Fuels Brochure

DDC-SVC-MAN-0120, ()

Published by
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DETROIT
DEMAND PERFORMANCE

Models:

MBE 4000 EPA04
MBE 4000 EPA07
Series 50
Series 55
Series 60 EPA98/04
Series 60 EPA07
MBE 900
MBE 900 EPA07
MBE 900 EuroV
DD13 EPA07
DD13 EPA10
DD13 GHG14
DD13 GHG17
DD13 Gen 5
DD13 Euro V
DD15 EPA07
DD15 EPA10
DD15 GHG14 AT
DD15 GHG14 TC
DD15 GHG17 AT
DD15 Gen 5
DD16 EPA10
DD16 GHG14
DD16 GHG17
DD16 Euro V

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DD5
DD5 FS
DD8 DST
DD8 SST

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1. Introduction

1.01 Introduction

This publication specifies the type of fuels required for the diesel-fueled engines manufactured and marketed by Detroit™. The information in this publication applies to DD13, DD15, DD16, DD5, DD8, MBE 900, MBE 4000, Series 60, and Series 50 engines. Use of fuels not meeting the specifications required in the present publication may cause engine damage and void warranties.

Chapter 2 Overview of Fuel Types 2.0

2. Overview of Fuel Types

2.01 Diesel Fuel

The quality of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels. For EPA07, EPA10, GHG14, GHG17, GHG21 and GHG Phase 2 exhaust compliant engines equipped with exhaust after treatment devices, the use of Ultra-Low Sulfur Diesel (ULSD) fuel (15 ppm, 0.0015% wt.) is critical to the function and service life of these devices. Use of this fuel in pre-2007 engines will provide cleaner combustion, less soot, and fewer fuel-related deposits. Detroit™ recommends ULSD fuel for use in DD13, DD15, DD16, DD5, DD8, MBE 900, MBE 4000, Series 60, and Series 50 engines..

2.02 Biodiesel Fuel

The term “biodiesel” (B100) refers to a first generation biofuel that consist of medium to long chain fatty acid methyl esters (FAME), and is typically made from vegetable oil, animal fats, used cooking oil, or greases. This fuel is typically created by a process called trans-esterification and is generally blended at a rate of 5-20% (B5-B20) by total volume with petroleum based diesel.

2.03 Renewable Diesel Fuel

The term Renewable Diesel (R100) refers to an advanced biofuel consisting of fully hydrogenated medium to long chain paraffinic and branched hydrocarbons and is typically made from vegetable oil, animal fats, used cooking oil, or greases. This fuel is typically created by a process called hydrotreating and isomerization and is generally blended at a rate of 1-100% (R1-R100) by total volume with petroleum-based diesel. Biodiesel is not “Renewable Diesel.” Detroit Diesel has approved renewable diesel up to 100% blend rates

2.04 Top Tier

All DD Platform engines can operate on Ultra-Low Sulfur Diesel (ULSD) fuel. For optimal fuel system performance, Detroit Diesel recommends Top Tier Diesel (see figure below). This standard is a voluntary retailer program that has supplemental requirements that exceed ASTM standards, and also has provisions for quality control of the fuel distribution.

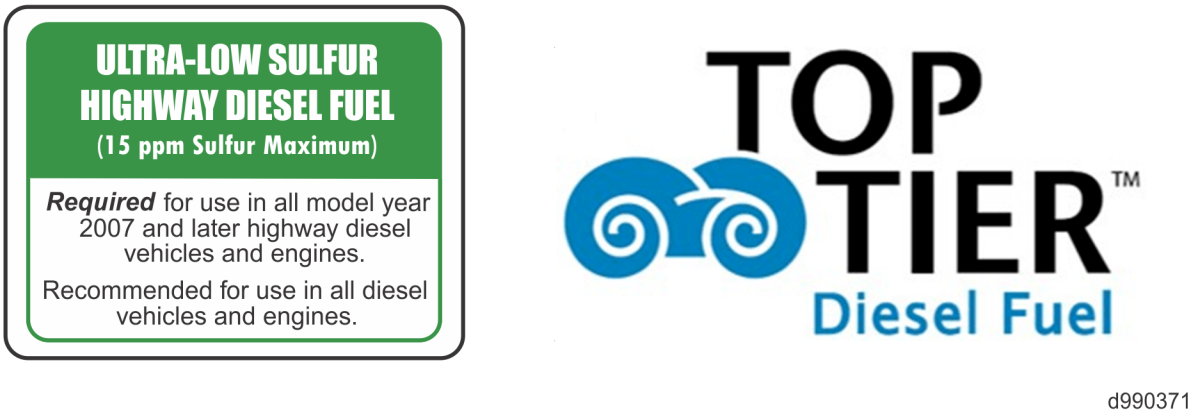

Fig 1,

For more information on Top Tier Diesel Fuel, please visit TOP TIER™ Diesel Fuel (toptiergas.com)

2.05 All Fuel Types

For optimum engine operation and maximum service life, diesel fuels meeting the properties listed in Table 2,Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines. Recommended Fuel Specifications of this brochure are recommended for use.

