



# Technical Circular

## 0199-99-3005/4 EN



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## Fuels

The 4th replacement is made on account of

- Supplement to engine series 2008 and 2009
- Note Tier III/EURO IV with electronic injection
- Specifications on bio-diesel fuels
- Adapt diesel fuel specification EN 590
- Supplement other fuels



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This technical circular applies for all air-cooled and liquid-cooled DEUTZ compact engines. This TC applies accordingly for engines no longer in the programme.

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## General

The following fuels are approved for the DEUTZ compact engines:

Diesel fuels

MDF distillate fuels

Light heating oils

Jet fuels

Bio-fuels

For general specifications of fuels, see section:

Biological contamination in the supply tanks

Fuel additives

Distillate fuels with residue oil parts or mixed fuels may not be used in DEUTZ compact engines.

The DEUTZ vehicle engines are designed for diesel fuels according to DIN EN 590 with a cetane number of at least 51. DEUTZ engines for mobile work machines are designed for a cetane number of at least 45. When using fuels with a lower cetane number, formation of white smoke and misfires may be a problem.

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Note:  
The part numbers stated in this documentation are not subject to the modification service.  
For identifying spare parts, the spare part documentation has to be referred to.

Copies to:  
- TR KM  
- According to SIT 001

A centane number of at least 40 is permissible for the US-American market, therefore special engine models have been developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions (EPA regulation – US EPA REGULATIONS FOR LARGE NONROAD COMPRESSION-IGNITION ENGINES).

If the white smoke behavior is unacceptable when using at a very low centane number, the use of ignition improvers is recommended as a retrofittable remedy. If the use of fuels with a very low centane number is known in advance, we recommend you to order the engines in the EPA version.

For DEUTZ engines for Tier III and EURO III/IV with electronic injection only the following fuels are released:

- Diesel fuel according to EN 590
- US diesel fuel according to ASTM D 975 Grade-No 1-D and 2-D,
- Japanese diesel fuel JIS K 2204 Grade 1 Fuel and Grade 2 Fuel with lubricating properties according to diesel fuel EN 590 (HFRR max. 460 micrometer according to EN ISO 12156)

Bio-diesel according to EN 14214, kerosene and light heating oils are not released for engines TCD 2012 and TCD 2013.

The certification measurements to satisfy the legal emission limits are performed with the test fuels defined by law. These correspond to the diesel fuels according to EN 590 and ASTM D 975 described in section 1. No emission values are guaranteed with the other fuels described in this circular. The owner is obliged to check whether the fuels are approved for use by regional regulations.

## Diesel fuels

Diesel fuels are released and can be used according to the following specifications.

Fuel	Specifications
EN 590	Annex 2
ASTM Designation: D 975 Grade-No 1-D and Grade Low Sulfur No. 1-D	Annex 3
ASTM Designation: D 975 Grade-No 2-D and Grade Low Sulfur No. 2-D	Annex 3
JIS K 2204 Grade 1 Fuel and Grade 2 Fuel	Annex 4
NATO F-54, equivalent to diesel fuel in acc. with EN 590	Annex 2

The European standard EN 590 has the status of a national standard with a national attachment in most European countries, e.g. DIN EN 590.

For DEUTZ engines for Tier III and EURO III/IV with electronic injection US diesel fuels are released according to ASTM D 975 Grade-No 1-D and 2-D. Japanese diesel fuels according to JIS K 2204 Grade 1 Fuel and Grade 2 Fuel are only released when the lubrication properties correspond to the diesel fuel EN 590 (HFRR max. 460 micrometer according to EN ISO 12156).

## Low sulphur and sulphur-free fuels

Low sulphur and sulphur-free diesel fuels (e.g. according to EN 590) with a sulphur content < 50 mg/kg or < 10 mg/kg are permissible. The wear problems in the injection system which used to occur due to the low lubrication capability of low sulphur fuels (especially in fuel-lubricated distributor injection pumps) are guaranteed in diesel fuels according to ASTM 975 or EN 950 by appropriate additives. In case of low sulphur diesel fuels which do not conform to this standard, the

lubrication capability must be guaranteed by additives. The characteristic value for sufficient lubrication capability is a maximum wear spot of 0.46 mm in the HFRR test (ISO 12156-1).

### High sulphur content in the fuel

Fuels with sulphur content  $\geq 0.5$  mass-% require a shorter lube oil change interval (see Technical Circular 0199-99-3002). Fuels with a sulphur content  $> 1.0$  mass-% are not permissible due to high corrosion and considerable reduction of the life of the engines.

