

---

# **Caterpillar On-highway Diesel Truck Engine Fluid Recommendations**

---



## Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

**Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.**

**Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.**

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

**Attention! Become Alert! Your Safety is Involved.**

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

**Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.**

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available.



**When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.**

**Failure to heed this warning can lead to premature failures, product damage, personal injury or death.**

---

---

# Table of Contents

Foreword ..... 4

## **Maintenance Section**

Lubricant Specifications ..... 6

Fuel Specifications ..... 19

Cooling System Specifications ..... 24

## **Reference Information Section**

Reference Materials ..... 34

## **Index Section**

Index ..... 36

## Foreword

### Literature Information

This manual should be stored in the literature storage area.

The information contained in this document is the most current information available for coolants, fuels, and lubricants. Refer to the Operation and Maintenance Manual for any special lubrication requirements for your engine.

Whenever a question arises regarding the engine, this publication, or the Operation and Maintenance Manual, please consult any Caterpillar dealer for the latest available information.

### Safety

Refer to the Operation and Maintenance Manual for your engine for all safety information. Read and understand the basic safety precautions listed in the Safety Section. In addition to safety precautions, this section identifies the text and locations of safety signs used on the engine.

Read and understand the basic precautions listed in the Safety Section before operating or performing lubrication, maintenance and repair on this engine.

### Maintenance

Refer to the Operation and Maintenance Manual for your engine to determine all maintenance requirements.

### Maintenance Intervals

Use the Maintenance Interval Schedule in the Operation and Maintenance Manual for your engine to determine servicing intervals. The actual operating environment of the engine also governs the maintenance interval schedule. Therefore, under extremely severe, dusty, wet or freezing cold operating conditions, more frequent lubrication and maintenance than is specified in the Maintenance Interval Schedule may be necessary.

### Extended Engine Oil Drains and Warranty

Failures that result from extended oil drain periods are not Caterpillar factory defects and therefore are not covered by Caterpillar's warranty. In addition, failures that result from not using the recommended oil type are not Caterpillar factory defects and therefore are not covered by Caterpillar's warranty.

Refer to the applicable Operation and Maintenance Manual for standard oil drain periods and to the Maintenance Section, "Lubricant Specifications" of this publication for engine oil type and viscosity grade recommendations.

To reduce the potential risk of failures associated with extended oil drain periods; it is recommended that oil drain intervals only be extended based on oil analysis, and subsequent engine inspections. Oil analysis alone does not provide an indication of the rate of formation of lacquer, varnish and/or carbon on pistons and other engine surfaces. The only accurate way to evaluate specific oil performance in a specific engine and application that utilizes extended oil drain periods is to observe the effects on the engine components. This involves tear-down inspections of engines that have run to their normal overhaul period with extended oil drain intervals. Following this recommendation will help ensure that excessive component wear does not take place in a given application.

---

#### NOTICE

Light loads, low hour accumulation, and excessive idling time can contribute to excessive water in the crankcase oil. Corrosive damage, piston deposits and increased oil consumption can also result. If oil analysis is not done or the results are ignored, the potential for corrosive damage and piston deposits increases. Refer to the appropriate Operation and Maintenance Manual for guidance.

---

**Note:** Failures that result from extended oil drain periods are not warrantable failures, regardless of use of this recommended procedure. Failures that result from extended engine oil drain periods are considered improper use under the warranty.

## Aftermarket Products and Warranty

---

### NOTICE

When auxiliary devices, accessories or consumables (filters, oil, additives, catalysts, fuel, etc.) made by other manufacturers are used on Caterpillar products, the Caterpillar warranty is not affected simply because of such use. Failures that result from the installation or usage of other manufacturers auxiliary devices, accessories or consumables, however, are not Caterpillar factory defects and therefore are NOT covered by Caterpillar's warranty.

Caterpillar is not in a position to evaluate the many auxiliary devices, accessories or consumables promoted by other manufacturers and their effect on Caterpillar products. Installation or use of such items is at the discretion of the customer who assumes ALL risks for the effects that result from this usage.

Furthermore, Caterpillar does not authorize the use of its trade name, trademark, or logo in a manner which implies our endorsement of these aftermarket products.

---

# Maintenance Section

## Lubricant Specifications

i01892224

### Lubricant Information

**SMCS Code:** 1000; 1300; 7581

#### NOTICE

These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date fluids recommendations.

### API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API.

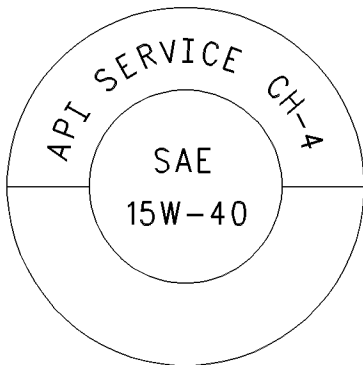


Illustration 1

g00546535

Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 1 summarizes the status of the classifications.

Table 1

API Classifications	
Current	Obsolete
CI-4 <sup>(1)</sup> , CH-4 <sup>(1)</sup> , CG-4 <sup>(2)</sup> , CF-4 <sup>(3)</sup>	CE
CF <sup>(4)</sup>	CC, CD
CF-2 <sup>(5)</sup>	CD-2 <sup>(5)</sup>

- (1) **API CH-4 and CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**
- (2) API CG-4 oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed 75 Percent of the standard oil drain interval for your engine.
- (3) API CF-4 oils are no longer recommended for Caterpillar on-highway diesel engines.
- (4) API CF oils are not recommended for Caterpillar on-highway diesel engines.
- (5) API CF-2 and CD-2 oils are classifications for two-cycle diesel engines. Caterpillar does not sell engines that utilize the CD-2 and the API CF-2 oils.

i01908938

## Engine Oil (On-highway Diesel Recommendations)

**SMCS Code:** 1348

### Caterpillar Diesel Engine Oil (DEO)

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

Due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Caterpillar Diesel Engine Oil (DEO) (10W-30)**
- **Caterpillar Diesel Engine Oil (DEO) (15W-40)**

Caterpillar multigrade Diesel Engine Oil is formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Caterpillar Diesel Engines.

Caterpillar multigrade Diesel Engine Oil is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. To choose the correct viscosity grade for the ambient temperature, see Table 2. Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade Diesel Engine Oil can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade Diesel Engine Oil. The current industry standards for Caterpillar Diesel Engine Oil are listed on the product label and on the data sheets for the product.

Consult your Caterpillar dealer for part numbers and for available sizes of containers.

**Note:** Caterpillar SAE 15W-40 multigrade Diesel Engine Oil (DEO) exceeds the performance requirements for the following API classifications: CI-4, CH-4, CG-4, CF-4, and CF. The Caterpillar multigrade DEO exceeds the requirements of the Caterpillar ECF-1 (Engine Crankcase Fluid-1) specification. The Caterpillar SAE 15W-40 multigrade DEO passes the following proprietary tests: sticking of the piston ring, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Caterpillar multigrade oil exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets.

**True high performance oil is produced with a combination of the following factors: industry standard tests, proprietary tests, field tests, and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.**

**Note:** Non-Caterpillar commercial oils are second choice oils.

## Commercial Oils

**Engine Crankcase Fluid Recommendations for all Current and Noncurrent Caterpillar On-highway Truck Diesel Engines:**

- API CH-4 oils and API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.
- API CG-4 oils are acceptable for all Caterpillar diesel engines. When the API CG-4 oils are used, the oil drain interval should not exceed 75 Percent of the standard oil drain interval for your engine.
- API CF-4 oils are no longer recommended.

---

### NOTICE

In selecting oil for any engine application, both the oil viscosity and oil performance classification/specification as specified by the engine manufacturer must be defined and satisfied. Using only one of these parameters will not sufficiently define oil for an engine application.

---

In order to make the proper choice of a commercial oil, refer to the following explanations:

**API CI-4** – API CI-4 oils were developed in order to meet the requirements of high performance diesel engines that use cooled Exhaust Gas Recirculation (EGR). API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

**API CH-4** – API CH-4 oils were developed in order to protect low emissions diesel engines that use a 0.05 percent level of fuel sulfur. However, API CH-4 oils may be used with higher sulfur fuels. Refer to illustration 2. API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met.

**Note: CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.**

---

### NOTICE

Failure to follow these oil recommendations can cause shortened engine service life due to deposits and/or excessive wear.

---

## Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN must be 10 times the fuel sulfur level. The TBN is determined by the "ASTM D2896" procedure. The minimum TBN of the oil is 5 regardless of a low fuel sulfur level. Illustration 2 demonstrates the TBN.

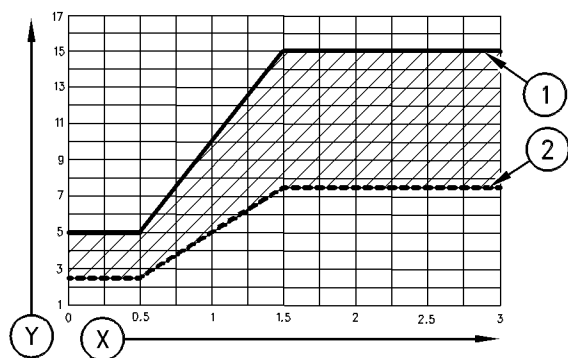


Illustration 2

g00104890

(Y) TBN by "ASTM D2896"

(X) Percentage of fuel sulfur by weight

(1) TBN of new oil

(2) Change the used oil when the TBN reaches this level.

Use the following guidelines for fuel sulfur levels that exceed 1.5 percent:

1. Choose an oil with the highest TBN that meets one of these classifications:

- API CG-4
- API CH-4
- API CI-4

**Note:** API CH-4 oils and API CI-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification-1) are met. CH-4 oils and CI-4 oils that have not met the requirements of Caterpillar's ECF-1 Specification may cause reduced engine life.

2. Reduce the oil change interval. Base the oil change interval on the oil analysis. Ensure that the oil analysis includes the condition of the oil and a wear metal analysis.

Excessive piston deposits can be produced by an oil with a high TBN. These deposits can lead to a loss of control of the oil consumption and to the polishing of the cylinder bore.

