Technical Circular

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DEUTZ engines

- All DEUTZ engines
- Assemblies:

  99

Fuels

Replacement is made on account of:

- Updating

General

This bulletin defines for which compact engines of the DEUTZ brand the following fuels are approved:

- Diesel fuels
- Non-road fuels and light heating oils
- Synthetic and paraffinic fuels (HVO, GtL, CtL, BtL)
- Biofuels (biodiesel and vegetable oils)
- Jet fuels
- Marine distillate fuels (MDF)

For general data on fuels, see section:

- Biological contamination in fuels
- Fuel additives
- Fuel filter
- General information on fuel properties

Note:
The part numbers indicated in this document are not subject to updating.
Binding for the identification of spare parts is exclusively the spare parts documentation.

This Technical Bulletin applies for all air-cooled and liquid-cooled compact engines of the DEUTZ brand. For engines which are no longer in production, this TR applies accordingly. This bulletin only applies up to year of production 2000 for engines of the 226 series.

Fuels must be used as regulated in the respective national regulations (e.g. in Germany in the 10th BImSchV). No fuels which deviate from these national regulations may be used (e.g. no fuel may be used in Europe if it only meets the limit values of the US standard purely by chance).

The certification measurements for compliance with the legal emission limit values are carried out with the test fuels specified in the laws. These correspond to the diesel fuels according to EN 590 and ASTM D975 described in the following section. With the other fuels described in this bulletin, no emission values are guaranteed. The operator is obliged to check the permission for the use of fuels according to the national regulations.

Engines which are equipped with exhaust gas after-treatment by a closed diesel particle filter (DPF), diesel oxidation catalytic converter (DOC), or an SCR system (selective catalytic reduction) may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15). Otherwise compliance with the emission requirements and durability is not guaranteed.

In a warranty case, the customer must prove by a certificate from the fuel supplier that a released fuel was used.

The following list specifies the released fuels for the different series and emission stages, the following text contains further data about these releases:

List of released fuels

	413 513 912 913 914 up to Tier 3 Stage IIIA	1008 2008 2009 226 909 910 up to Tier 3 Stage IIIA	1011 2011 up to Tier 3 Stage IIIA	1012 1013 2012 2013 up to Tier 2 Stage II EURO 3	1015 up to Tier 2 Stage II	413/513 912/913 1013M 1015M 2015M 914M Marine engines
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204[8]	✓	✓	✓	✓	✓	✓
Non-road fuels (light heating oils) in accordance with DIN 51603	✓	✓	✓	✓	✓	✓
Biodiesel (B30) up to 100 % EN14214, up to 20 % ASTM D7467	✓	-	✓	✓	-	✓ [6]
Jet fuels	✓	-	✓	✓	✓ [7]	-
Marine distillate fuels (MDF) in accordance with ISO 8217	✓	-	-	-	-	✓
Diesel fuel worldwide according to Appendix 5	✓	✓	✓	✓	✓	✓

	TCD 2012 2V 2012 4V Tier 3 Stage IIIA	TCD 2013 2V 2013 4V Tier 3 Stage IIIA	TCD 2013 4V Com-mercial vehicles up to Euro III	TCD 2013 4V Com-mercial vehicles from Euro IV	TCD 2015 Euro III Tier 3 Stage IIIA	DEUTZ Natural Fuel En-gine ® Stage IIIA
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204[8]	✓	✓	✓	✓	✓ [10]	✓
Non-road fuels (light heating oils) in accordance with DIN 51603	✓	✓	-	-	✓	✓ [2]
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	✓	✓	✓	✓ [3]	✓ [4]	✓
Vegetable oil (DIN 51605)	-	-	-	-	-	✓
Jet fuels	✓ [7]	✓ [7]	-	-	✓ [7]	-
Marine distillate fuels (MDF) in accordance with ISO 8217	-	-	-	-	-	-
Diesel fuel worldwide according to Appendix 5	✓	✓	✓	-	✓	-

	D/TD/ TCD 2.9 L4 TD/TDC 3.6 L4 up to Tier 3	D/TD/ TCD 2.9 L4 TD/TDC 3.6 L4 from Tier 4 interim Stage IIIB	TCD 4.1 L4 TCD 6.1 L6 TCD 7.8 L6 up to Tier 3	TCD 4.1 L4 TCD 6.1 L6 TCD 7.8 L6 from Tier 4 interim Stage IIIB	TCD 12.0 V6 TCD 16.0 V8 from Tier 4 interim Stage IIIB
Diesel fuels in accordance with EN 590, ASTM D975 or JIS K 2204[8]	✓	✓ 5	✓	✓ 5	✓ 5
Non-road fuels (light heating oils) in accordance with DIN 51603	-	✓ 2	-	✓ 2	✓ 2
Biodiesel (up to 100 % EN14214, up to 20 % ASTM D7467)	-	-	-	✓ 1	-
Jet fuels	-	-	-	-	-
Marine distillate fuels (MDF) in accordance with ISO 8217	-	-	-	-	-
Diesel fuel worldwide according to Appendix 5	✓ 9	-	✓ 9	-	-

Restrictions	
✓ 1	Release only for Agri Power engines (Stage IIIB) with SCR exhaust gas after-treatment system
✓ 2	Release only for non-road heating oils with EN 590 quality, see chapter Non-road fuels and light heating oils.
✓ 3	Release up to 30 %(V/V) EN14214 at replacement interval of the SCR catalytic converter of 200,000 km, see chapter Biofuels.
✓ 4	Release for engines as of 01.07.2010, retrofitting possible in earlier engines. US biodiesel release up to 50 %(V/V) for mine engines (MSHA)
✓ 5	Release for US diesel fuel in accordance with ASTM D975 S15 only
✓ 6	Does not apply for the 1015M series
✓ 7	Note special restrictions in the chapter “Jet fuels”.
8	HFRR maximum 460 µm
✓ 9	Sulphur content maximum 500 mg/kg
✓ 10	Also applies for EURO 3

Diesel fuels

DEUTZ vehicle engines are designed for diesel fuels with a cetane number of at least 51. DEUTZ engines for mobile work machinery are designed for a cetane number of at least 45. When using fuels with a low cetane number, a disturbing formation of white smoke and ignition stutter is to be expected under some circumstances.

A cetane number of at least 40 is approved for the US market, which is why special engine versions were developed to avoid starting difficulties, extreme white smoke or increased hydrocarbon emissions. If the use of fuels with a very low cetane number is also known in advance in other countries, we recommend ordering the engines in EPA versions. It is generally recommended to use fuels with a higher cetane number than the minimum requirement of 40 in winter.

Diesel fuels are released and can be used in accordance with the following specifications:

Fuel		Specifications
EN 590	Biodiesel content max. 7 %(V/V)	Appendix 2
ASTM D975 Grade 1-D S15	Biodiesel content max. 5 %(V/V)	Appendix 3
ASTM D975 Grade 2-D S15		
JIS K 2204		Appendix 4
NATO F-54		on request

Japanese diesel fuels according to JIS K 2204 Grade 1 Fuel and Grade 2 Fuel are only released if the lubricating properties correspond with diesel fuel EN 590 (HFRR max. 460 µm according to EN ISO 12156-1).

The EN 590 standard has the status of a national standard in the countries of the EU, e.g. DIN EN 590. The NATO fuel F-54 is equivalent to diesel fuel in accordance with EN 590, but with max. 50 mg/kg sulphur.