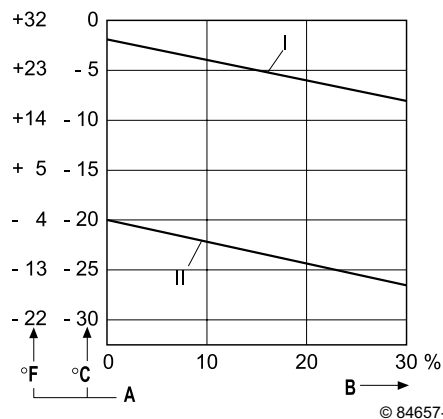
### Winter operation with diesel fuel

Special demands are made on the cold behavior (temperature limit value of the filtrability) for Winter operation. The suitable fuels are available at the filling stations in the specified times.

If only Summer diesel fuel is available, paraffin can be mixed at low temperatures with the diesel fuel up to 30% as shown in the diagram below to ensure the flow capability.



For engines TCD 2013 4V and fuel according to ASTM D 975 1-D/2-D paraffin may not be mixed.



A 1-1 Mixing of paraffin with Summer diesel fuel

The mixing takes place in the engine tank: Fill with the appropriate amount of paraffin first, then add the diesel fuel.

Mixing of normal petrol is not permissible for safety and technical reasons (cavitation on the injection system). Diesel fuels up to  $-44$  °C are available for an Arctic climate. It is possible to add flow improvers to the diesel fuel. The choice of a suitable additive and the necessary dosing and mixing procedure should take place in agreement with the fuel supplier.

### Marine distillate fuels

This includes distillate fuels used mainly in shipping. Only marine distillate fuels are used which contain no residue oils (residue from the distillation process).

The following marine distillate fuels can be used for DEUTZ marine engines:

Fuel	Specifications
ISO 8217 DMX	Annex 5
ISO 8217 DMA (restriction: Sulphur content max. 1.0 weight-%)	Annex 5

Fuel	Specifications
NATO F-75	Annex 6
NATO F-76	Annex 7

- Marine distillate fuels are not released for engine series 2008, 2009, 2015 and engines for Tier III and EURO IV with electronic injection.
- The cetane number must be at least 40 otherwise starting difficulties, extreme white smoke or increased hydrocarbon emissions may occur.
- The higher density demands a reverse blocking at the injection pump (may only be done by DEUTZ authorised personnel).
- The possible high sulphur content  $\geq 0.5$  mass-% demands a shorter lube oil change interval. Fuels with a sulphur content  $> 1.0$  weight-% are not permissible due to increased corrosion and reduction of the life of the engines. May we also remind you that fuels according to ISO 8217 DMA are only permissible when the sulphur content is a maximum 1.0 weight-%.
- Because of the potentially heavy contamination great emphasis must be placed on fuel purification and an additional fuel filter with a water trap installed if necessary.

## Non-road fuels and light heating oils

In some European countries non-road fuels with identical properties to heating oil are defined which are handled differently to heating oil in terms of tax. Usually heating oils are not allowed in diesel engines. The user must of course abide by the tax regulations. These are not an issue of this circular. With regard to use in the engine (warranty claims) no distinctions are to be made between the corresponding non-road fuels and light heating oils.

The following non-road fuels and light heating oils can be used:

Fuel	Specifications
DIN 51603	Annex 8
ASTM D 396 Grade-No 1	Annex 9
ASTM D 396 Grade-No 2	Annex 9
BS 2869 Class A2	Annex 10
CSR 441	Annex 11

- Non-road fuels and light heating oils are not released for Tier III and EURO IV engines with electronic injection.
- The cetane number must be at least 40 otherwise starting difficulties, extreme white smoke or increased hydrocarbon emission may occur.
- At a density of  $> 0.860 \text{ g/cm}^3$  a reverse blocking at the injection pump is necessary (may only be done by DEUTZ authorised personnel).

## Jet fuels

The following jet fuels can be used:



Fuel	Specifications
F 34 / F 35 (kerosene, NATO designation)	Annex 12
F 44 (kerosene, NATO designation))	
F-63 (kerosene, NATO designation, corresponds to F-34/F-35 with additives)	
F-65 (kerosene, NATO designation, 1:1 mixture of F-54 and F-34/F-35)	Specifications available on request
JP-8 (kerosene, US military designation)	
JP-5 (kerosene, US military designation)	
Jet A (kerosene for civil aviation)	
Jet A1 (kerosene for civil aviation)	

- Jet fuels F 34 and F 35 are equal for using in diesel engines.
- In the engine series 226/327/302/916 jet fuels may only be used in agreement with DEUTZ. Jet fuels are not released for engine series 2008, 2009 and engines for Tier III and EURO IV with electronic injection.
- The cetane number must be at least 40 otherwise starting difficulties, extreme white smoke or increased hydrocarbon emission may occur.
- Due to the lower density and the greater occurrence of leak fuel due to lower viscosity, depending on engine speed and torque, a power loss up to 10% is possible. **Blocking of the injection pump is not allowed.**
- Since the jet fuels F 34 / F 35 and F 44 are kerosene, a few problematical fuel properties exist (viscosity, lubrication capability and low distillation point). A slightly higher wear in the injection system is to be expected which may be expressed in a statistically shorter life of these components. The engine warranty is upheld when using these fuels.
- Jet fuels are intermixable. Addition of kerosene to the diesel fuel according to EN 590 to improve the flow capability in Winter operation is permissible.

