



Caterpillar Machine Fluids 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 57

Cooling System Specifications 76

Reference Information Section

Reference Materials 90

Index Section

Index 96

Foreword

Literature Information

This manual should be stored in the operator's compartment in the literature holder or seat back literature storage area.

The information contained in this document is the most current information available for coolant, fuels, and lubricants. Special lubricants are required for some machine compartments. Refer to the Operation and Maintenance Manual for your machine for any special lubrication requirements.

Whenever a question arises regarding the machine, 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 machine 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 warning signs used on the machine.

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

Maintenance

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

Maintenance Interval Schedule

Use the Maintenance Interval Schedule in the Operation and Maintenance Manual for your machine to determine servicing intervals. Calendar intervals shown (daily, weekly, monthly, etc.) can be used instead of service hour meter intervals if they provide more convenient servicing schedules and approximate the indicated service hour meter reading. Recommended service should always be performed at the interval that occurs first.

Under extremely severe, dusty or wet operating conditions, more frequent lubrication than is specified in the Maintenance Interval Schedule might 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

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Lubricant Information

SMCS Code: 1000; 1300; 7581

General Information

NOTICE

Every attempt is made to provide accurate, up to date information. By use of this document you agree that Caterpillar Inc. is not responsible for errors or omissions.

The information that is provided are the latest recommendations for Caterpillar engines and for Caterpillar machine compartments. This information supersedes all previous recommendations which have been published for the Caterpillar machines that are covered by this publication. Special lubricants are required for some machine compartments and it will be necessary to continue to use these special products. Refer to the applicable Operation and Maintenance Manual.

This publication is a supplement to the Operation and Maintenance Manual. This Special Publication does not replace the machine specific Operation and Maintenance Manuals.

NOTICE

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

Note: Instructions for the installation of the filter are printed on the side of each Caterpillar spin-on filter. For non-Caterpillar filters, refer to the installation instructions that are provided by the supplier of the filter.

NOTICE

In order to meet expected fuel system component life, 4 micron(c) absolute or less secondary fuel filtration is required for all Caterpillar diesel engines that are equipped with common-rail fuel systems, and for all Caterpillar diesel engines that are equipped with unit injected fuel systems. For all other Caterpillar diesel engines (mostly older engines with pump, line and nozzle type fuel systems), the use of 4 micron(c) absolute or less secondary fuel filtration is strongly recommended. Note that all current Caterpillar diesel engines are factory equipped with Caterpillar Advanced Efficiency 4 micron(c) absolute fuel filters.

In order to obtain additional information on Caterpillar designed and produced filtration products, refer to the "Reference Material" article, "Filters" and "Miscellaneous" topics in this Special Publication, and then contact your Caterpillar dealer for assistance with filtration recommendations for your Caterpillar machine.

NOTICE

Faulty engine coolant temperature regulators, or operating with light loads, short operation cycles, excessive idling, or operating in applications where normal operating temperature is seldom reached can contribute to excessive water in the crankcase oil. Corrosive damage, piston deposits and increased oil consumption can result. If a complete oil analysis program is not followed or if the results are ignored, the potential for corrosive damage and piston deposits increases.

NOTICE

Not following the recommendations found in this Special Publication can lead to reduced performance and compartment failure.

NOTICE

The Cat CD/TO-2 transmission/drive train oil specification has been obsolete since 1990. The obsolete CD/TO-2 specification is tied ONLY to the also obsolete API CD oil category. The "TO-2" oil specification existed only as CD/TO-2. Specification claims of CF/TO-2, ATF/TO-2, Cat TO-2 and other similar "TO-2" claims are not accurate. Caterpillar does not monitor or support the obsolete Cat CD/TO-2 specification. Use of CD/TO-2 oils, or the use of oils claiming to meet "TO-2" in machine compartments where Cat TO-4 specification oils are required is NOT recommended and their use is at the user's risk.

Caterpillar Fluids

Caterpillar fluids have been approved by Caterpillar in order to increase the performance of Caterpillar components and the life of Caterpillar components. Caterpillar fluids that are currently used for engines and for machines are offered by Caterpillar dealers. Caterpillar fluids are also offered for service refills. Consult your Caterpillar dealer for more information on these Caterpillar fluids.

Caterpillar recommends the use of the following Caterpillar fluids:

- Cat DEO (Multigrade Diesel Engine Oil)
- Cat DEO-ULS (Multigrade Diesel Engine Oil - Ultra Low Sulfur)
- Cat DEO SYN (Synthetic Diesel Engine Oil SAE 5W-40)
- Cat Arctic DEO SYN (Synthetic Diesel Engine Oil SAE 0W-30)
- Cat TDTO (Transmission/Drive Train Oil)
- Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend)
- Cat Arctic TDTO (Transmission/Drive Train Oil) (synthetic blend SAE 0W-20)
- Cat FDAO (Final Drive and Axle Oil)
- Cat MTO (Multipurpose Tractor Oil)
- Cat HYDO (Hydraulic Oil)
- Cat HYDO Advanced 10 (Hydraulic Oil)
- Cat GO (Gear Oil)
- Cat SYNTHETIC GO (SAE 75W-140 Gear Oil)
- Cat Multipurpose Grease
- Cat Advanced 3Moly Grease
- Cat Ultra 5Moly Grease
- Cat Desert Gold Grease
- Cat Arctic Platinum Grease
- Cat High Speed Ball Bearing Grease
- Cat White Assembly Grease
- Cat ELC (Extended Life Coolant)

- Cat DEAC (Diesel Engine Antifreeze/Coolant)

Note: Caterpillar fluids availability will vary by region.

Note: Additional Caterpillar fluids may be available.

This information is only for Caterpillar machines. For more lubricant recommendations, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations", Special Publication, SEBU6385, "Caterpillar On-Highway Diesel Engine Fluids Recommendations", Special Publication, SEBU6400, "Caterpillar Gas Engine Lubricant, Fuel, and Coolant Recommendations", and Special Publication, SEBU7003, "Caterpillar 3600 Series and C280 Series Diesel Engine Fluids Recommendations". Always check with your Caterpillar dealer in order to ensure that you have the current revision level of the publication.

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Engine Oil

SMCS Code: 1348; 7581

Applications

Caterpillar machine diesel engines.

Cat DEO (Diesel Engine Oil)

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

Due to the additional full-scale proprietary engine testing required of Cat DEO and Cat DEO-ULS, and due to significant variations in the quality and in the performance of commercially available oils, Caterpillar makes the following recommendations:

- **Cat DEO (Diesel Engine Oil) (10W-30)**
- **Cat DEO (Diesel Engine Oil) (15W-40)**
- **Cat DEO-ULS (Diesel Engine Oil - Ultra Low Sulfur) (15W-40)** (SAE 10W-30 is only available in bulk quantities)

Cat DEO-ULS and Cat DEO multigrade oils are the preferred oils for use in **ALL** Cat diesel engines that are covered by this Special Publication. Commercial alternative diesel engine oils are, as a group, second choice oils.

Cat DEO multigrade and Cat DEO-ULS multigrade oils are formulated with the correct amounts of detergents, dispersants, and alkalinity in order to provide superior performance in Cat diesel engines where recommended for use.

Cat DEO multigrade oils are available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. Cat DEO-ULS is currently only available in SAE 15W-40 viscosity grade at the retail (consumer) level. Cat DEO-ULS is available in bulk quantities in both the SAE 10W-30 and SAE 15W-40 viscosity grade. 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.

Cat DEO multigrade and Cat DEO-ULS multigrade oils can be used in other manufacturer's diesel engines and in gasoline engines. See the engine manufacturer's literature for the recommended categories/specifications. Compare the categories/specifications to the specifications of Cat DEO multigrade and Cat DEO-ULS multigrade oils. The current industry standards for Cat DEO multigrade and Cat DEO-ULS multigrade oils are listed on the product labels and on the datasheets for the product.

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

Note: Cat DEO multigrade exceeds the requirements of the following Cat Engine Crankcase Fluid (ECF) specifications: Cat ECF-1-a and Cat ECF-2. Cat DEO multigrade exceeds the performance requirements for the following American Petroleum Institute (API) oil categories: API CI-4, API CI-4 PLUS, API CH-4, API CG-4, and API CF. The availability of Cat DEO multigrade exceeding the noted requirements will vary by region. Cat DEO SAE 15W-40 also passes additional proprietary tests that include the following tests: sticking of the piston ring, piston deposits, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Cat multigrade oil provides superior performance in Cat diesel engines. In addition, Cat 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 by using a combination of the following factors: industry standard tests, proprietary tests, field tests, and often, 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: Cat DEO-ULS multigrade exceeds the requirements of the Cat ECF-1-a, Cat ECF-2, and Cat ECF-3 specifications. Cat DEO-ULS multigrade exceeds the performance requirements for the following API oil categories: API CJ-4, API CI-4, API CI-4 PLUS, API CH-4, API CG-4, and API CF. Cat DEO-ULS multigrade also passes additional proprietary tests that include the following tests: sticking of the piston ring, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Cat multigrade oil provides superior performance in Cat diesel engines. In addition, Cat 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 by using a combination of the following factors: industry standard tests, proprietary tests, field tests, and often, 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.**

Commercial Oils

Engine Crankcase Fluid Recommendations for all Current and Noncurrent Caterpillar Diesel Engines that are Covered by This Special Publication

Note: Non-Caterpillar commercial oils are as a group second choice oils. Within this grouping of second choice oils there are tiered levels of performance.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

Caterpillar developed the Engine Crankcase Fluid (ECF) specifications to ensure the availability of high performance commercial diesel engine oils in order to provide satisfactory life and performance in Cat diesel engines where recommended for use.

There are three current Cat ECF specifications: Cat ECF-1-a, Cat ECF-2, and Cat ECF-3. Each higher Cat ECF specification provides increased performance over lower Cat ECF specifications. For example, Cat ECF-3 provides higher performance than Cat ECF-2 and Cat ECF-3 provides much higher performance than Cat ECF-1-a.

Note: The Cat ECF-1-a and Cat ECF-2 specifications replaced the Cat ECF-1 specification as of 1 March 2007.

Note: Cat DEO and DEO-ULS are required to pass additional proprietary full-scale diesel engine testing that is above and beyond the testing required by the various Cat ECF specifications and by the various API oil categories that they also meet. This additional proprietary testing helps ensure that Cat multigrade diesel engine oils, when used as recommended, provide superior performance in Cat diesel engines. If Cat DEO multigrade or DEO-ULS multigrade oils are not used, as a second choice, use only commercial oils that meet the following specifications:

- When the recommended and preferred Cat diesel engine oils are not used, commercial oils that meet the requirements of the Cat ECF-1-a, Cat ECF-2, and/or the Cat ECF-3 specification are acceptable for use in Cat diesel engines that are covered by this Special Publication. API category oils that have not met the requirements of at least one Cat ECF specification may cause reduced engine life.
- When the recommended and preferred Cat diesel engine oils are not used, commercial oils that meet the requirements of the Cat ECF-3 specification are acceptable for use in Cat diesel engines that are covered by this Special Publication. **After** Cat DEO-ULS and Cat DEO, commercial oils that meet the Cat ECF-3 specification are preferred oils - when compared to commercial diesel engine oils that do not meet the Cat ECF-3 specification - for use in Cat diesel engines that are covered by this Special Publication.

API category oils that have not met the requirements of at least one Cat ECF specification may cause reduced engine life. Oils that meet the API CJ-4 oil category requirements are Cat ECF-3 specification compliant.

For diesel engines that are equipped with a Diesel Particulate Filter (DPF), the Cat ECF-3 specification and the API CJ-4 oil category limit sulfated ash to 1.0% or less, which helps maintain the expected DPF performance. Use of oil that does not meet the Cat ECF-3 specification and the API CJ-4 oil category may require more frequent DPF cleaning cycles and may contribute to DPF plugging. It is strongly recommended that DPF equipped engines use oil that meets the Cat ECF-3 specification and the API CJ-4 oil category.

NOTICE

API category oils that have not met the requirements of at least one Cat ECF specification may cause reduced engine life.

NOTICE

In selecting oil for any engine application, both the oil viscosity and oil performance category/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 diesel engine oil viscosity grade choice, refer to the applicable "Lubricant Viscosities for Ambient Temperatures" table in this Special Publication.

NOTICE

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

NOTICE

Do not use single grade API CF oils or multigrade API CF oils in Caterpillar 3500 Series, C175 Series and smaller Direct Injection (DI) diesel engines.

API CF oils may only be used in Caterpillar 3600 Series and C280 Series diesel engines, and older Caterpillar engines that have precombustion chamber (PC) fuel systems. Oils that are used in Caterpillar 3600 Series and C280 Series diesel engines must also pass a 7000 field performance evaluation. Contact your Caterpillar dealer for details.

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

For direct injection engines that use distillate fuel, the minimum new oil TBN must be 10 times the fuel sulfur level. The TBN is determined by the "ASTM D2896" procedure.