3. Engine Compatibility and Fuel Quality Requirements

3.01 Engine Compatibility

- Diesel Fuel
  - All Detroit® engines are approved to use Ultra Low Sulfur Diesel (ULSD) fuel meeting specification ASTM D975, CAN/CGSB- 3.517, or EN 590
- Biodiesel Fuel
  - All Detroit® engines are approved to use Biodiesel Blends up to 5% (B5) meeting specification ASTM D975, CAN/CGSB-3.520, or EN 590.
  - Only the Detroit® engines listed in Table 1,Maximum Allowable Biodiesel and Renewable Diesel blends below can operate on Biodiesel Blends of up to 20% (B20) meeting specification ASTM D7467, CAN/CGSB-3.522. Other fuels are prohibited.
- Renewable Diesel Fuel
  - All Detroit® engines are approved to use Renewable Diesel Fuel (R1-R100) meeting specification ASTM D975, CAN/CGSB-3.517, or EN 15940

Fuels not meeting the above specifications at a minimum are prohibited

The following table lists the maximum allowable Biodiesel and Renewable Diesel blends

Maximum Allowable Biodiesel and Renewable Diesel blends

Engine Platform	Model Year Relevance	Certification Type	Maximum biodiesel blend	Maximum Renewable Diesel blend
DD Platform	2024 Model Year and later	CARB certified	20%	100%
		US EPA certified	5%	100%
	Prior to 2024 Model Year	All	5%	100%
MBE 900 & 4000	All Model Years	All	5%	100%
Series 60	2004 Model Year and later	All	20%	100%
	Prior to 2004 Model Year	All	5%	100%

NOTE: You will find your engine's certification on Emission Control Labels that are on your engine and with your product information.

3.02 Fuel Quality Requirements and Recommendations

Diesel fuel

- Diesel fuel must meet the industry standard specification: ASTM D975, CAN/CGSB- 3.517, EN 590.

Biodiesel fuel

- Biodiesel blends up to 5% (B5) should preferably meet the Detroit ® B5 fuel quality recommendations. 5% biodiesel blends must meet the appropriate industry B5 specifications: ASTM D975, CAN/CGSB-3.520, EN 590.
- Biodiesel blends from 6% to 20% (B6-B20) should preferably meet the Detroit ® diesel fuel quality recommendations. Up to 20% biodiesel blends must meet the appropriate industry B6-B20 specifications at a minimum: ASTM D7467, CAN/CGSB-3.522.

- Biodiesel blendstock (B100) should preferably meet the Detroit ® diesel fuel quality recommendations before blending. Biodiesel blendstock must meet the appropriate industry biodiesel specifications at a minimum: ASTM D6751, CAN/CGSB-3.524, EN 14214

NOTE: The use B100 Blendstock is recommended as a blending component ONLY. The use of biodiesel fuel blends above B20 is not approved in any DETROIT engines

Renewable Diesel fuel

- Renewable Diesel fuel must meet the industry standard specifications: ASTM D975, CAN/CGSB-3.517, EN 15940

3.03 Fuels and Blendstocks not meeting the above specifications are prohibited.

NOTE: All fuels are REQUIRED to meet ASTM standards at minimum. For best engine performance, please refer to Table 2 Recommended Fuel Specifications.

NOTE: Detroit does not warrant damage caused by the use of unapproved fuels. Failure to use biodiesel fuel that meets the industry standards may result in warranty implications. For more information on warranty, please see the Warranty Implications section of this publication.

Detroit does not warrant damage caused by use of fuels outside Detroit's listed specifications, even where local, regional, national, or industry requirements regarding fuels or biodiesel content conflict with Detroit's listed specifications. Where local, regional, national, or industry requirements regarding fuels or biodiesel content conflict with the specifications listed herein, Detroit recommends using such fuels for the minimum duration possible, flushing fuel systems when in-specification fuel becomes available, and checking fuel filters and other fuel system components for deposits.

In our efforts to encourage the usage of domestically produced alternative fuels that benefit the environment, all of Detroit's engines are compatible with B5 biodiesel.

4. Recommended Fuel Specifications

4.01 Fuel Specifications

Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines						
Property	**ASTM Test Method**	**ISO Test Method**	**Base Specification: ASTM D975, CAN/CGSB-3.517 and/or CAN/CGSB-3.520 or EN 590 (Ultra Low Sulfur Fuel)**		**Base Specification: ASTM D7467, CAN/ CGSB-3.522**	**Base Specification: ASTM D6751 CAN/ CGSB-3.524, or EN 14214**
			No. 1 Diesel Fuel	**No. 2 Diesel Fuel**	**B6 - B20**	**B100 Blend stock only**
Biodiesel Content, % (V/V)	D7371	EN 14103	≤5	≤5	6-20	100
API Gravity, at 60°F (15.5°C)	D 287	–	Min 40 Max 43	Min 33 Max 38	–	–
Specific Gravity, g/ml @ 60°F (15.5°C)	1298	EN ISO 3675	Min 0.812 Max 0.825	Min 0.830 Max 0.855	–	–
Flash Point, °C Minimum *	D 93	EN ISO 2719 / EN ISO 3679	38	52	52	93
Distillation Temp. 90 %, % vol. recovered	D 86	EN ISO 3405	–	Min 282 Max 338	343	–
Cetane number, Minimum	–	–	–	–	43	47
(1) Cetane index, Minimum	ASTM D 4737	EN ISO 4264	40	40	40	–
(2) Aromaticity, % vol, Maximum	ASTM D 5186	EN 12916	–	35	35	–
Heat Content, net BTU/gal	D 4868		125,000 - 127,300	128,500 -130,900	–	–

