Trademark Information

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1 INTRODUCTION

This publication specifies the type of lubricants, fuels, filters, and related maintenance intervals required for the diesel-fueled engines manufactured and marketed by Detroit Diesel®. The information in this publication applies to Series 60, Series 50, Series 55, Series 40, MBE 900, MBE 4000, DD13, DD15, and DD16 engines.

Information on the use of diesel exhaust fluid (DEF) is located in *EPA10 DD Platform Operators Manual* (DDC-SVC-MAN-0075). Coolant references are located in *Coolant Requirements For Engine Cooling Systems,*(DDC-SVC-BRO-0002).

NOTE:
For 2-cycle and all Off-Highway engine lubricating oil, fuel, and coolant requirements, refer to MTU Technical Publication, *Fluids and Lubricants, Specification Bulletin,* A001061/33E (or most recent). This bulletin is available from authorized MTU distributors.

For information on fuels, lubricants, and filters required for Detroit Diesel engines using alternate fuels (other than diesel fuel) and other engine products not covered in this publication, refer to the specific publications for those engines.

Selection of the proper quality of fuel, lubricating oil, and filters in conjunction with required oil and filter maintenance is required to achieve the long and trouble-free service which Detroit Diesel engines are designed to provide. Operation with improper fuels, lubricants, and filters can degrade engine performance and may void the manufacturer's warranty.

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2 LUBRICATING OIL REQUIREMENTS

In general, lubricating oil selection for Detroit Diesel engines is based on viscosity grade and service category as defined by industry standards and is displayed in the API symbol shown in the following section. Oils identified by this system and licensed by API provide adequate service in most applications. In 2002, Detroit Diesel initiated additional criteria to these requirements through the use of *POWER GUARD*® Oil Specifications (PGOS) which resulted in a listing of preferred oils for Detroit Diesel engines.

NOTE:
For 2-cycle and all Off-Highway engine lubricating oil, fuel, and coolant requirements, refer to MTU Technical Publication, *Fluids and Lubricants, Specification Bulletin*, A001061/33E (or most recent). This bulletin is available from authorized MTU distributors.

2.1 IDENTIFICATION OF API SERVICE CLASSIFICATION

The lubricating oil requirements for Series 50, Series 55, Series 60, MBE 900, MBE 4000, DD13, DD15, and DD16 four-cycle engines are outlined in this section.

See Figure 2-1 for the API symbol of four-cycle engine oils.

SAE Viscosity Grade: 15W-40
API Classification: CJ-4

d180010

Figure 2-1 API Symbol: Four-Cycle Engine Oils

2.2 API CJ-4 VERSUS API CI-4 PLUS

API Service Category CJ-4 oils are designed primarily for use with EPA07 and EPA10 compliant engines equipped with cooled EGR and exhaust aftertreatment devices operating on Ultra-Low Sulfur Diesel (ULSD) fuel (below 15 ppm). These oils are designed with reduced ash and phosphorous content to minimize degradation of aftertreatment devices while providing complete wear, deposit, and soot control. API CJ-4 oils may also be used in all diesel engines operating with ULSD fuel.

API Service category CI-4 PLUS oils were designed primarily for use with 2002 EPA emission compliant engines equipped with cooled EGR operating on Low Sulfur Diesel (LSD) fuel (below 500 ppm). These oils are formulated with higher ash and phosphorus content and were not intended for use in engines with aftertreatment devices. Their use in EPA07 engines may cause premature aftertreatment filter plugging.

There is a subtle but important difference between oils meeting the API CI-4 and the API CI-4 PLUS service category. Shortly after their inception, the API CI-4 category requirements were modified for improved soot handling and shear stability. An engine oil formulation that meets the modified requirements would qualify for API CI-4 PLUS. Due to their superior performance in EGR-equipped engines without aftertreatment devices, Detroit Diesel recommends only CI-4 PLUS oils. Detroit Diesel does not recommend the use of oils that only meet the CI-4 service category.

2.3 APPROVED OILS — *POWER GUARD* OIL SPECIFICATION

In 2002, Detroit Diesel issued its first listing of approved oils based on PGOS. These specifications represented an enhanced performance level beyond the industry-based service category system. Oils meeting these specifications undergo additional review of performance claims, include added performance requirements for Detroit Diesel's international family of engines compared to API certified engine oils. The added confidence in performance of these oils allows Detroit Diesel customers to maximize oil drain intervals and engine service life beyond those permitted with industry-based engine oils, refer to Chapter 4.

Three Detroit Diesel-approved oil specifications exist for different applications. The list of oils meeting these specifications may be viewed as follows:

1. Go to: http://www.DDCSN.com
2. Select the *Literature* tab.
3. Select the *Lubricants / Fuels / Coolants* category.
4. Select the *POWER GUARD Oil Specs* bullet for the intended application.

Listed in Table 2-1 is a summary of the three oil specifications and their intended applications:

POWER GUARD Oil Specifications			
Specification	**U.S. EPA Emissions Certification**	**Fuel Sulfur, ppm**	**Intended Application**
93K218	EPA10 and Older	Ultra Low Sulfur, < 15	Recommended for all four-cycle Detroit Diesel engines including with and without an aftertreatment system, EPA10 and older (including legacy engines), operating on ULSD fuel. These oils are similar to API CJ-4.
93K214	EPA04 and Older	Low Sulfur, < 500	Cooled EGR-equipped engines without aftertreatment devices or any engine operating on Low Sulfur fuel. These engines meet 2002 to 2006 model year emission requirements. These oils are similar to API CI-4 PLUS.
93K215	EPA98 and Older	High Sulfur, < 5000	Non-EGR-equipped engines, operating on fuel below 5000 ppm sulfur fuel. These oils are similar to API CH-4.

Table 2-1 Approved *POWER GUARD* Oil Specifications

2.4 LOW AMBIENT TEMPERATURE STARTING

At ambient temperatures below -10°C (14°F), SAE 5W-30, 10W-30, 5W-40, or 10W-40 oils may be used, provided they are API CJ-4 and have demonstrated field performance in Detroit Diesel engines, refer to section 3.1. Preferred oils will be approved per PGOS 93K218. These oils must possess a High Temperature / High Shear (HT/HS) Viscosity of 3.5 cP minimum. For more information on HT/HS Viscosity, refer to section 3.2.

2.5 MONOGRADE OILS

Monograde oils, irrespective of API service category, should not be used in any Detroit Diesel four-cycle engine.

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3 LUBRICATING OIL ADDITIONAL INFORMATION

Selection of lubricating oil that meets the proper criteria is necessary for proper engine lubrication. Additional information which may be used to select an appropriate engine oil are provided in the following sections.

3.1 SAE VISCOSITY GRADE SELECTION

Viscosity is a measure of an oil's resistance to flow at various temperatures. The SAE Viscosity Grade system is defined in SAE Standard J300 that designates a viscosity range with a grade number. Lubricants with two grade numbers separated by a "W," such as 15W-40, are classified as multigrade, while those with a single number are monograde. The higher the number, the higher the viscosity.