Note: The minimum TBN of the new oil is 7 regardless of the fuel sulfur level. **Reaching one half of new oil TBN is one of the condemning factors for diesel engine oil.** For example, new oil with a TBN of 10 should be changed when, during use, the TBN deteriorates to 5.

Note: TBN is also commonly referred to as Base Number (BN).

Use the following guidelines for fuel sulfur levels that exceed 1.0 percent (10,000 ppm):

1. Choose a multigrade oil with the highest TBN that meets one of these specifications: Cat ECF-1-a, Cat ECF-2, or Cat ECF-3.

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. Cat S·O·S Services oil analysis is required.

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

Caterpillar strongly recommends that Cat S·O·S Services oil analysis be used to determine oil change intervals when fuel sulfur levels are above 0.5 percent (5,000 ppm).

NOTICE

Operating Direct Injection (DI) diesel engines on fuel with sulfur levels over 1.0 percent (10,000 ppm) may require significantly shortened oil change intervals in order to help maintain adequate wear protection.

Note: For PC (Precombustion Chamber) diesel engines, which are found mainly in 1990 and older machines, the minimum new oil TBN must be 20 times the fuel sulfur level. The diesel engine oil types, specifications, and viscosity grades recommendations provided for DI diesel engines in this Special Publication are also applicable to PC diesel engines. For additional fluids information related to PC diesel engines, refer to the most current revision level of Caterpillar Commercial Diesel Engine Fluids Recommendations, SEBU6251.

NOTICE

Operating PC diesel engine on fuel sulfur levels over 0.5 percent (5,000 ppm) may require shortened oil change intervals to maintain adequate wear protection.

Lubricant Viscosity Recommendations for Cat Machine 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 1 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 1 (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 generally preferred over SAE 0W-30.

Note: SAE 10W-30 is the preferred viscosity grade for the following diesel engines when the ambient temperature is above -18 °C (0 °F), and below 40 °C (104 °F).

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

Table 1

Lubricant Viscosities for Ambient Temperatures for Cat Machine Diesel Engines ⁽¹⁾⁽²⁾⁽³⁾		
Viscosity Grade	Ambient Temperature	
	Minimum	Maximum
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 ⁽³⁾	-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)

(1) Refer to this Special Publication, "Engine Oil" article for recommendations of diesel engine oil type.
 (2) Supplemental heat is recommended for cold-soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold-soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold-soaked starts occur when the engine has not been operated for a period of time, allowing the oil to become more viscous due to cooler ambient temperatures.
 (3) SAE10W-30 is the preferred viscosity grade for the 3116, 3126, C7, C-9 and C9 diesel engines when the ambient temperature is between -18 °C (0 °F) and 40 °C (104 °F).

Note: Supplemental heat is recommended for cold-soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold-soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold-soaked starts occur when the engine has not been operated for a period of time, allowing the oil to become more viscous due to cooler ambient temperatures.

Refer to this Special Publication, "Cold Weather Lubricants" and "Lubricant Viscosities" articles for additional information.

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Hydraulic Oil

SMCS Code: 5095; 7581

Applications

- Hydraulic Systems
- Hydrostatic Transmissions

Cat HYDO (Hydraulic Oil)

Cat HYDO (Hydraulic Oil) is formulated with a balanced additive system that includes detergents, rust inhibitors, antiwear agents, and defoamers.

Cat HYDO Advanced 10 (Hydraulic Oil)

Cat HYDO Advanced 10 (SAE 10W) is designed to provide extended oil drain intervals and to provide extra protection to Cat hydraulic system components.

Cat HYDO Advanced 10 is a combination of premium additives and premium base stock that pass severe qualification testing requirements in order to provide superior protection for Cat hydraulic systems.

Cat HYDO Advanced 10 has a 50% increase in the standard oil drain interval for machine hydraulic systems (3000 hours versus 2000 hours) over second and third choice oils - without requiring oil analysis. 6000 hour oil drain intervals are possible with Cat HYDO Advanced 10 when using S·O·S Services oil analysis. Contact your Cat dealer for details.

Cat HYDO Advanced 10 offers the following benefits: protection against mechanical wear, rusting, and corrosive wear in hydraulic systems and in hydrostatic transmission systems. Cat HYDO Advanced 10 should be used to achieve maximum life and maximum performance from hydraulic system components and from hydrostatic transmissions. In order to gain the most benefit from the improved performance designed into Cat HYDO Advanced 10, when switching to Cat HYDO Advanced 10, cross contamination with the previous hydraulic oil should be kept to less than 10%. Cat HYDO Advanced 10 is preferred in most hydraulic systems and in most hydrostatic systems when ambient temperature is between -20 °C (-4 °F) and 40 °C (104 °F).

- Cat HYDO Advanced 10

If a different viscosity is required due to ambient temperatures, the following Caterpillar oils can be used:

- Cat DEO Multigrade
- Cat DEO-ULS
- Cat DEO SYN
- Cat Arctic DEO SYN
- Cat TDTO
- Cat Arctic TDTO
- Cat TDTO-TMS
- Cat MTO

Note: Caterpillar oil availability will vary by region.

Commercial Oils

Note: Non-Caterpillar commercial oils that are acceptable for use in most Cat hydraulic and hydrostatic transmission systems are as a group third choice oils. Within this grouping of third choice oils there are tiered levels of performance.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

The minimum viscosity for commercial alternative oils used in most Caterpillar machine hydraulic systems and in most Cat hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) "ASTM D445".

If Caterpillar oils cannot be used, oils meeting the following commercial specifications can be used in most Cat hydraulic systems and in most Cat hydrostatic transmission systems:

- Engine oils that meet the Cat ECF-1-a, Cat ECF-2, or Cat ECF-3 specifications and have a minimum zinc additive of 0.09 percent (900 ppm)
- Biodegradable oils that meet the Cat BF-1 specification
- TO-4 specification oils that have a minimum zinc additive of 0.09 percent (900 ppm)

Note: Industrial hydraulic oils are not recommended for use as service fill in Caterpillar machine hydraulic systems.

Commercial Biodegradable Hydraulic Oil

Commercial oils that meet the Cat BF-1 specification should be used.

Note: Oil meeting the Cat BF-1 specification should only be used in hydraulic systems where specifically recommended.

NOTICE

Do not use commercial oils that meet the BF-1 specification in compartments containing friction material except Hydraulic Excavators. Refer to the machine Operation and Maintenance Manual or contact your local Cat dealer for guidance before using commercial oils that meet the BF-1 specification in Hydraulic Excavators.

Machines with this symbol are filled with biodegradable hydraulic oil. This symbol is located on the hydraulic tank.

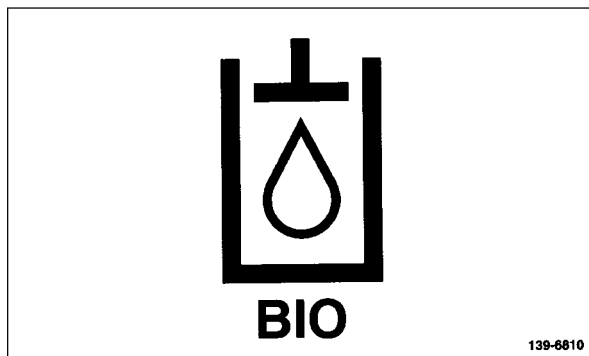


Illustration 1

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Transmission/Drive Train Oil

SMCS Code: 3080; 4000-OC; 4070; 7581

Transmission/drive train oils are classified by the Cat TO-4 and the Cat TO-4M specifications. These specifications were developed by Caterpillar for use in Cat Powershift transmissions and in most Cat final drives.

NOTICE

The Cat CD/TO-2 transmission/drive train oil specification has been obsolete since 1990. The obsolete CD/TO-2 specification is tied ONLY to the also obsolete API CD oil category. The "TO-2" oil specification existed only as CD/TO-2. Specification claims of CF/TO-2, ATF/TO-2, Cat TO-2 and other similar "TO-2" claims are not accurate. Caterpillar does not monitor or support the obsolete Cat CD/TO-2 specification. Use of CD/TO-2 oils, or the use of oils claiming to meet "TO-2" in machine compartments where Cat TO-4 specification oils are required is NOT recommended and their use is at the user's risk.

Applications

The information relates to the following products:

- Powershift Transmissions
- Certain Direct Drive Transmissions
- Series B Telehandler hydraulic systems
- Certain Winches
- Certain Pneumatic Compactor hydrostatic drive/hydraulic systems

This information relates to the final drives for the following products:

- Track-Type Tractors
- Pipelayers
- Skidders
- Loaders
- Track-Type Excavators

This information relates to the differentials, the final drives, or the drive axles for the following products:

- Wheel Tractors
- Loaders

- Skidders
- Wheel Feller Bunchers
- Compactors
- Certain Backhoe Loaders
- Motor Graders
- E Series II Articulated Trucks
- 700 Series Articulated Trucks
- AD 30 Underground Articulated Trucks
- AD 45 Underground Articulated Trucks
- AE 40 Underground Articulated Trucks
- AD 55 Underground Articulated Trucks
- Off-Highway Tractors
- Off-Highway Trucks

This information relates to the final drives, the differentials, and the transfer drives for the following products:

- H Series Compact Wheel Loaders

Cat TDTO (Transmission/Drive Train Oil)

Cat TDTO exceeds the requirements of the Cat TO-4 transmission/drive train oil specification by passing five additional Cat tests.

Cat TDTO is balanced in order to give maximum frictional material life in powershift transmissions. Cat TDTO also helps eliminate brake chatter in wet brake applications in Cat machines. This oil passes the requirements for the TO-4 oil specification which includes the frictional requirements and gear wear requirements. This oil is offered in several lubricant viscosity grades.

NOTICE

This oil is formulated for transmissions and drive trains only, and should not be used in engines. Shortened engine life will result.

NOTICE

Do not use the Cat GO (Gear Oil) or commercial gear oil in the machine compartments unless specifically recommended by Caterpillar. The gear oil can cause seals to fail. The seals can also leak. The gear oil may not be compatible with friction materials. The oil can reduce the efficiency of the transmission and the brake performance.

Commercial Transmission/Drive Train Oils

Note: Non-Caterpillar commercial oils are as a group typically second or third choice oils. Within this grouping of second and/or third choice oils there are typically tiered levels of performance.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

Commercial oils that are substituted for the Cat TDTO must comply with the requirements of the Cat TO-4 or the Cat TO-4M transmission/drive train oil specifications.

Note: Commercial multigrade oils must meet the requirements of the Cat TO-4M specification in order to be used in transmissions. Multigrade oils that use high molecular weight polymers as viscosity index improvers may lose the viscosity effectiveness. This effectiveness may be lost by the temporary shear of the polymer viscosity index improver. Permanent shear of the polymer viscosity index improver may also occur. These types of multigrade oils are not recommended for Caterpillar drive train compartments. The Cat TO-4M specification includes a test for the shear stability of multigrade oil.

Final Drive and Axle Oil

Final Drive and Axle Oils are classified by the Cat FD-1 (Final Drive - 1) oil specification. The Cat FD-1 specification was developed by Caterpillar for use in certain highly loaded Cat final drives and axles that do **not** contain friction material.

Cat FDAO (Final Drive and Axle Oil), Cat FDAO SYN, or commercial FD-1 are the preferred oil types to maximize gear and bearing life in machine compartments where recommended for use.

Applications

This information is for the final drives for the following products:

- Large Track-Type Tractors (Machines with steel tracks that have Elevated Final Drives)
- Pipelayers (Machines with steel tracks that have Elevated Final Drives)
- Track Skidders (Machines with steel tracks that have Elevated Final Drives)

This information is for the Differentials and Final Drives for the following products:

- Off-Highway Tractors
- Off-Highway Trucks
- Front Wheels on Off-Highway Trucks

Cat FDAO (Final Drive and Axle Oil)

Cat FDAO is blended specifically for applications with high load and high temperature conditions. In these conditions, the protection of gears and bearings is a primary concern. This is the preferred lubricant for Cat final drives and axles that formerly specified Cat TO-4 oils and that do not contain friction materials. This oil should not be used in compartments that contain friction material unless Cat FDAO or oil meeting Cat FD-1 (Final Drive oil specification - 1) has been specified because these oils do not develop a sufficient friction coefficient in order to satisfy the requirements of most clutches and brakes.

The performance of the Cat FDAO equalled or exceeded the performance of Cat TDTO in 18 of 18 tests for the following characteristics.

- Gear and bearing protection
- Physical properties and chemical properties

Cat FDAO also has the following qualities:

- Compatible with the Cat TDTO oils and the seals for the related compartments
- Excellent protection against rust
- Excellent protection against copper corrosion
- Minimizes foaming
- Extended life of the oil due to low rate of oxidation
- Reduced downtime due to extended oil change intervals

Cat FDAO SYN

Cat FDAO SYN is a full synthetic, natural multigrade (non-viscosity improved) final drive and axle oil that is designed for operation in a wide temperature range. Cat FDAO SYN exceeds the Cat FD-1 specification requirements.