### NOTICE

Operating Direct Injection (DI) diesel engines with fuel sulfur levels over 1.0 percent may require shortened oil change intervals in order to help maintain adequate wear protection.

## Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation.

Refer to Table 2 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 2 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

**Note:** Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is preferred over SAE 0W-20 or SAE 0W-30.

**Note:** SAE 10W-30 is the preferred viscosity grade for the following diesel engines when the ambient temperature is above  $-18^{\circ}\text{C}$  ( $0^{\circ}\text{F}$ ), and below  $40^{\circ}\text{C}$  ( $104^{\circ}\text{F}$ ).

- C7
- C-9
- C9
- 3116
- 3126



i01946671

Table 2

Engine Oil Viscosities for Ambient Temperatures <sup>(1)</sup>		
Viscosity Grade	Ambient Temperature	
	Minimum	Maximum
SAE 0W-20	-40 °C (-40 °F)	10 °C (50 °F)
SAE 0W-30	-40 °C (-40 °F)	30 °C (86 °F)
SAE 0W-40	-40 °C (-40 °F)	40 °C (104 °F)
SAE 5W-30	-30 °C (-22 °F)	30 °C (86 °F)
SAE 5W-40	-30 °C (-22 °F)	50 °C (122 °F)
SAE 10W-30 <sup>(2)</sup>	-18 °C (0 °F)	40 °C (104 °F)
SAE 10W-40	-18 °C (0 °F)	50 °C (122 °F)
SAE 15W-40	-9.5 °C (15 °F)	50 °C (122 °F)

<sup>(1)</sup> Refer to this publication, "Engine Oil (Recommendations)" for recommendations of diesel engine oil type.

<sup>(2)</sup> SAE 10W-30 is the preferred viscosity grade for the 3116, 3126, C7, C-9 and C9 diesel engines when the ambient temperature is above -18 °C (0 °F), and below 40 °C (104 °F)

**Note:** Supplemental heat is recommended below the minimum recommended ambient temperature.

i01908082

## Synthetic Base Stock Oils

**SMCS Code:** 1300; 1348; 7581

Synthetic base oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified for the engine compartment.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. However, Caterpillar does not recommend the automatic extension of oil change intervals for any type of oil. Oil change intervals for Caterpillar engines can only be adjusted after an oil analysis program that contains the following data: oil condition and wear metal analysis (Caterpillar's S-O-S oil analysis), trend analysis, fuel consumption, and oil consumption.

## Re-refined Base Stock Oils

**SMCS Code:** 1300; 1348; 7581

Re-refined base stock oils are acceptable for use in Caterpillar engines **if** these oils meet the performance requirements that are specified by Caterpillar. Re-refined base stock oils can be used exclusively in finished oil or in a combination with new base stock oils. The US military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base stock oils that meet the same criteria.

The process that is used to make re-refined base stock oil should adequately remove all wear metals that are in the used oil and all additives that are in the used oil. The process that is used to make re-refined base stock oil generally involves the processes of vacuum distillation and hydrotreating the used oil. Filtering is inadequate for the production of high quality re-refined base stock oils from used oil.

i01908182

## Aftermarket Oil Additives

**SMCS Code:** 1300; 1348; 7581

Caterpillar does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the engine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge in the crankcase. Caterpillar discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Caterpillar engine, conform to the following guidelines:

- Select the proper Caterpillar oil or a commercial oil that meets the Caterpillar recommendations.

- See the appropriate “Lubricant Viscosities” table in order to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine compartment. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.

i01908310

## Cold Weather Lubricants

**SMCS Code:** 1300; 1348; 7581

When an engine is started and an engine is operated in ambient temperatures below  $-20^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$ ), use multigrade oils that are capable of flowing in low temperatures.

These oils have lubricant viscosity grades of SAE 0W or SAE 5W.

When an engine is started and operated in ambient temperatures below  $-30^{\circ}\text{C}$  ( $-22^{\circ}\text{F}$ ), use a synthetic base stock multigrade oil with a 0W viscosity grade or with a 5W viscosity grade. Use an oil with a pour point that is lower than  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ).

The number of acceptable lubricants is limited in cold weather conditions. Caterpillar recommends the following lubricants for use in cold weather conditions:

- API licensed CI-4 and CH-4 oils that also meet the Caterpillar ECF-1 specification with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade.
- A CG-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used.

---

### NOTICE

Shortened engine service life could result if second choice oils are used.

---

i01911762

## Lubricating Grease

**SMCS Code:** 1000; 7581

Caterpillar provides a range of moderate to extremely high performance greases in order to service the entire line of Caterpillar products throughout the wide variety of climatic conditions where these products might be used. From among this variety of Caterpillar grease products, you can almost always find at least one of the Caterpillar greases that will meet or exceed the performance requirements of any Original Equipment Manufacturer (OEM) machine or equipment application.

Before selecting a grease product for any application, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment when the equipment is operated in the expected conditions. Then, consult with your Caterpillar dealer for a list of greases, their performance specifications, available container sizes, and part numbers.

**Note:** Always choose grease that meets or exceeds the recommendations that are specified by the equipment manufacturer for the application.

If it is necessary to choose a single grease to use for all of the equipment at one site, always choose a grease that meets or exceeds the requirements of the most demanding application. Remember, products that barely meet the minimum performance requirements can be expected to just barely produce minimum parts life. It is false economy to use grease that was purchased based on the lowest cost per pound. Instead, use the grease that yields the lowest total operating cost based on an analysis that includes the costs of parts, labor, and downtime, as well as the cost of the amount of grease that is actually used.

**Note:** Because some greases are not chemically compatible, it is generally recommended to **purge** all of the old grease from the joint when switching from one type of grease to another, and/or from one supplier to another. Consult your supplier in order to determine if the greases are compatible.

**If in doubt, Purge!**

**Note:** All Caterpillar brand name greases are compatible with each other.

## Caterpillar Multipurpose Grease (MPG)

Caterpillar MPG is a National Lubricating Grease Institute (NLGI) grade 2 grease that is made with petroleum base oil and lithium complex thickener. Caterpillar MPG is formulated for use in applications with low to medium severity and at moderate temperatures.

Caterpillar MPG meets the NLGI certification of "GC-LB". (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans and light trucks.)

**Note:** If the application calls for an MPG and a Caterpillar MPG is not available, consult the grease data sheets. Use a substitute that meets or exceeds the performance characteristics of Caterpillar MPG.

## Caterpillar Multipurpose White Assembly Grease (MPWAG)

Caterpillar MPG is also available in an extra tacky version, known as Caterpillar MPWAG. Caterpillar MPWAG has the same formula and the same performance as regular Caterpillar MPG grease. One difference between the MPG and the MPWAG is the white color. In addition, this grease has been made extra tacky in order to make it work better for holding gaskets, O-rings, and needle bearings in the assembly of engines, transmissions, and other components.

## Caterpillar Multipurpose Grease w/Moly (MPGM)

Caterpillar MPGM is an NLGI grade 2 grease made with a petroleum base oil and lithium complex thickener. It also has 3% Molybdenum diSulfide (MoS<sub>2</sub> or Moly). MPGM is formulated for use in applications with low to high severity at moderate temperatures. In addition, the Moly in MPGM is a special grade that has a median particle size of 3 microns in order to meet the special requirements of some roller element bearings. MPGM is recommended for heavily loaded pin joints, and high impact applications in machines such as track-type tractors, backhoe loaders and skid steer loaders.

Caterpillar MPGM meets the NLGI certification of "GC-LB" (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans, and light trucks.)

**Note:** If the application calls for an MPGM and a Caterpillar MPGM is not available, consult the grease data sheets. Use a substitute that meets or exceeds the performance characteristics of Caterpillar MPGM.

## Severe Applications

For more severe applications, Caterpillar has greases which are made with Calcium Sulfonate Complex thickener. These greases provide more load carrying (galling resistance), lower wear, longer working life, exceptional water washout, and corrosion resistance.

## Caterpillar Auto-lube Greases (A-L)

Caterpillar A-L greases are available in NLGI grades 0, 1, and 2. These greases are made with special blends of petroleum base oils and Calcium Sulfonate Complex thickener. These greases also have 5% Molybdenum diSulfide (MoS<sub>2</sub> or Moly) and added tackifier. The A-L greases are specially formulated to protect all of the most heavily loaded joints in any Caterpillar machine against galling, wear, and corrosion while working in moderate temperatures, whether the working conditions are wet or dry.

Caterpillar A-L greases are formulated with special blends of naphthenic petroleum base oils that have low pour points. This allows Caterpillar A-L greases to pump at lower temperatures. Being able to pump Caterpillar A-L greases at lower temperatures means added insurance that all of the grease joints in the machine will be adequately lubricated even if the ambient temperature drops unexpectedly. This is particularly important when the machine's critical lubrication points rely on an automatic lubrication system.

Getting grease to pump into the joints at low temperatures is a significant challenge. But once the grease gets there, in order to adequately protect highly loaded joints, it must have extremely high resistance to galling, wear, fretting, water washout, and corrosion.

Even under severely loaded conditions, the grease should preferably have a very long working life. It takes Calcium Sulfonate Complex thickener and properly blended naphthenic and/or synthetic base oil to make greases that meet these greater demands. This is the reason Caterpillar uses these ingredients in Caterpillar A-L greases.

Caterpillar A-L greases also have 5% Moly, instead of the 0% to 3% found in most other greases. This additional Moly greatly improves the ability of the grease to protect parts from damage in applications with severe impact (slamming). In addition, the Moly in A-L greases is a special grade that has a median particle size of 3 microns in order to meet the special requirements of some rolling element bearings.

Caterpillar A-L greases are also made to be extra tacky. In some applications, such as excavator swing gears, the grease film must adhere to vertical surfaces. Many conventional greases do not have enough of the tacky characteristic in order to adhere well enough to stay in place. In addition, many of these greases do not have the performance in order to adequately protect the gear teeth in these applications.

Caterpillar A-L greases exceeds the NLGI certification of "GC-LB". (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans, and light trucks.)

**Note:** If the application calls for Caterpillar A-L grease and Caterpillar A-L grease is not available, consult the grease data sheets and use a substitute that meets or exceeds the performance characteristics of Caterpillar A-L grease.

