DETROIT DIESEL

Lubricating Oil, Fuel, and Filters

Engine Requirements

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1 INTRODUCTION

This publication specifies the type of fuels, lubricants, filters and related maintenance intervals required for the diesel-fueled engines manufactured and marketed by Detroit Diesel Corporation, except the Series 2000® and Series 4000™ engines.

NOTE:
For Series 2000 or Series 4000 engine lubricating oil, fuel and coolant requirements, refer to publication, *MTU Fluid and Lube Specifications*, A001061/26E, available from authorized DETROIT DIESEL® distributors.

For information on fuels, lubricants and filters required for DDC® 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

Labeling terminology for today's oil is insufficient as a method of lubricant selection. The proper lubricating oil for Detroit Diesel engines is based on SAE (Society of Automotive Engineers) Viscosity Grade and API (American Petroleum Institute) Service Designation, displayed on the API symbol. For most Detroit Diesel engines, the proper lubricant must possess additional requirements that follow.

2.1 LUBRICANT REQUIREMENTS – FOUR-STROKE CYCLE ENGINES: DETROIT DIESEL SERIES 40, 40E, 50, 55, 60, 638, D700, MBE 900, MBE 4000

2.1.1 API SYMBOL

The API symbol is shown below.

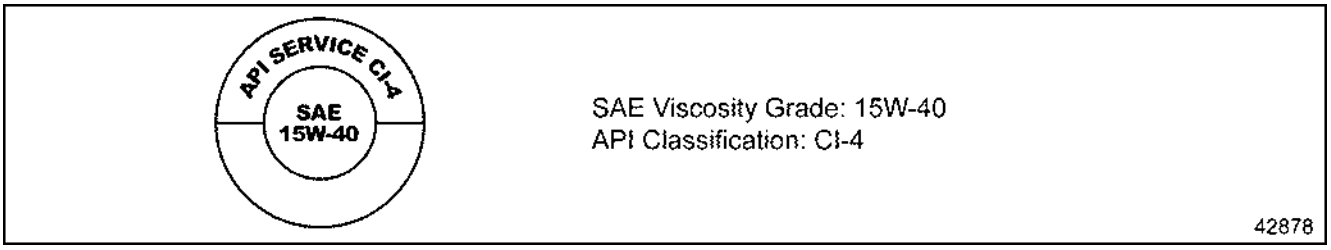

Figure 2-1 API Symbol: 4-Stroke Cycle Engine Oils

2.1.2 LOW AMBIENT TEMPERATURE STARTING

At ambient temperatures below -20° C (-4° F), SAE 15W-40, 5W-30, 10W-30 or 10W-40 oils may be used, provided they are API CI-4 and have demonstrated field performance in DDC engines. These oils must possess a "High Temperature / High Shear" (HT/HS) Viscosity of 3.7 minimum. For more information on HT/HS, refer to Section 3.2.

2.1.3 TOTAL BASE NUMBER

An oil TBN (ASTM D 2896) minimum of 8.0 is recommended.

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2.1.4 GLOBAL DHD-1 OILS

Engine oils meeting Global DHD-1 qualify for oil drain extension. See oil drain intervals listed in Table 4-1 and Section 3 , “Lubricating Oil Selection Criteria,” for more information.

2.1.5 ONLY API OILS RECOMMENDED

Only API-licensed oils may be used in Detroit Diesel engines. Lubricants meeting API criteria provide maximum engine life when used in conjunction with specified oil drain and filter maintenance schedules.

2.1.6 ENGINES WITH COOLED EGR

API Service Category CI-4 is intended for use with cooled EGR (exhaust gas recirculation) engines meeting 2002 and later exhaust emission regulations. Compared to the older API CH-4 category, the new API CI-4 engine oils have improved performance. Lubricants meeting API Service Category CI-4 are required for use in 2002 and newer engines and recommended for use in all Detroit Diesel Series 40™, 40E™, Series 50®, Series 55®, Series 60®, 638™, and D700™ engines and MBE 900 and MBE 4000 engines. API CH-4 can be used for 1998 through September 2002 non-EGR engines.

2.1.7 MONOGRADE OILS

Monograde oils, irrespective of API service category, should not be used in on-road applications in any DDC 4-stroke engines or in off-road applications in Series 40E, 50, 60, MBE 900 and MBE 4000 engines.

2.1.8 HIGH SULFUR FUEL

When the use of high sulfur fuel (greater than 0.05% mass sulfur) is unavoidable, higher alkalinity (TBN) lubricants are recommended. High sulfur fuels require modification to oil drain intervals. For further information, refer to Section 4.3, “The Use of High Sulfur Fuels.”

2.2 LUBRICANT REQUIREMENTS – TWO-STROKE CYCLE ENGINES: DETROIT DIESEL SERIES 53, 71, 92, 149

2.2.1 TWO-STROKE CYCLE ENGINE OIL REQUIREMENTS

The selection of the correct engine oil for DDC two-stroke cycle engines is dependent upon the application and fuel sulfur levels. The proper engine oils are listed in Table 2-1 and in Table 2-2. These tables should be used to select the proper engine oil.

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Engine Series	Fuel Sulfur	Recommended Oil Type	
		Primary	Secondary
53, 71, 92 All Applications	Less than 0.5%	1	2, 3 or 4
	0.5 to 1.0%	1[1]	4
149 Marine Only	Less than 0.5%	2 or 3	4
	0.5 to 1.0%	1[1]	3[1] or 4
149 All Applications, Except Marine	Less than 0.4%	3	4
	0.4 to 1.0%	4	None

1 The use of oils under these conditions requires a reduction in oil drain interval. Refer to Section 4.1, "Drain Intervals" and Section 4.3, "The Use of High Sulfur Fuel."

Table 2-1 DDC Two-Stroke Cycle Engine Oil Requirements

2.2.2 OIL TYPE SPECIFICATIONS

After determining the required oil type for the application and anticipated fuel sulfur content, use Table 2–2 to identify the type of lubricant required. These are listed in Table 2-2. The superscript numbers refer to notes of explanation provided after the table.