The viscosity requirements associated with each SAE viscosity grade are listed in Table 3-1. This information is important in selecting the best viscosity grade for the anticipated ambient temperature range at which the engine will start and operate. Use it only as a guideline, since actual operating conditions of the engine may determine the lowest practical temperature at which an engine will start and operate. Note that grades designated with a "W" are required to meet both low temperature and high temperature viscosity requirements.

SAE Viscosity Grade	Viscosity (cP) at Temp. (°C), Max		Viscosity (cSt) ASTM D 445 (100°C)		High Temperature High Shear Rate Visc @ 150°C & 10^5 sec
	Cranking ASTM D 5293	Pumping ASTM D 4684	Min	Max	
0W	6200 at -35	60,000 at -40	3.8	—	—
5W	6600 at -30	60,000 at -35	3.8	—	—
10W	7000 at -30	60,000 at -30	4.1	—	—
15W	7000 at -20	60,000 at -25	5.6	—	—
20W	9500 at -15	60,000 at -20	5.6	—	—
25W	13,000 at -10	60,000 at -15	9.3	—	—
20	—	—	5.6	9.3	>2.6
30	—	—	9.3	12.5	>2.9
40	—	—	12.5	16.3	>3.7
50	—	—	16.3	21.9	>3.7
60	—	—	21.9	26.1	>3.7

Table 3-1 SAE Viscosity Grades for Engine Oils (SAE J300)

For standard temperature limits of each viscosity grade; see Figure 3-1.

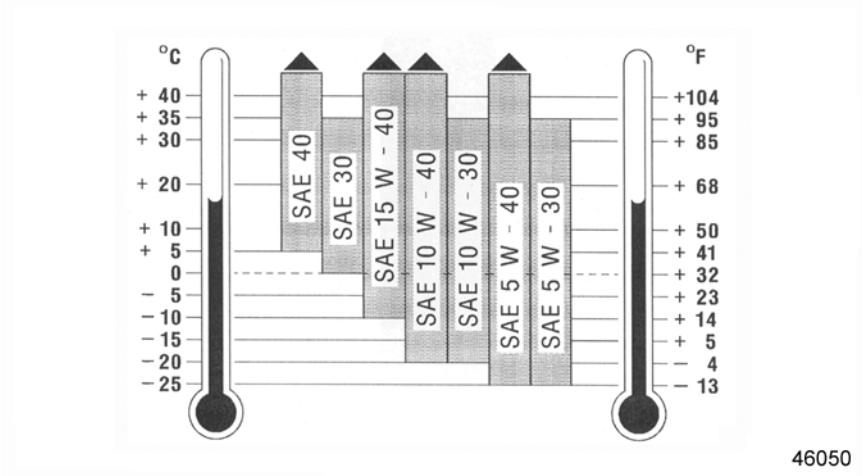

Figure 3-1 Operating Ranges for SAE Viscosity Grades

3.2 HIGH TEMPERATURE/HIGH SHEAR VISCOSITY

High Temperature / High Shear (HT/HS) viscosity is measured at 150°C (302°F) under shear stress conditions similar to very thin film lubrication areas such as those found at the piston ring-to-cylinder wall interface. The value obtained from this test provides an indication of temporary shear stability of the viscosity index improver used in multigrade oils. An HT/HS viscosity below 3.7 cP indicates that the oil will not perform as a 40 grade oil at engine operating conditions.

3.3 SULFATED ASH AND TOTAL BASE NUMBER

Sulfated ash is a lubricant property measured by a laboratory test (ASTM D 874) to determine the potential for formation of metallic ash. The ash residue is related to the oil's additive composition and is significant in predicting lubricants which may cause valve distress, cylinder kit scuffing, or exhaust catalyst plugging under certain operating conditions. CJ-4 approved oil cannot exceed 1.0 wt% of sulfated ash, and CI-4 PLUS approved oil cannot exceed 2.0 wt%. Total Base Number (TBN), which measures an oil's alkalinity and ability to neutralize acid using a laboratory test (ASTM D 2896 or D 4739), is related to sulfated ash level and plays an important role in controlling deposits in four-cycle diesel engines. Typically a quality engine oil will have a fresh TBN over 8.0 mg KOH/g per ASTM D 2896.

3.4 UNIVERSAL OILS

Universal oils are designed for use with both gasoline and diesel engines and provide an operational convenience in mixed engine fleets. These products are identified with combination API category designations such as SL/CF or CJ-4/SM. Although such products can be used in Detroit Diesel engines (provided they satisfy all Detroit Diesel requirements), their use is not as desirable as lubricants formulated specifically for diesel engines and having API CJ-4 or CF-2 designations. When selecting a universal oil, select one with the **"C" category *first,*** as this should be primarily intended for diesel service.

3.5 SYNTHETIC OILS

Synthetic oils may be used in Detroit Diesel engines provided they are approved by a *POWER GUARD* Oil Specification (PGOS). The use of synthetic oils does not necessarily ensure the extension of the recommended oil drain intervals beyond the limits.

3.6 LUBRICANT SELECTION OUTSIDE NORTH AMERICA

Engine oils specified in Table 2-1 for the appropriate engine emissions certification and fuel sulfur level are preferred for all Detroit Diesel engines operating outside North America. If these lubricants are not available, lubricants meeting European ACEA E2, E3 (or current Euro and ACEA approved oils), or E5 may be used at the specified oil drain intervals. Oils of lower performance may only be used at a 50% oil drain interval reduction, refer to Chapter 4.

3.7 TYPICAL PROPERTIES

Listed in Table 3-2 are the typical chemical and physical properties of a lubricating oils marketed today. This table is for information purposes only. It should neither be construed as being a specification, nor used alone in selection of an engine lubricant.

Viscosity Grade API Service	15W-40 CH-4, CI-4 PLUS PGOS 93K214 / 215	15W-40 CJ-4 PGOS 93K218	10W-30 CJ-4
Viscosity, Kinematic, cSt: 40°C	95 – 115	95 – 115	75 – 85
Viscosity, Kinematic, cSt: 100°C	12.5 – 16.3	12.5 – 16.3	9.3 – 12.5
HT/HS, cP 150°C	3.7 Min	3.7 Min	3.5 Min
Viscosity Index	130	130	130
Pour Point °C, Max	-23	-23	-30
Flash Point °C, Min	215	215	205
Sulfated Ash, % Mass	2.0 Max	1.0 Max	1.0 Max
Total Base Number	9.0 – 11.0	8.0 – 10.0	8.0 – 10.0
Sulfur, ppm	4000 – 8000	4000 Max	4000 Max
Phosphorous, ppm	1000 – 1200	1000 – 1200	1000 – 1200
Zinc, ppm	1000 – 1200	1000 – 1200	1000 – 1200

Table 3-2 Typical Properties of Detroit Diesel Recommended Engine Oil

3.8 THE USE OF SUPPLEMENTAL ADDITIVES

Lubricants meeting PGOS outlined in this publication contain a carefully balanced additive treatment. The use of supplemental additives, such as break-in oils, top oils, graphitizers, and friction-reducing compounds in these fully formulated lubricants are not necessary and can upset the oil's formulation, causing a deterioration in performance. These supplemental additives may be marketed as either oil treatments or engine treatments and should not be used. Their use will not void your Detroit Diesel product warranty; however; engine damage resulting from the use of such materials is not covered. The use of such additives is at the customer's risk. Detroit Diesel will not provide statements relative to their use beyond this publication.