## Bio-fuels

Only bio-diesel fuels according to EN 14214 (FAME = Fatty Acid Methyl Ester) are permitted

Fuel	Specifications
Bio-diesel fuel according to EN 14214	Annex 13

- The use of US bio-diesel, based on soy oil methylester is only permissible in mixtures with diesel fuel with a bio-diesel content of a max. 20 weight-%. The US bio-diesel used for the mixture must comply with the standard ASTM D6751 B100.
- The series 912, 913, 914, 1011, 2011, 1012, 2012, 1013, 2013, 413 and 513 are released for bio-fuels on compliance with the basic conditions below as of year of manufacture 1993; no conversions are necessary.
- The series 909, 910, 1015, 2008, 2009, 2015, TCD 2012, TCD 2013 are not released for bio-fuel as standard.
- Charged engines are excepted from release for applications which are usually operated with

a high workload above 80% of the rated performance; these are:

- Engines in block combined heating and power stations
- Engines in generator sets with power supply / parallel operation
- Engines in harvesting machines
- A power loss up to 5% is possible due to the low heating value. Blocking of the injection pump is not allowed.
- The lube oil quality must correspond with that of TC 0199-99-3002. The lube oil change interval must be halved in relation to operation with diesel fuel according to EN 590.
- Standstill times longer than 4-6 weeks with bio-diesel fuels must be avoided. Otherwise the engine must be started and stopped with diesel fuel.
- In series engines the fuel pipes, the diaphragm fuel pumps and the LDA diaphragms (series 1012, 1013, 2012 and 2013) are not resistant to bio-diesel fuel and must be changed annually. The use of bio-diesel-resistant fuel pipes (Viton) is recommended, in this case the annual changing can be omitted.
- Bio-diesel fuels can be mixed with the normal diesel fuel but the special guidelines for bio-diesel fuels always apply for mixtures (lube oil quality, lube oil change interval) except for mixtures with a content up to 5 weight-% bio-diesel fuel which is recently being sold at European filling stations. These fuels must be treated like normal diesel fuels.
- About 30-50 h after changing over from diesel to bio-diesel fuel the fuel filter should be changed to avoid a drop in performance due to blocked fuel filters. Bio-diesel loosens deposits of fuel ageing products and transports them into the fuel filter. The change should not be made immediately but after about 30-50 h because the loosening of the dirt takes time.

## Biological contamination in the supply tanks

A microbial contamination may occur in supply tanks in the case of contamination of the stored fuel by water. Water contamination is usually caused by condensation of water in the air. Water is very weakly fuel soluble so that the penetrated water collects at the bottom of the tank. The bacteria and fungi grow in the watery phase at the phase boundary to the fuel phase from which they draw their nutrition. Supply tanks should have water traps so that the penetrated water can easily be removed. In addition the tanks should be installed so that not too great temperature differences occur during the day to minimise condensation processes. Direct exposure to sunlight should be avoided because too high fuel temperatures favour the growth of microbes. Small supply tanks with correspondingly low dwell times of the stored fuel are to be preferred to large tanks.

Engine fuel filters block relatively quickly when using microbially contaminated fuel; a drop in performance is the result.

When the fuel in the supply tank has become microbially contaminated, the tank must be cleaned by specialist companies. Ask the fuel supplier to recommend suitable specialist companies. The decision whether to use biocides (such as Grotamar 71, Schülke & Mayr GmbH, Norderstedt) after cleaning to kill off the rest of the bacteria should be left up to the specialist company. The engine owner is strongly recommended not to use biocides because of their toxicity. Use of biocides without cleaning the tank is useless because the bacteria which lead to filter blockage are not removed.



## Fuel additives

The use of fuel additives is not permitted. The flow improvers mentioned above are an exception. Use of unsuitable additives will result in loss of warranty.