Oil Type	1	2	3	4
API Classification[1]	CF-2	CF-2	CF-2	CF-2 or LMOA[2]
Viscosity Grade[3]	40[4]	40[4]	50[5]	50[5]
Sulfated Ash (ASTM D 874)[6]	1.0% Max.	0.85 Max.	0.8% Max.	Not Specified
Alkalinity (ASTM D 2896)	7.0 Min.[7]	7.0 Min.[7]	7.0 Min. [7]	13.0 Min.
Calcium, ppm	Not Specified	Not Specified	400 – 600 Max.	Not Specified
Zinc, ppm	Not Specified[7]	Not Specified[7]	Not Specified[7]	100 Max.
Phosphorous, ppm	Not Specified[7]	Not Specified[7]	Not Specified [7]	100 Max.

Table 2-2 Oil Type Specifications

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Following are notes of explanation for Table 2-2.

1. Only oils licensed by American Petroleum Institute are recommended in Detroit Diesel two-stroke cycle engines. Licensed oils must display the API Symbol. See Figure 2-2.

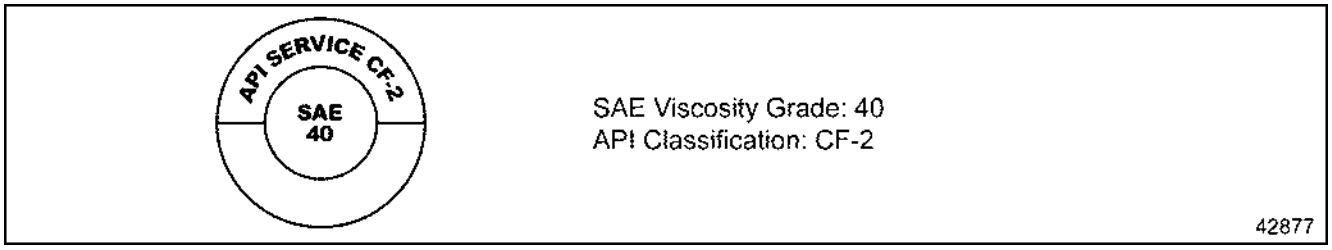

Figure 2-2 API Symbol: 2-Stroke Cycle Engine Oils

2. LMOA = Locomotive Maintenance Officers' Association
3. For continuous high temperature operation (over 200° F or 94° C coolant out), the use of an SAE grade 50 lubricant in DDC two-stroke cycle Series 53, 71 and 92 engines is required. SAE grade 50 lubricants are also required for all Series 149 engines where ambient temperatures are above 95° F (35° C).
4. At ambient temperatures below freezing (32° F or 0° C), sufficient starter cranking speed may not be achieved to start the engine with SAE 40 grade oils. Where starting aids are not available *or* at very cold temperatures (0° F to -25° F or -18° C to -32° C) even if starting aids are available, the use of multigrade SAE 15W-40 or monograde lubricant SAE 30 will improve startability. These lubricants must possess a High Temperature – High Shear Rate Viscosity (measured by ASTM D 4741 or equivalent) of 3.70 cP minimum. **These oils must be replaced with monograde SAE 40 lubricants as soon as ambient conditions permit. Do not use multigrade or SAE 30 grade lubricants in two-stroke cycle marine engines or Series 149 under any circumstances.**
5. At lower ambient temperatures where sufficient starter cranking speed may not be achieved to start the engine with SAE 50 grade oils, SAE grade 40 oils may be used. SAE 50 grade oils are not recommended below 45° F (7° C) ambient.
6. Engine oils with alkalinity between 6.5 and 7.0 may be used with demonstration of satisfactory performance and review by Detroit Diesel.
7. Not Specified; 700 ppm minimum recommended.

Lubricants meeting these criteria have provided maximum engine life when used in conjunction with recommended oil drain and filter maintenance schedules.

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2.2.2.1 Military Spec Oils

Military specified oils (Mil-L-2104 suffixes A through G) should not be used in commercial DDC two-stroke cycle engines *unless they are API CF-2 licensed*. Engine oils meeting military specification Mil-L-2104 are intended for use in military engines. Due to the specific operating and life cycle requirements of military engines, oils for these engines tend to be specialized toward that application. Refer to Section 3.9, “Military Engine Oil Requirements.” A more detailed description of each of these selection criteria may be found in further sections of this publication.

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3 LUBRICATING OIL SELECTION CRITERIA

3.1 SAE VISCOSITY GRADE SELECTION

Viscosity is a measure of an oil's ability to flow at various temperatures. The SAE Viscosity Grade system is defined in SAE Standard J 300 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 kinematic viscosity ranges with the associated 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. It should be used 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. ($^{\circ}$C), Max.		Viscosity (cSt) ASTM D 445 t 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 J 300, December 1999)

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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. In 15W-40 grade oils, a HT/HS viscosity below 3.7 centipoise (cP) indicates that the oil will not perform as a 40 grade oil at engine operating conditions.

3.3 GLOBAL DHD-1 SPECIFICATION

Engine and equipment manufacturers from the United States, Europe and Japan have jointly developed a global heavy duty diesel engine oil specification designated “Global DHD-1.” Oils meeting this specification provide premium performance beyond API CH-4, and are recommended by Detroit Diesel for use in all 4-cycle engine products throughout the world. Engine oils meeting Global DHD-1 may permit extension of oil drain intervals 50% on **non-EGR engines** beyond those listed in Table 4-1, if properly maintained as defined in Section 4.1 .

3.4 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. 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-stroke diesel engines.

When the use of a high ash oil is required, such as with high sulfur fuel, the oil selected should have the highest TBN to Ash ratio possible. For example, an oil with a TBN of 10 and an Ash of 1.2% mass is less desirable than an oil with the same TBN and 1.0% Ash. Also refer to Section 4, “Oil Drain Intervals.”