Cat FDAO SYN is the preferred lubricant for Cat Off-Highway Truck differentials, front wheels, and final drives that operate under high load factors and/or that are operated continuously (multiple shifts per day).

Commercial Final Drive and Axle Oil

Commercial oils that are substituted for Cat FDAO must comply with the Cat FD-1 final drive oil specification.

Note: Non-Caterpillar commercial oils that meet the Cat FD-1 specification are second choice oils.

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Gear Oil

SMCS Code: 7000; 7551; 7581

NOTICE

Do not use the Cat GO (Gear Oil) or commercial gear oil in the machine compartments unless specifically recommended by Caterpillar. The gear oil can cause seals to fail. The seals can also leak. The gear oil may not be compatible with friction materials. The oil can reduce the efficiency of the transmission and the brake performance.

Applications

- Direct Drive Transmissions for Pavement Profilers
- Differentials, Final Drives, and/or Axles for: Wheel Tractor-Scrapers, certain Wheel Excavators, certain Wheel Material Handlers, Mini Hydraulic Excavators, certain Backhoe Loaders, Pavement Profilers, and Articulated Trucks (**except for** the E Series II Articulated Trucks, 700 Series Articulated Trucks, and AD30, AD45, AE40, and AD55 Underground Articulated Trucks)
- Motor Grader Circle Drives
- Wheel Tractor-Scraper Auger Lower Bearings and Auger and Elevator Speed Reducers
- Certain Vibratory Compactor Drum Bearings

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- Axle - Differential and Planetaries for: Vibratory Soil Compactor models CP-323, CP-323C, CS-323, and CS-323C.
- Final Drives, Differentials, and Transfer Drives for: 902, 904B, 906, and 908 Compact Wheel Loaders

Cat GO (Gear Oil)

Cat GO offers maximum protection against the following damage: scoring of the gear teeth, pitting of the gear teeth, and pitting of the parts in roller bearings. Cat GO provides excellent stability under high temperature conditions. Cat GO also has superior low temperature performance. This oil also gives protection against rust and corrosion. Some applications require additives for the extreme pressures that can occur at the surfaces/edges of the components. For these applications, Cat GO provides the extra protection.

When the use of gear oil is specified, use Cat GO or Cat Synthetic GO in order to maximize the component life.

NOTICE

Cat GO is not the same as Cat TDTO, and does not meet Cat TO-4 or TO-4M oil specifications. Cat GO or commercial gear oils should not be used in compartments that specify Cat TO-4 or TO-4M oil.

NOTICE

Cat GO is not the same as Cat FDAO, and does not meet the Cat FD-1 oil specification. Cat GO or commercial gear oil should not be used in compartments that specify Cat FD-1 oil.

Commercial Gear Oils

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

Gear lubricants are classified by the API service category and by the SAE viscosity grade that is defined in "SAE J306".

If the Cat GO or Cat Synthetic GO cannot be used, select a commercial oil that meets the API GL-5 specification.

Note: Non-Caterpillar commercial API GL-5 gear oils are as a group second choice oils.

Multipurpose Tractor Oil

SMCS Code: 7000; 7581

Application

- Axle for the Series 500 Vibratory Soil Compactor (models with "D" suffix or lower)
- Final Drives and Axles for certain Wheel Excavators and for certain Wheel Material Handlers
- Implement steering, steering control mechanisms, and hydraulic systems of certain Challenger tractors
- Rear Drive Axle of certain Backhoe Loaders

Cat MTO (Multipurpose Tractor Oil)

NOTICE

Cat MTO is not the same as Cat TDTO, and does not meet Cat TO-4 or TO-4M transmission/drive train oil specifications. Cat MTO should not be used in compartments that specify Cat TO-4 or TO-4M oil.

NOTICE

Cat MTO is not the same as Cat FDAO, and does not meet the Cat FD-1 oil specification. Cat MTO should not be used in compartments that specify Cat FD-1 oil.

Commercial Multipurpose Tractor Oils

Note: Non-Caterpillar commercial multipurpose tractor oils are as a group second choice oils.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

If Cat MTO is not available, use an oil that meets the "Ford/New Holland M2C134-D" specification. The oil must also satisfy the requirements of the following commercial machine systems:

- Multipurpose tractor transmission
- Hydraulic drives on agricultural tractors and on industrial tractors
- Final drives on agricultural tractors and on industrial tractors

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Synthetic Basestock Oils

SMCS Code: 1300; 1348; 7581

Synthetic base oils are acceptable for use in Caterpillar engines and in Caterpillar machines **IF these oils meet the performance requirements that are specified by Caterpillar for a particular compartment**. Each compartment has specific lubrication specifications in order to ensure proper lubrication and life of the system.

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 automatically extending the oil drain interval for any machine compartment for any type of oil, whether synthetic or non-synthetic.

Oil drain intervals for Caterpillar diesel engines can only be adjusted after an oil analysis program that contains the following data:

- Oil condition, oil contamination, and wear metal analysis (Caterpillar S-O-S Services Oil Analysis)
- Trend analysis
- Fuel consumption
- Oil consumption

Refer to the “Extended Engine Oil Drains and Warranty” article in the forward of this special publication.

Re-refined Basestock Oils

SMCS Code: 1300; 1348; 7581

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

The process that is used to make re-refined basestock oil should adequately remove all wear metals that are in the used oil and all additives that are in the used oil. Vacuum distillation and the hydrotreating of the used oil are acceptable processes that are used for producing a re-refined base oil.

Note: Filtering is inadequate for the production of high quality re-refined basestock oils from used oil.

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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 machine’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. Caterpillar discourages the use of aftermarket additives in finished oils.

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

- Select the proper Caterpillar oil or select commercial oil that meets the specifications designated by Caterpillar for the compartment.

- See the appropriate “Lubricant Viscosities for Ambient Temperatures” table in this publication in order to find the correct oil viscosity grade for the machine compartment.
- At the specified interval, service the engine or service the other machine compartments. Use appropriate new oil and install an appropriate new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, “Maintenance Interval Schedule”.

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Lubricating Grease

SMCS Code: 0645; 1000; 7000; 7581

NOTICE

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

Note: Non-Caterpillar commercial greases are as a group second choice greases. Within this grouping of second choice greases there are tiered levels of performance.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar greases.

Caterpillar provides various greases that vary in performance from a moderate performance to an extremely high performance. These greases service the entire line of Caterpillar products in the wide variety of climates throughout the world. From this variety of Caterpillar grease products, you can find a Caterpillar grease that will meet or exceed the performance requirements for almost every machine that is produced by any Original Equipment Manufacturer (OEM), and for almost every machine application or equipment application.

Before selecting a grease product, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment. Then, consult with your Caterpillar dealer for a list of greases that have the performance specifications and the available container sizes.

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 that the products which barely meet the minimum performance requirements can be expected to barely produce the minimum parts life. False economy is being used if a grease is purchased with the lowest cost as the only consideration. Instead, use the grease that yields the lowest total operating cost. This cost should be based on an analysis that includes the costs of parts, labor, downtime, and the cost of the amount of grease that is required.

Note: When the grease in a joint is changed from one type of grease to another or a grease from a different supplier is to be used, it is generally recommended to purge all of the old grease from the joint because some greases are not chemically compatible. Consult your supplier in order to determine if the greases are compatible.

If in doubt, Purge!

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

Cat Multipurpose Grease

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

Cat Multipurpose Grease 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 a multipurpose grease and Cat Multipurpose Grease is not available, consult the grease data sheets. Use a substitute that meets or exceeds the performance characteristics of Cat Multipurpose Grease.

Cat White Assembly Grease

Cat Multipurpose Grease is also available in an extra tacky version, known as Cat White Assembly Grease. Cat White Assembly Grease has the same formula and the same performance as regular Cat Multipurpose Grease. One difference between Cat Multipurpose Grease and Cat White Assembly Grease is the white color. In addition, this grease has been made extra tacky in order to hold gaskets, O-rings, and needle bearings better in the assembly of engines, transmissions, and other components.

Cat Advanced 3Moly Grease

Cat Advanced 3Moly Grease is an NLGI grade 2 grease. This grease is made with petroleum base oil and a lithium complex thickener. This grease also has 3% Molybdenum diSulfide (MoS₂ or "Moly"). Cat Advanced 3Moly Grease is formulated for use in applications with low severity to high severity at moderate temperatures. In addition, the molybdenum in Cat Advanced 3Moly Grease 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. Cat Advanced 3Moly Grease is recommended for heavily loaded pin joints, and high impact applications in machines such as track-type tractors, backhoe loaders and skid steer loaders.

Cat Advanced 3Moly Grease 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 a multipurpose grease with molybdenum and Cat Advanced 3Moly Grease is not available, consult the data sheets for the greases. Use a substitute that meets or exceeds the performance characteristics of Cat Advanced 3Moly Grease.

Severe Applications

Caterpillar has greases which are made with a Calcium Sulfonate Complex thickener. This type of grease is necessary for more severe applications. These greases provide more load carrying (galling resistance), lower wear, longer working life, exceptional water washout, and resistance to corrosion.

Hammer Grease

Note: Refer to the Operation and Maintenance Manual for a particular hammer for recommendations that relate to greases for Caterpillar Hammers.

Cat Ultra 5Moly Grease

Cat Ultra 5Moly Greases are available in NLGI grades 0, 1, and 2. Cat Ultra 5Moly Greases are made with special blends of petroleum base oils and a Calcium Sulfonate Complex thickener. These greases also have 5% Molybdenum diSulfide (MoS₂ or "Moly") and added tackifier. Cat Ultra 5Moly Greases are specially formulated in order to protect all of the most heavily loaded joints in any Caterpillar machine against galling, wear, and corrosion. This protection is sustained while work is being done in moderate temperatures and with wet working conditions or dry working conditions.

Cat Ultra 5Moly Greases are formulated with special blends of naphthenic petroleum base oils that have low pour points. This allows the Cat Ultra 5Moly Greases to pump at lower temperatures. The ability to pump Cat Ultra 5Moly 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.

A significant challenge exists in order to get grease to pump into the joints at low temperatures. Once the grease gets to the joint, the grease must have extremely high resistance to galling, wear, fretting, water washout, and corrosion in order to adequately protect highly loaded joints.

Even under severely loaded conditions, the grease should preferably have a very long working life. In order to make greases that meet these greater demands, a Calcium Sulfonate Complex thickener with a properly blended naphthenic oil and/or a synthetic base oil is required. This is the reason that Caterpillar uses these ingredients in Cat Ultra 5Moly Greases.

Cat Ultra 5Moly Greases also have 5% Moly, instead of the 0% to 3% that is 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 Cat Ultra 5Moly Grease 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.

Cat Ultra 5Moly Greases are also made to be extra tacky. In some applications, the film of grease must adhere to the vertical surfaces. An example of this application is swing gears for excavators. Many conventional greases do not have enough of the tacky characteristic in order to allow the grease 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.

Cat Ultra 5Moly 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: If the application calls for Cat Ultra 5Moly Grease and Cat Ultra 5Moly Grease is not available, consult the data sheets for the grease. From these data sheets, use a substitute that meets the performance characteristics of Cat Ultra 5Moly Grease.

Cat Ultra 5Moly Grease is formulated not to contain lead, antimony, barium, zinc, phosphorous, or chlorine additives. Thus, when Cat Ultra 5Moly Greases are compared to many other types of grease, the Cat Ultra 5Moly Greases are more environmentally friendly.

Cat Desert Gold Grease

Cat Desert Gold Grease is formulated in order to protect the most severely loaded joints in Caterpillar machines against galling, wear, and corrosion. This protection is sustained while work is being done at moderate temperatures to very hot temperatures with wet conditions or dry conditions.

Cat Desert Gold Grease is an NLGI grade 2 grease. This grease is made with a synthetic base oil that has a very high viscosity and a Calcium Sulfonate Complex thickener. This grease also has 5% Molybdenum diSulfide (MoS₂ or "Moly") and tackifier.

As the temperature changes, Cat Desert Gold Grease will experience a minimal change in viscosity because the base is a synthetic oil. Because Cat Desert Gold Grease has a synthetic base oil with a high viscosity, Cat Desert Gold Grease maintains a thick lubricant film even at very hot temperatures.

Cat Desert Gold Grease is made with a Calcium Sulfonate Complex thickener. This provides the necessary protection against galling, wear, fretting, water washout, and corrosion. Cat Desert Gold Grease also has a very long life. This grease will resist breakdown even when the application is under extremely heavy loads and with frequent oscillations. This protection is sustained while work is being done at moderate temperatures to very hot temperatures with wet conditions or dry conditions.

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

Cat Desert Gold Grease is made to be extra tacky. In some applications, the film of grease must adhere to the vertical surfaces. An example of this application is swing gears for excavators. Many conventional greases do not have enough of the tackifier to allow the grease to stay in place. In addition, many of these greases do not have the performance, particularly at high ambient temperatures, to adequately protect the gear teeth in these applications.