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Annexes

## Annex 1: Explanation of important fuel properties

### Density

The density is usually specified in  $\text{g/cm}^3$  or  $\text{kg/m}^3$  at  $15\text{ }^\circ\text{C}$  and is important for converting the fuel consumption from volume - to mass-unit. The higher the density, the greater the mass of the injected fuel. At the same control linkage setting the engine performance increases with greater density.

### Distillation range

The distillation range indicates how many volume-% of the fuel is overdistilled at a certain temperature. The greater the distillation residue (residue after evaporation) the greater the combustion residue in the engine, especially in partial load operation.

### Viscosity

The kinematic viscosity in  $\text{mm}^2/\text{s}$  at a certain temperature ( $1\text{ mm}^2\text{ s}^{-1} = 1\text{ cSt}$  [Centistoke]) is specified. The viscosity must be within certain limits for engine operation. Too high a viscosity requires pre-heating.

### Flashpoint

The flashpoint is insignificant for engine operation. It is a value indicating the fire hazard and is important for classification in one of the hazard classes (decisive for storage, transport and insurance).

### Sulphur content

High sulphur content and low component temperature can cause increased wear due to corrosion. The sulphur content influences the lube oil change intervals. Too low a sulphur content may impair the lubricating capability of the fuel insofar as this has not had lubricating capability improvers added.

### Coke residue

The coke residue applies as a reference value for the tendency of residue to form in the combustion chamber.

### Water

Too high a water content leads to corrosion and in connection with corrosion products and sediments to sludge. Malfunctions in the fuel and injection system are the result.

### Sediments / overall soiling

Sediments are solids (dust, rust, scale) which cause wear in the injection system and combustion chamber as well as valve leaks.

### Ash

Ash is carbon-free combustion residue which can lead to wear when deposited in the engine and turbocharger.

### Cold behavior

The following characteristic values give an indication of the suitability of fuel at low temperatures:



- The solidification point indicates at what temperature the dead weight no longer gets the fuel flowing.
- The pour point is approx. 3 °C above the solidification point.
- The cloud point indicates at what temperature solid precipitation (paraffin) becomes visible.
- The limit value of filtrability (CFPP) indicates at what temperature filter and pipe blockages may occur.

#### **Cetane number / Cetane index**

The cetane number specifies the ignition willingness of the fuel. Too low a cetane number may cause starting difficulties, white smoke, increase hydrocarbon emission and thermal and mechanical overloading of the engine. The cetane number is determined on a test engine. The cetane index can be used as a substitute calculated value from density and distillation behavior and correlates well with the cetane number as a rule.

#### **Heating value**

The lower heating value ( $H_U$ ) indicates the amount of heat released when burning 1 kg of fuel.

**Annex 2: Fuel specification \*\* (minimum requirement): Diesel fuel according to EN 590:2004**

Properties	Units	Limit values EN 590:2004	Test method
Centane number		at least 51	EN ISO 5165:1998
Centane index		at least 46	EN ISO 4264:1996
Density at 15 °C	kg/m <sup>3</sup>	820 - 845	EN ISO 3675:1998 EN ISO 12185:1996/C1:2001
Polycyclic aromatic hydrocarbons	weight-%	max. 11	EN 12916:2000
Sulphur content	mg/kg	max. 350 (until 31.12.2004) or 50.00	EN ISO 20846 EN ISO 20847 EN ISO 20884
		10,00	EN ISO 20846/EN ISO 20884
Flashpoint	°C	at least 55	EN ISO 2719:2002
coke residue (from 10 % distillation residue)	weight-%	max. 0.30	EN ISO 10370:1995
Ash content	weight-%	max. 0.01	EN ISO 6245:2002
Water content	mg/kg	max. 200	EN ISO 12937:2000
Overall soiling	mg/kg	max. 24	EN 12662:1998
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160:1998
Oxidation stability	g/m <sup>3</sup>	max. 25	EN ISO 12205:1996
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max. 460	EN ISO 12156-1:2000
Viscosity at 40 °C	mm <sup>2</sup> /s	2,00 - 4,50	EN ISO 3104:1996
Distillation			EN ISO 3405:2000
- compensated at 250 °C	vol. %	max. 65	
- compensated at 350 °C	vol. %	at least 85	
- 95 vol. % compensated at	°C	360	
Fatty Acid Methyl Ester content (FAME)	vol. %	5	EN 14078:2003
Limit of filtrability (CFPP) *			EN 116:1997
- 15.04. up to 30.09.	°C	max. 0	
- 01.10. up to 15.11.	°C	max. -10	
- 16.11. up to 28.02.	°C	max. -20	
- 01.03. up to 14.04.	°C	max. -10	

\* data apply for the Federal Republic of Germany. National regulations may deviate.