3.5 LOW ZINC, HIGH TBN INDUSTRIAL DIESEL LUBRICANTS (OIL TYPE 4 FOR TWO-STROKE ENGINES)

The petroleum industry markets specialty lubricants for diesel engines which are characterized by their high TBN and the absence of magnesium and zinc in their composition. These lubricants take into consideration the unique environments and operational characteristics of marine propulsion and railroad locomotive applications. Consequently, they are formulated quite differently from the types of lubricants specified by Detroit Diesel. Marine and railroad lubricants are recommended for use in Series 149 and other DDC two-stroke cycle engines where fuel sulfur content exceeds 0.5%. These oils may also be selected for use when one of the following situations exists:

- ☐ They are required in other equipment and only a single engine lubricant can be inventoried.

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☐ Where there is a risk of resulting exhaust valve distress with conventional high ash oil.

Selection should be based on demonstrated satisfactory field performance in Detroit Diesel engines as provided by the oil supplier. **These oils are not recommended for use in DDC 4-cycle engines, unless API licensed as CH-4 or CI-4 (preferred).**

3.6 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 SJ/CF or CG-4/SH. 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 CF-2 or CG-4 / CH-4 / CI-4 designations. When selecting a universal oil, select one with the "C" category *first*, as this should be primarily intended for diesel service.

3.7 SYNTHETIC OILS

Synthetic oils may be used in Detroit Diesel engines, provided they are API licensed and meet the performance and chemical requirements outlined in this publication. For two-stroke cycle engines, only synthetic oils which do not contain viscosity improver additives may be used. Information on oil drain intervals is listed in Table 4-1.

3.8 LUBRICANT SELECTION OUTSIDE NORTH AMERICA

Engine Oils meeting Global DHD-1 are preferred for all DDC 4-cycle engines worldwide and permit extended oil drain intervals as listed in Table 4-1. If these lubricants are not available, lubricants meeting European ACEA E2-96, E3-96, or E5-99 *and* API CG-4, CH-4 or CI-4 (preferred) may be used at the oil drain intervals also shown in Table 4-1. Oils of lower performance may only be used at a 50% oil drain interval reduction.

Oils meeting API CF may be used in DDC 2-cycle products, provided they also meet military specification Mil-L-2104 F.

Contact Detroit Diesel Corporation for further guidance.

3.9 MILITARY ENGINE OIL REQUIREMENTS

For military engine applications worldwide, an engine oil meeting the latest military specification SAE J 2357 (MIL-PRF-2104G) is required. While other branches of the military may have similar engine oil specifications, only oils meeting this specification should be used in DDC engines.

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3.10 TYPICAL PROPERTIES

Listed in Table 3-2 are the typical chemical and physical properties of a lubricant meeting Detroit Diesel requirements in normal applications. Exceptions to these requirements were noted in previous sections. 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.

Engine Type	2-Stroke Cycle			4-Stroke Cycle	
Viscosity Grade API Service	**30 CF-2**	**40 CF-2**	**50 CF-2**	**15W-40 CF-4/CG-4 CH-4/CI-4**	**10W-30 CH-4/CI-4**
Viscosity, Kinematic, cSt: 40° C	100 – 120	130 – 150	200 – 230	95 – 115	75 – 85
Viscosity, Kinematic, cSt: 100° C	9.3 – 12.5	12.5 – 16.3	16.3 – 21.9	12.5 – 16.3	9.3 – 12.5
HT/HS, cP 150° C	—	—	—	3.7 Min.	3.7 Min. HD 3.5 Min. LD
Viscosity Index	95	95	95	130	130
Pour Point °C, Max.	-18	-15	-10	-23	-30
Flash Point °C, Min.	220	225	230	215	205
Sulfated Ash, % Mass	—	1.0 Max.	—	2.0 Max.	2.0 Max.
Total Base Number	—	7.0 – 10.0	—	Above 8	Above 8
Zinc, ppm	—	Above 700	—	Above 1,000	Above 1,000

Table 3-2 Typical Properties of a DDC-Recommended Engine Oil

3.11 THE USE OF SUPPLEMENTAL ADDITIVES

Lubricants meeting the Detroit Diesel specifications 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 Corporation 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.

3.12 BRAND NAME APPROVED LUBRICANTS

Detroit Diesel does not maintain a list of brand name approved products. All lubricants which meet the qualifications listed in this publication will provide satisfactory performance when used in conjunction with the oil drain and filter requirements. To ensure the selected lubricant meets these qualifications, the customer should verify the candidate oil's current API license number. Although the lubricant supplier should be able to supply this information, it may also be obtained from other sources. Refer to Section 8, "Supplemental Information."

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3.13 PURCHASING BULK ENGINE OIL

To assure 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.

3.14 WASTE OIL DISPOSAL AND REREFINED OILS

⚠ CAUTION:

To avoid injury 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 rerefined oils in all engine product lines, provided the rerefined oil meets the SAE Viscosity and API specifications previously mentioned. Several processes are used to rerefine oil. The only true rerefining 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.

3.15 CLOSED BREATHER APPLICATIONS

In some applications, such as marine and power generation, engine crankcase vapors are routed into the air intake system. Some multigrade engine oil formulations have a tendency to generate vapors that condense on turbocharger and intercooler components, adversely affecting the operation of the engine. The volume and composition of these vapors are dependent on the oil formulation. Monograde oils tend not to make these deposits.

A laboratory test, MTV 5040, has been found effective in predicting vaporization tendencies. The test was developed by MTU Motoren- und Turbinen- Union Friedrichshafen GmbH and has a passing limit of 110 mg. This performance test is not included as part of an API Service Category.

3.16 ADDITIONAL INFORMATION

The Engine Manufacturers' Association publishes the **EMA Lubricating Oils DataBook**, which contains information on several hundred engine oils. The data in the DataBook is provided by oil companies in response to a questionnaire. Information includes viscosity grade, API category, ash content and other useful engine oil properties. It may be obtained directly from EMA. Refer to Section 8 , "Supplemental Information."