3.9 PURCHASING BULK ENGINE OIL

To ensure continuing quality of engine oil purchased in bulk quantities, procurement specifications should include a requirement that the supplier follow *API Recommended Practice 1525* for handling bulk engine oils. This voluntary practice contains guidelines for quality control tracking within the supplier's process. In addition, customers are advised to obtain a control sample to be used as a reference for acceptance of bulk shipments.

3.10 WASTE OIL DISPOSAL AND RE-REFINED OILS

CAUTION:

USED ENGINE OIL

To avoid injury to skin from contact with the contaminants in used engine oil, wear protective gloves and apron.

Detroit Diesel favors the recycling of waste oil and permits the use of re-refined oils in all engine product lines, provided the re-refined oil meets the SAE Viscosity and API specifications previously mentioned. Several processes are used to re-refine oil. The only true re-refining process is one which treats the used oil as a crude oil, subjecting it to the same refinery processes normally used for geological crude, such as dehydration, vacuum distillation, and hydrogenation. Waste oil provides a more consistent feedstock, compared to the geological crudes that a refinery typically processes. As a result, the finished oil should also be consistent in properties and quality.

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4 OIL DRAIN INTERVALS

During use, engine lubricating oil undergoes deterioration from combustion by-products and contamination by the engine. In addition, certain components in a lubricant additive package are designed to deplete with use. For these reasons, regardless of the oil formulation, regular oil drain intervals are required.

NOTE:
The use of oil sampling and analysis to validate all drain intervals is highly recommended. To confirm oil drain intervals, use Detroit Diesel Genuine Oil Analysis with Total Base Number, Part Number 23520989.

4.1 OIL DRAIN INTERVALS FOR EPA07 & EPA10 HEAVY DUTY ON-HIGHWAY ENGINES

The oil drain intervals for the Series 60, MBE 4000, DD13, DD15, and DD16 On-Highway engines listed in Table 4-1 are based on engines operating with Ultra-Low Sulfur Diesel (ULSD) fuel (below 15 ppm) meeting the properties listed in Table 5-1 “Diesel Fuel Properties” with a *POWER GUARD* Oil Specification (PGOS) 93K218 approved oil. API CJ-4 certified oil that is not PGOS approved may be used at reduced drain intervals. These intervals should be considered as maximum and should not be exceeded.

Service Application / Engine Series	Long Haul *	Short Haul †	Severe ‡
Series 60, EPA07	30,000 miles (48,000 km)	20,000 (32,000 km) 500 h, or 6 mon§	15,000 miles (24,000 km) 300 h, or 3 mon§
MBE 4000, EPA07	30,000 miles (48,000 km)	15,000 miles (24,000 km), 500 h, or 6 mon§	10,000 miles (16,000 km) 300 h, or 3 mon§
DD13, DD15, DD16 EPA07, EPA10	50,000 miles (80,000 km) 1280 h	35,000 (56,000 km) 895 h, or 1 yr§	25,000 miles (40,000 km) 640 h, or 6 mon§

***** **Long Haul** (over-the-road transport) service applies to vehicles that annually travel more than 60,000 miles (96,000 kilometers) and average greater than 6 miles per gallon with minimal city stop-and-go operation.

† **Short Haul** service applies to vehicles that annually travel up to 30,000-60,000 miles (48,000-96,000 kilometers) and average between 5.1 and 5.9 miles per gallon.

‡ **Severe** service applies to vehicles that annually travel up to 30,000 miles (48,000 kilometers) and average less than 5 miles per gallon or that operate under severe conditions. Service applies to vehicles that annually travel up to 30,000 miles (48,000 km) or that operate under severe conditions. **Only one of these conditions needs be met to categorize an application as Severe Service.**

§ Whichever comes first.

Table 4-1 Maximum Oil Drain and Filter Change for Series 60, MBE 4000, DD13, DD15, and DD16 using PGOS 93K218 Approved Oils with ULSD Fuel

4.2 OIL DRAIN INTERVALS FOR EPA07 MEDIUM DUTY ON-HIGHWAY ENGINES

The oil drain intervals for EPA07 MBE 900 On-Highway engines listed in Table 4-2 are based on engines operating with ULSD fuel (below 15 ppm) meeting the properties listed in Table 5-1 “Diesel Fuel Properties” with a PGOS 93K218 approved oil. API CJ-4 certified oil that is not PGOS approved may be used at reduced drain intervals. These intervals should be considered as maximum and should not be exceeded.

Service Application / Engine Series	Long Haul *	Short Haul †	Severe ‡
MBE 900	20,000 miles (32,000 km)	15,000 miles (24,000 km), 500 h or 6 mon§	6,000 miles (9,600 km), 250 h or 3 mon§

*** Long Haul** service (over-the-road transport) applies to vehicles that annually travel more than 60,000 miles (96,000 km) with minimal city stop-and-go operation. Examples of Long Haul service are: regional delivery that is mostly freeway mileage, interstate transport, and any road operation with high annual mileage.

† **Short Haul** service applies to vehicles that annually travel up to 60,000 miles (96,000 km) or with a **load factor over 45%** and operate under normal conditions. Examples of Short Haul service are: operation primarily in cities and densely populated areas, local transport with infrequent freeway travel, or a high percentage of stop-and-go travel.

‡ **Severe** service applies to vehicles that annually travel up to 30,000 miles (48,000 km) or that operate under severe conditions. Examples of Severe Service are: **idle time over 35%**, **load factor over 55%**, operation on extremely poor roads or under heavy dust accumulation; constant exposure to extreme hot, cold, salt-air, or other extreme climates; frequent short-distance travel; construction-site operation; city operation (fire truck or garbage truck), or farm operation. **Only one of these conditions needs be met to categorize an application as Severe Service.**

§ Whichever comes first.

NOTE: Load factor and idle time values must be based on DDEC reports that accurately represent the current service application.