\*\* Specification also applies for NATO fuel F-54



**Annex 3: Fuel specification (minimum requirement) diesel fuel according to ASTM Designation D 975-02**

Properties	Units	Limit values		Test method
		Grade No. 1-D Grade Low Sulfur No. 1-D	Grade No. 2-D Grade Low Sulfur No. 2-D	
Density at 15 °C	kg/m <sup>3</sup>	max. 860 *	max. 860 *	
Flashpoint	°C	at least 38	at least 52	ASTM D 93
Water and sediments	vol. %	max. 0.05	max. 0.05	ASTM D 2709
Distillation range at 90 vol. %	°C	–	at least 282	ASTM D 86
	°C	max. 288	max. 338	
Kinematic viscosity at 40 °C	mm <sup>2</sup> /s	1,3 - 2,4	1,9 - 4,1	ASTM D 44
Ash	weight-%	max. 0.01	max. 0.01	ASTM D 482
Sulphur				
	- Grade No. 1/2-D	weight-%	max. 0.50	max. 0.50
- Grade Low Sulfur No. 1/2-D	weight-%	max. 0.05	max. 0.05	ASTM D 2622
Copper corrosion (max. 3 h at 50 °C)	Degree of corrosion	No. 3	No. 3	ASTM D 130
Centane number		at least 40	at least 40	ASTM D 613
Coke residue according to Ramsbottom of 10 % distillate residue	weight-%	0,15	0,35	ASTM D 524
Limit of filtrability	°C	**	**	

\* Minimum requirement DEUTZ

\*\* depending on season and region

**Annex 4: Fuel specification (minimum requirement) diesel fuel according to JIS K 2204:1997**

Properties	Units	Limit values		Test method
		Grade 1 Fuel	Grade 2 Fuel	
Flashpoint	°C	at least 50	at least 50	ISO 3405:1988 ISO 3924:1977
Distillation range at 90 vol. %	°C	max. 360	max. 350	ISO 3405:1988 ISO 3924:1977
Pour point	°C	max. -2.5	max. -7.5	ISO 3015:1974 ISO 3016:1974
Limit of filtrability	°C	max. -1	max. -5	ICS 75.160.20
Coke residue from 10% distillation residue	mg	max. 0.1	max. 0.1	ISO 4260:1992 ISO 4260:1992
Centane index		at least 50	at least 45	ISO 5163:1990 ISO 5164:1990 ISO 5165:1992 ISO 4264:1992
Kinematic viscosity at 30°C	vol. %	at least 2.7	at least 2.5	ISO 2909:1981 ISO 3104:1994
Sulphur	weight-%	max. 0.05 *	max. 0.05 *	ISO 4260:1992 ISO 8754:1992

\* from 2005 max. 0.005 weight-%



**Annex 5: Fuel specification (minimum requirement) distillate fuel according to ISO 8217:1996**

Properties	Units	Limit values Category ISO-F		Test method
		DMX	DMA	
Density at 15 °C	kg/m <sup>3</sup>	max. 890	max. 890	ISO 3675 ISO 12185
Viscosity at 40 °C	mm <sup>2</sup> /s	1,4 - 5,5	1,5 - 6,0	ISO 3104
Flashpoint	°C	at least 43	at least 60	ISO 2719
Pour point				
- Winter	°C	–	max. -6	ISO 3016
- Summer	°C	–	max. 0	ISO 3106
Cloud point	°C	max. -16 **	–	ISO 3015
Sulphur	weight-%	max. 1.0 ***	max. 1.0 * ***	ISO 8754
Centane number		at least 45	at least 40	ISO 5165
Coke residue from 10 % distillation residue	weight-%	max. 0.30	max. 0.30	ISO 10370
Ash	weight-%	max. 0.01	max. 0.01	ISO 6245

\* Minimum requirement DEUTZ

\*\* This fuel can be used without pre-heating up to - 15 °C.

\*\*\* Note the shorter lube oil maintenance interval

**Annex 6: Fuel specification (minimum requirement) diesel fuel according to NATO specification**

Properties	Units	Limit values F-75 *	Test method
Density at 15 °C	kg/m <sup>3</sup>	815 - 860	DIN 51757
Kinematic viscosity at 40 °C	mm <sup>2</sup> /s	1,8 - 4,3	DIN 51562 Part 1
Flashpoint	°C	at least 61	DIN EN 22719
Cloud point	°C	max. -13	DIN EN 23015
Pour point	°C	max. -18	DIN ISO 3016
Ash	weight-%	max. 0.01	DIN EN ISO 6245
Neutralisation number (acidic)	mg KOH/g	max. 0.5	DIN 51558 Part 1
Neutralisation number (water-soluble acids)	mg KOH/g	0,0	DIN 51558 Part 1
Sulphur content	weight-%	max. 0.05	DIN 51400 Part 1 and 6
Corrosion (copper) 3 h at 100 °C	Degree of corrosion	max. 1	DIN EN ISO 2160
Coking tendency	weight-%	max. 0.16	DIN 51551 Part 1
Distillation behavior at 90 vol. %	°C	max. 357	DIN 51751
Distillation end point at 90 vol. %	°C	max. 385	
Centane number		at least 45	DIN 51773
Water content	mg/kg	max. 200	DIN 51777 Part 1
Sediments	mg/l	max. 10	ASTM D 2276 App. A 2
Demulgation capacity	minutes	max. 10	ISO 6614