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4 OIL DRAIN INTERVALS

4.1 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.

The oil drain intervals listed in Table 4-1 (normal operation with low sulfur fuel) and the oil change intervals Listed in Table 4-3 (normal operation with high sulfur fuel) should be considered **maximum** and should not be exceeded. If the fuel used does not meet all the properties listed in Table 5-1, “Diesel Fuel Specifications,” the oil drain intervals shown in Table 4-3 apply. Always install new engine oil filters when the oil is changed.

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Service Application	Engine Series	Oil Drain Interval
Highway Truck & Motor Coach	40	12,000 Miles (19,200 km)
	50, 55, 60, 71, 92	15,000 Miles (24,000 km)
	MBE 900, MBE 4000	25,000 Miles (40,000 km)
Highway Truck	638	9,000 Miles (14,400 km)
City Transit Coach [2]	40	12,000 Miles (19,200 km)
	50[2], 55, 60, 71, 92	6,000 Miles (9,600 km),
	Series 50 Model 6047MK1E	3,000 Miles (4,800 km)
Fire Fighting/Crash Rescue Vehicles	50, 60	6,000 Miles (9,600 km), 300 hours or 1 Year[1]
	MBE 900	6,000 Miles (9,600 km)
Pick-Up & Delivery	40, 40E, 50, 53, 71	12,000 Miles (19,200 km)
	638	6,000 Miles (9,600 km)
	MBE 900	12,000 Miles (19,200 km)
Stop & Go, Short Trip	50	6,000 Miles (9,600 km)
	MBE 900	12,000 Miles (19,200 km)
Constructional / Industrial, Agricultural and Continuous Marine	40, 40E	450 Hours or 1 Year[1]
	50, 60	250 Hours or 1 Year[1]
	SUN / D700	250 Hours or 1 Year[1, 3]
	149	300 Hours or 1 Year[1]
	53, 71, 92	150 Hours or 1 Year[1]
Marine, Pleasure Craft and Commercial	60, MD700	250 Hours or 1 Year[1]
	149	300 Hours or 1 Year[1]
	53, 71, 92	150 Hours or 1 Year[1]
Stationary Electrical Generator Units, Standby	40	450 Hours or 1 Year[1]
	50, 53, 60, 92, 149	150 Hours or 1 Year[1]
Stationary Electrical Generator Units, Prime or Continuous	40	300 Hours or 3 Months[1]
	50, 53, 60, 71, 92, 149	300 Hours or 3 Months[1]

1. Whichever comes first.
2. All Series 50 engines, except model 6047MK1E.
3. Change oil filters every 250 hours maximum, and service the centrifugal filter based on the filter cake thickness. See the Operator's Guide for further details.

NOTE: On Non-EGR engines, oil drain intervals may be increased 50% with the use of oil meeting Global DHD-1. Increased filter capacity may be required. Refer to Section 4.4, "Extending Oil Drain Intervals," for additional information.

Table 4-1 Maximum Allowable Oil Drain Intervals (Normal Operation with Low Sulfur Fuel)

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4.2 OIL DRAIN INTERVALS SERIES 50 AND SERIES 60 ON-HIGHWAY ENGINES

Beginning in October 2002, more stringent exhaust emission requirements will be implemented for on-highway engines. To meet these requirements, cooled exhaust gas recirculation (EGR) technology will be used in addition to the existing retarded fuel injection timing. The new API CI-4 engine oils have been formulated to address these issues. While it is anticipated that these new oils provide the capability of maintaining the oil drain intervals listed in Table 4-1 and in Table 4-4, certain applications may involve engine operation which require an adjustment to oil drain intervals.

Adjusted oil drain intervals will depend on the engine's rate of soot production and the engine oil's capability to protect the engine. In some cases, it will be necessary to shorten oil drain intervals from the baseline oil drains, while in others it may be possible to operate at the maximum oil drain intervals listed in Table 4-1. Soot accumulations in the engine oil exceeding the capability of the oil formulation can result in increased wear and reduced engine durability. DDC recommends used oil analysis to determine the proper oil drain interval for these engines and oils. The oil analysis properties and limits should be considered when establishing oil drain intervals for these engines.

Used Oil Property	Test Method	Limit
Soot	TGA (E1131)[1], FTIR	3 % Max.
Kinematic Viscosity	ASTM D 445	25 cSt Max. @ 100° C
Iron	ASTM 5185	150 PPM

1. See Section 4.4, Item 1.

Table 4-2 Used Oil Drain Limits for 1998 Through Current-Build Series 50 and Series 60 On-Highway Engines

4.3 THE USE OF HIGH SULFUR FUELS

High fuel sulfur forms acids during combustion, particularly during idling and low temperature operation. The best defense against the effects of acid formation is to shorten oil drain intervals. The proper drain interval may be determined by oil analysis or by using the drain intervals listed in Table 4-3. A reduction in TBN to one-third of the initial value provides a general drain interval guideline. Marine fuels identified as meeting ASTM D 2609, *Specification for Marine Fuels*, should not be used in Detroit Diesel engines due to the high sulfur contents and boiling ranges permitted.

Should it be determined that the oil drain interval is unacceptably short, the selection of a lubricant with a TBN above 10 may be appropriate. Use the intervals listed in Table 4-3 until the best practical oil drain interval can be established by oil analysis. Used oil TBN may be determined with DDC POWER Trac oil analysis kit P/N 23520989.