Caterpillar A-L greases are not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus these greases are more environmentally friendly than many other types of grease.

## Caterpillar Desert Gold Grease (DG)

Caterpillar DG is formulated to protect even the most severely loaded joints in Caterpillar machines against galling, wear, and corrosion in wet or dry conditions and in temperatures that range from moderate to very hot.

Caterpillar DG is available as an NLGI grade 2 grease. It is made with a very high viscosity synthetic base oil and Calcium Sulfonate Complex thickener with 5% Molybdenum diSulfide (MoS<sub>2</sub> or Moly) and tackifier.

Caterpillar DG grease has a minimal change in viscosity as temperatures change because the base oil is a synthetic. Caterpillar DG maintains a thick lubricant film even at very hot temperatures because it has a high viscosity, synthetic base oil.

Caterpillar DG is made with a Calcium Sulfonate Complex thickener in order to provide the necessary protection against galling, wear, fretting, water washout, and corrosion. Caterpillar DG also has very long life, resisting breakdown even when working under extremely heavy loads in applications with frequent oscillations whether in wet or dry conditions, and from moderate to very high temperatures.

Caterpillar DG has 5% Moly instead of just 2 or 3%. This additional Moly greatly improves the ability of the grease to protect parts from damage in applications with severe impact (slamming). In addition, the Moly in Caterpillar DG is a special grade, with a median particle size of 3 microns in order to meet the special requirements of some rolling element bearings.

Caterpillar DG is made to be extra tacky. In some applications, such as the excavator swing gears, the grease film must adhere to the vertical surfaces. Many conventional greases do not have enough tackifier to adhere well enough in order to adequately protect the gear teeth in these applications, especially at high ambient temperatures.

Caterpillar DG has the ability to prevent galling and wear at very hot temperatures under extremely severe loads and conditions. In moderate temperatures, Caterpillar DG can be used in those extremely severe applications where an improvement over Caterpillar AL Grease is desired.

Caterpillar DG, because of its extremely high performance and long life, can be used in applications where the lubricant must last for very long periods of time.

Caterpillar DG exceeds the NLGI certification of "GC-LB" (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans, and light trucks.)

**Note:** If the application calls for Caterpillar DG and Caterpillar DG is not available, consult the grease data sheets and use a substitute that meets or exceeds the performance characteristics of Caterpillar DG. Depending on the application, either Caterpillar Paver Grease, Caterpillar Auto-Lube Grease, or Caterpillar Arctic Platinum Grease may perform acceptably, but their use may require a different schedule for lubrication.

Caterpillar DG are not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus these greases are more environmentally friendly than many other types of greases.

## Caterpillar Arctic Platinum (AP) Grease

Caterpillar AP Greases are formulated to protect the most heavily loaded joints in Caterpillar machines against galling, wear, and corrosion in wet or dry conditions in temperatures that range from moderate down to  $-60^{\circ}\text{C}$  ( $-76^{\circ}\text{F}$ ) depending on the consistency of the grease.

Caterpillar AP Greases are available in NLGI grades 000, 00, 0, 1, and 2, in order to ensure that the proper consistency is available for the ambient temperature in which the machine is working.

Caterpillar AP Greases are made with a synthetic base oil that has a very low viscosity. These greases are thickened with a Calcium Sulfonate Complex thickener, and then the performance is enhanced with 5% Molybdenum diSulfide ( $\text{MoS}_2$  or Moly) and tackifier.

Because the base oils are synthetic, the AP Greases have a minimal change in viscosity as the temperatures drop. Because the synthetic base oils have very low viscosity, the AP Greases that are made with these base oils have a minimal change in viscosity and flow easily as the temperature drops. The AP Greases pump easily, even at extremely low temperatures. In fact, Caterpillar AP Grease NLGI grade 000 can be pumped through standard machine mounted automatic lubrication systems at temperatures down to  $-60^{\circ}\text{C}$  ( $-76^{\circ}\text{F}$ ). This means that the grease can be pumped through those long unheated lines and into the required joints.

Caterpillar AP Greases are made with Calcium Sulfonate Complex thickener in order to provide the necessary protection against galling, wear, fretting, water washout, and corrosion.

Caterpillar AP Greases also last a long time, resisting breakdown even when working under extremely heavy loads in applications with frequent oscillations whether in wet or dry conditions, and from extremely cold to moderate temperatures.

Caterpillar AP Greases have 5% of Moly instead of just 2 or 3%. This additional Moly greatly improves the grease's ability to protect parts from damage in applications with severe impact (slamming). In addition, the Moly in Caterpillar AP Grease is a special grade, with a median particle size of 3 microns in order to meet the special requirements of some rolling element bearings.

Caterpillar AP Greases are made to be extra tacky. In some applications, such as the excavator swing gears, the grease film must adhere to the vertical surfaces. Many conventional greases do not have enough tackifier to adhere well enough in order to adequately protect the gear teeth in these applications.

Caterpillar AP Greases, have the ability to prevent galling and wear at very cold temperatures under extremely severe loads and conditions. In moderate temperatures, Caterpillar AP Greases can be used if the application/compartments is sealed well enough to contain the grease.

Caterpillar AP Greases are sometimes used in applications that require the lubricant to last for very long periods of time. This is because these greases have extremely high performance and long life.

Caterpillar AP Greases NLGI Grades 1 and 2 exceed the NLGI certification of "GC-LB" (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans, and light trucks).

**Note:** If the application calls for a Caterpillar AP Grease and no Caterpillar AP Greases are available, consult the grease data sheets and use a substitute that meets or exceeds the performance characteristics of the appropriate Caterpillar AP Grease.

Caterpillar AP Greases are not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus these greases are more environmentally friendly than many other types of grease.

## Caterpillar Paver Grease (PG)

Caterpillar PG is formulated for use in the bearings that support the conveyor belts on Caterpillar Paving Machines. These bearings are exposed to an extremely demanding range of temperatures, loads and environments.

Caterpillar PG is an NLGI grade 2 grease. This grease is made with a synthetic base oil that has an extra high viscosity. This grease also has a Calcium Sulfonate Complex thickener, with 5% Molybdenum diSulfide ( $\text{MoS}_2$  or Moly).

The Caterpillar PG has a minimal change in viscosity with changing temperatures because the base oil is synthetic. The grease maintains a thick lubricant film even in hot temperatures because the base oil has an extra high viscosity, and because it is synthetic. These hot temperatures occur when hot asphalt is allowed to sit on the conveyor belt. These temperatures can be so hot that most greases will just melt and run out of the bearings.

Caterpillar PG is made with a Calcium Sulfonate Complex thickener in order to provide the necessary protection against galling, wear, fretting, water washout, and corrosion.

Caterpillar PG also has very long life, resisting breakdown even when working under extremely heavy loads in applications with frequent oscillations, whether in wet or dry conditions, and from moderate up to very high temperatures.

These properties mean that Caterpillar PG will work in all the joints on the paving machines. One Grease Fits All.

Caterpillar PG has 5% of Moly instead of 0% to 3%. This additional Moly greatly improves the grease's ability to protect parts from damage in applications with severe impact (slamming). In addition, the Moly in Caterpillar PG is a special grade, with a median particle size of 3 microns in order to meet the special requirements of some rolling element bearings.

Caterpillar PG is not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus, this grease is more environmentally friendly than many other types of greases.

## Caterpillar Water and Temperature Resistant (WTR) Grease

Caterpillar WTR Grease is an NLGI grade 2 grease. This grease is made with a petroleum base oil and a Calcium Sulfonate Complex thickener. Caterpillar WTR Grease works in any application that may use MPG and will provide the additional benefits of higher galling resistance, more wear resistance, extremely good water and corrosion resistance, and very good resistance to breakdown from mechanical working.

Caterpillar WTR Grease has no Moly and provides a level of galling resistance better than Caterpillar MPG and Caterpillar MPGM but less than that of Caterpillar Auto-Lube, Caterpillar Desert Gold, Caterpillar Arctic Platinum, and Caterpillar Paver Greases.

Antiwear protection, resistance to breakdown from mechanical working, water washout, and corrosion protection are similar to that of Caterpillar Auto-Lube, Caterpillar Desert Gold, Caterpillar Arctic Platinum, and Caterpillar Paver Greases.

Caterpillar WTR Grease exceeds the NLGI certification of "GC-LB". (This certification relates to extended service intervals in automotive chassis points and in wheel bearings with disc brakes in automobiles, vans, and light trucks.)

**Note:** Caterpillar WTR Grease has been tested in a 5% salt spray test (ASTM B117)). Caterpillar WTR Grease lasted over 4000 hours. This grease performed better than many conventional greases in corrosion resistance. Caterpillar WTR Grease is available in an aerosol can for easy application wherever a water resistant rust proof coating is desired.

Caterpillar WTR Grease is not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus this grease is more environmentally friendly than many other types of greases.

## Caterpillar Special Purpose Grease (SPG)

Caterpillar SPG is an NLGI grade 2 grease. This grease is made with a petroleum base oil and a polyurea thickener. This grease is recommended for applications that utilize roller bearings and ball bearings and operate under low to moderate loads and at high speed. Typical applications for this grease are electric motors, alternators, and automotive constant velocity (CV) joints.

Caterpillar SPG is not formulated to contain lead, antimony, barium, zinc, phosphorous, and chlorine additives. Thus, this grease is more environmentally friendly than many other types of greases.