\* National specifications DE = TL 9140-0003 FR = STM 7120 BIT = MM C 1002/E



**Annex 7: Fuel specification (minimum requirement) diesel fuel according to NATO specification**

Properties	Units	Limit values F-76 *	Test method
Density at 15 °C	kg/m <sup>3</sup>	820 - 880	IP 160
Distillation compensated at 350 °C	vol. %	at least 85	IP 123
Kinematic viscosity at 40 °C	mm <sup>2</sup> /s	1,7 - 4,3	IP 71
Flashpoint	°C	at least 61	IP 34
Cloud point	°C	max. -1	IP 219
Pour point	°C	max. -6	IP 15
Ash	weight-%	max. 0.01	IP 4
Neutralisation number	mg KOH/g	max. 0.3	IP 139
Neutralisation number (water-soluble acids)	mg KOH/g	0,0	IP 182
Sulphur content	weight-%	max. 1.0 **	IP 336
Copper corrosion 3 h at 100 °C	Degree of corrosion	max. 1	IP 154
Coke residue (from 10% distillation residue)	weight-%	max. 0.2	IP 14
Centane number		at least 45	ASTM D 613
Sediments	mg/l	max. 10	

\* National specifications EN = DEF. STAN 91-4US = MIL-F-16884 JFR = STM 7120 BNL = KN 10323

\*\* Observe national requirements, max. 1.0 weight-%

**Annex 8: Fuel specification (minimum requirement) light heating oil according to DIN 51603-1:09/2003**

Properties	Units	Limit values DIN 51603-EL-1	Test method
Density at 15 °C	kg/m <sup>3</sup>	max. 860	DIN 51757 or DIN EN ISO 12185
Heating value	MJ/kg	at least 42.6	DIN 51900-1 and DIN 51900-2 or DIN 51900-3 or calculation
Flashpoint in closed pot according to Pensky-Martens	°C	over 55	DIN EN 22719
Kinematic viscosity at 20 °C	mm <sup>2</sup> /s	max. 6.0	DIN 51562-1
Distillation process total evaporated volume percentages			DIN EN ISO 3405 or ASTM D 86
- up to 250 °C	%	max. 65	
- up to 350 °C	%	at least 85	
Cloud point	°C	max. 3	DIN EN 23015
Temperature limit value of filtrability (CFPP) dependent on cloud point			DIN EN 116
- at cloud point = 3 °C	%	max. -11	
- at cloud point = 2 °C	%	max. -11	
- at cloud point ≤ 1 °C	%	max. -10	
Coke residue according to Conradson of 10% distillate residue	weight-%	max. 0.5	DIN EN ISO 10370 or DIN 51551-1
Sulphur content	mg/kg	at least more than 50	DIN EN 24260 or
- for heating oil EL-1 standard	%	at least more than 0.0050	DIN EN ISO 8754 or
- specified as a weight percentage	%	max. 0.2	DIN EN ISO 14596
Sulphur content	mg/kg	max. 50	E DIN 51400-11 or
- for heating oil EL-1 low-sulphur	%	max. 0.0050	DIN EN 24260 or
- specified as a weight percentage			DIN EN ISO 14596
Water content	mg/kg	max. 200	DIN 51777-1 or DIN EN ISO 12937
Overall soiling	mg/kg	max. 24	DIN EN 12662
Ash content	weight-%	max. 0.01	DIN EN ISO 6245
Storage and thermal stability	A limit value can only be specified after development of a suitable method.		