Table 4-2 Maximum Oil Drain and Filter Change Intervals for MBE 900 using PGOS 93K218 Approved Oils with ULSD Fuel

4.3 OIL DRAIN INTERVALS FOR PRE-2007 SERIES 60, SERIES 55, MBE 900, AND MBE 4000 ENGINES

The oil drain intervals for Series 60, Series 55, MBE 900, and MBE 4000 pre-2007 engines listed in Table 4-3 are based on On-Highway engines operating with ULSD fuel (below 15 ppm) with API licensed CJ-4 or CI-4 PLUS oil. These intervals should be considered as maximum and should not be exceeded. If operating in regions where ULSD is not available then these intervals will apply as long as the proper oil quality per Table 2-1 is utilized.

Service Application	Engine Series	Oil Drain Interval
Highway Truck, Motor Coach	50, 55, 60*	15,000 miles (24,000 km)
	MBE 900	20,000 miles (32,000 km)
	MBE 4000	25,000 miles (40,000 km)
City Transit Coach	50†, 55, 60	6,000 miles (9,600 km)
	50‡	3,000 miles (4,800 km)
Fire Fighting, Crash Rescue	50, 60	6,000 miles (9,600 km), 300 h, or 1 yr§
Pick-Up & Delivery	50	12,000 miles (19,200 km)
	MBE 900	15,000 miles (24,000 km)
Stop & Go, Short Trip	50	6,000 miles (9,600 km)

* * The oil drain interval for engines with EGR can be increased to 22,500 miles (36,200 km) if the oil used is PGOS 93K218 or 93K214 approved.
† All models except 6047MK1E
‡ Model 6047MK1E
§ Whichever comes first.

Table 4-3 Maximum Oil Drain and Filter Change Intervals for Pre-2007 Series 60, Series 55, MBE 900, MBE 4000 Engines Using PGOS Approved Oils with ULSD Fuel

4.4 ALTERNATE OIL DRAIN INTERVALS FOR MBE 900 ON-HIGHWAY ENGINES

To determine alternate oil drain intervals for those listed in Table 4-2, see Figure 4-1.

NOTE:
The oil drain interval are based on engine hours and fuel consumption.

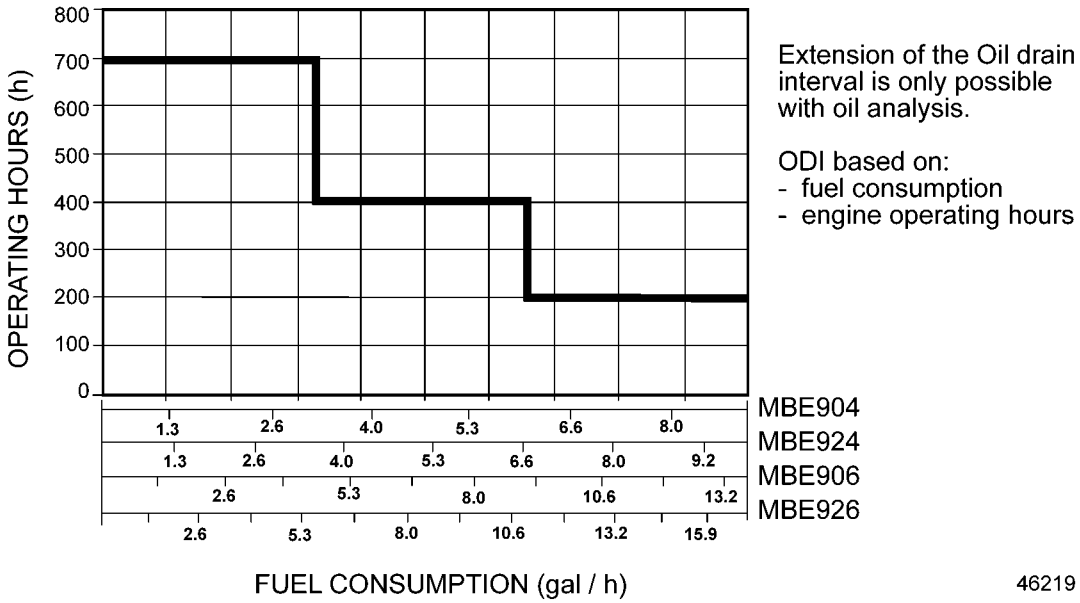

Figure 4-1 Oil Drain Interval in Hours for Pre-2007 MBE 900 On-Highway Engines

4.5 EXTENDING OIL DRAIN INTERVALS

Changing engine oil and filters at regular recommended intervals removes contaminants in the oil and filter and replenishes expendable oil performance additives. The extension of oil change intervals necessitates that an engine can tolerate increased levels of contaminants such as soot, dirt, wear metals, fuel residues, and water. Extending oil filter change intervals requires that filters have sufficient increased capacity to continue collecting these contaminants at a sufficient rate to protect the engine. The engine oils must be formulated with additives capable of extended performance for wear, oxidation, dispersency, detergency, and filterability.

While the extension of oil drain intervals can provide owners and operators of diesel-powered equipment a cost savings in materials (oil and filters), maintenance-related downtime, and waste disposal, there can be a significant reduction of engine life to overhaul. **Currently marketed engine oils and filters are not designed to operate at extended service intervals. These products meet performance requirements of standardized industry tests that are intended to predict actual engine operation under the conditions of standard service intervals.**

4.5.1 GUIDANCE FOR EXTENDING OIL DRAIN INTERVALS

Detroit diesel recognizes the desire by some fleets to maximize oil drain and filter change intervals beyond those listed in Table 4-1, Table 4-2, and Table 4-3. While Detroit Diesel has no formal program to extend these intervals, it will assist fleets in an advisory capacity to minimize equipment risks. Before a fleet embarks on an extended oil drain interval program, Detroit Diesel recommends:

- The fleet reviews its current maintenance program to ensure oil changes are performed properly and on time. A missed oil drain interval during an extended oil drain interval program will create a significant risk to the equipment.
- The fleet reviews the severity of the operation. High idling intervals, high load factors, and chronic mechanical problems are not conducive to extending the oil drain intervals.
- The fleet selects oil and filter suppliers who have the expertise and products to support the goals of such a program. They may include a field test results demonstration, formal program for extending oil and filter changes, and a warranty covering failure of their products in this service which results in a premature engine wear-out or failure.

Fleets are encouraged to review any drain extension program with Detroit Diesel before initiating the program. While Detroit Diesel will not provide approvals for these programs, they will provide feedback on the risk assessment.

Extending oil drain intervals will not void the Detroit Diesel product warranty. In the event of engine failure or premature wear-out when running extended oil and filter change intervals, Detroit Diesel will make a determination as to the extent, if any, that their workmanship and materials were responsible. If Detroit Diesel determines that the failure or early wear-out was related to workmanship or materials, warranty coverage of the repairs will apply. If the engine fails or wears out within the Detroit Diesel warranty period and Detroit Diesel determines it was the result of extending the oil drain intervals, any claim for reimbursement of expenses under the terms of the engine warranty will be denied.