## Grease Application Chart



## Grease Application Chart

Caterpillar Grease Name	NLGI Grade	<sup>1</sup> Low Temp. Pumpability	<sup>2</sup> Severe Applications	<sup>2</sup> Severe Applications	<sup>2</sup> Severe Applications	<sup>2</sup> Severe Applications with Extremely Heavy Loads	<sup>2</sup> Severe Applications	<sup>3</sup> Extreme Pressure (EP)	<sup>4</sup> Service Life	<sup>5</sup> Environmentally Friendly	<sup>6</sup> Corrosion Protection	<sup>7</sup> Water Washout Resistance
<b>Recommended Operating Conditions</b>		[In Centralized (Auto-Lube) Systems]	Extremely Low to Low Temps	Low to Moderate Temps	Moderate to High Temps	Moderate to High Temps	High to Extremely High Temps	(Anti-Wear Protection)	(Shear Stability)			
<b>Optimum Operating Temperature Range</b>			-59°C (-75°F) to -18°C (0°F)	-23°C (-10°F) to +29°C (+85°F)	+18°C (+65°F) to +41°C (+105°F)	+18°C (+65°F) to +41°C (+105°F)	+38°C (+100°F) to +232°C (+450°F)					
<b>Paver Grease</b>	2	above 10°C (+50°F)	N/R	<sup>8</sup> Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Yes	Excellent	Excellent
<b>Desert Gold</b>	2	above 2°C (+35 F)	N/R	Excellent	Excellent	Excellent	Very Good	Excellent	Excellent	Yes	Excellent	Excellent
<b>Auto-Lube Grease 2</b>	2	above -7°C (+20°F)	N/R	Excellent	Excellent	Very Good	Good	Excellent	Excellent	Yes	Excellent	Excellent
<b>Auto-Lube Grease 1</b>	1	above -18°C (0°F)	Good	Excellent	Good	Good	Fair	Excellent	Excellent	Yes	Excellent	Excellent
<b>Auto-Lube Grease 0</b>	0	above -29°C (-20°F)	Very Good	Excellent	Fair	Fair	Fair	Excellent	Excellent	Yes	Excellent	Excellent
<b>Arctic Platinum 2</b>	2	above -29°C (-20°F)	Very Good	Excellent	Good	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
<b>Arctic Platinum 1</b>	1	above -34°C (-30°F)	Excellent	Very Good	N/R	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
<b>Arctic Platinum 0</b>	0	above -43°C (-45°F)	Excellent	Very Good	N/R	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
<b>Arctic Platinum 00</b>	00	above -51°C (-60°F)	Excellent	Good	N/R	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
<b>Arctic Platinum 000</b>	000	above -59°C (-75°F)	Excellent	Good	N/R	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
<b>MPGM</b>	2	above -18°C (0°F)	N/R	Fair	Good	Good	N/R	Very Good	Good	No	Fair	Fair
<b>MPG</b>	2	above -23°C (-10°F)	N/R	N/R	N/R	N/R	N/R	Fair	Good	No	Fair	Fair
<b>WTR</b>	2	above -23°C (-10°F)	Good	Good	Good	Fair	Fair	Very Good	Very Good	Yes	Excellent	Excellent
<sup>1</sup> Based on USS Mobility and Lincoln Ventmeter Tests Performance may vary depending on lubrication equipment and length of lines												
<sup>2</sup> Severe Applications are those with: very heavy loads, frequent oscillations, and heavy shock loads.												
<sup>3</sup> Extreme pressure (EP), refer to 4-Ball Weld point in technical data sheet      ASTM D 2596												
<sup>4</sup> Service Life, refer to % change after 100,000 strokes in technical data sheet      ASTM D 217												
<sup>5</sup> Is not Formulated to Contain: Lead, Antimony, Barium, Zinc, Phosphorous, or Chlorine additives.												
<sup>6</sup> Resistance to Salt water and Salt Spray      ASTM B 117												
<sup>7</sup> Water Washout Resistance, refer to Roll Stability with Water, % Change      ASTM D 1264												
<sup>8</sup> depending on the application      Note : For additional performance data on these greases refer to NEHP5621												



i01958924

## S·O·S Oil Analysis

**SMCS Code:** 1000; 7542

Caterpillar has developed a tool for maintenance management that evaluates oil degradation and the tool also detects the early signs of wear on internal components. The Caterpillar tool for oil analysis is called S·O·S Oil Analysis and the tool is part of the S·O·S Services program. S·O·S Oil Analysis divides oil analysis into the following categories:

- Wear Analysis
- Oil condition
- Additional tests

The wear analysis monitors metal particles, some oil additives, and some contaminants.

Oil condition uses infrared (IR) analysis to evaluate the chemistry of the oil. Infrared analysis is also used to detect certain types of contamination.

Additional tests are used to measure contamination levels from water, fuel, or coolant. Oil viscosity and corrosion protection can be evaluated, as needed.

These three types of analysis are used to monitor the condition of your engine and potential problems can be detected. A properly administered S·O·S Oil Analysis program will reduce repair costs and the program will lessen the impact of downtime.

The S·O·S Oil Analysis program uses a wide range of tests to determine the condition of the oil and the condition of the lubricated compartment.

Guidelines that are based on experience and a correlation to failures have been established for these tests. See the following chart for the guidelines. Exceeding one or more of these guidelines could indicate serious fluid degradation or a pending component failure. A trained person at your Caterpillar dealership should make the final analysis.

**Note:** Cooling system problems will also reduce the life of engines. The combination of S·O·S Coolant Analysis and S·O·S Oil Analysis provide a complete, accurate method for monitoring the health of all Caterpillar engines. Refer to the S·O·S Coolant Analysis information in this publication. A properly administered S·O·S Services program will reduce repair costs. The program will also lessen the impact of downtime.

Table 3

S·O·S Oil Analysis Guidelines	
Test Parameter	Guideline
Oxidation	(1)
Soot	(1)
Sulfation	(1)
Wear Metals	Trend Analysis and Cat Wear Table <sup>(1)</sup> norms
Water	0.5% maximum
Glycol	0%
Fuel Dilution	4% maximum
Viscosity - engines by "ASTM D445" measured at 100° C (212° F)	+/-3 centistoke (cSt) change from new oil viscosity.
Total Base Number (TBN) by "ASTM D2896"	50% of new oil TBN
Total Acid Number (TAN) by "ASTM D664"	2.0 greater than new oil TAN or 3.0 maximum

(1) Acceptable values for these parameters are proprietary to the S·O·S Oil Analysis program.

Consult your Caterpillar dealer for complete information and assistance about the S·O·S Oil Analysis program.

## Obtaining S·O·S Oil Samples

Before you obtain an S·O·S oil sample, operate the engine until the oil is warm and the oil is well circulated. Then obtain the S·O·S oil sample.

In order to obtain a good oil sample, do not take the oil sample from the drain stream. The drain stream method can allow a stream of dirty oil from the bottom of the compartment to contaminate the sample. Likewise, never dip an oil sample from an oil container or pour a sample from a used filter.

### NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

There are two ways to obtain S·O·S oil samples. The following methods are listed in the order that is preferred:

- Use an in-line sampling valve for pressurized oil systems.

- Use a sampling gun that is inserted into the sump.

Use of the in-line sampling valve is the preferred method. This method provides samples that are less likely to be contaminated. Whenever you obtain the samples, obtain the samples from the same point. This makes the samples more representative of the oil that is in the system.

In order to obtain an oil sample from the engine compartment, it may be necessary to increase the engine's speed. Normally, the oil sample is taken at low idle. If the flow rate is too low, increase engine speed to high idle in order to obtain the oil sample.

Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for the proper interval.

## Sampling Interval

Take the oil samples as close as possible to the standard intervals. In order to receive the full value from S·O·S oil analysis, you must establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent oil samplings that are evenly spaced.

Table 4

Compartment	Engine
<b>Recommended Sampling Interval</b>	24140 kilometers (15000 miles) (1)
<b>Sampling Valve</b>	Yes
<b>Oil Type</b>	DEO
<b>Recommended Oil Change Interval</b>	(2)

(1) Under certain conditions, the Caterpillar dealer or the Operation and Maintenance Manual may allow a longer interval between oil samplings.

(2) Consult the Operation and Maintenance Manual that came with your engine for the recommended oil change intervals.

Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your equipment.

## More Frequent S·O·S Sampling Improves Life Cycle Management

Traditionally, the suggested S·O·S sampling intervals have been at each oil change. However in severe applications, more frequent oil sampling is recommended. If the engine is operated under a high load and/or high temperature condition, sample at every 250 hours of operation.

## Application

Studies have revealed that obtaining oil samples at every 24140 kilometers (15000 miles) is too long a time interval in some applications in order to predict potential failure modes. A sampling interval at every 16093 kilometers (10000 miles) provides more data between oil change intervals. More data increases the chance for detecting a potential failure.

## Determining Optimum Oil Change Intervals

Sampling the compartments at every 16093 kilometers (10000 miles) provides information for oil condition and for oil performance. This information is used to determine the optimum usable life of a particular oil. Also, more points of data will allow closer monitoring of component wear rates. Close monitoring also allows you to obtain the maximum use of the oil. For detailed information on extending oil change intervals, please contact your Caterpillar dealer.

## Optimizing the Component Life Cycle

An increase in the number of oil samples provides a better definition of the trends in data between oil change intervals. More oil samples will allow you to closely monitor wear patterns of components. This action will ensure that the full life of the components are achieved.

# Fuel Specifications

i01938722

## Fuel Recommendations

**SMCS Code:** 1250; 1280

### NOTICE

These recommendations are subject to change without prior notice. Contact your local Caterpillar dealer for the most up to date fluids recommendations.