**Annex 9: Fuel specification (minimum requirement) light heating oil according to ASTM Designation D 396-96**

Properties	Units	Limit values ASTM D 396-96		Test method
		No. 1	No. 2	
Density at 15 °C	kg/m <sup>3</sup>	max. 850	max. 876	ASTM D 1298
Flashpoint	°C	at least 38	at least 38	ASTM D 93
Water and sediments	vol. %	max. 0.05	max. 0.05	ASTM 2709
Distillation range				ASTM D 86
- 10 vol. % at	°C	max. 215	–	
- 90 vol. % at	°C	–	at least 282	
	°C	max. 288	max. 338	
Kinematic viscosity at 40 °C	mm <sup>2</sup> /s	1,3 - 2,1	1,9 - 3,4	ASTM D 445
Sulphur	weight-%	max. 0.5	max. 0.5	ASTM D 129
Copper corrosion (max. 3 h at 50 ° C)	Degree of corrosion	No. 3	No. 3	ASTM D 130
Centane number		at least 40 *	at least 40 *	
Coke residue according to Ramsbottom of 10 % distillate residue	weight-%	max. 0.15	max. 0.35	ASTM D 524
Pour point	°C	max. -18	max. -6	ASTM D 97

\* Minimum requirement DEUTZ

**Annex 10: Fuel specification (minimum requirement) light heating oil according to BS 2869:1998**

Properties	Units	Limit values BS 2869 Class A2	Test method
Kinematic viscosity at 40 °C			
- Summer (16.3.-30.9.)	mm <sup>2</sup> /s	2,0 - 5,5	EN ISO 3104:
- Winter (1.10.-15.3.)	mm <sup>2</sup> /s	1,5 - 5,5	EN ISO 3104:
Density	kg/m <sup>3</sup>	at least 820	EN ISO 3675 or EN ISO 12185
Centane number		at least 45	BS 5580
Coke residue from 10 % distillation residue	weight-%	max. 0.30	EN ISO 10370:
Distillation			
- compensated at 250 °C	vol. %	max. 65	BS 7392
- compensated at 350 °C	vol. %	at least 85	BS 7392
Flashpoint in closed pot according to Pensky-Martens	°C	at least 56	EN 22719
Water content	mg/kg	max. 200	ASTMD 1744
Sediments	weight-%	max. 0.01	EN ISO 3735:
Ash content	weight-%	0,01	EN ISO 6245:
Sulphur content	weight-%	0,20	EN ISO 8754:
Copper corrosion (max. 3 h at 100°C)	Degree of corrosion	1	EN ISO 2160:
Limit of filtrability			
- Summer (16.3.-30.9.)	°C	max. -4	EN 116
- Winter (1.10.-15.3.)	°C	max. -12	EN 116



**Annex 11: Fuel specification (minimum requirement) light heating oil according to CSR 441:01.07.2002**

Properties	Units	Limit values CSR 441	Test method
Density at 15 °C	kg/m <sup>3</sup> kg/m <sup>3</sup>	at least 830 max. 880	EN ISO 3675: EN ISO 12185:
Kinematic viscosity at 20 °C	mm <sup>2</sup> /s	max. 9.5	EN ISO 3104:
Sulphur content	weight-%	max. 0.20	EN 24260 EN ISO 14596
Distillation			
- compensated at 250 °C	vol. %	max. 65	EN ISO 3405:
- compensated at 350 °C	vol. %	at least 85	EN ISO 3405:
Flashpoint	°C	at least 55	NF T 60-103
Water content	mg/kg	max. 200	ISO 6296 EN ISO 12937
Water content and sediments	weight-%	max. 0.10	NF M 07-020
Oxidation resistance	g/m <sup>3</sup>	max. 25	EN ISO 12205:
Pour point	°C	max. -9	NF T 60-105
Limit of filtrability	°C	max. -4	EN 116
Coke residue (from 10 % distillation residue)	weight-%	max. 0.35	ISO 6615 EN ISO 10370
Centane number		at least 40	EN ISO 5165:

**Annex 12: Fuel specification (minimum requirement) jet fuels**
**NATO-Code F-34/F-35**

Properties	Units	Limit values NATO code F-34/F-35 *	Test method **
Density at 15 °C	kg/m <sup>3</sup>	775-840	DIN 51757/
Distillation range			
- at 10 vol. % distillate amount	°C	max. 205	DIN 51751
- Distillation end point	°C	max. 300	
- Distillation residue	vol. %	max. 1.5	
- Distillation loss	vol. %	max. 1.5	
Kinematic viscosity	mm <sup>2</sup> /s	max. 8.0 at -20 °C	DIN 51562-1
Flashpoint	°C	at least 38	EN ISO 2719/IP 170
Sulphur content	weight-%	max. 0.20	DIN 51400-1 and 6
Ash	vol. %	–	DIN EN ISO 6245
Water content	mg/kg	–	DIN 51777-1
Sediments	mg/dm <sup>3</sup>	–	ASTM D 2276 App. A2
Heating value H <sub>u</sub>	MJ/kg	at least 42.8	DIN 51900-1 und -2
Cloud point	°C	–	DIN EN 23015
Pour point	°C	–	DIN ISO 3016
Centane number		at least 40 ***	DIN 51773
Copper corrosion	Degree of corrosion	1 (2 h at 100 °C)	DIN EN ISO 2160