4.6 USED LUBRICATING OIL ANALYSIS

Detroit Diesel's used-oil analysis program is recommended for all engines. Oil analysis consists of laboratory tests to indicate conditions of the engine and/or the lubricant. The "Warning Limits" are listed in Table 4-4, "Single Sample Used-Oil Analysis Warning Limits." Oil analysis cannot completely assess the lubricating oil and should not be used to maximize oil drain intervals. Change oil immediately if contamination exceeds warning limits listed in Table 4-4.

Characteristics	ASTM or Other Methods	Conditions Measured	40, 50, 60	55	MBE 900	MBE 4000	DD13, DD15, DD16
Viscosity at 100 °C, cSt, Min	D 445 DIN 51562	Engine & Oil	12.5 SAE 15W-40				
Viscosity at 100 °C, cSt, Max	D 445 DIN 51562	Engine & Oil	21.9 SAE 15W-40				
Soot, %*	TGA (E1131)	Engine Combustion	4.5†				
Total Base No., Min	D4739	Oil	1/3 New or 3.0 mg KOH/g				
Total Base No., Min	D2896 ISO 3717	Oil	1/3 New or 3.0 mg KOH/g				
Glycol, Max	D2982 DIN 51375	Engine	Negative				
Water, Max	E203	Engine	0.3%				
Fuel Dilution, Max	D3524	Engine	2.5%		7%		
Fe, Max ‡	D5185	Engine Wear	200 ppm				
Al Max‡	D5185	Engine Wear	30 ppm				50 ppm
Si Max‡	D5185	Engine Wear	30 ppm				50 ppm
Cu, Max§	D5185	Engine Wear	30 ppm				50 ppm
Pb, Max‡	D5185	Engine Wear	30 ppm				10 ppm
Na, Max ‡	D5185	Engine Coolant Leak	100 ppm				
K, Max §	D5185	Engine Coolant Leak	150 ppm				

* Infrared spectroscopy (ASTM E 168/DIN 51452) may also be used, provided it is calibrated to be equivalent to the TGA method.

† With PGOS approved oils

‡ These are general limits. Wear metal limits must be determined for specific application and oil used.

§ Results may exceed limits during engine break-in period; see Section 4.7 for more information.

NOTE: These limits are intended as guidance when a single oil sample is tested and are based on the normal oil drain intervals listed in Table 4-1. Actual limits are dependent on engine, application, drain interval and oil type. Refer to Detroit Diesel Publication DDC-SVC-MAN-0047 for determining warning limits specific to your application.

Table 4-4 Single Sample Used-Oil Analysis Warning Limits

4.7 OIL ANALYSIS DURING ENGINE BREAK-IN PERIOD

Within the first three oil drains, copper (Cu) levels may exceed the specified limits. Under normal operating conditions, copper may leach from the oil cooler in new engines until the entire copper surface is passivated, which normally occurs within the first oil drain. In DD13, DD15, and DD16 engines, copper levels may reach as high as 500 ppm during the first oil change with no adverse effects. Copper levels should reduce with each oil change but may not remain below the specified limits until after the third oil drain.

Within the first three oil drains, potassium (K) and aluminum (Al) levels may also exceed the specified limits. Under normal operating conditions, brazing flux compound containing potassium and aluminum may leach from the Charge Air Cooler and be introduced into the engine oil through the air intake system. In DD13, DD15, and DD16 engines, potassium levels may reach as high as 300 ppm during the first oil change with no adverse effects. Potassium from brazing flux may be perceived as a coolant leak at these levels. During the first three oil drains, only sodium (Na) should be used as an indicator for potential coolant leaks. Aluminum levels during the first three oil drains may reach as high as 150 ppm. Potassium and aluminum levels should reduce with each oil change but may not remain below the specified limits until after the third oil drain.

5 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 and EPA10 exhaust compliant engines equipped with exhaust aftertreatment devices, the use of Ultra-Low Sulfur Diesel (ULSD) fuel 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. ULSD fuel is recommended by Detroit Diesel for use in Series 60, Series 50, Series 55, MBE 900, MBE 4000, DD13, DD15, and DD16 engines.

5.1 QUALITY AND SELECTION

For optimum engine operation and maximum service life, diesel fuels meeting the property requirements listed in Table 5-1 are recommended for use.

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

Property	ASTM Test	ISO Test	No. 1 Fuel	No. 2 Fuel
API Gravity, at 60°F	D 287	–		
Minimum Maximum			40 43	33 38
Specific Gravity, g/ml @ 60°F	D 1298	3675		
Minimum Maximum			0.812 0.825	0.830 0.855
Flash Point, °C Minimum *	D 93	2719	38	52
Viscosity, Kinematic cSt @ 40°C Minimum Maximum	D 445	3104	 1.3 2.4	 1.9 4.1
Sulfur, ppm (wt%) Maximum	D 2622 or D 5453	EN 24260	15 (0.0015)	15 (0.0015)
Cloud Point	D 2500	–	–	†
Cold Filter Plugging Point	D 4359	309	–	†
Cetane Number, Minimum	D 613	5165	43	43
Cetane Index, Minimum	D 4737	4264	40	40
Distillation % Vol.				
Recovery, °C (°F) IBP, Typical			163 (325)	194 (345)
10%, Typical			182 (360)	216 (420)
50%, Typical	D 86	3405	218 (425)	260 (500)
90%, Maximum			288 (550)	338 (640)
95%, Maximum			340 (644)	360 (680)
Recovered Volume, % Minimum			98	98
Water, % Maximum ‡	D 6304	12937	0.02	0.02
Sediment > 1µm, mg/L Maximum	D 2276 or D 5452	–	10	10
Total Contamination, mg/kg Maximum	–	EN 12662	24	24
Ash, % mass Maximum	D 482	6245	0.01	0.01
Carbon Residue, on 10%, % mass	D 524	10370	0.15	0.35
Copper Corrosion, Maximum	D 130	2160	No. 3a	No. 3a
Accelerated Storage Stability mg/L, Maximum	D 2274	–	15	15
Reflectance at 150° C, Minimum (High Temperature Stability)	D 6468	–	70	70
Heat Content, Net, BTU/gal	D 4868	–	125,000 – 127,300	128,500 – 130,900
Lubricity Wear Scar, µm, Maximum	D 6079	–	460	460
Fuel Cleanliness, Particle Count, maximum	-	4406	18/16/13	18/16/13
Biodiesel concentration, % maximum	ASTM D	EN 14078	5***	5

Property	ASTM Test	ISO Test	No. 1 Fuel	No. 2 Fuel
Oxidation Stability, hours minimum	-	EN 15751	6	6
Water Coalescing Effectiveness, % minimum	D 7261	-	70	70

* The flash point temperature is a safety-related property which must be established according to applicable local requirements.
† The cloud point and filter plugging point temperature should be equal to, or below the lowest ambient temperature to prevent clogging of fuel filters by wax crystals.
‡ No free water is visible.
*** Biodiesel is not recommended in low ambient temperatures due to its potential to form wax crystals.