Diesel fuels in other countries

The table in Appendix 5 contains the requirements for diesel fuels for the countries in which none of the released fuels named in this bulletin exist.

For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using these fuels.

Fuel	Specifications
For countries in which none of the named diesel fuels released by DEUTZ exist.	Appendix 5

Lubricity for low-sulphur and sulphur-free fuels

Insufficient lubricity can lead to serious wear problems, especially in common rail injection systems. Too low a lubricity is particularly a problem in fuels with a low sulphur content (and in this respect sulphur contents ≤ 500 mg/kg can already be considered low). An adequate lubricity is guaranteed by the appropriate additives at the refinery in low-sulphur (≤ 50 mg/kg) or sulphur-free (≤ 10 mg/kg or ≤ 15 mg/kg) diesel fuels according to EN 590 and ASTM D975. In low-sulphur and sulphur-free diesel fuels which do not comply with this standard, the lubricity may have to be guaranteed by additives. The parameter for sufficient lubricity is a maximum wear spot of 460 µm in the HFRR test (EN ISO 12156-1).

Biodiesel components from 1 %(V/V) ensure compliance with the limit values.

High sulphur content in the fuel

Fuels with a sulphur content > 0.5 %(m/m) (5,000 mg/kg) demand a shorter lubricating oil change interval (see Technical Bulletin 0199-99-01217). Fuels with a high sulphur content may not be used in engines with exhaust gas after-treatment (from Tier 4 interim / Stage IIIB / Euro 4). Fuels with a sulphur content > 1.0 %(m/m) are not permissible due to high corrosion and considerable shortening of the engine life. Low-ash / low SAPS engine lubricating oils (sulphate ash max. 1.0 %(m/m)) may only be used in engines without exhaust after-treatment systems if the sulphur content in the fuel does not exceed 50 mg/kg. However, low-ash lubricating oils may be used in engines without exhaust gas after-treatment systems up to sulphur contents of 500 mg/kg if the base number (TBN) is at least 9 mg KOH/g. A corresponding note regarding suitable lubricating oils is published in the DEUTZ lubricating oil release list.

Winter operation with diesel fuel

Special demands are placed on the cold behaviour (temperature limit value of the filtrability) for winter operation. Suitable fuels are available at fuel stations in winter.

Diesel fuels up to -44 °C are available for an arctic climate (e.g. EN 590, Class 4 or US-DK Grade 1-D).

Mixing with petrol is not permissible for safety and technical reasons (cavitation in the injection system).

Adding kerosene to diesel fuel to improve the low-temperature characteristics is not permissible for engines with exhaust gas after-treatment and externally cooled exhaust gas recirculation.

Adding flow improvers to the diesel fuel is only allowed in exceptional cases. The choice of a suitable additive and the necessary dosing and mixing procedure must be discussed with the fuel supplier.

Non-road fuels and light heating oils

In some European countries, non-road fuels are defined with the same properties as heating oil but are taxed differently to diesel fuels. Systems which allow the use of heating oils and are subject to tax relief in Germany are described in the Energy Taxation Act (§3).

The user must strictly adhere to the nationally applicable tax regulations concerning the use of heating oil. These are not part of this technical bulletin.

With regard to use in the engine (warranty rights), no differences are to be made between the appropriate non-road fuels and light heating oils.

- For all non-road engines that are operated in Europe outside of Germany, light heating oils or non-road fuels may only be used if they are comparable with the specification EN 590 , e.g. in France GNR (Gazole non Routier) and in Great Britain non-road fuel as per BS 2869:2010.
- The density of the fuel must be a maximum of 0.860 g/cm^3.
- Only biodiesel-free fuels may be used for emergency power supply units in standby operation. DEUTZ therefore recommends the use of light heating oil in accordance with **DIN 51603-1 low sulphur** (for Germany), **ÖNORM C1109 sulphur-free** (for Austria) or **SNV 181160-2 low sulphur** (for Switzerland).

Fuel	Specifications
DIN 51603-1 low sulphur	Appendix 6

Synthetic and paraffinic fuels (HVO, GtL, CtL, BtL)

These fuels are generated from natural gas (Gas-to-Liquid), carbon (Coal-to-Liquid), biomass (Biomass-to-Liquid) or from vegetable oils (HVO, Hydrogenated or Hydrotreated Vegetable Oils) through catalytic hydrogenation using the Fischer-Tropsch process.

In the case of BtL / HVO, reference is also made to so-called biogenic fuels of the 2nd generation.

These fuels are specified in the following standard:

Fuel	Specifications
EN 15940 (Automotive fuels - Paraffinic diesel fuel from synthesis or hydrotreatment)	Appendix 7

They fulfil the American diesel fuel standard ASTM D975 and, apart from the density, also the European diesel fuel standard EN 590.

They differ from diesel fuel as follows:

- Chemical composition: pure paraffins, no aromatics, no branched carbon chains, no carbon double bonds
- High cetane number > 70
- Positive influences on emissions (nitric oxides and particles) and the engine acoustics
- Lower density, this results in a slightly lower engine performance

Currently, the following engine series are released without exhaust gas after-treatment in consideration of the following recommendations:

- 912/914/914M
- 2011
- 1012/2012/1013/1013M/2013
- 1015/1015M/2015/2015M

Other engines with an exhaust gas after-treatment system are currently in the release testing phase.

It is a known fact that fuel leaks may occur in engines that were operated with standard diesel fuels for prolonged periods and then with paraffinic fuels. The reason for this behaviour is the altered swelling behaviour of NBR polymer seals in paraffinic diesel fuel compared to conventional diesel due to its freedom of aromatics.

The seals must be checked for leaks in the course of daily maintenance. DEUTZ therefore recommends that the critical seals be replaced when switching from diesel fuel to paraffinic fuel.

The swelling problem does not arise if an engine is operated with paraffinic diesel fuel from the start or if FKM seals and polymer hoses are used.

Because of their very positive influences with regard to the cetane number and emission behaviour, these paraffinic fuels are blended partly in the so-called premium diesel fuels

and in this case have no negative influences on the polymer compatibility or the density. This addition is permissible within EN 590.

Biofuels

The generic term biofuels includes biodiesel and pure vegetable oils.

Biodiesel

Biodiesel is Fatty Acid Methyl Ester (FAME) of vegetable oil. It is produced on a large scale by re-estering vegetable oil and methanol to glycerine and fatty acid methyl ester. It is possible to use different vegetable oils such as soya oil, palm oil, rapeseed oil, sunflower oil or old fats.

In Europe, biodiesel must comply with the EN 14214 standard. Because the biodiesel qualities available on the market do not always meet the requirements, DEUTZ customers in Germany are recommended to ensure the quality by buying biodiesel with an AGQM certificate (Association for Biodiesel Quality Management). The customers should also have compliance with the quality demands confirmed by the supplier by submission of a current analysis certificate of an ISO 17025 certified laboratory.

A 1 Biodiesel

The use of US biodiesel, based on soya oil methyl ester, is only permissible in mixtures with diesel fuel with a maximum biodiesel content of 20 %(V/V) in accordance with the ASTM D7467 standard. The US biodioesel greater than 20 %(V/V) used for the mixture must comply with the ASTM D6751 standard. Users are recommended to use biodiesel qualities with a quality certified in accordance with BQ 9000.