Table 2, Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines

Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines						
Property	**ASTM Test Method**	**ISO Test Method**	**Base Specification: ASTM D975, CAN/CGSB-3.517 and/or CAN/CGSB-3.520 or EN 590 (Ultra Low Sulfur Fuel)**		**Base Specification: ASTM D7467, CAN/ CGSB-3.522**	**Base Specification: ASTM D6751 CAN/ CGSB-3.524, or EN 14214**
			No. 1 Diesel Fuel	**No. 2 Diesel Fuel**	**B6 - B20**	**B100 Blend stock only**
Kinematic Viscosity, mm2/S at 104°F (40° C)	D 445	EN ISO 3104	Min 1.3 Max .2.4	Min 1.9 Max 4.1	Min 1.9 Max 4.1	Min 1.9 Max 6
Sulfur, ppm (µg/g) Maximum	D 5453/ D2622G/ D129	EN ISO 20846/ EN ISO 20884/ EN ISO 13032	15	15	15	15
Ash % mass, max	D 482	6245	0.01	0.01	0.01	0.02
Accelerated Storage Stability, mg/L max	D 2274	–	15	15	–	–
Reflectance at 302°F (150°C) (High Temperature Stability), min	D 6468	–	70	70	–	–

Operability Requirements						
Property	**ASTM Test Method**	**ISO Test Method**	**Base Specification: ASTM D975, CAN/CGSB-3.520, or EN 590 (Ultra Low Sulfur Fuel)**		**Base Specification: ASTM D7467, CAN/ CGSB-3.522**	**Base Specification: ASTM D6751 CAN/ CGSB-3.524, or EN 14214**
			No. 1 Diesel Fuel	**No. 2 Diesel Fuel**	**B6 - B20**	**B100 Blend stock only**
Water, max	ASTM D 6304	EN ISO 12937	200 ppm	200 ppm	200 ppm	200 ppm
Sediment, max	ASTM D 2276	–	24 ppm	24 ppm	24 ppm	24 ppm
Copper strip corrosion rating, max	D 130	EN ISO 2160	No. 1	No. 1	No. 1	No. 1
Cloud point, °C, max	D 2500	EN 23015	varies	varies	varies	varies
LTFT/CFPP, °C, max	D 4539/D 6371	EN ISO 5165 / EN 116	varies	varies	varies	varies
Ramsbottom carbon residue on 10 %	D 524	EN ISO 10370	–	–	–	–
Distillation Residue, % mass, max	–	–	0.15	0.2	0.2	0.5
Lubricity, HFRR @ 60° C, micron, max	D 6079	EN ISO 12156-1	460	460	460	–
Conductivity, pS/m or Conductivity Units (C.U.), min	D 2624/D 4308	–	25	25	–	–
Acid Number, mg KOH/g, max	D664/ D974	EN 14104	0.1	0.1	0.1	0.3
Oxidation Stability, hours, min	EN 15751/ EN 14214	EN 15751/ EN 14214	24	24	20	8

Table 3, Operability Requirements

Operability Requirements						
Property	**ASTM Test Method**	**ISO Test Method**	**Base Specification: ASTM D975, CAN/CGSB-3.520, or EN 590 (Ultra Low Sulfur Fuel)**		**Base Specification: ASTM D7467, CAN/ CGSB-3.522**	**Base Specification: ASTM D6751 CAN/ CGSB-3.524, or EN 14214**
			No. 1 Diesel Fuel	**No. 2 Diesel Fuel**	**B6 - B20**	**B100 Blend stock only**
Calcium and Magnesium, combined ppm	EN 14538	EN 14538	<1	<1	<1	2
Sulfated ash	D 874	ISO 3987	0.01	0.01	0.01	0.020 max
Sodium and Potassium, combined ppm	EN 14538	EN 14538	<1	<1	<1	1
Free glycerin	D 6584	ISO 3987	–	–	–	0.02 (see below)
Total glycerin	D 6584	EN 14105	–	–	–	0.24 (see below)
Mono-glyceride Content	–	EN 14105	–	–	–	0.8%
Diglyceride Content	–	EN 14105	–	–	–	0.20%
Triglyceride Content	–	EN 14105	–	–	–	0.20%
NACE Corrosion Test			B++ min	B++ min	B++ min	–
Water Coalescing Effectiveness, % minimum	D 7261	–	70	70	70	–

NOTE: ***Raw Vegetable Oil and similar triglycerides are not permissible in all DETROIT™ or MBE engines as a blend stock, additive, or contaminant***

Diesel fuel plays very critical role in the engine fuel injection systems lubrication process. The fuel injection system and fuel pump are protected from wear by the fuel. Some processes used to desulfurize diesel fuel, if severe enough, can also reduce the natural lubricating qualities of the diesel fuel. The use of inadequately lubricating fuel would decrease the life expectancy of the engine fuel injection systems. It is recommended that all fuels used in Detroit™ engines meet the minimum lubricity requirements listed in the above table. Fuels not meeting the lubricity requirements may be additized to meet them.