Cat Desert Gold Grease has the ability to prevent galling and wear at very hot temperatures under extremely severe loads and conditions. In moderate temperatures, Cat Desert Gold Grease can be used in those extremely severe applications if an improvement over Cat Ultra 5Moly Grease is desired.

Cat Desert Gold Grease can be used in applications that require the lubricant to last for very long periods of time because this grease has an extremely high performance and long life.

Cat Desert Gold 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: If the application calls for Cat Desert Gold Grease and Cat Desert Gold Grease is not available, consult the data sheets for the grease. From these data sheets, use a substitute that meets the performance characteristics of Cat Desert Gold Grease. With consideration given to the application, Cat Ultra 5Moly Grease, or Cat Arctic Platinum Grease may perform adequately. However, the use of these greases may require a different schedule for lubrication.

Cat Desert Gold Grease is formulated not to contain lead, antimony, barium, zinc, phosphorous, or chlorine additives. Thus, when Cat Desert Gold Grease is compared to many other types of grease, the Cat Desert Gold Grease is more environmentally friendly.

Cat Arctic Platinum

Cat Arctic Platinum Grease is formulated to protect the most heavily loaded joints in Caterpillar machines against galling, wear, and corrosion. With dependence on the consistency of the grease, this protection is sustained, while work is being done in moderate temperatures and in temperatures that may reach a temperature of -50 °C (-58 °F). In addition, the conditions may be wet or dry. Cat Arctic Platinum Grease is available in NLGI grade 0.

Cat Arctic Platinum Grease is made with a synthetic base oil that has a very low viscosity and a Calcium Sulfonate Complex thickener. The performance is enhanced with 5% Molybdenum diSulfide (MoS₂ or "Moly") and tackifier.

Because the base oil is synthetic, Cat Arctic Platinum Grease has a minimal change in viscosity as the temperatures drop. Because the synthetic base oil has a very low viscosity, the Cat Arctic Platinum Grease that is made with this base oil has a minimal change in viscosity and flows easily as the temperature drops. Cat Arctic Platinum Grease pumps easily at extremely low temperatures. In fact, Cat Arctic Platinum Grease NLGI grade 0 can be pumped through standard automatic lubrication systems that are machine mounted and at temperatures down to -50°C (-58°F). This means that the grease can be pumped through those long unheated lines and into the required joints.

Cat Arctic Platinum Grease is made with Calcium Sulfonate Complex thickener in order to provide the necessary protection against galling, wear, fretting, water washout, and corrosion.

Cat Arctic Platinum Grease performs well for long periods of time. This grease resists breakdown even with extremely heavy loads in applications with frequent oscillations. This grease provides protection that will be sustained in conditions that are wet or dry. Also, this grease will provide protection in moderate temperatures as well as extremely cold temperatures.

Cat Arctic Platinum Grease has 5% of molybdenum instead of 0% or 3% that is found in most of the other greases. This additional molybdenum greatly improves the ability of the grease in order to protect parts from damage in applications with severe impact (slamming). In addition, the molybdenum in Cat Arctic Platinum Grease is a special grade. This molybdenum has a median particle size of 3 microns in order to meet the special requirements of some rolling element bearings.

Cat Arctic Platinum Grease is made to be extra tacky. In some applications, the film of grease must adhere to the vertical surfaces. An example of this application is swing gears for excavators. Many conventional greases do not have enough tackifier to adhere well to the vertical surfaces. This ability is necessary in order to adequately protect the gear teeth in these applications.

Cat Arctic Platinum Grease has the ability to prevent galling and wear at very cold temperatures under extremely severe loads and conditions. In moderate temperatures, Cat Arctic Platinum Grease can be used in the application if the compartment is sealed tightly in order to contain the grease.

Cat Arctic Platinum Grease is sometimes used in applications that require the lubricant to last for very long periods of time. This is due to the fact that this grease has an extremely high performance and this grease also has a long life.

Note: If the application calls for Cat Arctic Platinum Grease and no Cat Arctic Platinum Grease is available, consult the data sheets for the grease. Use a substitute that most closely meets the performance characteristics.

Cat Arctic Platinum Grease is formulated not to contain lead, antimony, barium, zinc, phosphorous, or chlorine additives. Thus, when Cat Arctic Platinum Grease is compared to many other types of grease, the Cat Arctic Platinum Grease is more environmentally friendly.

Cat High Speed Ball Bearing Grease

Cat High Speed Ball Bearing Grease 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 at low loads to moderate loads at high speed. Typical applications for this grease are electric motors, alternators, and constant velocity (CV) joints for automotive products.

Cat High Speed Ball Bearing Grease is formulated not to contain lead, antimony, barium, zinc, phosphorous or chlorine additives. Thus, when Cat High Speed Ball Bearing Grease is compared to many other types of grease, the Cat High Speed Ball Bearing Grease is more environmentally friendly.

Grease Application Chart

Caterpillar Grease Name	NLGI Grade	¹ Low Temp. Pumpability	² Severe Applications	² Severe Applications	² Severe Applications	² Severe Applications with Extremely Heavy Loads	² Severe Applications	³ Extreme Pressure (EP)	⁴ Service Life	⁵ Environmentally Friendly	⁶ Corrosion Protection	⁷ Water Washout Resistance
Recommended Operating Conditions		[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)			
Optimum Temperature Range			-50°C (-58°F) to -18°C (0°F)	-23°C (-10°F) to +29°C (+85°F)	+18°C (+65°F) to +60°C (+140°F)	+18°C (+65°F) to +41°C (+105°F)	+38°C (+100°F) to +232°C (+450°F)					
Desert Gold	2	above +35°F	N/R	Excellent	Excellent	Excellent	Very Good	Excellent	Excellent	Yes	Excellent	Excellent
Ultra 5Moly	2	above +20°F	N/R	Excellent	Excellent	Very Good	Good	Excellent	Excellent	Yes	Excellent	Excellent
Ultra 5Moly	1	above 0°F	Good	Excellent	Good	Good	Fair	Excellent	Excellent	Yes	Excellent	Excellent
Arctic Platinum 0	0	above -45°F	Excellent	Very Good	N/R	N/R	N/R	Excellent	Excellent	Yes	Excellent	Excellent
Advanced 3Moly	2	above 0°F	N/R	Fair	Good	Good	N/R	Very Good	Good	No	Fair	Fair
Multipurpose Grease	2	above -10°F	N/R	N/R	N/R	N/R	N/R	Fair	Good	No	Fair	Fair
High Speed Ball Bearing Grease	2	above 0°F	N/R	N/R	N/R	N/R	N/R	N/R	Very Good	No	Good	Good

¹ Based on USS Mobility and Lincoln Ventmeter Tests. Performance may vary depending on lubrication equipment and length of lines
² Severe Applications are those with: very heavy loads, frequent oscillations, and heavy shock loads.
³ Extreme pressure (EP), refer to 4-Ball Weld point in technical data sheet (ASTM D 2596)
⁴ Service Life, refer to % change after 100,000 strokes in technical data sheet (ASTM D 217)
⁵ Is not formulated to contain: Lead, Antimony, Barium, Zinc, Phosphorus, or Chlorine additives.
⁶ Resistance to Salt water and Salt Spray (ASTM B 117)
⁷ Water Washout Resistance, refer to Roll Stability with Water, % Change (ASTM D 1264)
 N/R = Not Recommended
 Note: For additional performance data on these greases refer to this Special Publication, "Reference Material" article.
 Note: Cat Ultra 5Moly grease is also available in NLGI grade 0 for use in autolube systems that are used in moderate to cold ambient temperatures.

Grease Application Chart
(By Machine)

Vehicle	Application Point	Load Factor	Typical Applications (Load and Speed)	Ambient Temperature Range				NLGI Grade	Recommended Grease Type
				° C		° F			
				Min	Max	Min	Max		
Agricultural Products	Front Axle, Main Drive Shaft Slip Spline, Power Take-Off Drive Shaft	High	Agricultural drawbar work at full throttle, engine lugged to max. power most of the time, little or no idling or travel in reverse.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Asphalt Pavers	Track Takeup Linkage, Takeup Idler Bearings	High	Wide width, deep lift paving.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Backhoe Loaders	Drive Shaft Spline, Kingpin Bearing, Universal Joint, Wheel Bearing	High	Production work with long cycles and/or constant flow implements.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Vibratory Soil and Asphalt Compactors	Articulation Bearing, Control Cables, Drum Bearings, Leveling Blade, Operator Platform, Oscillating Bearings, Oscillating Pins, Steering Cylinder Ends, Steering Pins, Weight Bearings	High	Vibration 80-100%, heavy cohesive soil, 350mm (12") lifts or more.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Wheeled and Track-type Excavators	Axle Bearings, Belt Tensioner, Blade Linkage, Boom and Stick Linkage, Boom Cylinder Bearing, Boom Cylinder Head, Cab Riser, Drive Shaft Support Bearing, Fan Drive Bearing, Steering Linkage, Stick Linkage, Swing Bearings, Swing Drive Gear, Swing Frame	High	Most pipeline applications in hard rocky material. Digging 90-95% of the daily work schedule.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Wheeled and Track-type Excavators	Most utility, urban applications in sandy loam. Digging less than 50% of the daily work schedule. Scrap handling applications.	Low	Most utility, urban applications in sandy loam. Digging less than 50% of the daily work schedule. Scrap handling applications.	-30	40	-22	104	2	Multipurpose Grease
				-30	40	-22	104	2	
				-30	40	-22	104	2	

Grease Application Chart
(By Machine)

Vehicle	Application Point	Load Factor	Typical Application (Load and Speed)	Ambient Temperature Range				NLGI Grade	Recommended Grease Type	
				°C		°F				
				Min	Max	Min	Max			
Forest Products	Articulation Bearings, Bogie Bearings, Drive Shaft Support Bearing, Drive Shaft Universal Joint, Gate Cylinder, Grapple Head Rotator, Swing Drive Bearing, Swing Drive Gear, Winch Drive Shaft Bearing, Winch Drive Shaft Universal Joint, Winch Drum Bearing	High	517- Skidding loads over 4536 kg (10,000 lb) in steep terrain (over 30%) with high skidding resistance. 525B- Skidding loads over 6800 kg (15,000 lb) in steep terrain (over 10%) with high skidding resistance. 527- Skidding loads over 6360 kg (14,000 lb) in steep terrain (over 30%) with high skidding resistance.	-35	40	-31	104	1	Ultra 5Moly Grease	
		Medium	517- Skidding loads up to 4536 kg (10,000 lb) in moderate terrain (8-30%) with medium skidding resistance. 525B- Skidding loads up to 6800 kg (15,000 lb) in moderate terrain (5-10%) with average skidding resistance. 527- Skidding loads up to 6360 kg (14,000 lb) in moderate terrain (8-30%) with medium skidding resistance.	-20	40	-4	104	2	Advanced 3Moly Grease	
	Low	517- Skidding loads less than 4536 kg (10,000 lb) in flat terrain (0-8%) with low skidding resistance. 525B- Skidding loads less than 4500 kg (10,000 lb) in flat terrain (0-5%) with low skidding resistance. 527- Skidding loads less than 6360 kg (14,000 lb) in flat terrain (0-8%) with low skidding resistance.	-30	40	-22	104	2	Multipurpose Grease		
		Fan Drive Bearings		-20	40	-4	104	2	High Speed Ball Bearing Grease	
	Motor Graders	Articulation Bearings, Articulation Pins, Blade Lift Cylinder Socket, Centershift Cylinder Socket, Fan Drive Belt Tightener, Pump Drive Shaft	High	Ditching, fill spreading, spreading base material, ripping, heavy road maintenance, snow plowing.	-35	40	-31	104	1	Ultra 5Moly Grease
			Medium	Average road maintenance, road mix work, scarifying, snow plowing.	-30	50	-22	122	2	Advanced 3Moly Grease
		Low	Finish grading, light maintenance, road travel.	-20	40	-22	104	2	Multipurpose Grease	
		Fan Drive Bearings		-20	40	-4	104	2	High Speed Ball Bearing Grease	
	Off-Highway Trucks and Tractors	Belt Tightener, Drive Shaft Slip Joint, Drive Shaft Spine, Drive Shaft Universal Joint, Fan Drive Pulley, Hoist Control Bellcrank, Hoist Cylinder Bearing, Pump Drive Universal Joint, Front and Rear Axle A-Frame Bearing, Steering Cylinder End, Steering Linkage, Steering Tie Rod and Pin Bearings, Swaybar, Tachometer Drive	High	40-50% load factor.	-35	40	-31	104	1	Ultra 5Moly Grease
			Medium	30-40% load factor.	-30	50	-22	122	2	Advanced 3Moly Grease
Low		20-30% load factor.	-20	40	-4	104	2	Multipurpose Grease		
Autolube System			-35	40	-31	104	1	Ultra 5Moly Grease		
		Fan Drive Bearings		-30	50	-22	122	2	High Speed Ball Bearing Grease	
				-20	40	-4	104	2	High Speed Ball Bearing Grease	