Fuel	Specifications
Biodiesel according to EN 14214	Appendix 8
Biodiesel blends according to EN 16709 - High Fame Fuels (B20 and B30)	Appendices 9a / 9b
US biodiesel according to ASTM D6751 (B100) (only for biodiesel blends with diesel fuel > 20 %(V/V))	Appendix 10
US biodiesel blends according to ASTM D7467 (only for biodiesel blends with diesel fuel of 6-20 %(V/V))	Appendix 11

Biofuels in other countries

The table in Appendix 12 contains the requirements for biofuels for the countries in which none of the released fuels named in this bulletin exist.

For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using these fuels.

Fuel	Specifications
For countries in which none of the named diesel fuels released by DEUTZ exist.	Appendix 12

Released engines

- The series 413/513/912/913/914/1011/1012/1013/2011/2012 and 2013 are released if compliant with the basic conditions specified in the text below as of the year of construction 1993 for biodiesel according to EN 14214, as a Biodiesel Blend according to EN 16709 or ASTM D7467, as well as for other biodiesel fuels that meet the requirements of Appendix 12.
- The TCD 2012 2V/4V and TCD 2013 2V/4V series for mobile work machinery up to Stage IIIA/Tier 3 are released for 100 %(V/V) biodiesel according to EN 14214, as a Biodiesel Blend according to EN 16709 or ASTM D7467, as well as for other biodiesel fuels that meet the requirements of Appendix 12. For engines operated within the area of application of the Mine Safety and Health Administration (MSHA), mixing up to 100 %(V/V) US biodiesel is permissible according to ASTM D6751.
- The 1015 series of engines with no flame starting system is approved for mixtures of up to 20 % (V/V) biodiesel according to ASTM D7467, as well as other biodiesel blends that satisfy this standard.
- Engines of the series TCD 2015 with an MV injection system are released for 100 %(V/V) biodiesel according to EN 14214, as a Biodiesel Blend according to EN 16709 or ASTM D7467, as well as for other biodiesel fuels that meet the requirements of Appendix 12 from the production date 01/07/2010.
  For engines operated within the area of application of the Mine Safety and Health Administration (MSHA), mixing up to 50 %(V/V) US biodiesel is permissible according to ASTM D6751.
- Mixtures of US biodiesel with diesel fuel are not very suitable for cold weather and are not recommended for the winter.
  Engines with an earlier production date can be retrofitted. The head office can provide information about the scope of the retrofit.
- The addition of up to 30 %(V/V) biodiesel according to EN 16709 is released for TCD 2013 EURO III/IV/V commercial vehicles. Engines in which an additional diesel particle filter (DPF) is installed are excluded from the release.
- Agri Power engines with SCR exhaust gas after-treatment systems of stage IIIB of the TCD 4.1 L4, TCD 6.1 L6 and TCD 7.8 L6 series are released for 100 %(V/V) biodiesel according to EN 14214.

  In Agri Power engines, the SCR catalytic converter must be changed every 3,000 oh or after 2 years at the latest.

- For new customers it must be ensured that all the necessary basic conditions are satisfied and release by the Sales department is available before using biodiesel. Here too, DEUTZ customers are recommended to only use biodiesel with an AGQM certificate.
- Turbocharged engines are excepted from the release for applications which are normally operated with a high load above 80 % nominal power of the respective engine series; these are, for example, engines in block type heating power stations.

Basic conditions to be observed

- Because of the low heating value, a power loss of 5 - 9 % and an extra fuel consumption of 7 - 8 % in comparison with diesel fuel according to EN 590 is possible. Blocking up of the injection pump is not allowed.
- The lubricating oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
- Downtime periods of longer than 4 weeks must be avoided with biodiesel. Otherwise the engine must be started and shut down with diesel fuel.
- Engines with a low annual running time, e.g. emergency power supply units, are excluded from operation with biodiesel.
- In series engines, the fuel hoses, the manual fuel supply pumps, and the LDA diaphragms (series 1012/1013/2012/2013/TCD 2012 2V mechanical and TCD 2013 2V mechanical) are partly not resistant to biodiesel and must be changed annually. To avoid annual replacement of the manual fuel supply pumps, a piston with an LDA diaphragm resistant to biodiesel fuel was introduced. Since the fuel hoses can dissolve prematurely at increasing fuel temperature and high running performance, they may have to be replaced before one year is up. The fuel hoses must be checked for damage (swelling) in the course of daily maintenance E 20. It is advisable to use biodiesel-resistant fuel hoses made of FKM materials (fluorinated rubber). In this case, there is no need for an annual replacement.
- Biodiesel can be mixed with normal diesel fuel, but the basic conditions described in this section apply for mixtures. Mixtures containing up to 7 %(V/V) biodiesel (B7) as they are permitted in EU countries according to national laws are excepted. However, the biodiesel mixtures must comply with EN 14214 in any case.
- Approx. 30 - 50 oh after changing over from diesel fuel to biodiesel, the fuel filter should be changed as a precaution to avoid a drop in performance due to clogged fuel filters. Deposited fuel-ageing products are dissolved by biodiesel and transported into the fuel filter. They should not be changed immediately, but after approx. 30 to 50 hours, because the dissolving of dirt takes a certain amount of time.
- All parts carrying fuel which are installed later (by OEM or end customers, e.g. fuel prefilter and fuel pipes) must be suitable for operation with biodiesel.
- To increase the oxidation stability of the used rapeseed oil and to increase the service life and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro®" in the recommended concentration (see TR 0199-99-01210).

Vegetable oils

Pure vegetable oils (e.g. rapeseed oil, soya oil, palm oil) are not classified as biodiesel and have problematic properties in engines which were not developed for vegetable oil operation (great tendency for coking, danger of piston seizure, extremely high viscosity, poor evaporation behaviour).

DEUTZ NATURAL FUEL ENGINE®

DEUTZ has developed the first series engine based on the TCD 2012 2V/4V series with the DEUTZ Common Rail System ® (DCR) for use with rapeseed oil.

These engines are released for use of 100 %(V/V) rapeseed oil (refined or cold pressed) according to DIN 51605 (Appendix 13) and biodiesel according to EN 14214 (Appendix 10).

Fuel	Specifications
Rapeseed oil fuel according to DIN 51605	Appendix 13

Basic conditions to be observed

- Because of the low heating value, a power loss of 5 - 10 % and an extra fuel consumption of 4 - 5 % in comparison with diesel fuel according to EN 590 is possible. Blocking up of the injection pump is not allowed.
- The engine is a two-tank system which switches between diesel fuel and rapeseed oil. Alternatively biodiesel can be used instead of rapeseed oil or diesel fuel.
- At temperatures below 5 °C, rapeseed oil should be replaced by diesel fuel or biodiesel.
- Downtime periods of longer than 4 weeks must be avoided with biodiesel and rapeseed oil. Otherwise the engine must be started and shut down with diesel fuel.
- The lubricating oil change interval must be halved in comparison with operation with diesel fuel according to EN 590.
- Important fuel properties such as water content, oxidation stability, calcium, magnesium and phosphorus content and the total contamination are influenced especially by the harvest time, the pressing process in the oil mill, the storage of the rapeseed oil and the further logistics chain. Due to the limit values at distributed oil mills being frequently exceeded, the user is recommended to have the quality of the rapeseed fuel delivery confirmed by an analysis certificate. In cases of doubt, the quality can be certified by an analysis carried out by a laboratory accredited according to ISO 17025, (e.g. ASG Analytik GmbH, D-86356 Neusäß, Tel. +49 (0)821-450-423-0).
- Mixtures with other vegetable oils such as sunflower seed oil, soya oil or palm oil are not permissible because these vegetable oils can have problematic properties (strong coking tendency, danger of piston seizure, poorer low-temperature properties, increased oxidation tendency).
- To increase the oxidation stability of the used rapeseed oil and to increase the service life and reduce deposits and clogging in the injection system, it is recommended to use the DEUTZ additive "DEUTZ Clean-Diesel InSyPro®" in the recommended concentration (see Technical Bulletin 0199-99-01210).