Premium diesel fuels are not covered by any existing industry specification. It is recommended that the customer obtain additional information from the fuel marketer and compare properties to those listed in the above table 2,Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines before using.

5. Fuel Properties

5.01 Distillation

Although many specifications contain only a partial listing of the distillation results (Distillation Temperature at 90% Recovered, for example), this is not enough to determine the quality and suitability of the fuel for use in diesel engines. Diesel fuels are blended products which may contain high boiling constituents that can affect combustion. Only use fuels with a minimum 98% recovery by distillation.

5.02 Cetane Number

Cetane Number is a relative measure of the time delay between the beginning of fuel injection and the start of combustion. In a cold engine, a low cetane number will cause difficult starting and white exhaust smoke until the engine warms up. In engines with charge air cooling, a low cetane number fuel may also cause white exhaust smoke during light load operation. A minimum cetane number of 43 is specified for best engine performance. However, the cetane number alone should not be considered when selecting a quality fuel. Other properties, such as 95% distillation temperature and carbon residue, should also be considered. Calculated Cetane Index is sometimes reported instead of Cetane Number. Cetane Index is an empirical property determined mathematically from boiling range temperatures and specific gravity of the fuel, whereas Cetane Number is determined through an engine test. Additives may be used by the fuel marketer to improve the cetane number; however, they have no effect on cetane index. Evaluate both properties when selecting diesel fuel. The effect of biodiesel fuel on Calculated Cetane Index is unknown.

5.03 Fuel Stability

In the presence of air, heat, and water diesel fuel does oxidize. The oxidation of fuel can result in the formation of undesirable gums, deposits and sediments. These adverse byproducts can cause filter plugging, combustion chamber deposit formation, and gumming or lacquering of fuel injection system components, with resultant reduced engine performance and fuel economy. These adverse byproducts can also have the potential to cause fuel system component failures. The following tests are specified for fuel stability.

5.04 Oxidation Stability

ASTM D 2274 (Accelerated) measures diesel fuel storage oxidative stability. It is a weighed measure of the sediment filtered from the fuel after storage. Although the results of ATSM D 2274 may vary with actual field storage, it does measure characteristics in fuels containing no biodiesel that will affect fuel storage stability for periods of up to 12 months.

EN 15751 Rancimat Oxidation Stability measures oxidative stability in biodiesel, blends. Biodiesel blends have lower oxidative stability than 100% petroleum-based diesel fuel. For biodiesel blends, the test method must be run at 110ºC with a minimum oxidation induction time of 6 hours. This method is capable of measuring characteristics of biodiesel blends that will affect fuel storage stability for periods of up to 3 months. Due to the lower oxidative stability of biodiesel blends, they are not recommended for use in applications where fuel will be stored, either in bulk containers or in vehicle tanks, for more than 3 months.

5.05 High Temperature Stability

ASTM D 6468, measures high temperature stability. It must be run at 150°C (302°F). The results of the test are based on a visual rating of the filter pad by the amount of light reflected from the filter pad. A 100% rating is a clean pad, while a 50% rating is very dirty.

5.06 Fuel Operating Temperature and Viscosity

Since diesel fuel provides cooling of the injection system, the temperature of the fuel may vary considerably due to engine operating temperature. As fuel temperature increases, fuel viscosity decreases along with the lubrication capabilities of the fuel. Maintaining proper fuel temperatures and selecting fuels with the viscosity ranges listed in table “Fuel Specifications,” will ensure the injection system functions properly.

When operating with reduced fuel viscosity or elevated fuel temperatures, the injectors will operate at reduced internal clearances. As a result, dirt and smaller particulate material may cause injector durability concerns. Change filters on Detroit™ On-Highway engines to those specified for “Severe Duty Service.” Installing a fuel cooler or operating with fuel tanks above half full may also help eliminate the concern.

5.07 Low Temperature Operability or Cold Weather Operation

All Diesel fuel contains paraffin waxes which are crystalline in nature containing straight chain (normal alkanes) that will begin to solidify at low ambient temperatures forming a gel that collects on the fuel filter restricting fuel flow to the engine. Low temperature performance of diesel fuel can be characterized by its Cloud Point and Cold Filter Plugging Point (CFPP) and Pour Point

5.08 Cloud Point

Cloud Point (CP) is the temperature at which the paraffin wax begins to solidify, precipitate from the fuel and the fuel begins to appear cloudy as measured by ASTM D2500 method. The wax formation can be identified with fuel filter problems. The fuel filter and possibly the fuel lines could become clogged with waxes or gels and potentially starve the engine of fuel.

The only effective means of lowering a fuel's Cloud Point is by blending with No. 1 Diesel Fuel. Cold Flow Additives are typically not very effective at lowering the Cloud Point; they generally are effective at lowering the CFPP (see below).