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Service Application	Engine Series	Oil Drain Interval New Oil TBN Above 10
Highway Truck & Motorcoach	40, 40E, 50, 55, 60, 71, 92	10,000 Miles (16,000 km)
Highway Truck	638	6,000 Miles (9,600 km)
City Transit Coaches	40, 40E, 50, 55, 60, 71, 92	4,000 Miles (6,400 km) or 3 Months Maximum[1]
Fire Fighting / Crash Rescue Vehicles	50, 60	200 Hours, 4,000 Miles (6,400 km) or 6 Months[1]
Pick-Up & Delivery	40, 40E, 50, 55, 60, 71, 92	6,000 Miles (9,600 km)
	638	4,000 Miles (6,400 km)
Construction / Industrial, Agricultural and Continuous Marine	40	200 Hours or 6 Months[1]
	50, 60, SUN, D700	100 Hours or 6 Months[1]
	149	300 Hours or 1 Year[1]
	53, 71, 92	150 Hours or 1 Year[1]
Marine, Pleasure Craft and Commercial	60, MD700	150 Hours or 1 Year[1]
	149	300 Hours or 1 Year[1]
	53, 71, 92	150 Hours or 1 Year[1]
Stationary Electrical Generator Units, Standby	40, 40E, 50, 60, 71, 92	150 Hours or 6 Months[1]
Stationary Electrical Generator Units, Prime or Continuous	40	250 Hours or 4 Months[1]
	50, 60, 71, 92, 149	150 Hours or 3 Months[1]

1. Whichever comes first.

NOTE: These oil drain intervals are to be used for all engines and applications where the fuel used does not meet the recommended properties listed in Table 5-1, “Diesel Fuel Specifications.”

Table 4-3 Maximum Allowable Oil Drain Intervals When Using a Fuel Not Meeting DDC Recommendations Listed in Table 5–1, “Diesel Fuel Specifications”

4.4 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 and oxidation, dispersency and 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.**

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While some oil companies promote engine lubricants with a claimed longer useful life, Detroit Diesel Corporation does not recommend the extension of oil drain intervals on **EGR engines** beyond the maximum allowable periods listed in Table 4-1.

NOTE:
For non-EGR engines, oil drain intervals may be increased 50% with the use of oil meeting Global DHD-1. Increased filter capacity may be required. Refer to Section 4.4, "Extending Oil Drain Intervals," for additional information.

If oil and filter change interval extension beyond 50% is pursued, the following criteria will help to minimize the detriment to performance and engine life. DDC recommends that oil and filter change intervals not be extended at anytime beyond the used oil analysis limits listed in Table 4-4, "Single Sample Used Oil Analysis Warning Limits."

The following criteria also apply:

1. A rigorous maintenance program which includes used oil sampling, close adherence to maintenance schedules, and consistent make-up oil additions. DDC POWER Trac® used oil analysis kit with TBN, P/N 23520989, or equivalent is recommended in determining the proper oil drain interval.
2. Duty cycle severity no greater than defined as 60% maximum load factor, based on fuel consumption and a 40% maximum operating time at idling conditions.
3. The oil and filters should have field test demonstrated performance. Depending on the engine and application, the field test should be conducted at drain intervals at least 30% higher than the intended target for a duration of 500,000 miles or 5,000 hours.
4. The oil and filter suppliers should have a written policy regarding extended service intervals beyond manufacturer recommendations. This policy should clearly state the requirements to be met by the customer and warranty support for early engine wearout resulting from the use of their product in extended service.

The decision to extend oil and filter change intervals beyond those recommended rests with the customers, the oil and oil filter suppliers. Extending oil drain interval will not void the DDC product warranty. In the event of engine failure or premature wearout when running extended oil and filter change intervals, a determination will be made as to the extent, if any, that DDC workmanship and materials were responsible. If DDC determines that the failure or early wearout is related to workmanship or materials, warranty coverage of the repairs will apply. If the engine fails or wears out within the DDC engine warranty period and this is determined to be a result of extending oil drain intervals, any claim for reimbursement of expenses under the terms of the engine warranty will be denied.

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4.5 USED LUBRICATING OIL ANALYSIS

Detroit Diesel's **POWER Trac** 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 extend oil drain intervals. Oil should be changed immediately if contamination exceeds warning limits listed in Table 4-4.

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Character-istics	ASTM or Other Methods	Conditions Measured	Two-Stroke Cycle Engine Series		Four-Stroke Cycle Engine Series		
			53, 71, 92	149	40, 50, 60	55	MBE 900, MBE 4000
Viscosity	D 445 DIN 51562	Engine & Oil					
Kv100 °C, cSt., Min.			12.5 SAE 40	16.0 SAE 50	12.5 SAE 15W-40	12.5 SAE 15W-40	12.5 SAE 15W-40
Kv100 °C, cSt., Max.			16.3 SAE 40	22.0 SAE 50	16.3 (25.0[1]) SAE 15W-40	16.3 (25.0[1]) SAE 15W-40	16.3 (25.0[1]) SAE 15W-40
Soot, % Max.	TGA (E1131) or FTIR[2]	Engine Combustion	0.8	0.8	1.5 (3.0)[1]	1.5	3
Pentane Insolubles, Max.	D 893 DIN 51565	Engine Combustion	1.0	1.0	1.0 (N/A)[1]	2.0	1.0 (NA)[1]
Total Base Number, Min.	D 4739	Oil	1.0 or 1/3 New Oil[3]				
Total Base Number, Min.	D 2896 ISO 3771		2.0 or 1/3 New Oil[3]				
Glycol, Max.	D 2982 DIN 51375	Engine	Negative				
Water, Max.	D 1744	Engine	0.3%				
Fuel Dilution, Max.	D 3524	Engine	2.5%				
Flash Point COC °C, Min.	D 92 ISO 2592	Engine & Oil	Not Specified				
Iron, Max.	D 5185	Engine Wear	150 (250)[5]	35	150	200	150
Copper, Max.	D 5185	Engine Wear	25	25	30	20	30
Lead, Max.	D 5185	Engine Wear	10	10	30	40	20

1. With API CH-4 / CI-4 Oil
2. Infrared spectroscopy may also be used, provided it is calibrated to be equivalent to TGA.
3. Whichever is higher
4. These are general limits. Wear metal limits must be determined for specific application and oil used.
5. Marine engines only

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 DDC Publication 7SE398 for determining warning limits specific to your application.