Instructions for the storage of rapeseed oil in fuel stations for own use:

- To be stored in dark places at constant low temperatures (maximum 20 °C, optimal in ground tanks at 5 - 10 °C). Storage temperatures below freezing point should be avoided, ground tanks are also optimal in this respect. The tanks may not be permeable to light (no polythene tanks).
- The storage time for rapeseed oil should be limited to a maximum of 6 months at storage temperatures up to 20 °C, for ground tanks < 10 °C maximum 12 months).
- Due to the hygroscopic (water-attracting) properties of rapeseed oil, company fuel stations should, if possible, be fitted with a dehumidifier on the air exchange system.
- Minimise contact with air using tight seals.
- Contact with metals with a catalytic effect, particularly copper or brass, must be avoided at all costs. These materials must not be used at all in the storage system (e.g. pipes, screw connections, pumps, etc.).
- Avoid gathering of sediments by removal approx. 10 cm above the tank floor.
- The tanks should be regularly cleaned and, if bacterial contamination occurs, the bactericide Grotamar® 71 or 82 should be used by a specialist company.

Series diesel engines

The conversion of other DEUTZ engines to operation with pure plant oil with conversion kits and modified tanks systems of various manufacturers is not allowed and leads to loss of the warranty rights.

Only engines of the 912W/913W/413FW/413W series with the 2-tank system from Henkelhausen, D-47809 Krefeld, Fax no. +49 (0)2151 574 112, can be operated with rapeseed oil fuel according to DIN 51605, see appendix 10.

Jet fuels

The following jet fuels can be used:

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

- The following engine series are released:
  - Engines **without** a common rail injection system and without external exhaust gas recirculation up to Tier 3 / Stage IIIA and EURO III

    413/513/912/913/914

    1011/2011/1012/1013/2012/2013/1015

    TCD 2011/TCD 2012/TCD 2013
  - Engines **with** a common rail injection system

    Genset COM II

    - **TCD 2013 L06**

    Tier 3 / Stage IIIA / EURO III

    - **TCD 2012 2V/TCD 2013 2V/TCD 2013 4V** without exhaust gas recirculation

    Tier 3 / Stage IIIA / EURO III

    - **TCD 2015**
- All engines with exhaust gas after-treatment are not released for jet fuels either.
- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emission may occur.
- Because of the lower density and the greater leak fuel volume due to lower viscosity, depending on the engine speed and torque, a power loss between 3 - 10 % is possible.

An increase in the fuel injection rate is impermissible!

- There are some problematic fuel properties amongst the listed jet fuels (viscosity, high sulphur content, low lubricity and low boiling point). A slight increase in wear in the injection system is to be expected, which can lead to a statistically shorter service life of these components. The warranty is maintained when these fuels are used.
- Jet fuels can be mixed together and with diesel fuel.
- Releases are exclusively restricted to official and special vehicles.

Marine distillate fuels (MDF)

This includes distillate fuels which are used in shipping. Only marine distillate fuels which contain no residue oils (residue from the distillation process) may be used. The releases apply exclusively for DEUTZ marine engines of the 413/513/912/913/914M/1011/2011/1013M/1015M/2015M series.

The following marine fuels may be used:

Fuel	Specifications
ISO 8217 DMX	Appendix 14
ISO 8217 DMA (restriction: sulphur content max. 1.0 %(m/m))	Appendix 14
NATO F-75	Specifications available on request
NATO F-76	

- The cetane number must be at least 40, otherwise starting difficulties, extreme white smoke or increased hydrocarbon emissions may occur.
- At a density of > 0.860 g/cm^3, a return blocking in the injection pump is necessary (may only be carried out by authorised DEUTZ personnel).
- The possible high sulphur content ≥ 0.5 %(m/m) requires a shorter lubricating oil change interval. Fuels with a sulphur content > 1.0 %(m/m) are not permissible due to higher corrosion and considerable shortening of the engine life. It must therefore be pointed out that fuels in accordance with ISO 8217 DMA are only permissible when the maximum sulphur content is 1.0 %(m/m).
- Low-ash oils (low SAPS) are not permissible at sulphur contents > 50 mg/kg or > 500 mg/kg already (see Technical Bulletin 0199-99-01217), i.e. generally not suitable for marine distillate fuels.
- Because of the possible heavier contamination, great emphasis must be placed on fuel cleaning and possibly the installation of an additional fuel filter with a water trap to avoid biological contamination in particular.

Biological contamination in fuels

Symptoms

The following symptoms may indicate that a fuel tank is contaminated by micro-organisms:

- Corrosion of inside of tank
- Filter blockage and associated loss of power due to gel-like deposits on the fuel filter (especially after prolonged downtime periods)

Cause

Micro-organisms (bacteria, yeast, fungi) can multiply into biological sludge under favourable conditions (especially favoured by heat and water).

The water entry is usually caused by condensation of the water contained in the air. Water dissolves poorly in fuel, so the water which enters sinks to the bottom of the tank. The bacteria and fungi grow in the aqueous phase at the boundary with the fuel phase from which they draw their nutrition. There is an increased risk especially with biogenic fuels or biodiesel blend.

Remedial measures

- Keep storage tanks clean, regular tank cleaning (including the fuel line) by specialist companies.
- Installation of fuel pre-filters with water traps, especially in countries with frequently fluctuating fuel qualities and high percentage of water (e.g. Separ-filter or RACOR filter).
- Use of biocide Grotamar® 71 or Grotamar® 82 of

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  D-22840 Norderstedt,
  Tel.: +49 (0)4052 100-0,
  E-mail: info@schuelke.com

  if fuel system and storage tank are already contaminated by micro-organisms. The biocide must be dosed according to the manufacturer's specifications.

- The use is restricted exclusively to eliminating microbe contamination. Prophylactic use is not permissible.
- In suspicious cases, biological contamination according to DIN 51441 (determination of the number of colonies in mineral oil products in the boiling range below 400 °C) can be analysed by laboratories certified according to ISO 17025 (e.g. Petrolab GmbH, D-67346 Speyer, Tel.: +49 (0) 6232-33011).
- Avoid direct radiation of sunlight on the storage tank.
- Use of smaller storage tanks with correspondingly short dwell times of the stored fuel.
- Equip the fuel tank with a drying cartridge on the air exchange system.

- The tank must be cleaned before adding the biocide if there is a clearly visible biofilm in the tank or on the tank walls.
- Appropriate quick check kits are also available from the biocide suppliers.

Tank system maintenance

Instructions for proper tank system maintenance can be found in the Technical Report CEN/TR 15367-1:2015-12 (Petroleum products - Guidelines for good housekeeping - Part 1: Automotive diesel fuels).

Fuel additives

The DEUTZ Clean-Diesel InSyPro® additive is released exclusively for use in DEUTZ engines. See Technical Bulletin 0199-99-01210 for notes on use and dosing.