## Distillate Diesel Fuel

Diesel fuels that meet the specifications in Table 5 will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Table 5 is for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Table 5

Caterpillar Specification for Distillate Diesel Fuel			
Specifications	Requirements	ASTM Test	ISO Test
Aromatics	35% maximum	"D1319"	"ISO 3837"
Ash	0.02% maximum (weight)	"D482"	"ISO 6245"
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	"D524"	"ISO 4262"
Cetane Number <sup>(1)</sup>	40 minimum (DI engines)	"D613" or "D6890"	"ISO 5165"
	35 minimum (PC engines)		
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	-	-
Copper Strip Corrosion	No. 3 maximum	"D130"	"ISO 2160"

(continued)

(Table 5, contd)

Caterpillar Specification for Distillate Diesel Fuel			
Specifications	Requirements	ASTM Test	ISO Test
Distillation	10% at 282 °C (540 °F) maximum	"D86"	"ISO 3405"
	90% at 360 °C (680 °F) maximum		
Flash Point	legal limit	"D93"	"ISO 2719"
Thermal Stability	Minimum of 70% reflectance after aging for 180 minutes at 150 °C (302 °F)	"D6468"	No equivalent test
API Gravity	30 minimum	"D287"	No equivalent test
	45 maximum		
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"	"ISO 3016"
Sulfur <sup>(2)</sup>	3% maximum	"D3605" or "D1552"	"ISO 8691"
Kinematic Viscosity <sup>(3)</sup>	1.4 cSt minimum and 20.0 cSt maximum as delivered to the fuel injection pumps.	-	-
Water and Sediment	0.1% maximum	"D1796"	"ISO 3734"
Water	0.1% maximum	"D1744"	No equivalent test
Sediment	0.05% maximum (weight)	"D473"	"ISO 3735"

(continued)

(Table 5, contd)

Caterpillar Specification for Distillate Diesel Fuel			
Specifications	Requirements	ASTM Test	ISO Test
Gums and Resins <sup>(4)</sup>	10 mg per 100 mL maximum	“D381”	“ISO 6246”
Lubricity <sup>(5)</sup>	3100 g minimum	“D6078”	No equivalent test
	0.45 mm (0.018 inch) maximum at 60 °C (140 °F)	“D6079”	“ISO 12156”

- (1) Alternatively, to ensure a minimum cetane number of 35 (PC engines), and 40 (DI engines), distillate diesel fuel should have a minimum cetane index of 37.5 (PC engines), and 42.5 (DI engines) using ASTM D 4737-96a.
- (2) Caterpillar fuel systems and engine components can operate on high sulfur fuels. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. For additional information, see this publication, “Engine Oil” topic (Maintenance Section).
- (3) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain a 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to bring down the viscosity to a 20 cSt viscosity or less.
- (4) Follow the test conditions and procedures for gasoline (motor).
- (5) The lubricity of a fuel is a concern with low sulfur fuel. To determine the lubricity of the fuel, use either the “ASTM D6078 Scuffing Load Wear Test (SBOCLE)” or the “ASTM D6079 High Frequency Reciprocating Rig (HFRR)” test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

### Ultra Low Sulfur Diesel (ULSD)

Caterpillar recommends that all distillate diesel fuel, including ULSD fuel (ie fuel ≤ 15 ppm sulfur using ASTM D 2622 or DIN 51400) meet the requirements of the Caterpillar Specifications for Distillate Diesel Fuel.

**Note:** Caterpillar recommends that fuel be filtered through a fuel filter with a rating of less than five (5) microns absolute at the point where the fuel is dispensed into the vehicle.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, these other diesel fuel specifications do not contain all of the parameters that are addressed by Caterpillar. To achieve optimum engine performance, obtain a complete analysis of the fuel before operating the engine. The fuel analysis must cover all of the properties that are listed in Table 5.

---

### NOTICE

Operating with fuels that do not meet Caterpillar’s recommendations can cause the following effects: starting difficulty, poor combustion, deposits in the fuel injectors, reduced service life of the fuel system, deposits in the combustion chamber, and reduced service life of the engine.

---

In the USA, 0.05 percent diesel fuels have been used in all on-highway truck engines since 1 January 1994. This low sulfur diesel fuel was mandated as a means of directly reducing particulate emissions from diesel truck engines. This low sulfur fuel will also be used in Caterpillar commercial diesel engines and in Caterpillar machine engines. This diesel fuel will be used when low emissions are required. This fuel will be used when the fuel supplier can provide this type of fuel. Caterpillar has not seen any detrimental effects with 0.05 percent sulfur fuel in Caterpillar diesel engines.

---

### NOTICE

Heavy Fuel Oil (HFO), Residual fuel, or Blended fuel must **NOT** be used in Caterpillar diesel engines (except in 3600 Series HFO engines). Blended fuel is residual fuel that has been diluted with a lighter fuel (cutter stock) so that they will flow. Blended fuels are also referred to as heavy fuel oils. Severe component wear and component failures will result if HFO type fuels are used in engines that are configured to use distillate fuel.

---

### Aftermarket Fuel Additives

There are many different types of fuel additives that are available to use. Caterpillar does not generally recommend the use of fuel additives.

In special circumstances, Caterpillar recognizes the need for fuel additives. Fuel additives need to be used with caution. The additive may not be compatible with the fuel. Some additives may precipitate. This action causes deposits in the fuel system. The deposits may cause seizure. Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can make recommendations for additives to use and for the proper level of treatment. For best results, your fuel supplier should treat the fuel when additives are needed.

## Biodiesel

Biodiesel is a fuel that can be made from a variety of sources, primarily from soybean oil or rapeseed oil. Without esterification, these oils gel in the crankcase and fuel tank and may not be compatible with many of the elastomers used in today's engines. In their original form, these oils are not suitable for use as a fuel in compression engines. To use these oils as fuel, they must be esterified. Alternate base stocks for biofuel may include animal tallow, waste cooking oils, or a variety of other feedstocks.

Caterpillar certifies its engines using the prescribed EPA and European Certification Fuels. Caterpillar does not certify engines on any other fuel.

**Note:** It is the user's responsibility to use the correct fuel as recommended by the manufacturer and allowed by EPA or other local regulatory agencies. It is the responsibility of the user to obtain the proper local, regional, and/or national exemptions required for the use of biodiesel in any emissions regulated Caterpillar engine.

### Warranty and the Use of Biodiesel Fuel in Caterpillar Engines

Caterpillar neither approves nor prohibits the use of biodiesel fuels. Caterpillar is not in a position to evaluate the many variations of biodiesel fuels, and the long term effects on performance, durability or emissions compliance of Caterpillar products. The use of biodiesel fuels does not affect Caterpillar's materials and workmanship warranty.

**Failures resulting from the use of any fuel are not Caterpillar factory defects and therefore the cost of repair would NOT be covered by Caterpillar's warranty.**

### Recommendation for the Use of Biodiesel Fuel in Caterpillar Engines

**Note:** Biodiesel has not been validated for use in Caterpillar diesel engines that utilize ACERT technology. Once testing is complete, recommendations will be published in Service Magazine, Engine News, and Truck Engine News articles. Recommendations will then be included in Caterpillar Fluids Recommendations and Operation and Maintenance Manuals.

For Caterpillar 3046, 3064, 3066, 3114, 3116, 3126, 3176, 3196, 3208, 3306, C-9, C-10, C-12, 3406, C-15, C-16, 3456, 3408, 3412, 3500 series, 3600 series, CM20, CM25 and CM32 engines: Biodiesel meeting the requirements listed in Caterpillar's biodiesel specification or, meeting either ASTM D6751 or DIN 51606, are acceptable. They may also be blended in any percentage with an acceptable diesel fuel, provided the biodiesel constituent meets the requirements outlined in Table 6 prior to blending.

For Caterpillar 3003 through 3034, 3054 and 3056 engines: Biodiesel meeting the requirements listed in Caterpillar's biodiesel specification or, meeting either ASTM D6751 or DIN 51606, may be blended with an acceptable diesel fuel at a maximum of 5% biodiesel fuel blended with 95% diesel fuel. The biodiesel fuel must meet the requirements listed in Table 6 prior to blending. Use of more than a 5% biodiesel fuel can cause premature failures whose repair would not be covered under Caterpillar warranty.

**Note:** When burning biodiesel, or any blend of biodiesel, it is the responsibility of the user to obtain the proper local, regional, and/or national exemptions required for the use of biodiesel in any emissions regulated Caterpillar engine. When using a fuel that meets Caterpillar's Biodiesel specification, ASTM D6751, or DIN 51606 specifications, and when adhering to the following recommendations, the use of biodiesel should pose no problems.

### Recommendations

- The oil change interval can be affected by the use of biodiesel fuel. Use Scheduled Oil Sampling (S·O·S) to monitor the engine oil condition and to determine the optimum oil change interval.
- Biodiesel provides approximately 5-7% less energy per gallon of fuel when compared to distillate fuels. To avoid engine problems when the engine is converted back to 100% distillate diesel fuel, do not change the engine rating to compensate for the power loss.
- Elastomer compatibility with biodiesel is still being monitored. The condition of seals and hoses should be monitored regularly.

- Biodiesel fuels may pose low ambient temperature problems for both storage and operation. At low ambient temperatures, fuel may need to be stored in a heated building or a heated storage tank. The fuel system may require heated fuel lines, filters, and tanks. Filters may plug and fuel in the tank may solidify at low ambient temperatures if precautions are not taken. Consult your biodiesel supplier for assistance in the blending and attainment of the proper cloud point fuel.
- Biodiesel has poor oxidation stability, which can result in long term storage problems. The poor oxidation stability qualities may accelerate fuel oxidation in the fuel system. This is especially true in engines with electronic fuel systems because they operate at higher temperatures. Consult the fuel supplier for oxidation stability additives.
- Biodiesel fuel is an excellent medium for microbial growth. Microbes cause fuel system corrosion and premature filter plugging. The effectiveness of conventional anti-microbial additives, when used in biodiesel is not known. Consult your fuel and additive supplier for assistance.
- Care must be taken to remove water from fuel tanks. Water accelerates microbial growth. Water is naturally more prevalent in biodiesel fuels than in distillate fuels.