Although cold flow additives may be effective at improving the cold weather operability of diesel fuel, extreme caution must be taken not to use too much additive. As with any fuel additive, excessive use may cause operability problems. The best and most effective means of improving the cold weather operability of No. 2 Diesel Fuel is to blend with No. 1 Diesel Fuel until its Cloud Point is equal to or below the expected ambient temperature. Refer to 8.01 Allowed Fuel Additives for further information.

5.09 Cold Filter Plugging Point

Cold Filter Plugging Point (CFPP) is the temperature at which the fuel (20 ml) will no longer pass through a wire (45 micron) filter within a given period of time (60 seconds) as measured by ASTM D6371-10. Cold Filter Plugging Point is always lower than Cloud Point. Diesel fuel can safely operate down to its Cloud Point and, in some cases, slightly below. Operability problems are usually encountered before the CFPP. Therefore, it is recommended to only use diesel fuel in ambient temperatures at or above its Cloud Point.

After market cold flow additives could help to lower the CFPP. However, it is important to understand the primary function of additives is to inhibit the wax particles ability to agglomerate in the fuel, helping to prevent filter clogging. Overtreatment of the fuel beyond the manufacturer's recommendations could have an adverse effect in the fuel where the anti-gel material will clog-up the filter. Also, the operator should check with the fuel supplier whether the fuel is already winterized by the supplier before adding any type of cold flow improver additives. Refer to 8.01 Allowed Fuel Additives for further information.

5.10 Pour Point

Pour Point is the temperature at which the fuel will no longer flow or eventually turn solid. Typically and effectively, the pour point of fuels can be adjusted with mixing D1 or kerosene.

NOTE: When prolonged idling periods or cold weather conditions below 0°C (32°F) are encountered, the use of No. 1 Diesel fuel is recommended. However, note that transit coach engines are emission certified on either No. 1 or No. 2 Diesel fuel. To maintain emission compliance, only use the correct certified fuel.

5.11 Boiling Range

The boiling range indicates the temperature range over which the fuel turns to a vapor and is a very important property in consideration of diesel fuel quality. Lower boiling range fuels, such as No.1, have a higher volatility, while fuels, such as No. 2, are of lower volatility and higher temperature boiling range. Higher volatility fuels are preferred in conditions of prolonged idling, such as city coach applications or in cold temperatures. The determination of boiling range is made using ASTM Test Method D 86 (Distillation) or D 2887 (Gas Chromatography).

5.12 95% Boiling Point

Fuel can be burned in an engine only after it has been completely vaporized. The temperature at which the fuel is completely vaporized is described as the “End Point Temperature” in Distillation Test Method, ASTM D 86. Since this temperature is difficult to measure with good repeatability, the fuel's 90% or 95% distillation point is often used. Detroit™ specifies the 95% temperature because it is closer to the end point than the 90% used in ASTM D 975.

6. Biodiesel Fuel - Additional Cautions

6.01 Fuel Filter Plugging

- Due to biodiesel's solvency, it can clean fuel systems and deposit debris on filters and lead to premature plugging immediately after switching to biodiesel.
- If running with biodiesel blends higher than 5%, fuel filters should be changed at ½ the recommended service intervals published in the engine owner's manual. This is due to accelerated filter plugging from glycerides.
- Fuel filter replacement is not to be covered under Detroit Diesel warranty. Detroit Diesel recommends using genuine Detroit Diesel fuel filters.
- Secondary fuel system hardware failure attributable to premature fuel filter plugging with biodiesel blends is not covered under Detroit Diesel warranty.

6.02 Storage & Oxidative Stability

- Biodiesel blends are less stable than diesel fuel and should not be stored for more than 1 month.
- Biodiesel blends are not suitable for applications involving low frequency use.
- Before parking an engine for an extended time period, the fuel system must be purged of all biodiesel blends and flushed with petroleum diesel fuel.

6.03 Compatibility with After-treatment Systems

- Biodiesel blends contaminated with phosphorus, alkali (Na and K) or alkaline (Ca and Mg) metals, not meeting the specification limits, may lead to premature poisoning and plugging of after-treatment devices.
- Biodiesel blends will reduce the performance of the diesel oxidation catalyst and may result in the use of more parked particulate filter regeneration

6.04 Cold Weather Performance

- Use of biodiesel blends above 5% is not recommended in colder regions.
- The cloud point and cold filter plugging point (CFPP) properties of the fuel on the certificate of analysis should be regularly monitored and compared to expected ambient temperature to be encountered in use.
- Cold flow or anti-gel additives may respond differently to biodiesel blends; consult with the fuel supplier to determine actual performance.

6.05 Water Contamination

- Water is more difficult to separate from biodiesel as compared to diesel fuel. This significantly reduces water separator efficiency. More frequent changes of fuel coalescers may offset the reduced water separation efficiency.
- Excessive water contamination may lead to corrosion in fuel system and promote microbe growth.
- Fuel injection system failure due to corrosion caused by use of unapproved biodiesel fuel blends will not be covered by Detroit Diesel warranty.

6.06 Microorganism Growth

- Biodiesel has an increased tendency for microbial growth.
- Microbial contamination may cause premature fuel filter plugging and/or corrosion in the fuel system.
- Laboratory testing for microbial growth is available. Fuel samples must be collected from the bottom of the tank (water layer) to accurately detect the microbes.