The previously mentioned flow improvers are an exception. The use of other fuel additives is impermissible. Voiding of the warranty is to be expected when unsuitable additives are used which have not been released.

Fuel filter

Modern diesel engines, especially with high-pressure injection and common rail injection system make very high demands on the fuel quality. The **DEUTZ original fuel filters** are adapted and tested for these demands. Continuous, trouble-free operation of the engines is only guaranteed when the original filters are used. In the event of damage to the injection system within the warranty period and proof that no original filters were used, the warranty will be voided.

If you have questions on any of the topics mentioned here, please contact us using the details given below:

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This document has been created digitally and is valid without a signature.

Appendix 1

General information on fuel properties and exhaust gas after-treatment systems

Exhaust gas after-treatment systems

The introduction of new, strict exhaust emission regulations demands the use of exhaust gas after-treatment systems such as the SCR technique (selective catalytic reduction) and the closed diesel particle filter (DPF). For the trouble-free use of fuels, it is necessary to reduce ash and deposit-forming elements as well as elements which damage the catalytic converter, such as sulphur, as much as possible. Therefore, these engines may only be operated with sulphur-free diesel fuels (EN 590, ASTM D975 Grade 2-D S15, ASTM D975 Grade 1-D S15 or heating oil or non-road fuels in EN 590 quality (sulphur content max. 10 mg/kg)). Other elements such as phosphorus, calcium, magnesium, sodium and potassium, which especially biogenic fuels may contain, should also be minimised. Otherwise, compliance with the emission requirements and durability of the exhaust gas after-treatment systems is not guaranteed.

Ash

Ash is carbon-free combustion residue, which can lead to wear due to deposits in the engine and turbocharger.

Biodiesel

Biodiesel is made by re-estering of greases or oils (triglyceride) with methanol. The correct chemical name is fatty acid methyl ester, often abbreviated to FAME. In Europe it is usually produced by re-estering of rapeseed oil (rapeseed oil methyl ester = RME). In the USA, biodiesel comes almost exclusively from soya oil (soya methyl ester = SME). Other vegetable oils (sunflower oil, palm oil, jatropha oil), animal fats or used vegetable oils (frying fats) are also possible as raw materials.

Due to national and EU regulations, biodiesel (FAME) percentages are now possible or prescribed in most diesel fuels. In the new EN 590, max. 7 %(V/V) is permissible for example, in the US-ASTM D975 max. 5 %(V/V).

Cetane number/cetane index

The cetane number indicates the fuel's ignitibility. Too low a cetane number may lead to starting difficulties, formation of white smoke, increased carbon emission and thermal and mechanical overloading of the engine. The cetane number is determined on a test engine. The cetane index can be substituted as a value calculated from density and boiling behaviour. The cetane index serves for estimating the cetane number for the basic fuel, but it does not usually take the effect of ignitibility improvers into account when the cetane number of finished fuels is determined.

Density

The density is usually specified in g/cm^3 or kg/m^3 at 15 °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.

Flashpoint

The flashpoint has no significance for the engine operation. It applies as a value for the flammability and is important for classification into one of the hazard classes (crucial for storage, transport and insurance).

Heating value

The lower heating value (H_u) indicates the amount of heat which is released when burning 1 kg of fuel.

Low-temperature performance

The following parameters indicate the suitability of the fuel for low temperatures:

- The solidification point indicates at what temperature the fuel no longer flows under its own weight.
- The pour point is approx. 3 °C above the solidification point.
- The cloud point indicates at what temperature solid emissions (paraffin crystals) become visible.
- The limit of filtrability (CFPP) indicates at what temperature filters and pipes may be blocked and is determined nationally or regionally for specific climatic regions (summer/transitional/winter period). For engines that are used only temporarily, the corresponding low-temperature performance must be considered.

Coke residue

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

Copper corrosion

Diesel fuel can be corrosive, especially during prolonged storage with fluctuating temperature and formation of condensation on the tank walls. To check the limit value defined in DIN EN 590, a polished copper strip is immersed in diesel fuel at 50 °C for 3 hours. Appropriate additives ensure protection of the metals which come into contact with the fuel even under difficult conditions.

Neutralisation number

The neutralisation number is a measure of the content of free acids in the diesel fuel or biodiesel fuel. It describes the amount of caustic potash required for neutralising the acids. Acid compounds in the fuel lead to corrosion, wear and formation of residue in the engine.

Oxidation resistance

Fuels may oxidise and polymerise partly during prolonged storage. This can lead to the formation of insoluble (varnish like) components and the associated filter blockage. Biofuel parts are more sensitive to oxidation and impair oxidation resistance as a result.

Lubricity

The lubricity decreases with the degree of desulphurisation and can drop to a level that leads to considerable wear in the distributor injection pumps and common rail systems. Extremely desulphurised fuels contain special lubricity additives. The HFRR test (High Frequency Reciprocating Wear Rig) was developed for evaluating the fuels (EN ISO 12156-1). This test simulates the sliding wear in the injection pump by rubbing a ball on a polished steel plate with constant contact force. The flattening of the ball after 75 minutes is measured as an average wear diameter (limit value max. 460 µm).

Diesel fuels with a biodiesel content of at least 2 % always fulfil the lubricity properties of max. 460 µm according to EN ISO 12156-1.

Sulphur content

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

Sediments/total contamination

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

Boiling curve

The boiling curve indicates how much volume% of the fuel is overdistilled at a certain temperature. The greater the boiling residue (amount remaining after evaporation), the more combustion residue may occur in the engine, especially in partial load operation.

Trace elements in the fuel (zinc, lead, copper)

Even small traces of zinc, lead and copper can lead to deposits in the injection nozzles, especially in the modern common rail injection systems.

Zinc and lead coatings are therefore not permissible in tank systems (especially in fuel stations for own use) and fuel pipes. Materials containing copper (copper pipes, brass parts) must also be avoided because they can lead to catalytic reactions in the fuel with subsequent deposits in the injection system.

Conversion ppm

The term parts per million (ppm) is often used in fuel analyses.

The term ppm alone is not a unit of measure. It usually describes the weight concentration (1 ppm (m/m) = 1 mg/kg). 1 ppm = 10^{-6} = parts per million = 0.0001 %

Viscosity

The kinematic viscosity in mm^2/s at a certain temperature (1 mm^2/s = 1 cSt [centistoke]) is specified. The viscosity must be within certain limits for engine operation. Too high a viscosity requires pre-heating because otherwise a lower engine performance is to be expected.

Water

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

Fuel quality and exhaust gas legislation

The fuel qualities to be used are closely related to the used engine and exhaust gas aftertreatment technologies and these are selected in turn with regard to the emission limits of the exhaust laws of the countries in which the engines are used.