Grease Application Chart
(By Machine)

Vehicle	Application Point	Load Factor	Typical Application (Load and Speed)	Ambient Temperature Range				NLGI Grade	Recommended Grease Type
				° C		° F			
				Min	Max	Min	Max		
Articulated Trucks	Belt Tightener, Drive Shaft Slip Joint, Drive Shaft Spline, Drive Shaft Universal Joint, Fan Drive Pulley, Hoist Control Belcrank, Hoist Cylinder Bearing, Pump Drive Universal Joint, Rear Axle A-Frame Bearing, Steering Cylinder End, Steering Linkage, Steering Tie Rod and Pin Bearings, Tachometer Drive, Tailgate Bearings	High	Long haul time with frequent adverse grades. Continuous use on very poorly maintained haul roads with high rolling resistance.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	Normal load and haul time. Varying load and haul road conditions. Some adverse grades. Some high rolling resistance.	-20	40	-4	104	2	Advanced 3Moly Grease
	Low	Large amount of idling. Short to medium hauls on well maintained level haul roads. Minimum total resistance.	-30	40	-22	104	2	Multipurpose Grease	
		Fan Drive Bearings			-20	40	-4	104	2
Pavement Profilers/Road Reclaimers	Chain Tensioner, Fan Drive Bearings, Propel Transmission Control Cable, Pump Drive Shaft, Rotor Transmission Shift Linkage, Wheel Hub Bearings	High	457 mm (18") soil/305 mm (12") asphalt.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	305 mm (12") soil/150 mm (6") asphalt.	-30	50	-22	122	2	Advanced 3Moly Grease
		Low	150 mm (6") soil/100 mm (4") asphalt.	-20	40	-4	104	2	Multipurpose Grease
Telescopic Handlers	Boom Chain, Boom Cylinder Pin, Boom Extension and Retraction Chain Pulley, Boom Head Section, Boom Pivot Shaft, Compensating Cylinder Bearing, Drive Shaft Spline, Fork Leveling Cylinder Pin, Frame Leveling Cylinder Pin, Stabilizer and Cylinder Bearings	High	Heavy loading, continuous loading with steady cycling.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	Normal load and work conditions.	-30	50	-22	122	2	Advanced 3Moly Grease
		Low	Considerable idling or travel with no load.	-20	40	-4	104	2	Multipurpose Grease
			Equalizer Bar Pin, Recoil Piston, Track Adjustment			-35	40	-31	104
Track Loaders	Equalizer Bar Pin, Recoil Piston, Track Adjustment	High	Continuous excavating and loading from bank. Land clearing.	-30	50	-22	122	2	Advanced 3Moly Grease
		Medium	Bank or stockpile loading with idling periods. Load and carry.	-20	40	-4	104	2	Multipurpose Grease
Track-Type Tractors	Adjust Track, Angle Blade Tilt Brace, Equalizer Bar Pins, Fan Drive Belt Tightener, Lift Cylinder Yoke Bearing, Winch Drum Bearing, Winch Fairlead Rollers	High	Large amounts of idling in any application.	-30	40	-22	104	2	Multipurpose Grease
		Medium	Ditching, fill spreading, spreading base material, ripping, heavy road maintenance, snow plowing.	-35	40	-31	104	1	Ultra 5Moly Grease
		Low	Average road maintenance, road mix work, scarifying, snow plowing.	-30	50	-22	122	2	Advanced 3Moly Grease
			Finish grading, light maintenance, road travel.	-20	40	-4	104	2	Multipurpose Grease
Wheel Dozers and Compactors	Fan Drive Bearings	High	Heavy dozing, compacting heavy material. Heavy landfill work.	-30	40	-22	104	2	High Speed Ball Bearing Grease
		Medium	Production dozing, most pushing, shovel cleanup, normal compaction.	-35	40	-31	104	1	Ultra 5Moly Grease
		Low	Considerable idling or travel with no load.	-30	50	-22	122	2	Advanced 3Moly Grease
			Articulation Bearings, Drive Shaft Spline, Drive Shaft Support Bearing, Drive Shaft Universal Joint, Lift Cylinder Yoke Bearing, Steering Shaft, Tilt Cylinder Bearing			-20	40	-4	104
	Fan Drive Bearings			-30	40	-22	104	2	High Speed Ball Bearing Grease

Grease Application Chart
(By Machine)

Vehicle	Application Point	Load Factor	Typical Applications (Load and Speed)	Ambient Temperature Range				NLGI Grade	Recommended Grease Type
				° C		° F			
				Min	Max	Min	Max		
Wheel Loaders	Articulation Bearings, Axle Oscillation Bearings, Bucket Pivot Bearings, Drive Shaft Spine, Drive Shaft Support Bearing, Drive Shaft Universal Joint, Frame Pivot Bearings, Steering Cylinder Bearings, Steering Shaft, Wheel Brake Camshafts	High	Continuous and aggressive light truck loading, hard bank excavation, and shot rock loading from a face.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	Maximum productivity in aggregate truck loading and hopper charging. Assumes the normal trimming and load and carry associated with the high productivity stockpile load-out and batch plant applications.	-20	40	-4	104	2	Advanced 3Moly Grease
	Low	Light utility, construction, low production aggregate truck loading, and most logging applications where there is considerable idling, empty traveling, and load and carry.	-30	40	-22	104	2	Multipurpose Grease	
	Fan Drive Bearings	High	Continuous and aggressive light truck loading, hard bank excavation, and shot rock loading from a face.	-20	40	-4	104	2	High Speed Ball Bearing Grease
Integrated Toolcarriers	Articulation Bearings, Axle Oscillation Bearings, Bucket Pivot Bearings, Drive Shaft Spine, Drive Shaft Support Bearing, Drive Shaft Universal Joint, Frame Pivot Bearings, Steering Cylinder Bearings, Steering Shaft, Wheel Brake Camshafts	High	Continuous and aggressive light truck loading, hard bank excavation, and shot rock loading from a face.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	Maximum productivity in aggregate truck loading and hopper charging. Assumes the normal trimming and load and carry associated with the high productivity stockpile load-out and batch plant applications.	-20	40	-4	104	2	Advanced 3Moly Grease
	Low	Light utility, construction, low production aggregate truck loading, and most logging applications where there is considerable idling, empty traveling, and load and carry.	-30	40	-22	104	2	Multipurpose Grease	
	Fan Drive Bearings	High	Continuous high total resistance conditions with steady cycling.	-20	40	-4	104	2	High Speed Ball Bearing Grease
Wheel Tractor-Scrapers	Brake Camshaft Bearings, Drive Shaft Spine, Ejector Carrier and Support Rollers, Sprocket Shaft Support Bearings	High	Continuous high total resistance conditions with steady cycling.	-35	40	-31	104	1	Ultra 5Moly Grease
		Medium	Typical road building use.	-20	40	-4	104	2	Advanced 3Moly Grease
	Low	Average use but with considerable idling, favorable grades, low rolling resistance and easy loading material.	-30	40	-22	104	2	Multipurpose Grease	
	Fan Drive Bearings	High	Continuous high total resistance conditions with steady cycling.	-20	40	-4	104	2	High Speed Ball Bearing Grease
Hammers	Hammer Lubrication							2	Hammer Paste
Extreme Temperature Conditions - All Applications Except Hammers		High, Medium, and Low		-50	20	-58	68	0	Arctic Platinum
				-20	60	-4	140	2	Desert Gold

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Specialty Lubricants

SMCS Code: 7000; 7581

Table 2

Special-Purpose Caterpillar Lubricants	
Item	Size
6V - 4876 Lubricant ⁽¹⁾	500 g (17.6 oz)
5P - 3931 Thread Compound ⁽²⁾	150 g (5.3 oz)

⁽¹⁾ Recommended for use on typical components such as head bolt threads and washers.

⁽²⁾ Recommended for mating connectors such as exhaust manifold studs and exhaust manifold nuts.

Table 3

Special Additive Requirement for Axles on Wheel Loaders, IT machines, Wheel Dozers, and Compactors	
Required Volume of 1U-9891 Oil Additive for axles that have Wet Disc, Axle Shaft Speed Brakes ⁽¹⁾	
Machine Model	Number of bottles per axle
All Small (910-930) Wheel Loaders IT28-IT62 machines 938-962 Wheel Loaders	0.5
966F, 970F, 966G, and 972G Wheel Loaders 815 and 816 Compactors 814 Wheel Dozers	1.0
980F, 980G, and 980H Wheel Loaders 824G and 824H Wheel Dozers 825G, 825H, 826G, and 826H Compactors	1.5
988FII, 988G, and 988H Wheel Loaders 834B, 834G, and 834H Wheel Dozers 836, 836G, and 836H Compactors	3
990 Series II Wheel Loaders 844 Wheel Dozers	4
992G Wheel Loaders 854G Wheel Dozers 854K Wheel Dozers	5
993K Wheel Loaders	7

⁽¹⁾ 1U-9891 Oil Additive is not to be used in brake compartments when the service brake is also used as the parking brake unless specifically recommended by Caterpillar. This table and footnote are also applicable to the 9U-7062 and 185-4771 part numbers.

Dry Brake Shoe Applications

SMCS Code: 4250-OC; 7579; 7581

This publication is a supplement to the machine Operation and Maintenance Manuals. This publication does not replace the Operation and Maintenance Manuals that are specific to the machine.

Note: In machine applications where U.S. Department Of Transportation (DOT) specification brake circuit actuation fluids are required, refer to the machine specific Operation and Maintenance Manual for fluid type and usage recommendations.

Note: DOT-3, DOT-4, and DOT-5.1 fluids are glycol-based. DOT-5 fluids are silicone based.

NOTICE

DOT-3, DOT-4, DOT-5.1, or DOT-5 fluids are not compatible with petroleum based products.

Do not mix DOT-3, DOT-4, and DOT-5.1 with DOT-5 fluids.

Do not use DOT-3, DOT-4, DOT-5.1, or DOT-5 brake circuit actuation fluids in compartments that contain friction material or wet brake systems.

Do not use DOT-3, DOT-4, DOT-5.1, or DOT-5 brake circuit actuation fluids in compartments where hydraulic oil or TO-4 fluids are recommended.

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Dry Film Lubricant

SMCS Code: 7581

222-3116 Dry Film Lubricant has the following characteristics: superior lubricity, excellent adhesion to most surfaces, fast dry times, and easy application.

The dry lubricant can be used for the following applications: backhoe extendable stick, blade circles for motor graders, shift mechanisms, masts for lift trucks, slides that require frequent lubrication, locks that have tumblers, and applications that require a press fit. This lubricant is recommended for use on the Compact Wheel Loaders. Use the dry film lubricant for the following applications: all moving door latches, hinges, door locks, lock for the hood, hinges for the hood, and throttle pedal linkage.

Use this lubricant in a well ventilated area.

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Table 4

Contamination Control

SMCS Code: 1280; 1348; 3080; 5095; 7581

Defining Contamination

Contaminants are any substance in the system that is not intended to be in the system. Contamination is the wear particles, water, fibers, dirt, dust, or products of combustion that are suspended in the oil or the fuel. The size of these particles is much smaller than the size of a human hair. A human hair is 80 microns in diameter. The newer machine systems operate at higher pressure. The newer machine systems are designed with closer tolerances. This emphasizes the importance of filter maintenance, as well as clean fuels and clean lubricants.

Measuring Cleanliness

The fluid cleanliness can be measured by taking fluid samples from the machine hydraulic compartments and from drive train compartments and having them analyzed by your Caterpillar dealer. The analysis is similar to monitoring the engine oil with S·O·S Services Oil Analysis. The amount of particulate matter is expressed in ISO (International Organization for Standardization) units. This standard of cleanliness is expressed as two numbers. An example of a standard for cleanliness is ISO16/13. The first number (16) relates to the number of particles that are larger than 6 microns in size. The second number (13) relates to the number of particles that are larger than 14 microns in size. There are 28 code numbers on the ISO Code scale. Each code has a given range of particles per milliliter. The smaller code number designates fewer particles.

Note: Currently, sample pretreatment is the recommended way to **accurately** complete the particle count measurement process. Contact your local Caterpillar dealer S·O·S Services Lab for guidance.

Standards for Machine Systems

Maintain the machine systems as close as possible to the standards for the new machines.

Recommended Maximum Contamination Levels - Through fluid system testing and accepted industry wide contamination targets, a maximum contamination level has been established for various machine systems (see table 4 below). If a system is maintained at or below this target, the system should not see any harmful effects from contamination throughout its engineered life.

Caterpillar Recommended Cleanliness Targets	
Hydraulic Systems (Implement & Steering)	ISO 18/15
Vehicles With Electronic Controlled Transmissions	ISO 18/15
Vehicles With Mechanical Transmissions	ISO 21/17
Fill oils	ISO 16/13
Non-Pressurized, Non-Filtered Compartments. Target To Be Established	

Although older technology machines may not be able to consistently maintain the recommended cleanliness targets of today's advanced models, the same contamination control intervention measures and subsequent service procedures should be used on all Caterpillar products.