6.07 Engine Oil Analysis

- Using biodiesel blends may require reduced engine oil drain intervals. Strictly follow the oil change intervals published Lube Oil Requirements manual (DDC-SVC-BRO-0001).
- Biodiesel may accelerate acid formation in the engine oil.
- Biodiesel fuel dilution is very harmful to the engine oil and will not evaporate from the engine oil as easily as diesel fuel.
- Biodiesel fuel dilution will reduce the oil viscosity and accelerate oil degradation, requiring reduced oil drain intervals.
- Used oil analysis is required for the first few oil changes after converting to biodiesel blends to check for fuel dilution and to confirm the proper oil drain interval. Detroit Genuine Oil Analysis Program is recommended.

7. Renewable Diesel

7.01 Renewable Diesel - Additional Information

Confirm with your fuel supplier that the fuels they produce conform to the ASTM D975, CAN/CGSB-3.517 or EN 15940 fuel standard.

- Storage & Oxidative Stability:
  - Renewable diesel is very suitable for long term storage. There are no additional cautions.
- Compatibility with After-treatment Systems:
  - Renewable diesel generally does not contain alkali metals and should not affect after-treatment performance. There are no additional cautions.
- Cold Weather Performance:
  - Cloud points of -30° C are possible with winter renewable diesel. Summer blend Renewable Diesel should be drained from tanks and winter Renewable Diesel blends should be used in cold weather.

8. Aftermarket Fuel Additives

8.01 Allowed Fuel Additives

- Detroit™ engines are designed to operate satisfactorily on a wide range of diesel fuels. The regular use of aftermarket fuel additives is not required or recommended due to potential fuel injector system or engine damage. The use of such additives may increase operating costs without providing benefit. Aftermarket fuel additive supplements available at most retail stores are intended to be added to the fuel by the customer. These include a variety of independently marketed products which claim to be:
  - Cold Flow Improvers (prevents fuel jelling). Lower CFPP (help prevent fuel filter plugging)
  - Biocide
  - Fuel injection system deposit cleaners or removers
  - Oxidative stability
  - Cetane Improvers (booster)
  - Emission Control Additives
  - Fuel Economy
  - Smoke Suppressants
  - Detergents
  - Combustion Improvers
  - Icing preventers

Detroit™ recognizes some of the above listed additives may be beneficial in addressing temporary fuel quality issues, but they should not replace proper fuel selection and handling as described in this brochure.

Should a customer decide that a supplemental additive is temporarily required; the following is intended to provide guidance to the customer in selecting an additive partner, evaluating potential safety hazards and deleterious engine effects.

- Choose a fuel additive company with strong technical support in both the field and laboratory. Fuel additive companies should be able to test your fuel and show that it is deficient in some way and be able to demonstrate that their product fixes the finding(s).
- Review a Material Safety Data Sheet (MSDS) or a Technical Product Bulletin carefully for special handling instructions and hazardous material content.
- Get a detailed compositional analysis from the supplier. Ash forming metallic elements and corrosive elements must not be present. Additives containing calcium, barium, zinc, phosphorous, sodium, magnesium, iron, copper, and manganese are known to cause combustion ash deposits that can foul fuel injectors and create deposits which may adversely affect cylinder life. Halogenated compounds containing chloride, fluoride, and bromide are corrosive, as are some sulfur containing compounds. Avoid the use of additives with these components. Also, be cautious of language that says all in one products.
- Be sure to ask your additive supplier to explain the proper handling, mixing, and storage of the additive(s). Be sure to follow all recommendations made by the additive supplier. Improper mixing and storage can negatively affect the performance characteristics of any additive.
- Many additives act as surfactants; evaluate the effect of water separation characteristics on the fuel in combination with the additive. See Table 2,Diesel Fuel Recommendations for DD Platform Family, MBE and S60 Engines"Recommended Fuel Specifications" for performance requirements.
- Many commercial diesel fuels today contain performance additives, particularly those marketed as premium diesel fuel. Any supplemental additive being considered must be compatible with the fuel it is to be used in.

8.02 Prohibited Fuel Additives

The following fuel additives are NOT allowed:

- Used Lubricating Oil - Detroit™ specifically prohibits the use of drained lubricating oil in diesel fuel. Used lubricating oil contains combustion acids and particulate materials, which erode injector components, resulting in loss of power and increased exhaust emissions. In addition, the use of drained lubricating oil will increase maintenance requirements due to filter plugging and combustion deposits. for recommendations on proper used oil disposal.
- Gasoline - The addition of gasoline to diesel fuel will create a serious fire hazard. The presence of gasoline in diesel fuel will reduce the fuel cetane number and increase combustion temperatures.
- Ethanol - The addition of ethanol to diesel fuel will create a serious fire hazard. The presence of ethanol in diesel fuel will reduce the fuel cetane number and increase combustion temperatures. Drain and clean tanks that contain such mixtures as soon as possible. Detroit™ will not be responsible for any detrimental effects which it determines resulted from the use of used lubricating oil, gasoline, or ethanol in diesel fuel.
- Used Cooking Oil/ Unused Cooking Oil or Waste Animal Fat, Grease, Oil- The use of any cooking oil or animal fat or oil is prohibited in diesel fuel or used in place of diesel fuel. These substances are not approved for use as fuel and may cause permanent damage to your engine. Check your local jurisdiction for proper disposal of these substances.