Appendix 2

Fuel specification
Diesel fuel according to EN 590
April 2014 edition

Properties	Units	Limit values	Test method
Cetane number	-	min. 51	EN ISO 5165 EN 15195 EN 16144
Cetane index		min. 46	EN ISO 4264
Density at 15 °C	kg/m^3	min. 820 max. 845	EN ISO 3675 EN ISO 12185
Polycyclic aromatic hydrocarbons	%(m/m)	max. 8.0	EN 12916
Sulphur content	mg/kg	max. 10.0	EN ISO 20846 EN ISO 20884 EN ISO 13032
Flashpoint	°C	min. 55	EN ISO 2719
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 200	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160
Oxidation stability	g/m^3	max. 25	EN ISO 12205
Oxidation stability at 110 °C	hours	min. 20	EN ISO 15751
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	max. 460	EN ISO 12156-1
Kinematic viscosity at 40 °C	mm^2/s	min. 2.0 max. 4.5	EN ISO 3104
Distillation			EN ISO 3405
– collected at 250 °C	%(V/V)	max. 65	EN ISO 3924
– collected at 350 °C	%(V/V)	min. 85	
– 95 vol.% starting at	°C	max. 360	
Fatty Acid Methyl Ester (FAME)	%(V/V)	max. 7.0	EN 14078
Manganese content	mg/l	max. 2.0	EN 16576
Limit of filtrability* (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 3

Fuel specification
US diesel fuel according to ASTM D975-15

Properties	Units	Limit values		Test method
		Grade No. 1-D S15	Grade No. 2-D S15	
Density at 15 °C	kg/m^3	max. 860*	max. 860*	ASTM D4052
Flashpoint	°C	min. 38	min. 52	ASTM D93
Water and sediments	%(V/V)	max. 0.05	max. 0.05	ASTM D2709
Boiling curve at 90 vol.%	°C °C	- max. 288	min. 282 max. 338	ASTM D86
Kinematic viscosity at 40 °C	mm^2/s	min. 1.3 max. 2.4	min. 1.9 max. 4.1	ASTM D445
Ash content	%(m/m)	max. 0.01	max. 0.01	ASTM D482
Sulphur content – Grade Low Sulphur No. 1/2-D S15	mg/kg	max. 15	max. 15	ASTM 5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 3	Class 3	ASTM D130
Cetane number	-	min. 40	min. 40	ASTM D613
Cetane index	-	min. 40	min. 40	ASTM D976
Lubricity, HFRR at 60 °C	µm	max. 520	max. 520	ASTM D6079 ASTM D7688
Aromatic content	%(V/V)	max. 35	max. 35	ASTM D1319
Coke residue (from 10 % distillation residue) according to Ramsbottom	%(m/m)	0.15	0.35	ASTM D524
Limit of filtrability	°C	**	**	-
* DEUTZ restriction				
** depending on the season and region				

Appendix 4

Fuel specification
Japan diesel fuel according to JIS K 2204:2007

Properties	Units	Limit values					Test method
		Special No. 1	No. 1	No. 2	No. 3	Special No. 3	
Flashpoint	°C min.	50					JIS K 2266-3
Boiling curve at 90 vol.%	°C max.	360		350	330	330	JIS K 2254
Pour point	°C max.	+5	-2.5	-7.5	-20	-30	JIS K 2269
Limit of filtrability (CF-PP)	°C max.	-	-1	-5	-12	-19	JIS K 2288
Coke residue (from 10 % distillation residue)	%(m/m) max.	0.1					JIS K 2270
Cetane index	min.	50		45			JIS K 2280
Kinematic viscosity at 30 °C	%(V/V) min.	2.7		2.5	2.0	1.7	JIS K 2283
Sulphur content	mg/kg max.	10					JIS K 2254-1, -2, -6, -7
Density at 15 °C	kg/m^3 max.	860					JIS K 2249
Fatty Acid Methyl Ester (FAME)	%(m/m) max.	5					-

Appendix 5

Minimum requirements for fuels in countries in which none of the named diesel fuels released by DEUTZ exist.

Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Density at 15 °C	-	ISO 3675 ISO 12185	kg/m^3	820[1]	876[2]
Cetane number	Ambient temperatures > 0 °C	ISO 5156 ISO 15195 ASTM D613 ASTM D6890	-	40.0	-
	Ambient temperatures < 0 °C			45.0	-
Kinematic viscosity at 40 °C	Ambient temperatures > 0 °C	ISO 3104 ASTM D44	mm^2/s	1.8	5.0
	Ambient temperatures < 0 °C			1.2	4.0
Cloud point	-	-	°C	Not higher than the ambient temperature	
Pour point	-	ISO 3016 ASTM D97	°C	At least 5 °C lower than the ambient temperature	
Sulphur content	Engines without exhaust gas after-treatment[3]	ISO 20846 ISO 20847 ASTM D3605 ASTM D1552	%(m/m)	-	1.0
	Engines with externally cooled exhaust gas recirculation and without exhaust gas after-treatment		mg/kg	-	500
	Engines with exhaust gas after-treatment		mg/kg	-	15
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	-	ISO 12156-1 ASTM D6079	µm	-	460
50 %(V/V) boiling temperature	-	ISO 3405 ASTM D86	°C	-	282
90 %(V/V) boiling temperature	-			-	360
Coke residue (from 10 % distillation residue)	-	ASTM D524	%(m/m)	-	0.35
Ash content	-	ISO 6245 ASTM D482	%(m/m)	-	0.01
Inorganic elements (Ca+Mg+Na+K)	Engines with exhaust gas after-treatment	EN 14108 EN 14109 EN 14538	mg/kg	-	5

Parameter	Basic condition	Test method	Units	DEUTZ requirement	
				min.	max.
Water content	-	ISO 12937	mg/kg	-	200[4]
Total contamination	-	EN 12662	mg/kg	-	24[5]
Alternative to water content and total contamination: water and sediments	-	ASTM D473	%(V/V)	-	0.05
Corrosion effect on copper (3 h at 50 °C)	-	ISO 2160 ASTM D130	Degree of corrosion	-	3
Fatty Acid Methyl Ester (FAME)	-	EN 14078	%(V/V)	-	7.0[6]

[1] For Arctic diesel fuels, the lower density limit is 800 kg/m^3 at 15 °C

[2] At densities > 860 kg/m^3 at 15 °C, return blocking of the engine power by authorised DEUTZ dealers is necessary.

[3] At sulphur contents > 5000 mg/kg, the oil change intervals must be halved.

[4] Water contents up to 1000 mg/kg are possible when water-trapping fuel filters are used.

[5] At dirt contents > 24 mg/kg, fuel filters with a higher dirt capacity and very high efficiency must be used.

[6] Biodiesel rate is based on national regulations

Appendix 6

Fuel specification
Light heating oil EL according to DIN 51603-1, low sulphur
August 2016 edition

Properties	Units	Limit values	Test method
Density at 15 °C	kg/m^3	max. 860	DIN 51757 EN ISO 12185
Combustion point	MJ/kg	min. 45.4	DIN 51900-1 DIN 51900-2 DIN 51900-3 or calculation
Flashpoint in closed pot according to Pensky-Martens	°C	min. 55	EN ISO 2719
Kinematic viscosity at 20 °C	mm^2/s	max. 6.0	DIN 51562-1
Distillation curve Total evaporated volume parts			EN ISO 3405
– up to 250 °C	%(V/V)	max. 65	
– up to 350 °C	%(V/V)	min. 85	
Cloud point	°C	max. 3	EN 23015
Temperature limit of filtrability (CFPP) depending on the cloud point			EN 116
– at cloud point = 3 °C	°C	max. -12	
– at cloud point = 2 °C	°C	max. -11	
– at cloud point < 1 °C	°C	max. -10	
Coke residue (from 10 % distillation residue) according to Conradson	%(m/m)	max. 0.3	EN ISO 10370 DIN 51551-1
Sulphur content – for heating oil EL-1 low sulphur	mg/kg	max. 50	EN ISO 20884 EN ISO 20846
Water content	mg/kg	max. 200	DIN 51777-1 EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Thermal stability (sediment)	mg/kg	max. 140	DIN 51371
Storage stability	mg/kg	to be specified	DIN 51471
Note: Low-sulphur heating oil according to DIN 51603-1 has sufficient lubricity (according to EN ISO 12156-1) of 460 µm.			