\* National specifications D = TL 9130-0012, D. STAN 91-91 USA = MIL-DTL-83133 EF = DCSEA 134/AGB = D. STAN 91-87/91 NL = D. STAN 91-87/91

\*\* applies for the Federal Republic of Germany

\*\*\* Minimum requirement DEUTZ



**NATO-Code F-44/F-63**

Properties	Units	Limit values NATO code		Test method
		F-44 *	F-63 **	
Density at 15 °C	kg/m <sup>3</sup>	788-845	797	ASTM-D 1298
Distillation range				
- at 10 vol. % distillate amount	°C	max. 205	max. 205	ASTM-D 86
- Distillation end point	°C	max. 290	max. 300	
- Distillation residue	vol. %	max. 1.5	max. 1.5	
- Distillation loss	vol. %	max. 1.5	max. 1.5	
Kinematic viscosity	mm <sup>2</sup> /s	max. 8.5 at -20 °C	max. 8.0 at -20 °C	ASTM-D 445
Flashpoint	°C	at least 61	at least 38	ASTM-D 93
Sulphur content	weight-%	max. 0.30	max. 0.20	ASTM-D 1266/2622
Ash	vol. %	–	–	
Water content	mg/kg	–	–	
Sediments	mg/dm <sup>3</sup>	–	–	
Heating value H <sub>U</sub>	MJ/kg	at least 42.6	at least 42.8	ASTM-D 240/2382
Cloud point	°C	–	–	
Pour point	°C	–	–	
Centane number		at least 40 ***	at least 48	
Copper corrosion	Degree of corrosion	1 (2 h at 100 °C)	1 (2 h at 100 °C)	ASTM-D 130

\* National specifications DE = D. STAN 91-86 USA = MIL-DTL-5624 T Grade JP-5F = DCSEA 144/AGB = D. STAN 91-86

\*\* National specifications F = DCSEA 108/A

\*\*\* Minimum requirement DEUTZ

**Annex 13: Fuel specification (minimum requirements) Fatty Acid Methyl Ester (FAME)  
 for diesel engines (bio diesel fuel)**

Properties	Units	Limit values EN 14214:2003	Test method
Ester content	weight-%	at least 96.5	EN 14103
Density at 15 °C	kg/m <sup>3</sup>	860 - 900	EN ISO 3675:1998 EN ISO 12185:1996/C1:2001
Viscosity at 40 °C	mm <sup>2</sup> /s	3,5 - 5,0	EN ISO 3104:1998/C2:1999
Flashpoint	°C	at least 120	prEN ISO 3679:2002
Sulphur content	mg/kg	max. 10.0	prEN ISO 20846:2002 prEN ISO 20884:2002
Coke residue (from 10 % distillation residue)	weight-%	max. 0.30	EN ISO 10370:1995
Centane number		at least 51	EN ISO 5165:1998
Ash content (sulfate ash)	weight-%	max. 0.02	ISO 3987:1994
Water content	mg/kg	max. 500	EN ISO 12937:2000
Overall soiling	mg/kg	max. 24	EN 12662:1998
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	1	EN ISO 2160:1998
Oxidation stability, 110 °C	Hours	at least 6	EN 14112
Acid number	mg KOH/g	max. 0.5	EN 14104
Iod number	gr Iod/100gr	max. 120	EN 14111
Content of linolenic acid-methylester	weight-%	max. 12.0	EN 14103
Content of fatty acid-methylester with ≥ 4 double bonds	weight-%	max. 1	
Methanol content	weight-%	max. 0.20	EN 14110
Monoglyceride content	weight-%	max. 0.80	EN 14105
Diglyceride content	weight-%	max. 0.20	EN 14105
Triglyceride content	weight-%	max. 0.20	EN 14105
Content of free glycerine	weight-%	max. 0.020	EN 14105 EN 14106
Content of total glycerine	weight-%	max. 0.25	EN 14105
Content of alkaline metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109
Content of alkaline earth metals (Ca + Mg)	mg/kg	max. 5.0	prEN 14538:2002
Phosphor content	mg/kg	max. 10.0	EN 14107
Limit of filtrability (CFPP) * - 15.04. up to 30.09.	°C	max. 0	EN 116:1997



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Properties	Units	Limit values EN 14214:2003	Test method
- 01.10. up to 15.11.	°C	max. -10	
- 16.11. up to 28.02.	°C	max. -20	
- 01.03. up to 14.04.	°C	max. -10	

\* data apply for the Federal Republic of Germany. National regulations may deviate.