9. Fuel Storage Best Practices

9.01 Diesel and Renewable Diesel Fuel Storage

Diesel fuel storage tanks are one of the most important pieces of equipment in truck fleet operations as it helps to save time and finances for the ownership. Diesel fuel tanks produced from Monel, stainless steel, black iron, welded steel, or reinforced (non-reactive) plastic are considered acceptable materials for use.

Maintenance (good housekeeping) practices should play a major role to ensure the quality of the diesel fuel is free of contaminants, such as water, and microbial growth to prevent costly down time due to unexpected repair in the operation.

To keep diesel fuel tanks clean and free of contamination, the following preventive maintenance should be included at any operation:

- Inspection of storage tanks and stored fuel regularly for dirt, water, and sludge.
- Regular fuel filter replacements.
- Establish fuel sampling and testing program for microorganisms and degradation byproducts. Drain and clean tanks with regular discharge of water bottoms.

NOTE: Do not use galvanized steel or sheet metal tanks and galvanized pipes or fittings in any diesel fuel storage, delivery, or fuel system. The diesel fuel will react chemically with the zinc coating, forming a compound which can clog filters and cause engine damage.

9.02 Biodiesel Storage

Biodiesel should be visually free of undissolved water, sediment, and suspended matter. Contamination levels in fuel can be reduced by storage in tanks kept free of water, and tankage should have provisions for water draining on a scheduled basis. Water promotes corrosion, and microbiological growth may occur at a fuel-water interface.

Underground storage is preferred to avoid temperature extremes; above ground storage tanks should be sheltered or painted with reflective paint. High storage temperatures accelerate fuel degradation. Fixed roof tanks should be kept full to limit oxygen supply and tank breathing.

To keep diesel fuel tanks clean and free of contamination, the following preventive maintenance should be included at any operation:

- Inspection of storage tanks and stored fuel regularly for dirt, water, and sludge.
- Regular fuel filters replacements.
- Establish fuel sampling and testing program for microorganisms and degradation by products.
- Drain and clean tanks with regular discharge of water bottoms.
- Removal of contaminated diesel fuel from problem areas including sludge and other materials.

NOTE: Do not use galvanized steel or sheet metal tanks and galvanized pipes or fittings in any diesel fuel storage, delivery, or fuel system. The diesel fuel will react chemically with the zinc coating, forming a compound, which can clog filters and cause engine damage.

10. Fuel Filters

10.01 Fuel Filter Requirements

Engine fuel filters should be changed at recommended service intervals aligning with oil changes, or when the "Fuel Filter Service Lamp" activates on the dashboard.

For maximum life of fuel system components, it is not recommended to exceed 100,000 miles on engine fuel filters under any condition.

Currently the Detroit Frame Mounted Fuel Filter and the Davco 385, 482, 485 & 487 are the only compatible frame mounted fuel filters approved for use with GHG17 DD13®/DD15®/DD16® engines.

Fuel Filter Minimum Requirements				
Product	**Description**	**Efficiency Specification**	**CapacitySpecification**	**ApplicationYears**
S60/S50	Detroit™ Genuine Fuel Spin-On Primary Filter	98% minimum on 23 to 27 micron particles at 100 gph per SAE J1858	48 g minimum at 100 gph and 10 psid terminal pressure per SAE J905	Pre-2004
S60/S50	Detroit™ Genuine Spin-On Primary Water/Fuel Separator Filter	98% minimum on 23 to 27 micron particles at 100 gph per SAE J1858 Water removal: 93% minimum emulsified per ISO 4020 at 125 lph	48 g minimum at 100 gph and 10 psid terminal pressure per SAE J905	All
S60/S50	Detroit™ Genuine Fuel Spin-On Secondary Filter	98% minimum on 7 to 9 micron particles at 100 gpm per ISO 4548-12	15 g minimum at 100 gph per and 10 psid terminal pressure per SAE J905	Pre-2004
S60	Detroit™ Genuine Fuel Spin-On Secondary Filter	87.5% minimum on 3 to 5 micron, 98.5%minimum on 5 to 10 micron, 99.4% minimum on 10 to 15 micron particles at 125 lph ISO TR 13353, 1994-10-1 (single pass, fine dust) Reference Bosch Application Guideline Y414 E20 022, dated 23.12.1999	23 g minimum at 100 gph per and 10 psid terminal pressure per SAE J905	2004 and newer
S60	Davco® Fuel Pro® 382 Elemax Fuel Cartridge	87.5% minimum on 3 to 5 micron, 98.5% minimum on 5 to 10 micron, 99.4% minimum on 10 to 15 micron particles at 125 lph ISO TR 13353, 1994-10-1	58 g minimum at 100 gph, 4 psid terminal pressure per SAE J905	All