Appendix 7

Fuel specification
Paraffinic diesel fuel from synthesis or hydrotreatment according to EN 15940
June 2016 edition

Properties	Units	Limit values				Test method
		Class A		Class B		
		min.	max.	min.	max.	
Cetane number	-	70.0	-	51.0	-	EN ISO 5165 EN 15195 DIN 51773
Density at 15 °C	kg/m^3	765	800	780	810	EN ISO 3675 EN ISO 12185
Flashpoint	°C	55.0	-	55.0	-	EN ISO 2719
Viscosity at 40 °C	mm^2/s	2.00	4.50	2.00	4.50	EN ISO 3104
Distillation						
collected at 250 °C	%(m/m)	65	-	65	-	EN ISO 3405 EN ISO 3924
collected at 350 °C	%(m/m)	85	-	85	-	
95 %(m/m) collected at	°C	-	360	-	360	
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm	-	460	-	460	EN ISO 12156-1
Fatty Acid Methyl Ester (FAME)	-	-	7	-	7	EN 14078
Manganese content	mg/l	-	2.0	-	2.0	EN 16136
Total aromatic content	%(m/m)	-	1.1	-	1.2	EN 12916
Sulphur content	mg/kg	-	5	-	5	EN ISO 20846 EN ISO 20884
Coke residue (from 10 % distillation residue)	%(m/m)	-	0.30	-	0.30	EN ISO 10370
Ash content	%(m/m)	-	0.01	-	0.01	EN ISO 6245
Water content	mg/kg	-	200	-	200	EN ISO 12937
Total contamination	mg/kg	-	24	-	24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1		Class 1		EN ISO 2160
Oxidation stability	g/m^3	-	25	-	25	EN ISO 12205
Limit of filtrability* (CFPP)						EN 116
– 15.04. - 30.09.	°C	-	0	-	0	EN 16329
– 01.10. - 15.11.	°C	-	- 10	-	- 10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	-	- 20	-	- 20	
– 01.03. - 14.04.	°C	-	- 10	-	- 10	
* specifications apply for Germany. National regulations may deviate.						

Appendix 8

Fuel specification
Fatty Acid Methyl Esters (FAME) for use in diesel engines and as heating oil in accordance with EN 14214
June 2014 edition

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min. 96.5	EN 14103
Density at 15 °C	kg/m^3	min. 860 max. 900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm^2/s	min. 3.5 max. 5.0	EN ISO 3104
Flashpoint	°C	min. 101	EN ISO 2719 EN ISO 3679
Sulphur content	mg/kg	max. 10	EN ISO 20846 EN ISO 20884 EN ISO 13032
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Cetane number	-	min. 51.0	EN ISO 5165
Ash content (Sulphate ash)	%(m/m)	max. 0.02	ISO 3987
Water content	mg/kg	max. 500	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160
Oxidation stability at 110 °C	hours	min. 8.0	EN 15751 EN 14112
Acid number	mg KOH/g	max. 0.50	EN 14104
Iodine number	g Iodine/100 g	max. 120	EN 14111 EN 16300
Content of linolenic acid methyl ester	%(m/m)	max. 12.0	EN 14103
Content of multiple unsaturated fatty acid methyl esters with ≥ 4 double bonds	%(m/m)	max. 1.00	EN 15779
Methanol content	%(m/m)	max. 0.20	EN 14110
Monoglyceride content	%(m/m)	max. 0.70	EN 14105
Diglyceride content	%(m/m)	max. 0.20	EN 14105
Triglyceride content	%(m/m)	max. 0.20	EN 14105
Content of free glycerine	%(m/m)	max. 0.02	EN 14105 EN 14106
Content of total glycerine	%(m/m)	max. 0.25	EN 14105

Properties	Units	Limit values	Test method
Content of alkaline metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109 EN 14538
Content of earth alkaline metals (Ca + Mg)	mg/kg	max. 5.0	EN 14538
Phosphor content	mg/kg	max. 4.0	EN 14107 EN 16294
Limit of filtrability			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02.	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 9a

Fuel specification
Fuel with high FAME content (B20) according to EN 16709
December 2015 edition

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min. 14.0 max. 20.0	EN 14078
Cetane number	-	min. 51.0	EN ISO 5165 EN 15195 EN 16144
Density at 15 °C	kg/m^3	min. 820 max. 860	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min. 55.0	EN ISO 2719
Viscosity at 40 °C	mm^2/s	min. 2.00 max. 4.62	EN ISO 3104
Sulphur content	mg/kg	max. 10	EN ISO 20846 EN ISO 20884 EN ISO 13032
Manganese content	mg/l	- 2.0	EN 16576
Polycyclic aromatic hydrocarbons	%(m/m)	- 8.0	EN 12916
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 260	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	hours	min. 20.0	EN 15751
Distillation			
collected at 250 °C	%(m/m)	max. 65	EN ISO 3405
collected at 350 °C	%(m/m)	min. 85	EN ISO 3924
95 %(m/m) collected at	°C	max. 360	
Limit of filtrability* (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 9b

Fuel specification
Fuel with high FAME content (B30) according to EN 16709
December 2015 edition

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min. 24.0 max. 30.0	EN 14078
Cetane number	-	min. 51.0	EN ISO 5165 EN 15195 EN 16144
Density at 15 °C	kg/m^3	min. 825 max. 865	EN ISO 3675 EN ISO 12185
Flashpoint	°C	min. 55.0	EN ISO 2719
Viscosity at 40 °C	mm^2/s	min. 2.00 max. 4.65	EN ISO 3104
Sulphur content	mg/kg	max. 10	EN ISO 20846 EN ISO 20884 EN ISO 13032
Manganese content	mg/l	- 2.0	EN 16576
Polycyclic aromatic hydrocarbons	%(m/m)	- 8.0	EN 12916
Ash content	%(m/m)	max. 0.01	EN ISO 6245
Water content	mg/kg	max. 290	EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Oxidation stability	hours	min. 20.0	EN 15751
Distillation			
collected at 250 °C	%(m/m)	max. 65	EN ISO 3405
collected at 350 °C	%(m/m)	min. 85	EN ISO 3924
95 %(m/m) collected at	°C	max. 360	
Limit of filtrability* (CFPP)			EN 116
– 15.04. - 30.09.	°C	max. 0	EN 16329
– 01.10. - 15.11.	°C	max. - 10	
– 16.11. - 28.02. (in leap years 29.02.)	°C	max. - 20	
– 01.03. - 14.04.	°C	max. - 10	
* specifications apply for Germany. National regulations may deviate.			