Note: Do not use the particle count for the evaluation of the engine's oil. Large amounts of soot are produced within an engine. Evaluate the engine's oil by using S·O·S Services Oil Analysis.

Recommendations or Practices

Some guidelines to use for controlling contaminants are listed in this Special Publication. By maintaining a low contaminant level, a machine's maintenance cost can be controlled. The machine's productive life may also be increased.

Follow the general guidelines for controlling contaminants.

1. Use fuels that meet Caterpillar diesel fuel specifications. Filter all diesel fuel through a 4 or less micron(c) absolute filter when you refuel the machine. Make sure that you use Caterpillar Advanced Efficiency Fuel Filters for all engines that have a high pressure fuel injection system.

NOTICE

In order to meet expected fuel system component life, 4 micron(c) absolute or less secondary fuel filtration is required for all Caterpillar diesel engines that are equipped with common-rail fuel systems, and for all Caterpillar diesel engines that are equipped with unit injected fuel systems. For all other Caterpillar diesel engines (mostly older engines with pump, line and nozzle type fuel systems), the use of 4 micron(c) absolute or less secondary fuel filtration is strongly recommended. Note that all current Caterpillar diesel engines are factory equipped with Caterpillar Advanced Efficiency 4 micron(c) absolute fuel filters.

In order to obtain additional information on Caterpillar designed and produced filtration products, refer to the "Reference Material" article, "Filters" and "Miscellaneous" topics in this Special Publication, and then contact your Caterpillar dealer for assistance with filtration recommendations for your Caterpillar machine.

2. Use only coolants that are recommended by Caterpillar for your machine. Follow the recommended maintenance procedure for the cooling system in the Operation and Maintenance Manual for your machine.
3. When you add oil to a machine, filter the oil through a 5 or less micron(c) absolute filter to ensure that it is clean.
4. Refer to the machine's Operation and Maintenance Manual for the required maintenance for all machine compartments.
5. Perform scheduled S·O·S Services Oil Analysis for contamination in order to maintain the recommended ISO cleanliness level. Refer to the S·O·S Oil Analysis section in this Special Publication. The particle count analysis can be performed by your Caterpillar dealer. Particle count can be conducted during the scheduled S·O·S Services Oil Analysis for the compartment. Extra oil samples are not required for the particle count sampling.
6. Maintain the engine's intake air filters. This will minimize contamination at the engine's air intake system.

Cold Weather Lubricants

SMCS Code: 1300; 1348; 7581

Engine

NOTICE

Recommended compartment warm-up procedure must be followed. Refer to the machine Operation and Maintenance Manual. Also refer to the relevant "Lubricant Viscosities for Ambient Temperatures" tables footnotes in this Special Publication and to the "Warm-up Procedures for Machines that are used in Cold Weather - (Generic)" topic in this Special Publication.

NOTICE

Excessive engine idling time can contribute to excessive water in the crankcase oil, causing corrosion, sludge, and other problems. Excessive engine idling time can also lead to injector fouling, piston and combustion chamber deposits, corrosive damage, and increased oil consumption.

For proper selection of oil type and/or specification, refer to this Special Publication, "Engine Oil" section. Also, refer to the relevant "Lubricant Viscosities for Ambient Temperatures" table in this Special Publication.

For the proper selection of oil viscosity grade, refer to the relevant "Lubricant Viscosities for Ambient Temperatures" table in this Special Publication. Also, refer to this Special Publication, "Lubricant Viscosities" article.

NOTICE

Not following the recommendations found in the "Lubricant Viscosities for Ambient Temperatures" tables and associated footnotes can lead to reduced performance and engine failure.

NOTICE

Do NOT use only the oil viscosities when determining the recommended oil for an engine compartment. The oil type (specification) MUST also be used.

For easier cold weather starting, make sure that all of the components of the engine electrical system are properly maintained. All electrical wiring and connections should be free of the following: fraying, damaged insulation, and corrosion. Batteries should be kept fully charged and warm. The batteries and the battery cables should be properly sized for the application.

A variety of starting aids are available in order to assist with cold engine starts in low temperature conditions. Follow the recommendations that are provided by the manufacturer of the starting aid. Refer to the foreword section of this Special Publication, "Aftermarket Products and Warranty".

For additional information concerning cold weather operation, refer to this Special Publication, "Fuel Specifications" section. Also refer to this Special Publication, "Cooling System Specifications" (Maintenance Section).

Before attempting to start the engine, make sure that the oil in the engine is fluid enough to flow. Check the oil by removing the dipstick. If the oil will drip from the dipstick, then the oil should be fluid enough to allow the engine to start. Do not use oil that has been diluted with kerosene. Kerosene will evaporate in the engine. This will cause the oil to thicken. Kerosene will cause swelling and softening of the silicone seals. Kerosene will dilute the oil's additives. Dilution of the oil's additives will reduce the oil's performance, and reduce the engine protection that the additives provide. If your machine is equipped with a gasoline starting engine (earlier machine), make sure that the oil is fluid enough to flow.

If the viscosity of the oil is changed for colder weather, also change the filter element. If the filter is not changed, the filter element and the filter housing can become a solid mass. After you change the oil, operate the engine in order to circulate the thinner oil.

When you start a cold-soaked engine or when you operate an engine in ambient temperatures that are below -18°C (0°F) use base oils that can flow in low temperatures. These multigrade oils have lubricant viscosity grade of SAE 0W or of SAE 5W. An example of viscosity grade is SAE 5W-40.

When you start a cold-soaked engine or when you operate an engine in ambient temperatures that are below -30°C (-22°F), use a synthetic basestock multigrade oil. The oil should have a lubricant viscosity grade of SAE 0W or SAE 5W. Use an oil with a pour point that is lower than -40°C (-40°F).

Note: Use the highest oil viscosity grade that is allowed for the ambient temperature when you start the engine. If a different oil viscosity grade is specified in the table for "Lubricant Viscosities for Ambient Temperatures", use the viscosity grade that is specified in the table. **In arctic applications, the preferred method of lubrication is to use an engine compartment heater that is properly sized and to use an oil that is a higher viscosity grade.** Refer to the "Lubricant Viscosities" article in this Special Publication for further details.

Note: Cold-soaked starts occur when the engine has not been operated for a period of time, allowing the oil to become more viscous due to cooler ambient temperatures. Supplemental heat is recommended for cold-soaked starts that are below the minimum ambient temperatures listed in the "Lubricant Viscosities for Ambient Temperatures" tables. Supplemental heat may be required for cold-soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors.

NOTICE

Engines that use fluid or pan heaters, or heated enclosures, or are kept running under load, etc. can, and generally should use higher viscosity oil. The "Lubricant Viscosities for Ambient Temperatures" tables (Maintenance Section) "**Minimum**" viscosity for ambient temperature recommendations are for cold-soaked conditions. Use the highest viscosity oil that is allowed for the ambient temperature when you start the engine - **BUT**, under **Continuous Usage (Multiple Shifts/Day)**, and/or when using **fluid or pan heaters**, etc., use a higher viscosity oil, **NOT** the oil with the minimum recommended viscosity for cold-soaked starting conditions. The higher viscosity oil will maintain the highest possible oil film thickness. Refer to the "Lubricant Viscosities for Ambient Temperatures" tables and the table footnotes for exceptions.

Example: The oil viscosity recommended for use in Caterpillar diesel engines for cold-soaked starts at -40°C (-40°F) is multigrade oil of the SAE 0W viscosity grade (SAE 0W-30, etc.). If the diesel engine is run continuously, SAE 15W-40 viscosity grade diesel engine oil can be used - and is generally the preferred oil viscosity in this situation.

NOTICE

If ambient conditions warrant, a higher viscosity oil of the recommended specification for a given compartment may need to be installed in order to provide adequate film thickness.

Non-Engine Machine Compartments

NOTICE

Recommended compartment warm-up procedure must be followed. Refer to the machine Operation and Maintenance Manual. Also refer to the relevant "Lubricant Viscosities for Ambient Temperatures" tables footnotes in this Special Publication and to the "Warm-up Procedures for Machines that are used in Cold Weather - (Generic)" topic in this Special Publication.

For the proper selection of oil type and/or specification, refer to this Special Publication, "Lubricant Specifications" section. Also, refer to the relevant "Lubricant Viscosities for Ambient Temperatures" tables (Oil Type and Specification column) and table footnotes in this Special Publication.

For the proper selection of oil viscosity grade, refer to this Special Publication, "Lubricant Viscosities for Ambient Temperatures" tables. Also, refer to this Special Publication, "Lubricant Viscosities" article.

NOTICE

Not following the recommendations found in the "Lubricant Viscosities for Ambient Temperatures" tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the oil viscosities when determining the recommended oil for an engine compartment. The oil type (specification) MUST also be used.

If the viscosity of the oil is changed for colder weather, also change the filter element. If the filter is not changed, the filter element and the filter housing can become a solid mass. After you change the oil, operate the engine in order to circulate the thinner oil.

Note: Use the highest oil viscosity grade that is allowed for the ambient temperature when you start the machine. If a different oil viscosity grade is specified in the table for "Lubricant Viscosities for Ambient Temperatures", use the viscosity grade that is specified in the table. **In arctic applications, the preferred method of lubrication is to use an engine compartment heaters that are properly sized and to use an oil that is a higher viscosity grade.** Refer to the "Lubricant Viscosities" article in this Special Publication for further details.

Note: Cold-soaked starts occur when the machine has not been operated for a period of time, allowing the oil to become more viscous due to cooler ambient temperatures.

NOTICE

Machines that use fluid or pan heaters, or heated enclosures, or are kept running under load, etc. can, and generally should use higher viscosity oil. The "Lubricant Viscosities for Ambient Temperatures" tables (Maintenance Section) "**Minimum**" viscosity for ambient temperature recommendations are for cold-soaked conditions. Use the highest viscosity oil that is allowed for the ambient temperature when you start the machine - **BUT**, under **Continuous Usage (Multiple Shifts/Day)**, and/or when using **fluid or pan heaters**, etc., use a higher viscosity oil, **NOT** the oil with the minimum recommended viscosity for cold-soaked starting conditions. The higher viscosity oil will maintain the highest possible oil film thickness. Refer to the "Lubricant Viscosities for Ambient Temperatures" tables and the table footnotes for exceptions.

NOTICE

Some machine compartments do not allow the use of SAE 0W, SAE 5W or certain other viscosity grade oils. Refer to the tables for "Lubricant Viscosities for Ambient Temperatures" that are in this Special Publication.

NOTICE

If ambient conditions warrant, a higher viscosity oil of the recommended specification/category for a given compartment may need to be installed in order to provide adequate film thickness.

NOTICE

Recommended compartment warm-up procedure must be followed. Refer to the machine Operation and Maintenance Manual. Also refer to the relevant "Lubricant Viscosities for Ambient Temperatures" tables footnotes in this Special Publication and to the "Warm-up Procedures for Machines that are used in Cold Weather - (Generic)" topic in this Special Publication.

Warm-Up Procedures for Machines that are used in Cold Weather (Generic)

Note: For recommendations that are specific to your machine, refer to the Operation and Maintenance Manual for your machine.

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After the engine is warm, warm up the other systems. Start with the hydraulic system. Run the engine at less than one-third throttle and slowly move the control lever in order to lift the attachment. Initially, lift the control lever for a few centimeters (inches). Lower the attachment slowly. Continue the following sequence: raising, lowering, extending, and retracting. Extend the travel during each cycle. Perform this operation for all hydraulic circuits. Alternate between all of the attachments.

Exercise the transmission and the power train. If you cannot move the control for the transmission, perform the following steps:

- Engage the parking brake or apply the parking brake.
- Run the engine slightly above LOW IDLE.
- Shift the transmission several times from FIRST GEAR FORWARD to FIRST REVERSE.

Release the brake. Move the equipment forward and backward for several meters (yards). Exercise the machine for several minutes.

In order to reduce the total warm up time, start exercising the entire machine before you complete the hydraulic warm up time.

Operate under a light load until the systems reach normal operating temperatures.

If the engine temperature is not high enough, enclose the engine and block the radiator. A thermostat that opens at a higher temperature will not increase the engine temperature if the engine is not under load.

In order to prevent seal damage and gasket damage, keep the pipe for the engine crankcase breather clear of blockage.

In extreme conditions, use a canvas over the engine compartment. Heat the engine area with a space heater. This will aid in starting the engine. Extending the canvas over the hydraulic components will provide initial warming of the components. **Follow all applicable safety guidelines.**

Running the engine at low idle will not keep the hydraulic systems warm.

Cold weather operations require more time for completion than other operations. The extra time that is spent in properly caring for the equipment can prolong the life of the equipment. This is especially true in extreme conditions. Longer equipment life will decrease overall cost.