Table 5-1 Diesel Fuel Specifications

5.1.1 FUEL LUBRICITY

It is recommended that all fuels used in Detroit Diesel engines meet the minimum lubricity requirements listed in Table 5-1, “Diesel Fuel Specifications.” Fuels not meeting the lubricity requirements may be additized to meet them.

5.1.2 PREMIUM DIESEL FUEL

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 Table 5-1 before using.

5.1.3 BIODIESEL FUELS

Detroit Diesel supports biodiesel as a renewable fuel. Biodiesel fuels are mono alkali esters of long chain fatty acids commonly referred to as Fatty Acid Methyl Esters (FAME) and are derived from renewable resources through a chemical process called transesterification. Detroit Diesel approves the use of biodiesel fuel blends up to 5% maximum by volume in diesel fuel providing the following three conditions are met:

- The biodiesel used in the blend must meet ASTM D 6751 or EN 14214 specifications.
- The biodiesel used in the blend must be sourced from a BQ-9000 Accredited Producer or a BQ-9000 Accredited Marketer.
- The finished blend must meet the fuel properties listed in Table 5-1 and either ASTM D 975 or EN 590 specification.

Biodiesel is not recommended for use in low ambient temperatures due to its potential to form wax crystals.

Biodiesel should not be used in applications where fuel is stored, either in bulk containers or in vehicle tanks, for more than 3 months.

Detroit Diesel is responsible for the materials and workmanship of its engines. Failures attributed to the use of fuels which do not meet industry standards are not the fault of Detroit Diesel and will not be covered by the Detroit Diesel product warranty. While Detroit Diesel supports the use of B5, the use of unacceptable quality fuel that does not meet industry standards can result in warranty denial. Refer to Chapter 7 for more details regarding Detroit Diesel's warranty coverage.

5.2 DIESEL FUEL PROPERTIES

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).

5.2.1 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. Use the full boiling range as listed in Table 5-1 for proper selection.

5.2.2 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 Diesel specifies the 95% temperature because it is closer to the end point than the 90% used in ASTM D 975.

5.2.3 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.

5.2.4 FUEL STABILITY

Diesel fuel oxidizes in the presence of air, heat, and water. The oxidation of fuel can result in the formation of undesirable gums and black sediment. Such undesirable products can cause filter plugging, combustion chamber deposit formation, and gumming or lacquering of injection system components, with resultant reduced engine performance and fuel economy. Three tests are specified for fuel stability. ASTM Test Method D 2274 (Accelerated), which measures diesel fuel storage oxidative stability, ASTM Test Method D 6468, which measures high temperature stability and EN 15751 Rancimat Oxidation Stability, which measures oxidative stability in biodiesel blends. ATSM D 6468 must be run at 150°C (302°F). The results of ATSM D 6468 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. ATSM D 2274 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.

Biodiesel blends have lower oxidative stability than 100% petroleum-based diesel fuel. For biodiesel blends, EN 15751 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.

5.2.5 FUEL SULFUR CONTENT

Since January 2007, 80% of diesel fuel sold for On-Highway use must be ULSD fuel (below 15 ppm). Until the complete phase-in of ULSD fuel in December, 2010, dispensing pumps must be identified with the sulfur level of the fuel being sold. If operating EPA07 compliant engines, or older engines with API CJ-4 oils, it is highly recommended that only ULSD fuel be used. Fuels with sulfur content above 15 ppm are not recommended for these engines due to poisoning of aftertreatment devices and the corrosion of EGR components. Engines, particularly EGR-equipped engines, operated on 500 ppm sulfur fuel and API CJ-4 oils may require a reduction in oil drain intervals.

5.2.6 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 5-1, “Diesel 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 Diesel 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.

5.2.7 COLD WEATHER OPERATION

Diesel fuel contains paraffin wax 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). Cloud Point 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. Cold Filter Plugging Point is the temperature at which the fuel will no longer pass through a certain wire filter within a given period of time as measured by ASTM D4359.

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. 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. 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, too much may cause other operability problems. The proper treat rate of any fuel additive cannot be predicted. 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 or below the expected ambient temperature.

5.3 FUEL ADDITIVES

Detroit Diesel engines are designed to operate satisfactorily on a wide range of diesel fuels. The use of supplemental fuel additives is not recommended due to potential injector system or engine damage. Our experience has been that such additives increase operating costs without providing benefit.

5.3.1 WATER CONTAMINATION

Some fuel additives claim temporary benefit when fuel is contaminated with water. They are not intended to replace good fuel handling practices. Good fuel handling practices include bulk tank filtration, regularly removing the water from the bottom of the storage tank and regular tank cleaning.

Where water contamination is a concern, equip the fuel system with a fuel/water separator and service it regularly. Supplemental fuel additives designed to disperse, emulsify or carry the water through the fuel system should not be used, as they can disable or significantly reduce the efficiency of fuel/water separators, resulting in fuel system corrosion. Since many fuel additives act as surfactants, their effect on the efficiency of fuel/water separators should be evaluated by ASTM D7261 test method, which is a quick measurement of roughly how much water passes through a coalescing filter in a single pass.

5.3.2 MICROBIAL CONTAMINATION

In marine and other environments where microbe growth is a problem, a biocide may be used. Microbial activity may be confirmed with commercially available test kits. When checking for microbial activity, collect fuel samples from the bottom of the fuel tank. Follow the manufacturer's instructions for treatment. Avoid the use of biocides containing chlorine, bromine, or fluorine compounds, since these may cause fuel system corrosion.

5.3.3 FUEL ADDITIVES THAT ARE NOT ALLOWED

The following fuel additives are NOT allowed:

⚠ CAUTION:

USED ENGINE OIL

To avoid injury to skin from contact with the contaminants in used engine oil, wear protective gloves and apron.

- **Used Lubricating Oil –** Detroit Diesel 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. Refer to section 3.10, "Waste Oil Disposal and Re-refined Oils," 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 Diesel 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.

5.3.4 EVALUATION OF SUPPLEMENTAL FUEL ADDITIVES FOR TEMPORARY USE

Many supplements available today are intended to be added to the fuel by the customer. These include a variety of independently marketed products which claim to be:

- Cetane Improvers
- Emission Control Additives
- Detergents
- Combustion Improvers
- Smoke Suppressants
- Cold Weather Flow Improvers
- Fuel Economy

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

- Review a Material Safety Data Sheet (MSDS) carefully for special handling instructions and hazardous material content. Additives containing hazardous materials should not be used due to personal safety risk.
- 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.
- Many additives act as surfactants, evaluate the effect of water separation characteristics on the fuel in combination with the additive. Refer to Table 5-1 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. Evaluate a mixture containing twice the recommended concentration of additive for compatibility to represent an over dosage condition, using the tests listed in Table 5-1, “Diesel Fuel Specifications”.