Table 4-4 Single Sample Used Oil Analysis Warning Limits

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5 DIESEL FUEL

5.1 QUALITY AND SELECTION

The quality of fuel used is a very important factor in obtaining satisfactory engine performance, long engine life and acceptable exhaust emission levels. For optimum engine operation and maximum service life, diesel fuels meeting the property requirements in Table 5-1, or the properties of EMA FQP-1a or 1b are recommended for use.

NOTE:
Fuels with sulfur content above 0.05 mass percent (500 ppm) are not recommended for DDC EGR engines. If engines are operated with fuels not meeting the 500 ppm sulfur content limit, the drain intervals must be shortened. Drain intervals may be determined by oil analysis or by using the drain intervals in Table 4-3.

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Property	Test Method		On-Highway		Off-Highway
	ASTM	ISO	No. 1	No. 2	
API Gravity, at 60° F Minimum Maximum	D 287	—	 40 44	 34 38	 33 43
Specific Gravity, g/ml @ 60° F Minimum Maximum	D 1298	3675	 0.806 0.825	 0.835 0.855	 0.810 0.860
Flash Point, °C Minimum	D 93	2719	38	52	Note 1
Viscosity, Kinematic cSt @ 40° Minimum Maximum	D 445	3104	 1.3 2.4	 1.9 4.1	 1.3 4.5
Sulfur, wt.% (ppm) Maximum	D 2622	EN 24260	0.05 (500)	0.05 (500)	0.4 (4000)
Cloud Point	D 2500	—	—	Note 2	—
Filter Plugging Point	D 4359	309	—	Note 3	—
Cetane No., Minimum	D 613	5165	45	45	45
Cetane Index, Minimum	D 4737	4264	40	40	40
Distillation % Vol. Recovery, °F (°C) –IBP, Typical 10 %, Typical 50%, Typical 90%, Maximum 95%, Maximum Recovered Volume, % Minimum	D 86	3405	 350 (177) 385 (196) 425 (218) 500 (260) 550 (288) 98	 375 (191) 430 (221) 510 (256) 625 (329) 671 (355) 98	 320 (160) - 392 (200) 437 (225) - 527 (275) 626 (330) 680 (360) 98
Water, % Maximum (Note 4)	D 2709		0.02	0.02	0.02
Sediment > 1µm, mg/L Maximum	D 2276 or D 5452		10	10	10
Total Contamination, mg/kg Maximum		DIN 51419	24	24	24
Ash, % mass Maximum	D 482	6245	0.01	0.01	0.01
Carbon Residue, on 10%, % mass	D 524	10370	0.15	0.35	0.3
Copper Corrosion, Maximum	D 130	2160	No. 3a	No. 3a	No. 3a
Accelerated Storage Stability mg/L, Maximum	D 2274		15	15	15
DuPont Pad Test, Reflectance at 150° C, Minimum (High Temperature Stability)	D 6468		70	70	70
Heat Content, Net, BTU/gal	D 4868		125,000 – 127,300	128,500 – 130,900	126,600 – 131,500
Lubricity Load, gms, Minimum Wear Scar, µm, Maximum	 D 6078 D 6069		 3100 460	 3100 460	 3100 460

Table 5-1 Diesel Fuel Specifications

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Notes to Table 5–1

1. The flash point temperature is a safety-related property which must be established according to applicable local requirements.
2. The cloud point should be 10° F (6° C) below the lowest ambient temperature to prevent clogging of fuel filters by wax crystals.
3. The filter plugging point temperature should be equal to or below the lowest expected fuel temperature.
4. No free water visible.

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

5.1.1 FUEL LUBRICITY

It is recommended that all fuels used in DDC 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 HEAVY FUELS NOT RECOMMENDED

Heavy fuels intended for use in slow speed diesel engines and as burner fuel are not recommended for use in any Detroit Diesel engine. Marine fuels specified by ASTM D2609 are examples of such fuels. These fuels are known to cause combustion deposits and will likely reduce engine durability.

5.1.4 BIODIESEL FUELS

Biodiesel fuels are alkyl esters of long chain fatty acids derived from renewable resources. Biodiesel fuels must meet ASTM Specification D 6751. Biodiesel meeting the D 6751 specifications can be blended up to 20% maximum by volume in diesel fuel. The resulting mixture must meet the fuel properties listed in Table 5-1. Failures attributed to the use of biodiesel will not be covered by Detroit Diesel product warranty.

The following quotation is extracted from *World-Wide Fuel Charter – Draft for comments – June 2002, page 46* for reference and guidance:

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"Based on the technical effects of FAME [Fatty Acid Methyl Esters], it is strongly advised that FAME content be restricted to less than 5%. As a pure fuel, or at higher levels in diesel fuel, the vehicles need to be adapted to the fuel, and particular care is needed to avoid problems."

5.1.5 OTHER FUELS

Fuels listed in Table 5-2 and Table 5-3 have provided economic and availability advantages for some applications, particularly where No. 1 type fuels are required. These do not meet requirements listed in Table 5-1. Although not recommended, they have demonstrated acceptable performance in controlled applications.