Lubricant Viscosities

SMCS Code: 1000; 7000; 7581

Selecting the Viscosity

Ambient temperature is the temperature of the air in the immediate vicinity of the machine. This may differ due to the machine application from the generic ambient temperature for a geographic region. When selecting the proper oil viscosity for use, review **both** the regional ambient temperature and the potential ambient temperature for a given machine application. Generally, use the higher temperature as the criterion for the selection of the oil viscosity. Generally, use the highest oil viscosity that is allowed for the ambient temperature when you start the machine. Refer to the "Lubricant Viscosities for Ambient Temperatures" tables and the associated footnotes for guidance. In arctic applications, the preferred method is to use properly sized machine compartment heaters and a higher viscosity grade oil. Thermostatically controlled heaters that circulate the oil are preferred.

The proper oil viscosity grade is determined by the minimum ambient temperature (the air in the immediate vicinity of the machine). This is the temperature when the machine is started and while the machine is operated. In order to determine the proper oil viscosity grade, refer to the "Min" column in the table. This information reflects the coldest ambient temperature condition for starting a cold machine and for operating a cold machine. Refer to the "Max" column in the table in order to select the oil viscosity grade for operating the machine at the highest temperature that is anticipated. Unless specified otherwise in the "Lubricant Viscosities for Ambient Temperatures" tables, use the highest oil viscosity that is allowed for the ambient temperature when you start the machine.

Machines that are operated continuously should use oils that have the higher oil viscosity in the final drives and in the differentials. The oils that have the higher oil viscosity will maintain the highest possible oil film thickness. Refer to this Special Publication, "Lubricant Viscosities for Ambient Temperatures" tables and associated footnotes for any exceptions. Consult your dealer if additional information is needed.

Note: SAE 0W and SAE 5W oils, where allowed for use in non-hydraulic system compartments, are generally not recommended for use in machines that are operated continuously and/or are heavily loaded. Refer to the “Lubricant Viscosities for Ambient Temperatures” tables and the associated footnotes for guidance. These viscosity grades are also not recommended for use in hydraulic hammers. The oils that have the higher oil viscosity will maintain the highest possible oil film thickness. Consult your Caterpillar dealer if additional information is needed.

Note: Oil viscosity grade selection is also machine compartment specific. Some machine models and/or machine compartments do not allow the use of all available viscosity grades. For guidance on selecting oil viscosity, refer to the “Lubricant Viscosities for Ambient Temperatures” tables and to the associated footnotes.

NOTICE

Proper oil viscosity **AND** oil type/specification are required to maximize machine compartment performance and life. Do **NOT** use only oil viscosity, or only oil type to determine the machine compartment oil selection. Using only the oil viscosity or only the oil type to determine a machine compartment oil selection can lead to reduced performance and compartment failure. Refer to the “Lubricant Viscosities for Ambient Temperatures” tables and to ALL of the associated footnotes.

NOTICE

The footnotes are an integral part of the “Lubricant Viscosities for Ambient Temperatures” tables - read ALL footnotes!

NOTICE

Not following the recommendations found in the “Lubricant Viscosities for Ambient Temperatures” tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

In colder ambient conditions a machine warm-up procedure and/or supplemental machine fluid compartment heat may be required. Machine specific warm-up procedures can typically be found in the Operation and Maintenance Manual for the machine. In addition, generic machine warm-up procedures can be found in this Special Publication, “Procedures for Machines that are Used in Cold Weather - (Generic)” topic. Some of the “Lubricant Viscosities for Ambient Temperatures” tables in this Special Publication include footnotes that address compartment warm-up.

Lubricant Viscosities for Ambient Temperatures

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 5

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Hoist (Ejector), Steering and Brake System and Suspension Hydraulic System for E Series II Articulated Trucks 700 Series Articulated Trucks Hoist, Torque Converter, and Brake System for Off-Highway Trucks ⁽¹⁾	Cat TDTO Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾⁽³⁾	-40	40	-40	104
		SAE 10W ⁽³⁾	-20	50	-4	122
Hoist, Torque Converter, and Brake System for AD45 and AE40 Underground Articulated Trucks ⁽⁴⁾ Hoist, Steering and Brake System for AD30 and AD55 Underground Articulated Trucks ⁽⁴⁾	Cat TDTO Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾	-40	40	-40	104
		SAE 10W	-20	50	-4	122
		SAE 30	-15	50	5	122
Differential, Front Wheels and Final Drives for Off-Highway Trucks	Cat FDAO⁽⁵⁾ Cat FDAO SYN⁽⁵⁾ commercial FD-1⁽⁶⁾	SAE 50 ⁽⁷⁾	⁽⁷⁾	32	⁽⁷⁾	90
		SAE 60 ⁽⁷⁾	⁽⁷⁾	50	⁽⁷⁾	122
		Cat FDAO SYN ⁽⁷⁾	⁽⁷⁾	50	⁽⁷⁾	122
Differentials and Final Drives for E Series II Articulated Trucks 700 Series Articulated Trucks	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽⁸⁾⁽⁹⁾	-40	-10	-40	14
		SAE 50 ⁽¹⁰⁾	-15	40	5	104
		SAE 60 ⁽¹⁰⁾	-10	50	14	122
		Cat TDTO-TMS	-25	22	-13	72
Output Transfer Gear for E Series II Articulated Trucks 700 Series Articulated Trucks	Cat TDTO Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽⁸⁾⁽⁹⁾	-40	-10	-40	14
		SAE 30	-20	50	-4	122
Differentials and Final Drives for AD30, AD45, AD55, and AE40 Underground Articulated Trucks ⁽⁴⁾	Cat TDTO commercial TO-4	SAE 50 ⁽¹¹⁾	-10	32	14	90
		SAE 60 ⁽¹¹⁾	-5	50	23	122
Nondriven Scraper Wheels	Cat TDTO commercial TO-4	SAE 50 ⁽¹⁰⁾	⁽⁹⁾	32	⁽⁹⁾	90
		SAE 60 ⁽¹⁰⁾	⁽⁹⁾	50	⁽⁹⁾	122

(continued)

(Table 5, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Motor Grader Circle Drive, Auger and Elevator Speed Reducers AND Auger Lower Bearings for Wheel Tractor-Scraper, Direct Drive Transmissions for Pavement Profilers, Final Drives for certain Multi Terrain Loaders⁽¹²⁾, Final Drives and Axles for certain Wheel Excavators⁽¹³⁾⁽¹⁴⁾, Final Drives and Axles for certain Wheel Material Handlers⁽¹³⁾⁽¹⁴⁾, Differentials and Final Drives for Wheel Tractor-Scrapers, Mini Hydraulic Excavators, certain Backhoe Loaders⁽¹⁵⁾, Pavement Profilers, Articulated Trucks (except for E Series II Articulated Trucks, 700 Series Articulated Trucks, and AD30, AD45, AE40, and AD55 Underground Articulated Trucks), Axle - Differential and Planetaries for Vibratory Soil Compactor models CP-323, CP-323C, CS-323, and CS-323C, Final Drives, Differentials and Transfer Drives for 902, 904B, 906, and 908 Compact Wheel Loaders⁽¹⁶⁾⁽¹⁷⁾	Cat GO (Gear Oil)⁽¹⁸⁾ Cat SYNTHETIC GO⁽¹⁹⁾ commercial API GL-5 gear oil	SAE 75W-90	-30	40	-22	104
		SAE 75W-140	-30	45	-22	113
		SAE 80W-90	-20	40	-4	104
		SAE 85W-140	-10	50	14	122
		SAE 90	0	40	32	104

- (1) Some Off-Highway Truck torque converters have a common sump with the transmission. Therefore, these torque converters will use the same fluid recommendations as the transmission. The affected Off-Highway Truck models include 769D, 770, 771D, 772, 773D, 773E, 773F, 775D, 775E, 775F, 793C, 793D, 797, and 797B
- (2) First Choice: Cat Arctic TDTO SAE 0W-20. Second Choice: Commercial SAE 0W-20 oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Third Choice: Commercial oils that contain a Cat TO-4 additive package and a lubricant viscosity grade of SAE 0W-20.
- (3) The maximum allowable oil viscosity at 100°C is 6.6 cSt ("ASTM D445").
- (4) Special articulated truck for use in underground mining applications
- (5) Cat FDAO, Cat FDAO SYN(Final Drive and Axle Oil) (exceeds the Cat FD-1 specification requirements)
- (6) Cat TDTO or a commercial TO-4 oil may be used as a third choice in place of the recommended Cat FDAO, Cat FDAO SYN or commercial FD-1 oil.
- (7) Cat FDAO SYN, Cat FDAO SAE 60 or commercial FD-1 SAE 60 is preferred in most applications, particularly continuous operation. If the ambient temperature is below -10°C (14°F), warm up the oil prior to operation. The oil must be maintained to a temperature above -10°C (14°F) during operation. If the ambient temperature is below -10°C (14°F), perform the procedures in the Operation and Maintenance Manual, "Differential Warm-up and Break-in" prior to operation. If the ambient temperature is below -25°C (-13°F) (below -35°C (-31°F) for Cat FDAO SYN), consult your Caterpillar dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (8) First Choice: Cat Arctic TDTO SAE 0W-20. Second Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Third Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.
- (9) Do NOT use when the typical daily maximum ambient temperature is above -10 °C (14 °F).
- (10) Cat TDTO SAE 50 or commercial TO-4 SAE 50 is preferred in most applications, particularly continuous operation. If the ambient temperature is below -15 °C (5 °F), warm up the oil prior to operation. The oil must be maintained to a temperature above -15 °C (5 °F) during operation. If the ambient temperature is below -15 °C (5 °F), perform the procedures in the Operation and Maintenance Manual,

(continued)

(Table 5, contd)

- “Differential Warm-up and Break-in” prior to operation. If the ambient temperature is below $-25\text{ }^{\circ}\text{C}$ ($-13\text{ }^{\circ}\text{F}$), consult your Caterpillar dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (11) If the ambient temperature is below $-15\text{ }^{\circ}\text{C}$ ($5\text{ }^{\circ}\text{F}$), warm up the oil prior to operation. The oil must be maintained to a temperature above $-15\text{ }^{\circ}\text{C}$ ($5\text{ }^{\circ}\text{F}$) during operation. If the ambient temperature is below $-15\text{ }^{\circ}\text{C}$ ($5\text{ }^{\circ}\text{F}$), perform the procedures in the Operation and Maintenance Manual, “Differential Warm-up and Break-in” prior to operation. If the ambient temperature is below $-25\text{ }^{\circ}\text{C}$ ($-13\text{ }^{\circ}\text{F}$), consult your Cat dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (12) Cat Synthetic GO (SAE 75W-140) is the preferred oil for the final drive on Series B2 and Series C Multi Terrain Loaders.
- (13) Certain Wheel Excavators and Wheel Material Handlers require the addition of Caterpillar Limited Slip (LS) additive. Refer to table 15 in this Special Publication and also refer to the machine’s Operation and Maintenance Manual for guidance.
- (14) Refer to table 15 in this Special Publication for guidance on selecting the proper oil type for the final drives and axles for Wheel Excavators and Wheel Material Handlers by machine model number and/or by machine model number and serial number range.
- (15) Refer to table 14 in this Special Publication for the lubricant type recommendations and for the “Lubricant Viscosities for Ambient Temperatures” recommendations for Backhoe Loaders with a fixed rear axle (2 wheel steering). For Backhoe Loaders with All Wheel Steering (AWS) rear axles, refer to the lubricant recommendations in the machine Operation and Maintenance Manual.
- (16) Add 0.5 L (0.53 qt) of 1U-9891 Hydraulic Oil Additive to the front axle differential on all 902, 904B, 906, and 908 Compact Wheel Loaders. Add 0.5 L (0.53 qt) of 1U-9891 Hydraulic Oil Additive to the rear axle differential (**only** where the optional limited slip differential is fitted) on all 902, 904B, 906, and 908 Compact Wheel Loaders.
- (17) The 906H, 907H, and 908H Compact Wheel Loader models require oil that meets the Cat TO-4 specification in the Final Drive, Differential, and Transfer Drive compartments. Refer to table 13 in this Special Publication for the “Lubricant Viscosities for Ambient Temperatures” recommendations.
- (18) Cat GO (Gear Oil) is available in SAE 80W-90 and SAE 85W-140 viscosity grades.
- (19) Cat SYNTHETIC GO is an SAE 75W-140 viscosity grade oil.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at $100\text{ }^{\circ}\text{C}$ ($212\text{ }^{\circ}\text{F}$) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at $100\text{ }^{\circ}\text{C}$ ($212\text{ }^{\circ}\text{F}$) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Table 6

Lubricant Viscosities for Ambient Temperatures							
NOTICE: Cat FDAO (SAE 60) oil is recommended for maximum component life for the final drive assemblies.							
Compartment or System	Application	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
				Min	Max	Min	Max
Final Drives for: Large Track-Type Tractors, Pipelayers, and Track Skidders (Steel Tracked Machines with Elevated Final Drives except the D5M, D6M, D5N, D6N, 561M and 561N)⁽¹⁾	Moderate Usage or Intermittent Operation	Cat FDAO⁽²⁾⁽³⁾ Cat FDAO SYN⁽²⁾⁽³⁾ commercial FD-1⁽²⁾ Cat TDTO Cat TDTO-TMS⁽⁴⁾ commercial TO-4	SAE 60	-7	50	19	122
			SAE 50	-15	32	5	90
			SAE 30	-25	15	-13	59
			Cat TDTO-TMS	-35	15	-31	59
			Cat FDAO SYN	-15	50	5	122
	Severe Usage or Continuous Operation (Multiple Shifts/Day)	Cat FDAO⁽²⁾⁽³⁾ Cat FDAO SYN⁽²⁾⁽³⁾ commercial FD-1⁽²⁾ Cat TDTO Cat TDTO-TMS⁽⁴⁾ commercial TO-4	SAE 60	-25 ⁽⁵⁾	50	-13 ⁽⁵⁾	122
			SAE 50	-33 ⁽⁵⁾	14	-27 ⁽⁵⁾	58
			SAE 30	-40 ⁽⁵⁾	0	-40 ⁽⁵⁾	32
			Cat TDTO-TMS	-40 ⁽⁵⁾	0	-40 ⁽⁵⁾	32
			Cat FDAO SYN	-33 ⁽⁵⁾	50	-27 ⁽⁵⁾	122

⁽¹⁾ Cat TDTO is the first choice for the D5M, D6M, D5N, D6N, 561M and 561N models. Refer to Table 7 in this publication for guidance. Cat FDAO SYN, Cat FDAO, and Cat FD-1 specification oils are also acceptable for these models.