## Caterpillar Biodiesel

Table 6

Property	Test Method	Test Method	Units	Limits
	United States	International	Fuel Specific Properties	
Density @ 15°C	"ASTM D1298"	"DIN/ISO 3675"	g/cm <sup>3</sup>	0.86-0.90
Viscosity @ 40°C	"ASTM D445"	"DIN/ISO 3104"	mm <sup>2</sup> /s	4.0-6.0
Flash Point	"ASTM D93"	"DIN/ISO 22719"	°C	100 minimum
Cold Filter Plugging - Summer - Winter	"ASTM D4539"	"DIN EN 116"	°C	0 6 below ambient
Pour Point - Summer - Winter	"ASTM D97"	"ISO 3016"	°C	-9 maximum -20 maximum
Sulfur Content	"ASTM D2622"	"ISO 8754"	% weight	0.0015 maximum
Distillation - 10% Evaporation - 90% Evaporation	"ASTM D1160"	"ISO 340"	°C	To Be Determined 345
Carbon Residue, Conradson (CCR)	"ASTM D189"	"DIN/ISO 10370"	% weight	0.5 maximum
Cetane Number	"ASTM D613"	"ISO 5165"		45 minimum
Ash Content	"ASTM D482"	"DIN 51575" "ISO 6245"	mg/kg	0.02 maximum
Water Content	"ASTM D1796"	"DIN 51777-1" "ISO 3733"	g/m <sup>3</sup>	500 maximum
Particulate Matter	"DIN 51419"	"DIN 51419"		15
Copper Corrosion	"ASTM D130"	"DIN/ISO 2160"		No. 1
Oxidation Stability	"ASTM D2274"	"IP 306 mod."	mg/100mL	15 maximum
Esterification			% volume	98.0 minimum
Acid Value	"ASTM D664"	"DIN 51558"	mg NaOH/g	0.5 maximum
Methanol Content	GC Method	"DIN 51608"	% weight	0.2 maximum
Monoglycerides	GC Method	"DIN 51609"	% weight	0.8 maximum
Diglycerides	GC Method	"DIN 51609"	% weight	0.2 maximum
Triglycerides	GC Method	"DIN 51609"	% weight	0.2 maximum
Free Glycerine	GC Method	"DIN 51609"	% weight	0.02 maximum
Total Glycerine	GC Method	"DIN 51609"	% weight	1.2 maximum
Iodine Number	"DIN 53241 or IP 84/81"	"DIN 53241 or IP 84/81"	cg I <sub>2</sub> /g	110 maximum
Phosphorus Content	"DGF C-VI4"	"DIN 51440-1"	mg/kg	0.2

**Note:** Fuels meeting "ASTM D6751" or "DIN51606" may be used.

# Cooling System Specifications

i01908600

## General Coolant Information

**SMCS Code:** 1350; 1395

---

### NOTICE

These recommendations are subject to change without prior notice. Contact your local Caterpillar dealer for the most up to date fluids recommendations.

---

---

### NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

---

---

### NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

---

---

### NOTICE

Frequently check the specific gravity of the coolant for proper freeze protection or for anti-boil protection.

---

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

**Note:** Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 20 L (5 US gal) per minute.

After you drain the cooling system and after you refill the cooling system, operate the engine. Operate the engine without the filler cap until the coolant reaches normal operating temperature and the coolant level stabilizes. Ensure that the coolant is maintained to the proper level.

---

### NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

---

Refer to Special Instruction, SEBD0518, "Know Your Cooling System" and Special Instruction, SEBD0970, "Coolant and Your Engine" for more detailed information.

Many engine failures are related to the cooling system. The following problems are related to cooling system failures: overheating, leakage of the water pump, plugged radiators or heat exchangers, and pitting of the cylinder liners.

These failures can be avoided with proper cooling system maintenance. Cooling system maintenance is as important as maintenance of the fuel system and the lubrication system. Quality of the coolant is as important as the quality of the fuel and the lubricating oil.

Coolant is normally composed of three elements: water, additives, and glycol.

## Water

---

### NOTICE

All Caterpillar diesel engines equipped with air-to-air aftercooling (ATAAC) require a minimum of 30 percent glycol to prevent water pump cavitation.

---

---

### NOTICE

Never use water alone without Supplemental Coolant Additives (SCA) or without inhibited coolant. Water alone is corrosive at engine operating temperatures. Water alone does not provide adequate protection against boiling or freezing.

---

Water is used in the cooling system in order to transfer heat.

**Distilled water or deionized water is recommended for use in engine cooling systems.**

DO NOT use the following types of water in cooling systems: hard water, softened water that has been conditioned with salt, and sea water.

If distilled water or deionized water is not available, use water with the properties that are listed in Table 7.



Table 7

<b>Caterpillar Minimum Acceptable Water Requirements</b>		
<b>Property</b>	<b>Maximum Limit</b>	<b>ASTM Test</b>
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	“D512”, “D4327”
Sulfate (SO <sub>4</sub> )	100 mg/L (5.9 grains/US gal)	“D516”
Total Hardness	170 mg/L (10 grains/US gal)	“D1126”
Total Solids	340 mg/L (20 grain/US gal)	“D1888”
Acidity	pH of 5.5 to 9.0	“D1293”

For a water analysis, consult one of the following sources:

- Caterpillar dealer
- Local water utility company
- Agricultural agent
- Independent laboratory

## Additives

Additives help to protect the metal surfaces of the cooling system. A lack of coolant additives or insufficient amounts of additives enable the following conditions to occur:

- Corrosion
- Formation of mineral deposits
- Rust
- Scale
- Pitting and erosion from cavitation of the cylinder liner
- Foaming of the coolant

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

## Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and cylinder liners

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

**Note:** Use a mixture that will provide protection against the lowest ambient temperature.

**Note:** 100 percent pure glycol will freeze at a temperature of  $-23\text{ }^{\circ}\text{C}$  ( $-9\text{ }^{\circ}\text{F}$ ).

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 8 and 9.

Table 8

<b>Ethylene Glycol</b>		
<b>Concentration</b>	<b>Freeze Protection</b>	<b>Boil Protection</b>
50 Percent	$-37\text{ }^{\circ}\text{C}$ ( $-34\text{ }^{\circ}\text{F}$ )	$106\text{ }^{\circ}\text{C}$ ( $223\text{ }^{\circ}\text{F}$ )
60 Percent	$-51\text{ }^{\circ}\text{C}$ ( $-60\text{ }^{\circ}\text{F}$ )	$111\text{ }^{\circ}\text{C}$ ( $232\text{ }^{\circ}\text{F}$ )

### NOTICE

Do not use propylene glycol in concentrations that exceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glycol in conditions that require additional protection against boiling or freezing.

Table 9

Propylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	-32 °C (-26 °F)	106 °C (223 °F)

To check the concentration of glycol, use the **1U-7298** Coolant/Battery Tester (Degree Celsius) or use the **1U-7297** Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

**Note:** Propylene glycol coolant used in Caterpillar Diesel Engine cooling systems must meet "ASTM D6211-98a "Fully-Formulated Propylene Glycol-Based Engine Coolant for Heavy-Duty Engines". When Propylene glycol coolant is used in heavy-duty diesel engines, regular addition of Supplemental Coolant Additive (SCA) is required for liner cavitation protection. Consult your Caterpillar dealer for more information.

i01908384

## Coolant Recommendations

**SMCS Code:** 1350; 1352; 1395

### NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 specification. This type of coolant/antifreeze is made for light duty automotive applications.

The following two coolants are used in Caterpillar diesel engines:

**Preferred** – Caterpillar Extended Life Coolant (ELC) or a commercial extended life coolant that meets the Caterpillar EC-1 specification

**Acceptable** – Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D4985", or "ASTM D6210" specifications

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

**Note:** Caterpillar DEAC does not require a treatment with an SCA at the initial fill. A commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D6210" specifications MAY require a treatment with an SCA at the initial fill. These coolants WILL require a treatment with an SCA on a maintenance basis.

Table 10

Service Life Before Flushing and Before Refilling	
Coolant	Service Life <sup>(1)(2)(3)</sup>
Cat <sup>®</sup> ELC	965,606 kilometers (600,000 miles) or 12000 hours or 6 years
Commercial coolant that meets the Caterpillar EC-1 specification	482,803 kilometers (300,000 miles) or 6000 hours or 6 years
CAT <sup>®</sup> DEAC	321,869 kilometers (200,000 miles) or 3000 hours or 3 years
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D4985" or "ASTM D6210"	241,402 kilometers (150,000 miles) or 3000 hours or 1 year

(1) Which ever comes first

(2) Refer to the specific engine OMM, "Maintenance Interval Schedule" for the interval for the Cooling System Water Temperature Regulator.

(3) Cat truck engines with excessive idle time must reduce coolant drain intervals to one-half of the stated kilometers/miles recommendations, or base the coolant service life on the stated hours. Engine hours of operation are reported in the ECM (Electronic Control Module). Two examples where engines may experience excessive idle time are engines that are normally operated in city pickup and delivery applications, and over the road truck applications where the engines are kept running in order to provide heat and/or air conditioning while the driver sleeps. Refer to the OMM for the specific engine for additional information.

**Note:** Add Cat<sup>®</sup> ELC Extender at the half-life of the coolant drain interval.

**Note:** These drain intervals are only achievable with annual Level 2 coolant analysis.

i01908410

## Extended Life Coolant (ELC)

**SMCS Code:** 1350; 1352; 1395

Caterpillar provides Extended Life Coolant (ELC) for use in the following applications:

- Heavy-duty diesel engines
- Automotive applications

The Cat ELC anti-corrosion package is based on a totally different additive system when compared to conventional coolants. ELC has been formulated with the correct amounts of additives in order to provide superior corrosion protection for all metals in engine cooling systems.

Cat ELC extends the service life of the coolant to 967 000 km (600,000 miles) or six years. ELC does not require a frequent addition of a SCA (Supplemental Coolant Additive). An Extender is the only additional maintenance that is needed at 483 000 km (300,000 miles) or one half of the ELC service life.

Cat ELC is available in a 1:1 premixed cooling solution with distilled water. The Premixed ELC provides freeze protection to  $-37^{\circ}\text{C}$  ( $-34^{\circ}\text{F}$ ). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

Cat ELC Concentrate is also available. ELC Concentrate can be used to lower the freezing point to  $-51^{\circ}\text{C}$  ( $-60^{\circ}\text{F}$ ) for arctic conditions.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

**Note:** Caterpillar developed the EC-1 specification. The EC-1 specification is an industry standard. The EC-1 specification defines all of the performance requirements that are needed for an engine coolant to be sold as an extended life coolant for Caterpillar engines. Cat ELC can be used in most OEM engines of the following types: diesel and gasoline. ELC meets the performance requirements of "ASTM D4985" and "ASTM D6210" for heavy-duty low silicate antifreeze/coolants. Cat ELC also meets the performance requirements of "ASTM D3306" for automotive applications.

i01908654

## Extended Life Coolant (ELC) Cooling System Maintenance

**SMCS Code:** 1350; 1352; 1395

### Proper additions to the Extended Life Coolant

**Note:** Do not add Cat ELC Concentrate as a makeup solution for maintaining the correct coolant level. The addition of the concentrated Extended Life Coolant will increase the concentration of glycol in the cooling system.

During daily maintenance, use the premixed Cat ELC as a cooling system top-off. This will bring the coolant up to the proper level. Check the specific gravity of the coolant system with the **1U-7298** Coolant/Battery Tester (Degree Celsius) or with the **1U-7297** Coolant/Battery Tester (Degree Fahrenheit). Use ELC Concentrate to restore the proper glycol concentration in the coolant system. This should be done before the engine is exposed to freezing temperatures.