Property	Jet A/A-1 D 1655	JP-5	JP-8[1]	CONUS DF-1	CONUS DF-2	OCONUS DF-2
API Gravity, @ 60° F	44.3	41.1	45.6	42.3	34.2	38.5
Flash Point, °C	38	62	45	50	74	70
Viscosity, Kin., cSt @ 40° C	—	1.5	1.2	1.6	2.8	3.0
Cloud Point °C	-40	-46	-47	-41	-12	-19
Sulfur, % mass	0.3 Max.	0.4 Max.	0.4 Max.	0.05 Max.	0.05 Max.	0.3 Max.
Cetane Number	—	42	45	44	47	49
Distillation % Vol. Rec., °C						
–IBP	—	180	157	174	190	176
–10% Typical	205	191	175	196	222	219
–50% Typical	Report	215	200	219	265	365
–90% Max.	Report	242	236	246	313	311
Final Boiling Point, Max. Temp.	300	—	—	—	—	—
Heat Content, Btu/gal., Net	123, 608	125, 270	123, 069	125, 960	131, 207	127, 820

1. JP + 100 is not recommended in equipment with water-coalescing filters.

Table 5-2 Selected Typical Fuel Properties

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Type	NATO Spec.	Mil. Spec	Application
JP-4	F-40	Mil-T-5624	Jet Fuel, Contains 50% Gasoline: Not Recommended
JP-5	F-44	Mil-T-5624	Jet Fuel, Kerosene Based
JP-8	F-34	Mil-T-83133	Jet A-1 with De-Icer and Corrosion Inhibitor
Jet A	None	None	Industry Standard Jet Fuel
Jet A-1	F-35	None	Jet Fuel, ASTM D 1655
DL-1/DL-2	F-54	W-F 800 CONUS	Specified Military Use Inside Continental U.S.
DA-2	F-54	W-F 800 OCONUS	Specified Military Use Outside Continental U.S.

Table 5-3 Fuel Type Specifications and Applications

Lower density fuels, such as those listed in Table 5-2 and Table 5-3 and “winter blended” diesel fuels, have a lower volumetric heat content than the standard No. 2 fuel listed in Table 5-1, “Diesel Fuel Specifications.” Operating with these fuels will result in reduced engine output and reduced fuel mileage, compared to standard No. 2 fuel. Reductions of 5% are not unusual and may be as high as 10%. A good rule of thumb is this: *The engine power is proportional to the heating value of the fuel.*

Lower density fuels also tend to have lower viscosity and poor lubrication characteristics. Fuel filtration should be changed to that recommended for “Severe Duty Service” to prevent potential injector seizure from dirt contamination of fuel.

5.2 DIESEL FUEL PROPERTIES

5.2.1 DISTILLATION

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 or D 2887 (Gas Chromatography Test Method).

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 fuels with a minimum 98% recovery by distillation should be used. The full boiling range as shown in previous tables should be used for proper selection.

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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 ASTM D 86 Distillation Test Method. Since this temperature is difficult to measure with good repeatability, the fuel's 90% or 95% distillation point is often used. DDC specifies the 95% temperature because it is closer to the end point than the 90% used by ASTM in 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 45 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. Both properties should be evaluated when selecting diesel fuel.

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. Two tests are specified for fuel stability, ASTM Test Method D 2274 which measures diesel fuel storage oxidative stability and the DuPont Pad Test which measures high temperature stability. The DuPont Pad test should be conducted at 302° F (150° C). The results of the DuPont Pad 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. ASTM D 2274 is a weighed measure of the sediment filtered from the fuel after storage. Although the results of D 2274 may vary with actual field storage, it does measure characteristics that will affect fuel storage stability for periods of up to 12 months.

5.2.5 FUEL SULFUR CONTENT

Fuels with sulfur content above 0.05 mass percent (500 ppm) are not recommended for DDC EGR engines. If engines are operated with fuels not meeting the 500 ppm sulfur content limit, the drain intervals must be shortened. Drain intervals may be determined by oil analysis or by using the drain intervals in Table 4-3.

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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 assure proper injection system functioning.

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. Filters on Detroit Diesel two stroke-cycle engines should be changed 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.

5.3 FUEL ADDITIVES

Detroit Diesel engines are designed to operate satisfactorily on a wide range of diesel fuels. The regular use of supplemental fuel additives is not required or recommended. Some additives may be beneficial in addressing **temporary** fuel quality problems, but should not replace proper fuel selection and handling.

5.3.1 WATER CONTAMINATION

Some fuel additives provide temporary benefit when fuel is contaminated with water. They are not intended to replace good fuel handling practices. Where water contamination is a concern, the fuel system should be equipped with a fuel/water separator that should be serviced regularly. In marine and other environments where microbe growth is a problem, a fungicide such as Biobor® JF (or equivalent) may be used. Microbial activity may be confirmed with commercially available test kits. Follow the manufacturer’s instructions for treatment. Avoid the use of fungicides containing chlorine, bromine or fluorine compounds, since these may cause fuel system corrosion.

When small amounts of water are present, supplemental additives containing methyl carbitol or butyl cellusolve are effective. Follow the manufacturer’s instructions for their use. The use of isopropyl alcohol is no longer recommended due to its negative effect on fuel lubricity.

5.3.2 FUEL ADDITIVES THAT ARE NOT ALLOWED

The following fuel additives are NOT allowed:

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 3.14, “Waste Oil Disposal and Rerefined Oils,” for recommendations on proper used oil disposal.

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⚠ CAUTION:

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

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. Tanks that contain such mixtures should be drained and cleaned as soon as possible.

Detroit Diesel Corporation will not be responsible for any detrimental effects which it determines resulted from the use of used lubricating oil or gasoline in the diesel fuel.

5.3.3 EVALUATION OF SUPPLEMENTAL FUEL ADDITIVES

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

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.

1. A Material Safety Data Sheet (MSDS) should be carefully reviewed for special handling instructions and hazardous material content. Additives containing hazardous materials should not be used due to personal safety risk
2. A detailed compositional analysis should be provided by 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. The use of additives with these components should be avoided.
3. 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. A mixture containing twice the recommended concentration of additive should be evaluated for compatibility to represent an overdosage condition, using the tests listed in Table 5-1, “Diesel Fuel Specifications.”

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4. Performance evaluation of a fuel supplemental additive should be conducted 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 are not substantial claims of performance.

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. These products should be accompanied with performance data supporting their merit. Detroit Diesel Corporation 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

Fuel oil should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water and sludge. Tanks should be drained and cleaned, 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.

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6 FILTRATION

6.1 FUEL AND LUBRICATING OIL FILTERS

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. Filters, however, should be used to maintain a clean system, not to clean up a contaminated system.