Appendix 10

Fuel specification
US biodiesel according to ASTM D6751-15 (B100)

Properties	Units	Limit values Grade S15	Test method
Calcium and Magnesium (together)	mg/kg	max. 5	EN 14538
Flashpoint	°C	min. 93	ASTM D93
Water and sediments	%(V/V)	max. 0.05	ASTM D2709
Kinematic viscosity at 40 °C	mm^2/s	min. 1.9 max. 6.0	ASTM D445
Ash content (oxide ash)	%(m/m)	max. 0.02	ASTM D874
Sulphur content	mg/kg	max. 15	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 3	ASTM D130
Cetane number		min. 47	ASTM D613
Cloud point	°C	to be specified	ASTM D2500
Coke residue	%(m/m)	max. 0.05	ASTM D4530
Acid number	mg KOH/g	max. 0.50	ASTM D664
Methanol content	%(m/m)	max. 0.20	EN 14110
Content of free glycerine	%(m/m)	max. 0.02	ASTM D6584
Content of total glycerine	%(m/m)	max. 0.24	ASTM D6584
Phosphor content	%(m/m)	max. 0.001	ASTM D4951
Boiling curve at 90 vol.%	°C	max. 360	ASTM D1160
Sodium and potassium (together)	mg/kg	max. 5	EN 14538
Oxidation stability at 110 °C	hours	min. 3	EN 14112 EN 15751

Appendix 11

Fuel specification
US biodiesel blends according to ASTM D7467-15 (B6-B20)

Properties	Units	Limit values	Test method
Biodiesel content	%(V/V)	min. 6 max. 20	ASTM D7371
Flashpoint	°C	min. 52	ASTM D93
Water and sediments	%(V/V)	max. 0.05	ASTM D2709
Kinematic viscosity at 40 °C	mm^2/s	min. 1.9 max. 4.1	ASTM D445
Ash content (oxide ash)	%(m/m)	max. 0.01	ASTM D482
Sulphur content	mg/kg	max. 15	ASTM D5453
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 3	ASTM D130
Cetane number		min. 40	ASTM D613
Cloud point or LTFT/CFPP	°C	to be specified	ASTM D2500 ASTM D4539 ASTM D6371
Coke residue	%(m/m)	max. 0.35	ASTM D524
Acid number	mg KOH/g	max. 0.30	ASTM D664
Boiling curve at 90 vol.%	°C	max. 343	ASTM D86
Lubricity, HFRR at 60 °C	µm	max. 520	ASTM D6079
Oxidation stability at 110 °C	hours	min. 6	EN 14112
Limit of filtrability* (CFPP)			EN 116

* Country-dependent and dependent on the type of application in cold seasons.

Appendix 12

Minimum requirements for biodiesel fuels (FAME) in countries in which none of the named biodiesel fuels released by DEUTZ exist.

Properties	Units	Limit values	Test method
Fatty Acid Methyl Ester (FAME)	%(m/m)	min. 96.5	EN 14103
Density at 15 °C	kg/m^3	min. 860 max. 900	EN ISO 3675 EN ISO 12185
Viscosity at 40 °C	mm^2/s	min. 1.9 max. 6.0	ASTM D445 EN ISO 3104
Flashpoint	°C	min. 93	ASTM D93 EN ISO 2719 EN ISO 3679
Sulphur content	mg/kg	max. 10	ASTM D5453 EN ISO 20846 EN ISO 20884 EN ISO 13032
Coke residue (from 10 % distillation residue)	%(m/m)	max. 0.30	EN ISO 10370
Cetane number		min. 47	ASTM D664 EN ISO 5165
Ash content (Sulphate ash)	%(m/m)	max. 0.02	ASTM D874 ISO 3987
Water content	mg/kg	max. 500	ASTM D2709 EN ISO 12937
Total contamination	mg/kg	max. 24	EN 12662
Corrosion effect on copper (3 h at 50 °C)	Degree of corrosion	Class 1	EN ISO 2160
Oxidation stability at 110 °C	hours	min. 6	EN 15751 EN 14112
Acid number	mg KOH/g	max. 0.50	ASTM D664 EN 14104
Iodine number	g Iodine/100 g	max. 130	EN 14111 EN 16300
Content of linolenic acid methyl ester	%(m/m)	12.0 12.0	EN 14103
Content of multiple unsaturated fatty acid methyl esters with ≥ 4 double bonds	%(m/m)	max. 1.00	EN 15779
Methanol content	%(m/m)	max. 0.20	EN 14110
Monoglyceride content	%(m/m)	max. 0.70	EN 14105
Diglyceride content	%(m/m)	max. 0.20	EN 14105
Triglyceride content	%(m/m)	max. 0.20	EN 14105
Content of free glycerine	%(m/m)	max. 0.02	EN 14105 EN 14106

Properties	Units	Limit values	Test method
Content of total glycerine	%(m/m)	max. 0.25	EN 14105
Content of alkaline metals (Na + K)	mg/kg	max. 5.0	EN 14108 EN 14109 EN 14538
Content of earth alkaline metals (Ca + Mg)	mg/kg	max. 5.0	EN 14538
Phosphor content	mg/kg	max. 10.0	ASTM D4951 EN 14107 EN 16294
Limit of filtrability* (CFPP)	°C	to be specified	EN 116 EN 16329
* Country-dependent and dependent on the type of application in cold seasons.			

Appendix 13

Fuel specification
Rapeseed oil fuel according to DIN 51605
January 2016 edition

Properties	Units	Limit values		Test method
Visual assessment	-	Free from visible contamination and sediments and free water		-
Density at 15 °C	kg/m^3	min.	910.0	EN ISO 3675
		max.	925.0	EN ISO 12185/C1
Flashpoint according to Pensky-Martens	°C	min.	101	EN ISO 2719
Kinematic viscosity at 40 °C	mm^2/s	max.	36.0	EN ISO 3104/C2
Heating value	kJ/kg	min.	36 000	DIN 51900-1,-2,-3
Cetane number	-	min.	40	EN ISO 5165
Iodine number	g Iodine/100 g	max.	125	EN 14111
Sulphur content	mg/kg	max.	10	EN ISO 20884 EN ISO 20846
Total contamination	mg/kg	max.	24	EN 12662
Acid number	mg KOH/g	max.	2.0	EN 14104
Oxidation stability at 110 °C	hours	min.	6.0	EN 14112
Phosphor content	mg/kg	max.	3.0	DIN 51627-6
Calcium content	mg/kg	max.	1.0	DIN 51627-6
Magnesium content	mg/kg	max.	3.0	DIN 51627-6
Water content	%(m/m)	max.	0.075	EN ISO 12937

Appendix 14

Fuel specification
Marine distillate fuel according to ISO 8217
December 2013 edition

Properties	Units	Limit values Category ISO-F		Test method
		DMX	DMA	
Kinematic viscosity at 40 °C	mm^2/s	min. 1.4 max. 5.5	min. 2.0 max. 6.0	ISO 3104
Density at 15 °C	kg/m^3 max.	-	890	ISO 3675 ISO 12185
Cetane number	- min.	45	40	ISO 4264
Sulphur content	%(m/m) max.	1.0 **	1.0 */**	ISO 8754 ISO 14596
Flashpoint	°C min.	43	60	ISO 2719
Hydrogen sulphide	mg/kg max.	2.00	2.00	IP 570
Acid number	mg KOH/g max.	0.5	0.5	ASTM D664
Oxidation stability	g/m^3 max.	25	25	ISO 12205
Coke residue (from 10 % distillation residue)	%(m/m) max.	0.30	0.30	ISO 10370
Cloud point	°C max.	- 16	-	ISO 3015
Pour point – Winter quality – Summer quality	 °C max. °C max.	 - -	 - 6 0	 ISO 3016 ISO 3106
Ash content	%(m/m) max.	0.01	0.01	ISO 6245
Visual inspection	-	clear and transparent		-
Lubricity, corrected "wear scar diameter" (wsd 1.4) at 60 °C	µm max.	520	520	ISO 12156-1
* DEUTZ restriction				
** observe shorter lubricating oil maintenance interval				