---

#### NOTICE

Do not use a conventional coolant to top-off a cooling system using Extended Life Coolant (ELC).

Do not use Supplemental Coolant Additives (SCA) other than Extender in cooling systems filled with Extended Life Coolant.

When using Caterpillar ELC, do not use standard SCA's or SCA filters.

---

## Caterpillar ELC Extender

Caterpillar ELC Extender is added to the cooling system halfway through the ELC service life. Treat the cooling system with ELC Extender at 483 000 km (300,000 miles) or 3 years. Use Table 11 in order to determine the proper amount of ELC Extender that is required.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

Table 11

<b>Caterpillar ELC Extender Additions by Cooling System Capacity</b>	
<b>Cooling System Capacity</b>	<b>Addition of ELC Extender</b>
22 to 30 L (6 to 8 US gal)	0.57 L (20 fl oz)
31 to 38 L (9 to 10 US gal)	0.71 L (24 fl oz)
39 to 49 L (11 to 13 US gal)	0.95 L (32 fl oz)
50 to 64 L (14 to 17 US gal)	1.18 L (40 fl oz)
65 to 83 L (18 to 22 US gal)	1.60 L (54 fl oz)
84 to 114 L (23 to 30 US gal)	2.15 L (72 fl oz)
115 to 163 L (31 to 43 US gal)	3.00 L (100 fl oz)
164 to 242 L (44 to 64 US gal)	4.40 L (148 fl oz)

---

#### NOTICE

When using Caterpillar ELC, do not use standard SCA's or SCA filters. To avoid SCA contamination of an ELC system, remove the SCA filter base and plug off or by-pass the coolant lines.

---

## ELC Cooling System Cleaning

**Note:** If the cooling system is already using Cat ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when Cat ELC is drained from the cooling system.

Cat ELC can be distilled in order to reclaim the ethylene glycol and the water. Consult your Caterpillar dealer for more information.

After the cooling system has been drained and the cooling system is refilled, operate the engine while the cooling system filler cap is removed. Operate the engine until the coolant level reaches the normal operating temperature and the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

## Changing to Caterpillar ELC

To change from heavy-duty coolant/antifreeze to Cat ELC, perform the following steps:

---

### NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

---

1. Drain the coolant into a suitable container.
2. Dispose of the coolant according to local regulations.

---

### NOTICE

Do not leave an empty SCA maintenance element on a system that is filled with ELC.

The element housing may corrode and leak causing an engine failure.

Remove the SCA element/canister base and plug off or by-pass the coolant lines.

---

3. Remove the empty SCA maintenance element and remove the element base. Plug the coolant lines or bypass the coolant lines.
4. Flush the system with clean water in order to remove any debris.
5. Use Caterpillar Cooling System cleaner to clean the system. Follow the instructions on the label.
6. Drain the cleaner into a suitable container. Flush the cooling system with clean water.

**Note:** Deposits that remain in the system may be loosened and removed by the ELC.

7. In systems with heavy deposits, it may be necessary to disconnect the hoses. Clean the deposits and debris from the hoses and the fittings. Install the hoses and tighten the hose fittings. Pipe threads may also need to be cleaned and sealed. Seal the threads with 5P-3413 Pipe Sealant.
8. Fill the cooling system with clean water and operate the engine until the engine is warmed to 49 to 66°C (120 to 150°F).

---

### NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

---

9. Drain the cooling system into a suitable container and flush the cooling system with clean water.

**Note:** The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

10. Repeat Steps 8 and 9 until the system is completely clean.

11. Fill the cooling system with Cat ELC.
12. Operate the engine until the engine is warmed. While the engine is running, inspect the engine for leaks. Tighten hose clamps and connections in order to stop any leaks.
13. Attach the Special Publication, PEEP5027, "Label - ELC Radiator Label" to the radiator top tank in order to indicate the use of Cat ELC.

**Note:** Clean water is the only flushing agent that is required when the ELC is drained from the cooling system.

## ELC Cooling System Contamination

### NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for premixed or concentrate coolants. Use only Caterpillar ELC Extender with Caterpillar ELC. Failure to follow these recommendations can result in shortened cooling system component life.

ELC cooling systems can withstand contamination to a maximum of ten percent of conventional heavy-duty coolant/antifreeze or SCA before the advantages of ELC are reduced. If the contamination exceeds ten percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Flush the system with clean water. Fill the system with the Caterpillar ELC.
- Maintain the system as a conventional Diesel Engine Antifreeze/Coolant (DEAC) or other conventional coolant. Treat the system with an SCA. Change the coolant at the interval that is recommended for Diesel Engine Antifreeze/Coolant (DEAC) or other conventional coolant.

## Commercial ELC

If Caterpillar ELC is not used, then select a commercial coolant that meets the Caterpillar specification of EC-1 and either the "ASTM D4985" specification or the "ASTM D6210" specification. Do not use an extended life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial extended life coolant. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

i01908729

## Diesel Engine Antifreeze/Coolant (DEAC)

**SMCS Code:** 1350; 1352; 1395

Caterpillar recommends using Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) for cooling systems that require a heavy-duty coolant/antifreeze. Caterpillar DEAC is an alkaline single-phase ethylene glycol type antifreeze that contains corrosion inhibitors and antifoam agents.

Caterpillar DEAC is formulated with the correct amount of Caterpillar Supplemental Coolant Additive (SCA). Do not use SCA at the initial fill when DEAC is used.

Containers of several sizes are available. Consult your Caterpillar dealer for the part numbers.

If concentrated DEAC is used, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, use water which has the required properties. For the water properties, see this publication, "General Coolant Information" topic (Maintenance Section).

i01946863

## Supplemental Coolant Additive (SCA)

**SMCS Code:** 1350; 1352; 1395

The use of SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liners
- Foaming of the coolant

Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) is formulated with the correct level of Caterpillar SCA. When the cooling system is initially filled with DEAC, adding more SCA is not necessary until the concentration of SCA has been depleted. To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Refer to the specific engine's Operation and Maintenance Manual, "Maintenance Interval Schedule".

Containers of Cat SCA are available in several sizes. Consult your Caterpillar dealer for the part numbers.

i01940049

## Conventional Coolant/ Antifreeze Cooling System Maintenance

**SMCS Code:** 1350; 1352; 1395

---

### NOTICE

Never operate an engine without water temperature regulators in the cooling system. Water temperature regulators help to maintain the engine coolant at the proper operating temperature. Cooling system problems can develop without water temperature regulators.

---

**Note:** Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for a specific engine in order to locate the maintenance interval for the Cooling System Water Temperature Regulator.

Check the coolant/antifreeze (glycol concentration) in order to ensure adequate protection against boiling or freezing. Caterpillar recommends the use of a refractometer for checking the glycol concentration. Use the **1U-7298** Coolant/Battery Tester (Degrees Celsius) or use the **1U-7297** Coolant/Battery Tester (Degrees Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or with propylene glycol.

Caterpillar engine cooling systems should be tested at 250 hour or PM Level 1 intervals for the concentration of Supplemental Coolant Additive (SCA). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer at 250 hour or PM Level 1 intervals. Refer to S-O-S Coolant Analysis for more information on this topic.

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. An SCA that is liquid or a maintenance element for an SCA (if equipped) may be needed at 250 hour or PM Level 1 intervals.

Table 12 lists the amount of Caterpillar SCA that is needed in order to treat coolant/antifreeze. These amounts of SCA are for systems that use heavy-duty coolant/antifreeze.

Table 12 also lists additions of SCA for liquid and for maintenance elements at 250 hours or PM Level 1 intervals. The additions are required for Caterpillar DEAC and for commercial coolant/antifreezes.

Table 12

<b>Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze</b>				
<b>Cooling System Capacity</b>	<b>Initial Fill<sup>(1)</sup></b>	<b>250 Service Hour or PM Level 1 Maintenance<sup>(2)</sup></b>	<b>Spin-on Element at 250 Service Hour or PM Level 1 Maintenance<sup>(3)</sup></b>	<b>Quantity of Elements Used</b>
22 to 30 L (6 to 8 US gal)	0.95 L (32 fl oz)	0.24 L (8 fl oz)	111-2370	1
31 to 38 L (9 to 10 US gal)	1.18 L (40 fl oz)	0.36 L (12 fl oz)	111-2369	1
39 to 49 L (11 to 13 US gal)	1.42 L (48 fl oz)	0.36 L (12 fl oz)	111-2369	1
50 to 64 L (14 to 17 US gal)	1.90 L (64 fl oz)	0.47 L (16 fl oz)	9N-3368	1
65 to 83 L (18 to 22 US gal)	2.37 L (80 fl oz)	0.60 L (20 fl oz)	111-2371	1
84 to 114 L (23 to 30 US gal)	3.32 L (112 fl oz)	0.95 L (32 fl oz)	9N-3718	1
115 to 163 L (31 to 43 US gal)	4.75 L (160 fl oz)	1.18 L (40 fl oz)	111-2371	2
164 to 242 L (44 to 64 US gal)	7.60 L (256 fl oz)	1.90 L (64 fl oz)	9N-3718	2

(1) When the coolant system is first filled, the SCA is not required to be used with Caterpillar DEAC or with fully formulated coolants that meet the "ASTM D6210-98a" specification.

(2) Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit.

(3) Do not use the maintenance element for the SCA and the liquid for the SCA at the same time.

**Note:** Specific engine applications may require maintenance practices to be periodically evaluated in order to properly maintain the engine's cooling system.

Refer to Table 13 for part numbers and for quantities of SCA.

Table 13

<b>Caterpillar Liquid SCA</b>	
<b>Part Number</b>	<b>Quantity</b>
6V-3542	0.24 L (8 oz)
111-2372	0.36 L (12 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
5P-2907	208 L (55 US gal)

## Cleaning the Heavy-Duty Cooling System

Caterpillar cooling system cleaners are designed to clean the cooling system of harmful scale and corrosion. Caterpillar cooling system cleaners dissolve mineral scale, corrosion products, light oil contamination and sludge.