- □ Conduct performance evaluation of a fuel supplemental additive in customer equipment for a minimum of six months. Testing should be a side-by-side comparison with and without the additive to verify performance claims. Testimonials do not guarantee similar performance in all applications.

Supplemental fuel additives are not recommended due to potential injector system or engine damage. Our experience has been that such additives increase operating costs without providing benefit. The use of supplemental fuel additives does not necessarily void the engine warranty. However, repair expenses which result from fuel system or engine component malfunctions or damage attributed to their use will not be covered. Accompany these products with performance data supporting their merit as well as the manufacturer's warranty policy. Detroit Diesel will not test or verify the performance of any supplemental additives and will not accept responsibility for use, selection, or hazards relating to the use of such products.

5.4 DIESEL FUEL STORAGE

Diesel fuel should be clean and free of contamination. Inspect storage tanks and stored fuel regularly for dirt, water, and sludge. Drain and clean tanks, if contaminated. Diesel fuel tanks can be made of monel, stainless steel, black iron, welded steel, or reinforced (non-reactive) plastic.

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

6 FILTRATION

Filters make up an integral part of fuel and lubricating oil systems. Proper filter selection and maintenance are important to satisfactory engine operation and service life. Use filters, however, to maintain a clean system, not to clean up a contaminated system.

6.1 FUEL AND LUBRICATING OIL FILTERS

Filter performance and test specifications vary between manufacturers. These specifications are general in nature and do not reflect the actual performance of Detroit Diesel genuine filters. The user is also cautioned when comparing micron ratings between filter makes. Some filter manufacturers may publish results from tests in which the SAE J1858 test procedure was not used. It is also important to note that capacity and efficiency (micron) ratings should not be the only criteria on which to judge filter performance. Many other important factors, including media strength, resistance to impulse failures, and burst strength, often differ greatly between filter makes and should enter into the filter selection process.

Finer filtration will generally provide increased engine service life, but may require shorter filter change intervals. Detroit Diesel specifies filter performance based on the optimum combination of filter micron rating, filter capacity, and mechanical requirements (assembly integrity).

The oil and fuel filter used must meet the minimum requirements as listed in Table 6-1 and Table 6-2.

6.2 SUPPLEMENTAL OIL FILTERS

The use of supplemental by-pass oil filtration devices are not allowed on DD13, DD15, and DD16 engines.

Product	Description	Part Number	Efficiency Specification	Capacity Specification	Application Years
S60/S50	Detroit Diesel Genuine Full Flow Oil Filter	23530573	98% minimum on 23-27 micron particles at 25 gpm per SAE J1858	70 g minimum at 25 gpm and 25 psid terminal pressure per SAE J1858	1993 and newer
S60/S50	Detroit Diesel Genuine Full Flow Oil Filter	23530407	98% minimum on 28 micron particles at 25 gpm per SAE J1858	70 g minimum at 25 gpm and 25 psid terminal pressure per SAE J1858	Pre-1993
S60/S50	Detroit Diesel Genuine Fuel Spin-On Primary Filter	23530706	98% minimum on 23-27 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 Diesel Genuine Spin-On Primary Water/Fuel Separator Filter	23535985	98% minimum on 23-27 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 Diesel Genuine Fuel Spin-On Secondary Filter	23530707	98% minimum on 7-9 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 Diesel Genuine Fuel Spin-On Secondary Filter	23530645	87.5% minimum on 3-5 micron, 98.5% minimum on 5-10 micron, 99.4% minimum on 10-15 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	23533816	87.5% minimum on 3-5 micron, 98.5% minimum on 5-10 micron, 99.4% minimum on 10-15 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 Water removal: minimum 95% efficiency at both emulsified and free water per SAE J1488 and SAE J1839	58 g minimum at 100 gph, 4 psid terminal pressure per SAE J905	All

Table 6-1 Oil and Fuel Filter Minimum Requirements (1 of 2)

Product	Description	Part Number	Efficiency Specification	Capacity Specification	Applica-tion Years
MBE 4000	Fuel Filter	5410900151	69.3% on 4-6µm, 92.2% on 6-8µm, 98% on 8-10µm, 99.5% on 10-12µm, 99.8% on 12-15µm, 99.9% on 15-20µm, 100% on >20µm 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 4000	Oil Filter	A0001802109	50% on 21µm, 70% on 25µm, 82,5% on 30µm, 88% on 35µm, 90% minimum on >40µm (ISO 4548-12)	100 g minimum at 125 lpm (ISO 4548-12) (25.4 psid terminal differential pressure)	All
MBE 900	Fuel Filter Primary (in-housing system with main filter)	000 090 1351	300 µm screen	Not applicable	All
	Fuel Filter Main (in-housing system)	000 090 1551	90% minimum > 6micron particles according to ISO 4548-12 (Test report from Mahle® Filter System dated 17.12.2003	Minimum 75 minutes after ISO 4020 with test flow 75 lph or 34 g after ISO 19438, test flow 360 lph	All
			80% minimum on 5micron, 90% minimum on 6micron, 99% minimum >10micron particles initial efficiency according to ISO 19 438 (Test report from Mahle® Filter System dated 18.03.2005, MFP value 6,5 + 1 µm)		All
MBE 906/926	Oil Filter	000 180 1709	85% minimum on > 23micron particles according to BN 2.21 in dependence on ISO 4548	–	All
MBE 904/924	Oil Filter	000 180 1609	85% minimum on > 23micron particles according to BN 2.21 in dependence on ISO 4548	–	All
DD13, DD15, DD16	Prescreen Fuel Filter	A4720900251	98% minimum on > 100micron particles	at 2.91 gpm	All
	Coalescer Fuel Filter	A0000903451	98% minimum on > 10micron particles	at 2.91 gpm	All
	Final Fuel Filter	A0000903551	98% minimum on 3-5micron particles	at 4.49 gpm	All
	Oil Filter	A4721800109	50% at 19µm (ISO 4548-12)	126 g minimum at 125 lpm (ISO 4548-12) (25.4 psid terminal differential pressure)	All

Table 6-2 Oil and Fuel Filter Minimum Requirements (2 of 2)

6.3 BOSCH/DELPHI FUEL FILTRATION SYSTEMS

The minimum requirements from the Bosch Application Guideline Y-414-E20-22 (December 23, 1999) for the Bosch unit injector and unit pump systems are illustrated in Figure 6-1. The initial retention efficiency must be minimum 85–90% for particles 3–5 micron. For applications in regions or applications where high particle contaminated fuels may be expected such as mining and fueling from drums, efficiency has to be adopted to meet the recommended >95% for particles 3–5 micron. See Figure 6-1.