Table 4, Fuel Filter Minimum Requirements

Fuel Filter Minimum Requirements				
Product	**Description**	**Efficiency Specification**	**CapacitySpecification**	**ApplicationYears**
		(single pass, fine dust) Reference Bosch Application Guideline Y414 E20 022, dated 23.12.1999 Water removal: minimum 95% efficiency at both emulsified and free water per SAE J1488 and SAE J1839		
MBE 4000	Fuel Filter	69.3% on 4 to 6 µm 92.2% on 6 to 8 µm, 98% on 8 to 10 µm, 99.5% on 10 to 12 µm, 1. % on 12 to 5µm, 2. % on 15 to 20 µm, 100% on greater than 20 µm acc to ISO TR 13353	326 g minimum at 2.5 lpm acc to ISO TR 13353 (11.6 psid terminal differential pressure)	All
MBE 900	Fuel Filter Primary (in-housing system with main filter)	300 µm screen	Not applicable	All
	Fuel Filter Main (in-housing system)	90% minimum greater than 6 micron particles according to ISO 4548-12 (Test report from Mahle® Filter System dated 17.12.2003 80% minimum on 5 micron, 90% minimum on 6 micron, 99% minimum greater than 10 micron particles initial efficiency according to ISO 19 438 (Test report from Mahle® Filter System dated 18.03.2005, MFP value 6,5 + 1 µm)	Minimum 75 minutes after ISO 4020 with test flow 75 lph or 34 g after ISO 19438, test flow 360 lph	All

Table 4, Fuel Filter Minimum Requirements

Fuel Filter Minimum Requirements				
Product	**Description**	**Efficiency Specification**	**CapacitySpecification**	**ApplicationYears**
DD13, DD15, DD16	Prescreen Fuel Filter	98% minimum on greater than 300 micron particles	at 2.91 gpm	All
	Coalescer Fuel Filter	98% minimum on greater than 10 micron particles	at 2.91 gpm	
	Final Fuel Filter	98% minimum on 3 to 5 micron particles	at 4.49 gpm	
DD5, DD8	Fuel Filter Kit	98% minimum on greater than 100 micron particles	at 2.91 gpm	All

11. Warranty Notes

11.01 Warranty Implications

Using biodiesel blends does not automatically void Detroit Diesel's warranty. However, any failure, including after-treatment devices and fuel injection system failures, determined to be caused by fuels that fail to meet industry requirements documented in this publication will not be covered by Detroit Diesel warranty.

Biodiesel blends above those specified in the tables above, based on engine type and model year, create additional risk of poor fuel quality leading to potential component failures such as the failures listed in the Biodiesel Additional Cautions Section of this document. Use of biodiesel blends above those specified for each engine, based on its engine type and model year, may invalidate warranties.

Detroit Diesel is not responsible for any cost arising from a failure to properly perform required maintenance oil, lubricants, and coolants meeting Detroit Diesel-recommended specifications. Performance of required maintenance and use of proper oil, lubricants, and coolants are the responsibility of the owner. For full details, see the engine operator's guide for your engine.

11.02 Aftermarket Filtration Systems

Aftermarket fuel supplemental filtration systems may be used, provided they do not replace the factory-installed system or reduce fuel volumes, pressures, or flow rates delivered to the engine. Fuel filters must be properly sized to provide the proper fuel flow to the engine. A fuel/water separator, if used, must be installed between the fuel tank and the inlet side of the engine fuel pump (>93% water separation at maximum flow per ISO-4020).

11.03 Detroit™ Genuine Maintenance Products

Regular and optional Detroit™ genuine service spin-on fuel filters for Series 50, Series 55, and Series 60 Detroit™ engines are listed in Table 5,Detroit™ Genuine Spin-On Fuel Filter Elements Fuel Pro filters are listed below, and Sea Pro® marine engine fuel filters are listed in Table 7,Sea Pro Fuel Filter Elements.

Detroit™ Genuine Spin-On Fuel Filter Elements		
Engine	**Primary Fuel Filter Qty**	**Secondary Fuel Filter Qty**
Series 50	1	1
Series 55	—	1
Series 60 (non-EGR, 2002 DDEC IV EGR)	1	1
Series 60 (2004 DDEC V EGR & later)	1	1
NOTE: A fuel/water separator assembly may be used in place of the primary filter assembly, but not together with it. For Series 50 and Series 60 engines the fuel/water separator filter number is 23535985.		

Fuel Pro Fuel Filter Elements Description
Fuel Pro 230
Fuel Pro 232

Table 6, Fuel Pro Fuel Filter Elements Description

Fuel Pro Fuel Filter Elements Description
Fuel Pro 380/382
Fuel Pro 40 Mega Filter™
Fuel Pro 382 (2004 Series 60 Engine)

Sea Pro Fuel Filter Elements	
Filter Description	**Micron Rating**
Sea Pro 50 / 100	30
Sea Pro 152 / 511	15
600	20
Water-in-Fuel Sensor Kit	—
NOTE: The numbers after the Sea Pro name indicate the Gallon Per Hour (GPH) flow capacity of the filter. (Does not apply to Fuel Pro filters.)	

CONTACT INFORMATION

For questions, please create a Service Technical Request using the DTTS Application on the DTNA Portal.

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