- Clean the cooling system after used coolant is drained or before the cooling system is filled with new coolant.
- Clean the cooling system whenever the coolant is contaminated or whenever the coolant is foaming.
- For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for your engine.

## Commercial Heavy-Duty Coolant/Antifreeze and SCA

**SMCS Code:** 1350; 1352; 1395

If Caterpillar DEAC is not used, select a coolant/antifreeze with low silicate content for heavy-duty applications that meets “ASTM D6210” or “ASTM D4985” specifications.

**Note:** When you are not using Caterpillar DEAC the cooling system must be drained one time during every year. The cooling system must be flushed at this time as well.

When a heavy-duty coolant/antifreeze is used, the cooling system should be treated with three to six percent Caterpillar SCA by volume. Refer to this publication, “Conventional Coolant/Antifreeze Cooling System Maintenance” topic (Maintenance Section).

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 1200 mg/L or 1200 ppm (70 grains per gallon) of nitrites in the final coolant mixture.

Coolant/antifreezes for heavy-duty applications that meet the “ASTM D4985” specifications MAY require treatment with SCA at the initial fill. These coolants WILL require treatment with SCA on a maintenance basis.

Coolant/antifreezes for heavy-duty applications that meet “ASTM D6210” specifications do not require treatment with SCA at the initial fill. Treatment with SCA will be required on a maintenance basis.

When concentrated coolants are mixed, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, refer to the table in this publication, “General Coolant Information” topic (Maintenance Section).

## S·O·S Coolant Analysis

**SMCS Code:** 1350; 1352; 1395; 7542-008; 7542

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S·O·S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Coolant Analysis is a program that is based on periodic samples.

### NOTICE

Do not use the same vacuum sampling pump for extracting oil samples that is used for extracting coolant samples.

A small residue of either type sample may remain in the pump and may cause a false positive analysis for the sample being taken.

Always use a designated pump for oil sampling and a designated pump for coolant sampling.

Failure to do so may cause a false analysis which could lead to customer and dealer concerns.

## Recommended Interval for S·O·S Coolant Sample

Table 14

Recommended Interval		
Type of Coolant	Level 1	Level 2
DEAC	Every 250 Hours	Yearly <sup>(1)</sup>
ELC	Not Required	Yearly

<sup>(1)</sup> The Level 2 Coolant Analysis should be performed sooner if a problem is identified by a Level 1 Coolant Analysis.

**Note:** Check the DEAC or check the commercial conventional coolant/antifreeze SCA concentration at every oil change, or at every 250 hours, whichever comes first.

## Converted Systems

Perform a coolant analysis (**Level 2**) annually or at 500 service hours, whichever comes first, for new systems or for converted systems that use ELC or use DEAC. This 500 hour check will also check for any residual cleaner that may have contaminated the converted system.



## **S·O·S Coolant Analysis (Level 1)**

A coolant analysis (Level 1) is a test of the properties of the coolant.

The following properties of the coolant are tested:

- Glycol Concentration for freeze protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Water hardness
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

## **S·O·S Coolant Analysis (Level 2)**

Level 2 coolant analysis is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

The S·O·S Coolant Analysis has the following five features:

- Full analysis of Level 1
- Identification of the source of metal corrosion and of contaminants
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of possible electrolysis within the engines' cooling system

The results are reported, and appropriate recommendations are made.

For more information on S·O·S Coolant Analysis, consult your Caterpillar dealer.

## Reference Information Section

### Reference Materials

i01909146

#### Reference Material

**SMCS Code:** 1000

The following literature can be obtained through any Caterpillar dealer.

This information is subject to change without notice.

#### Coolants

- Special Publication, PELJ0176, "Cat ELC (Extended Life Coolant) Dilution Test Kits-P/N 223-9116"
- Special Publication, PEHP4036, "Data Sheet-Extended Life Coolant" (For North America and South America)
- Special Publication, PEHP9557, "Data Sheet-Extended Life Coolant" (For Europe, Africa, and Middle East countries)
- Special Publication, PEEP5027, "Label - ELC Radiator Label"
- Special Publication, PEHP7057, "S·O·S Coolant Analysis"

#### Lubricants

- Special Publication, PELJ0179, "Caterpillar Engine Crankcase Fluid-1 Specifications" (All World Market Areas)
- Special Publication, PEHP7062, "Product Data Sheet for Caterpillar Full Synthetic Diesel Engine Oil (DEO)" Multigrade diesel engine oil (North American Markets)
- Special Publication, PEHJ0021, "Product Data Sheet for Cat DEO (Diesel Engine Oil) Multigrade"
- Special Publication, PEDP7035, "Optimizing Oil Change Intervals" (diesel engines)
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

- Special Publication, SEBD0640, "Oil and Your Engine"
- Special Publication, NEHP5621, "How To Select The Right Grease For Any Job"
- Special Publication, NEHP6012, "Data Sheet - Desert Gold (DG) Grease"
- Special Publication, NEHP6011, "Data Sheet - Arctic Platinum (AP) Grease"
- Special Publication, NEHP6015, "Data Sheet - Special Purpose Grease (SPG) Bearing Lubricant"
- Special Publication, NEDG6022, "Data Sheet - Multipurpose Lithium Complex Grease (MPG)"
- Special Publication, PELE0761, "Hydraulic Fluid Recommendations" (service fill)
- Special Publication, PEHJ0009, "Product Data Sheet for Caterpillar HYDO (Hydraulic Oil)"
- Special Publication, PEHP7508, "Product Data Sheet for Caterpillar Gear Oil (GO)"
- Special Publication, NEHP6013, "S·O·S Fluids Analysis Products"
- Special Publications, PEDP7036, "S·O·S Fluids Analysis Cornerstone"
- Special Publications, PEHP7076, "Understanding S·O·S Services Tests"

#### Miscellaneous

- Special Publication, PECP9067, "One Safe Source" (English Language for use in NACD/CACO/APD) (2002-2003)
- Special Publication, PECP9068, "One Safe Source" (English Language for use in EAME) (2002-2003)
- Special Publication, AECQ1042, "Caterpillar Product Line Brochure"

i01909470

### Additional Reference Material

**SMCS Code:** 1000

Engine Manufacturers Association, "Engine Fluids Data Book"

Engine Manufacturers Association  
Two North LaSalle Street, Suite 2200  
Chicago, Illinois, USA 60602  
E-mail: [ema@enginemanufacturers.org](mailto:ema@enginemanufacturers.org)  
(312) 827-8700  
Facsimile: (312) 827-8737

# Index

## A

Additional Reference Material .....	34
Aftermarket Oil Additives .....	9

## C

Cold Weather Lubricants .....	10
Commercial Heavy-Duty Coolant/Antifreeze and SCA .....	32
Conventional Coolant/Antifreeze Cooling System Maintenance .....	30
Cleaning the Heavy-Duty Cooling System .....	31
Coolant Recommendations .....	26
Cooling System Specifications .....	24

## D

Diesel Engine Antifreeze/Coolant (DEAC) .....	29
---	----

## E

Engine Oil (On-highway Diesel Recommendations).....	6
Caterpillar Diesel Engine Oil (DEO).....	6
Commercial Oils.....	7
Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines .....	8
Extended Life Coolant (ELC).....	26
Extended Life Coolant (ELC) Cooling System Maintenance .....	27
Caterpillar ELC Extender .....	27
Changing to Caterpillar ELC .....	28
Commercial ELC.....	29
ELC Cooling System Cleaning.....	28
ELC Cooling System Contamination.....	29
Proper additions to the Extended Life Coolant ..	27

## F

Foreword.....	5
Literature Information.....	4
Maintenance .....	4
Safety.....	4
Fuel Recommendations.....	19
Biodiesel .....	21
Distillate Diesel Fuel .....	19
Fuel Specifications .....	19

## G

General Coolant Information .....	24
Additives .....	25
Glycol .....	25
Water .....	24

## I

Important Safety Information .....	2
------------------------------------	---

## L

Lubricant Information.....	6
API Oils .....	6
Lubricant Specifications .....	6
Lubricating Grease .....	10
Caterpillar Arctic Platinum (AP) Grease .....	13
Caterpillar Auto-lube Greases (A-L).....	11
Caterpillar Desert Gold Grease (DG) .....	12
Caterpillar Multipurpose Grease (MPG) .....	11
Caterpillar Multipurpose Grease w/Moly (MPGM).....	11
Caterpillar Multipurpose White Assembly Grease (MPWAG) .....	11
Caterpillar Paver Grease (PG).....	13
Caterpillar Special Purpose Grease (SPG) .....	14
Caterpillar Water and Temperature Resistant (WTR) Grease.....	14
Grease Application Chart.....	14

## M

Maintenance Section.....	6
--------------------------	---

## R

Re-refined Base Stock Oils .....	9
Reference Information Section .....	34
Reference Material .....	34
Coolants.....	34
Lubricants .....	34
Miscellaneous .....	34
Reference Materials .....	34

## S

S-O-S Coolant Analysis .....	32
Recommended Interval for S-O-S Coolant Sample .....	32
S-O-S Coolant Analysis (Level 1).....	33
S-O-S Coolant Analysis (Level 2).....	33

S·O·S Oil Analysis ..... 17  
    Obtaining S·O·S Oil Samples..... 17  
    Sampling Interval ..... 18  
Supplemental Coolant Additive (SCA)..... 29  
Synthetic Base Stock Oils ..... 9

**T**

Table of Contents..... 3



# Product and Dealer Information

**Note:** For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual.

**Delivery Date:** \_\_\_\_\_

## Product Information

Model: \_\_\_\_\_

Product Identification Number: \_\_\_\_\_

Engine Serial Number: \_\_\_\_\_

Transmission Serial Number: \_\_\_\_\_

Generator Serial Number: \_\_\_\_\_

Attachment Serial Numbers: \_\_\_\_\_

Attachment Information: \_\_\_\_\_

Customer Equipment Number: \_\_\_\_\_

Dealer Equipment Number: \_\_\_\_\_

## Dealer Information

Name: \_\_\_\_\_ Branch: \_\_\_\_\_

Address: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Dealer Contact

Phone Number

Hours

Sales: \_\_\_\_\_

Parts: \_\_\_\_\_

Service: \_\_\_\_\_