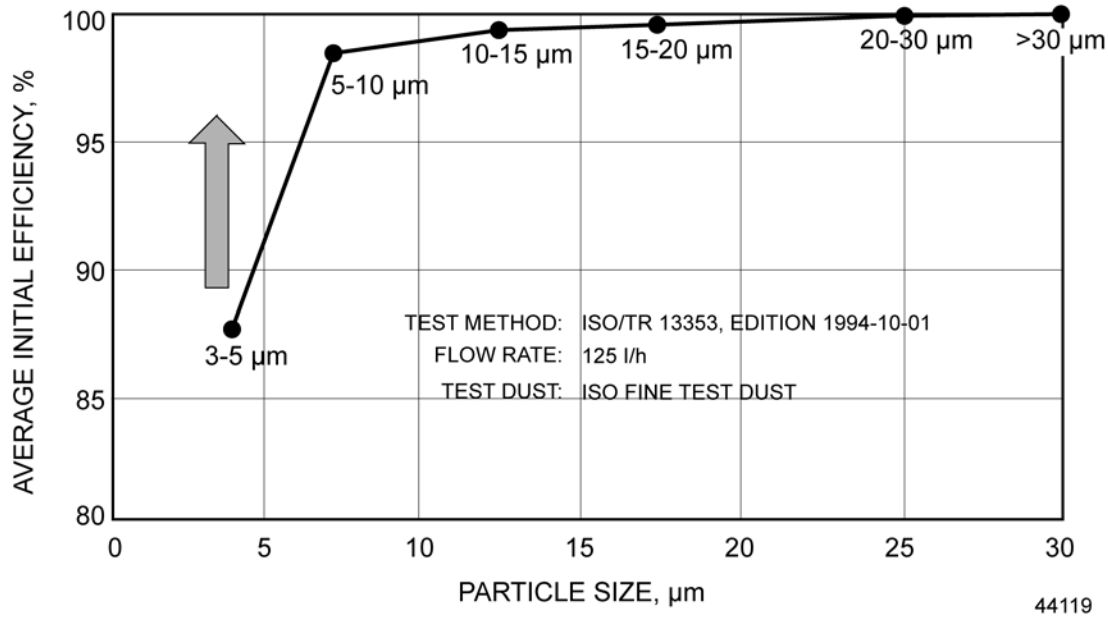

Figure 6-1 Bosch Unit Injector and Unit Pump Requirements

6.4 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).

6.5 DETROIT DIESEL GENUINE MAINTENANCE PRODUCTS

Regular and optional Detroit Diesel genuine service spin-on fuel filters for Series 50, Series 55, and Series 60 Detroit Diesel engines are listed in Table 6-3. Fuel Pro filters are listed in Table 6-4, and Sea Pro® marine engine fuel filters are listed in Table 6-5. Cartridge-type fuel filters are listed in Table 6-6. Detroit Diesel genuine spin-on lubricating oil filters are listed in Table 6-7. Detroit Diesel genuine oil analysis kits are listed in Table 6-8.

Engine	Primary Fuel Filter		Secondary Fuel Filter		
	Qty	Part No.	Qty	Part No.	Higher Filtration Part No.
Series 50	1	23530706	1	23530707	—
Series 55	—	—	1	23530707	—
Series 60 (non-EGR, 2002 DDEC IV EGR)	1	23530706	1	23530707	—
Series 60 (2004 DDEC V EGR & later)	1	23535985	1	23530645	—

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.

Table 6-3 Detroit Diesel Genuine Spin-On Fuel Filter Elements

Filter Description	Part Number
Fuel Pro 230	23521527
Fuel Pro 232	23528565
Fuel Pro 380/382	23529168
Fuel Pro 40 Mega Filter™	23530646
Fuel Pro 382 (2004 Series 60 Engine)	23533816

Table 6-4 Fuel Pro Fuel Filter Elements

Filter Description	Micron Rating	Part Number
Sea Pro 50 / 100	30	23532245
Sea Pro 152 / 511	15	23521528
600	20	23530641
Water-in-Fuel Sensor Kit	—	23518182

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.)

Table 6-5 Sea Pro Fuel Filter Elements

Engine Series	Primary Filter Element	Coalescer Filter Element	Secondary Filter Element
	Part Number	Part Number	Part Number
MBE 904	N/A	N/A	0000901551
MBE 906	N/A	N/A	0000901551
MBE 4000	N/A	N/A	5410900151
DD13, DD15, DD15	A4720900251*	A0000903451*	A0000903551*

* Included in Fuel Filter Service Kit **A0000901552** on the DD15 maintenance required stock list.

Table 6-6 Cartridge Type Fuel Filter Elements

Engine Series	Filter Type	Qty	Part No.	Higher Filtration Part No.
Series 50	Spin-On	2	23530573	—
Series 55	Spin-On	1	5241800310	—
Series 60	Spin-On	2	23530573	DELF3998
Series 60 (Pre-1993)	Spin-On	2	23530407	23530409
Series 60 (Pre-1993)	Spin-On	1	23530413	—
MBE 904	Cartridge	1	0001801609	N/A
MBE 906	Cartridge	—	0001801709	N/A
MBE 4000	Cartridge	—	0001802109	N/A
DD13, DD15, DD16	Cartridge	1	A4721800109	N/A

Table 6-7 Detroit Diesel Genuine Lubricating Oil Filters

Part No.	Description
23515823	Standard Oil Analysis
23517267	Oil Analysis with Oil Suction Bottle
23520989	Oil Analysis with Total Base Number
23516922	Fuel Analysis
23521982	Oil Analysis (Canada)
23521983	Oil Analysis with Total Base Number (Canada)
23521984	Oil Analysis with Oil Suction Bottle (Canada)
23516921	Conventional Coolant Test
23523398	LLC/ELC Organic Coolant Test

Table 6-8 Detroit Diesel Genuine Fluid Analysis Kits

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7 STATEMENT OF DETROIT DIESEL WARRANTY

Detroit Diesel is not responsible for the cost of maintenance or repairs due to the lack of performance of required maintenance services or the failure to use fuel, oil, lubricants, and coolants meeting Detroit Diesel-recommended specifications. Performance of required maintenance and use of proper fuel, oil, lubricants, and coolants are the responsibility of the owner. For full details, see the engine operator's guide for your engine.

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8 SUPPLEMENTAL INFORMATION

Specifications referred to in this publication and other related information may be obtained by contacting the following sources:

SAE Standards
Society of Automotive Engineers
Technical Publications
400 Commonwealth Drive
Warrendale, PA 15096-0001
www.sae.org

ASTM Annual Book of Standards, Section 5
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
www.astm.org

API Annual List of Licensees and Other Publications
American Petroleum Institute
1220 L Street Northwest
Washington, D.C. 20005
Directory of Licensees: www.eolcs.api.org

DIN Deutsches Institut für Normung e. V. (DIN EN)
Burggrafenstraße 6
10787 Berlin
Germany
www.din.de

International Organization for Standardization (ISO)
1, ch. de la Voie-Creuse
Case postale 56
CH-1211 Geneva 20
Switzerland
www.iso.org