Filter performance and test specifications vary between manufacturers. These specifications are general in nature and do not reflect the actual performance of genuine DDC *Power Guard*® filters. The user is also cautioned when comparing micron ratings between filter makes. Some filter makers 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.

Regular and optional service spin-on fuel filters for most DDC engines are listed in Table 6-1. Fuel Pro® filters are listed in Table 6-2, and Sea Pro® marine engine fuel filters are listed in Table 6-3. Cartridge-type fuel filters are listed in Table 6-4. Spin-on lubricating oil filters are listed in Table 6-5. *Power Trac*® oil analysis kits are listed in Table 6-6.

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).

6.2 AFTERMARKET FILTRATION SYSTEMS

Aftermarket supplemental filtration systems may be used, provided they do not replace the factory-installed system or reduce oil volumes, pressures or flow rates delivered to the engine. The use of such systems does not address oil degradation from normal use and, therefore, does not permit extension of oil drain intervals. 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.

6.3 DETROIT DIESEL MAINTENANCE PRODUCTS

The fuel and lubricating oil filter applications for Detroit Diesel engines are shown below.

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Primary Fuel Filter			Secondary Fuel Filter		
Engine	Qty.	POWER GUARD	Qty.	POWER GUARD	POWER GUARD Plus
3-53	1	23518527	1	23530640	23518669
4-53	1	23518527	1	23530640	23518669
6V-53	1	23518481	1	23518482	23530645
3-71	1	23518527	1	23530640	23518669
4-71	1	23518527	1	23530640	23518669
6-71	1	23518481	1	23518482	23530645
6V-71	1	23518481	1	23518482	23530645
8V-71	1	23518481	1	23518482	23530645
12V-71	2	23518528	1	23518532	23530644
16V-71	2	23518528	1	23518532	23530644
6V-92	1	23518481	1	23518482	23530645
8V-92	1	23518481	1	23518482	23530645
12V-92	1	23518528	1	23518532	23530644
16V-92	1	23518528	1	23518532	23530644
8V-149	2	23518528	1	23518532	23530644
12V-149	2	23518528	2	—	23530644
16V-149	2	23518528	2	—	23530644
DDC 500	1	—	1	23530640	23518669
Series 40	—	—	1	1 820 479 C1 (6 In.)	—
Series 40	—	—	1	23523907	—
Series 50	1	23518481	1	23518482	—
Series 55	—	—	1	23518482	—
Series 60	1	23518481	1	23518482	—

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 23512317.

Table 6-1 Spin-On Fuel Filter Elements

Filter Description	Part Number
Fuel Pro® 230	23521527
Fuel Pro 232	23528565
Fuel Pro 321	23518481
Fuel Pro 380/382	23521528 / 23529168 [1]
Fuel Pro 40 Mega Filter™	23530646

1. Elemax® extended service element (optional).

Table 6-2 Fuel Pro® Fuel Filter Elements

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Filter Description	Micron Rating	Part Number
Sea Pro® 50 / 100	30	23519851
Sea Pro 50 / 100	5	23519852
Sea Pro 150 / 300	20	23518169
Sea Pro 150 / 300	30	23518168
Sea Pro 152 / 511	15	23521528
600	20	23519404
600	30	23519405
Water-in-Fuel Sensor Kit	—	23518182

NOTE: The numbers after the Sea Pro name indicate the GPH (gallon per hour) flow capacity of the filter. (Does not apply to Fuel Pro filters.)

Table 6-3 Sea Pro® Fuel Filter Elements

Engine Series	Primary Filter Element	Secondary Filter Element
	Part Number	Part Number
3-53	P550522	23519162
4-53	P550522	23519162
6V-53	P550552	P550540
3-71	P550522	23519162
4-71	P550522	23519162
6-71	P550552	P550540
6V-71	P550552	P550540
8V-71	P550552	P550540
12V-71	P550541	P551624
16V-71	P550541	P551624
6V-92	P550552	P550540
8V92	P550552	P550540
12V-92	P550541	P551624
16V-92	P550541	P551624
8V-149	N/A	N/A
12V-149	P550532	P551624
16V-149	P550532	P551624

Table 6-4 Cartridge Type Fuel Filter Elements

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Spin-On Lubricating Oil Filters	Qty.	POWER GUARD Part No.	POWER GUARD Plus Part No.
3-53	1	23530409	—
4-53, 6V-53	1	23530407	23530408
3-71, 4-71, 6-71	1	23530407	23530408
6V-71, 8V-71, 12V-71, 16V-71	1	23530407	23530408
6V-92, 8V-92	1	23530407	23530408
12V-92, 16V-92	2 or 4	23530407	23530408
8V-149	3	—	23530408
12V-149, 16V-149	4 or 6	—	23530408
20V-149	6	—	23530408
DDC 500	2	23518668	—
Series 40	1	23529744	—
Series 50	2	23527033	—
Series 55	1	5241800310	—
Series 60	2	23527033	DELF3998 [1]
Series 60	2	DELF3998 (High Capacity)	—
Series 60 (Pre-1993)			
Series 60	2	—	—
Series 60	1	—	—

1. For use with synthetic lubricating oil only.

Table 6-5 Spin-On Lubricating Oil Filters

Part No.	Description
23515823	Standard Kit
23517267	Includes Extraction Kit
23520989	Includes Prepaid Test for TBN

Table 6-6 *Power Trac*®Oil Analysis Kits

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7 STATEMENT OF DETROIT DIESEL CORPORATION WARRANTY

Detroit Diesel Corporation 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 DDC-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.

A requirement of Detroit Diesel Corporation's service contract (Power Protection Plan) is that the customer use the lubricants, fuels and filters described in this publication in conjunction with a used oil analysis program such as the Detroit Diesel *POWER Trac* oil analysis program.

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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:

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

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

3. EMA Lubricating Oils Databook
Engine Manufacturer's Association
Suite 2200
Two North LaSalle Street
Chicago, IL 60602
www.engine-manufacturers.com

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

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