISO 3405
Fatty acid methyl ester (FAME) content <sup>k</sup>	% (V/V)	–	5	EN 14078

NOTE Requirements in bold refer to the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2]

<sup>a</sup> See also 5.6.1

<sup>b</sup> See also 5.6.4

<sup>c</sup> See also 5.6.2

<sup>d</sup> For the purposes of this European Standard, polycyclic aromatic hydrocarbons are defined as the total aromatic hydrocarbon content less the mono-aromatic hydrocarbon content, both as determined by EN 12916.

<sup>e</sup> EN 12916 is not able to distinguish between polycyclic aromatic hydrocarbons and fatty acid methyl esters (FAME). FAME, if present in diesel fuels, will overestimate the value for polycyclic aromatic hydrocarbons. An improved method for the determination of polycyclic aromatic hydrocarbons is under development by CEN/TC 19.

<sup>f</sup> See also 5.6.3

<sup>g</sup> See also 5.4.2

<sup>h</sup> For the calculation of the cetane index the 10 %, 50 % and 90 % (V/V) recovery points are also needed.

<sup>i</sup> The limits for distillation at 250 °C and 350 °C are included for diesel fuel in line with EU Common Customs tariff.

<sup>k</sup> FAME shall meet the requirements of EN 14214

## 5.5 Climate dependent requirements and related test methods

**5.5.1** For climate-dependent requirements options are given to allow for seasonal grades to be set nationally. The options are for temperate climates six CFPP (cold filter plugging point) grades and for arctic or severe winter climates five different classes. Climate-dependent requirements are given in Table 2. Table 2 is divided into two sections, one for temperate climates (Table 2a) and one for arctic or severe winter climates (Table 2b). When tested by the methods given in Tables 2a and 2b, automotive diesel fuel shall be in accordance with the limits specified in these tables.

**5.5.2** The cetane number limits for arctic or severe winter grades in Table 2b are lower than for the temperate class (Table 1), reflecting the correlation between ignition quality and density, and the low density of arctic or severe winter grades. The values for cetane number given in Table 2b do not meet the requirements of the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2], and are included for use in countries where the European Fuels Directive 98/70/EC [1], including Amendment 2003/17/EC [2], does not apply or for countries where cetane number exceptions have been granted for arctic or severe winter grades.

**5.5.3** In a national annex to this European Standard each country shall detail requirements for a summer and a winter grade and may include (an) intermediate and/or regional grade(s) which shall be justified by national meteorological data.

**Table 2 - Climate-related requirements and test methods**

**Table 2a - Temperate climates**

Property	Unit	Limits						Test method <sup>a</sup> (See 2. Normative references)
		Grade A	Grade B	Grade C	Grade D	Grade E	Grade F	
CFPP	°C, max.	+5	0	-5	-10	-15	-20	EN 116

<sup>a</sup> See also 5.6.1

**Table 2b - Arctic or severe winter climates**

Property	Units	Limits					Test method <sup>a</sup> (See 2. Normative references)
		class 0	class 1	class 2	class 3	class 4	
CFPP	°C, max.	-20	-26	-32	-38	-44	EN 116
Cloud point	°C, max.	-10	-16	-22	-28	-34	EN 23015
Density at 15 °C <sup>b</sup>	kg/m <sup>3</sup> , min.	800	800	800	800	800	EN ISO 3675
	kg/m <sup>3</sup> , max.	845	845	840	840	840	EN ISO 12185
Viscosity at 40 °C	mm <sup>2</sup> /s, min.	1,50	1,50	1,50	1,40	1,20	EN ISO 3104
	mm <sup>2</sup> /s, max.	4,00	4,00	4,00	4,00	4,00	
Cetane number <sup>c</sup>	minimum	49,0	49,0	48,0	47,0	47,0	EN ISO 5165
Cetane index	minimum	46,0	46,0	46,0	43,0	43,0	EN ISO 4264
Distillation <sup>d,e</sup>							
% (V/V) recovered at 180 °C	% (V/V), max.	10	10	10	10	10	EN ISO 3405
% (V/V) recovered at 340 °C	% (V/V), min.	95	95	95	95	95	

<sup>a</sup> See also 5.6.1  
<sup>b</sup> See also 5.6.2  
<sup>c</sup> See also 5.6.4  
<sup>d</sup> EU Common Customs Tariff definition of gas oil may not apply to the grades defined for use in arctic or severe winter climates.  
<sup>e</sup> For the calculation of the cetane index the 10 %, 50 % and 90 % (V/V) recovery points are also needed



## 5.6 Precision and dispute

**5.6.1** All test methods referred to in this European Standard include a precision statement. In cases of dispute, the procedures for resolving the dispute and interpretation of the results based on test method precision, described in EN ISO 4259, shall be used.

**5.6.2** In cases of dispute concerning density, EN ISO 3675 shall be used.

**5.6.3** In cases of dispute concerning sulfur content, EN ISO 20847 is unsuitable as an arbitration method.

**5.6.4** For the determination of cetane number alternative methods may also be used in cases of dispute, provided that these methods originate from a recognized method series, and have a valid precision statement, derived in accordance with EN ISO 4259, which demonstrates precision at least equal to that of the referenced method. The test result, when using an alternative method, shall also have a demonstrable relationship to the result obtained when using the referenced method.

**Annex A**  
(Normative)  
**Details of inter-laboratory test programme**

**Table A.1 - Precision data obtained by the CEN/TC 19 inter-laboratory testing program that differ from those of test methods listed in Table 1**

Property	Test method	Unit	CEN/TC 19 data for 5 % (V/V) FAME blend
Viscosity at 40 °C	EN ISO 3104	mm <sup>2</sup> /s	r = 0,11 % R = 1,8 %
Flash point	EN ISO 2719	°C	r = 2,0 R = 3,5
where: r is repeatability (EN ISO 4259) R is reproducibility (EN ISO 4259)			
NOTE The following methods were found to have precision data for 5 % (V/V) FAME blends similar to the published values: Ash content           EN ISO 6245 Oxidation stability   EN ISO 12205 Distillation           EN ISO 3405 CFPP                   EN 116 No data were obtained for total contamination (EN 12662) pending method revision			

## Bibliography

- [1] *Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC*
- [2] *Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC*
- [3] EN 14331:2004, *Liquid petroleum products – Separation and characterization of fatty acid methyl esters (FAME) from middle distillate fuels – Liquid chromatography (LC)/ gas chromatography (GC).*