⁽²⁾ Cat FDAO SYN, Cat FDAO, or commercial FD-1 are the preferred oil types to maximize gear and bearing life. Do not use Cat FDAO, Cat FDAO SYN or other Cat FD-1 specification oils in compartments containing clutches and/or brakes. Cat TDTO, Cat TDTO-TMS, or commercial TO-4 oil, commercial TO-4M oil must be used in any compartment containing friction material unless specified otherwise by Caterpillar.

⁽³⁾ Cat FDAO and Cat FDAO SYN (Final Drive and Axle Oil) (exceeds the Cat FD-1 specification requirements)

⁽⁴⁾ Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements).

⁽⁵⁾ WARM-UP Required - Exercise the final drives for several minutes with the engine at partial throttle in order to warm up the oil prior to production operation.

Table 7

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Final Drive (Differential Gearboxes) including Oval Track-Type Tractors, D5M, D6M, D5N, D6N, 561M and 561N, Track-Type Loaders, and for Motor Grader Tandem Drives, Final Drives and Swing Drives for Track-Type Hydraulic Excavators NOTE: This table is for machine final drives, differentials, and drive axles that require the use of oil that meets the Cat TO-4 specification that are not specifically addressed by other tables in this Special Publication.	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽¹⁾	-40	0	-40	32
		SAE 0W-30 ⁽²⁾	-40	10	-40	50
		SAE 5W-30 ⁽²⁾	-30	10	-22	50
		SAE 10W	-30	0	-22	32
		SAE 30	-25	25	-13	77
		SAE 50	-15	50	5	122
		Cat TDTO-TMS ⁽³⁾	-30	25	-22	77

- (1) First Choice: Cat Arctic TDTO synthetic blend SAE 0W-20. Second Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Third Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.
- (2) First Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Second Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.
- (3) Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements).

Engine Crankcase

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 8

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Engine Crankcase for all Machines⁽¹⁾⁽²⁾⁽⁶⁾ and Splitter Box (Pump Drive Gearbox) for Track-Type Loaders and Drive Chain Boxes for Skid Steer Loaders	Cat DEO-ULS Cat DEO Multigrade Cat DEO SYN⁽³⁾ Cat Arctic DEO SYN⁽⁴⁾ Cat ECF-1-a, Cat ECF-2, Cat ECF-3⁽⁵⁾	SAE 0W-20	-40	10	-40	50
		SAE 0W-30	-40	30	-40	86
		SAE 0W-40	-40	40	-40	104
		SAE 5W-30	-30	30	-22	86
		SAE 5W-40	-30	50	-22	122
		SAE 10W-30 ⁽⁶⁾	-18	40	0	104
		SAE 10W-40	-18	50	0	122
		SAE 15W-40	-9.5	50	15	122

- (1) Supplemental heat is recommended for cold-soaked starts below the minimum ambient temperature. Supplemental heat may be required for cold-soaked starts that are above the minimum temperature that is stated, depending on the parasitic load and other factors. Cold-soaked starts occur when the engine has not been operated for a period of time, allowing the oil to become more viscous due to cooler ambient temperatures.
- (2) Cat DEO-ULS or commercial oils meeting Cat ECF-3 specification are strongly recommended for use in diesel engines that are equipped with Diesel Particulate Filters (DPF) and other aftertreatment devices.
- (3) Cat DEO SYN is an SAE 5W-40 viscosity grade oil.
- (4) Cat Arctic DEO SYN is an SAE 0W-30 viscosity grade oil.
- (5) Cat Engine Crankcase Fluid specifications. Commercial alternative diesel engine oils must meet one or more of these Cat ECF specifications.
- (6) SAE 10W-30 is the preferred viscosity grade for the 3116, 3126, C7, C-9 and the C9 diesel engines when the ambient temperature is between -18° C (0° F) and 40° C (104° F).

Powershift Transmissions

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

NOTICE

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NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 9

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Powershift, Manual Transmissions, and Winch Gear Case (including Track-Type Tractors and Pipelayers) Except for: Off-Highway Trucks Articulated Trucks	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽¹⁾	-40	10	-40	50
		SAE 0W-30 ⁽²⁾	-40	20	-40	68
		SAE 5W-30 ⁽²⁾	-30	20	-22	68
		SAE 10W	-20	10	-4	50
		SAE 30 ⁽³⁾	0	35	32	95
		SAE 50 ⁽³⁾⁽⁴⁾	10	50	50	122
		Cat TDTO-TMS ⁽³⁾⁽⁵⁾	-20	43	-4	110
Petroleum Transmissions TH48-E70, TH48-E80, and TH55-E70, Powershift Transmissions in Off-Highway Trucks and Articulated Trucks Except for: 768C, 769C, 771C, 768D, 769D, 771D, and 797 Off-Highway Trucks and Except for 700 Series and D400EII Articulated Trucks	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽¹⁾	-40	10	-40	50
		SAE 0W-30 ⁽²⁾	-40	20	-40	68
		SAE 5W-30 ⁽²⁾	-30	20	-22	68
		SAE 10W	-20	10	-4	50
		SAE 30	0	50	32	122
		Cat TDTO-TMS ⁽⁵⁾	-10	50	14	122
Powershift Transmission in 797 Off-Highway Truck	Cat TDTO commercial TO-4	SAE 30	⁽⁶⁾	50	⁽⁶⁾	122
Petroleum Transmissions TH31-E61 and TH35-E81, Powershift Transmission in 700 Series and D400EII Articulated Trucks And the following Off-Highway Trucks: 768C, 769C, 771C, 768D, 769D, and 771D	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽¹⁾	-40	22	-40	72
		SAE 0W-30 ⁽²⁾	-40	30	-40	86
		SAE 5W-30 ⁽²⁾	-30	30	-22	86
		SAE 10W	-20	22	-4	72
		SAE 30	10	50	50	122
		Cat TDTO-TMS ⁽⁵⁾	10	50	50	122

- (1) First Choice: Cat Arctic TDTO - SAE 0W-20. Second Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Third Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.
- (2) First Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Second Choice: Oils with a TO-4 type additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.
- (3) Except for machines that are equipped with a hydraulic drive winch gear case. Use SAE 30 viscosity grade for 0°C (32°F) to 43°C (110°F) or Cat TDTO-TMS for -20°C (-4°F) to 50°C (122°F).
- (4) Except for machines that are equipped with ICM controlled transmissions. Do not use SAE 50 viscosity grade oil in ICM controlled transmissions.
- (5) Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements).
- (6) SAE 30 viscosity grade Cat TDTO or commercial TO-4 oil is required for all ambient temperatures in the Transmission/Torque Converter compartment of the 797 Off-Highway Truck. The 797 Transmission will not shift beyond first gear until the oil warms to greater than 40 °C (104 °F).

Hydrostatic Transmissions and Hydraulic Systems

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 10

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Hydrostatic Transmission Except for: Pneumatic Compactors PS-150B s/n:3XR00621-Up, PS-200B s/n:5JR00393-Up, PS-360B s/n:9LS00259-Up, PS-150C, and PS360C ⁽¹⁾	Cat HYDO Advanced 10⁽²⁾⁽³⁾ Cat HYDO⁽²⁾⁽³⁾ Cat MTO⁽²⁾⁽³⁾ Cat DEO⁽²⁾⁽³⁾ Cat DEO-ULS⁽²⁾⁽³⁾ Cat TDTO⁽²⁾⁽³⁾ Cat Arctic TDTO⁽²⁾⁽³⁾ Cat TDTO-TMS⁽²⁾⁽³⁾ Cat DEO SYN⁽²⁾⁽³⁾ Cat Arctic DEO SYN⁽²⁾⁽³⁾ Cat ECF-1-a, Cat ECF-2, Cat ECF-3, Cat TO-4, Cat TO-4M, Cat BF-1⁽²⁾⁽³⁾	SAE 0W-20	-40	40	-40	104
		SAE 0W-30	-40	40	-40	104
		SAE 0W-40	-40	40	-40	104
		SAE 5W-30	-30	40	-22	104
		SAE 5W-40	-30	40	-22	104
		SAE 10W	-20	40	-4	104
		SAE 30	10	50	50	122
		SAE 10W-30	-20	40	-4	104
		SAE 15W-40	-15	50	5	122
		Cat MTO	-20	40	-4	104
		Cat TDTO-TMS ⁽⁴⁾	-15	50	5	122
		Hydraulic Systems, Hydraulic Excavator Swing Motor and Travel Motor Systems, Hydraulic Hammers,⁽⁵⁾ Track Feller Bunchers⁽⁶⁾ Off-Highway Truck Steering Systems⁽⁷⁾ Asphalt Compactors⁽⁸⁾ Except for the following machines: certain Asphalt Compactors ⁽⁸⁾ E Series II Articulated Trucks, 700 Series Articulated Trucks, Pneumatic Compactors PS-150B s/n:3XR00621-Up, PS-200B s/n:5JR00393-Up, PS-360B s/n:9LS00259-Up, PS-150C, and PS360C ⁽¹⁾ Series B Telehandlers ⁽⁹⁾ M Series Motor Graders	Cat HYDO Advanced 10⁽²⁾⁽³⁾ Cat HYDO⁽²⁾⁽³⁾ Cat MTO⁽²⁾⁽³⁾ Cat DEO⁽²⁾⁽³⁾ Cat DEO-ULS⁽²⁾⁽³⁾ Cat TDTO⁽²⁾⁽³⁾ Cat Arctic TDTO⁽²⁾⁽³⁾ Cat TDTO-TMS⁽²⁾⁽³⁾ Cat DEO SYN⁽²⁾⁽³⁾ Cat Arctic DEO SYN⁽²⁾⁽³⁾ Cat ECF-1-a, Cat ECF-2, Cat ECF-3, Cat TO-4, Cat TO-4M, Cat BF-1⁽²⁾⁽³⁾	SAE 0W-20	-40	40
SAE 0W-30	-40			40	-40	104
SAE 0W-40	-40			40	-40	104
SAE 5W-30	-30			40	-22	104
SAE 5W-40	-30			40	-22	104
SAE 10W	-20			40	-4	104
SAE 30	10			50	50	122
SAE 10W-30	-20			40	-4	104
SAE 15W-40	-15			50	5	122
Cat MTO	-20			40	-4	104
Cat TDTO-TMS ⁽⁴⁾	-15			50	5	122

(continued)

(Table 10, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Hydraulic Systems M Series Motor Graders ⁽¹⁰⁾	Cat HYDO Advanced 10 ⁽¹¹⁾⁽¹²⁾ Cat HYDO ⁽¹¹⁾⁽¹²⁾	SAE 0W-20	-40	40	-40	104
		SAE 0W-30	-40	40	-40	104
		SAE 10W	0	40	32	104

- (1) PS-150B s/n:3XR00621-Up, PS-200B s/n:5JR00393-Up, PS-360B s/n:9LS00259-Up Pneumatic Compactors hydrostatic drive/hydraulic systems require Cat TDTO-TMS or commercial oil that meets the Cat TO-4M specification requirements. The PS-150C and PS-360C hydrostatic drive/hydraulic systems require Cat TDTO-TMS or commercial oil that meets the Cat TO-4M specification. The oil viscosities for ambient temperature recommendations from this section of the table apply.
- (2) Cat HYDO Advanced 10 is the preferred oil for use in most Caterpillar machine hydraulic and hydrostatic transmission systems when ambient temperature is between -20 °C (-4 °F) and 40 °C (104 °F). Cat HYDO Advanced 10 has an SAE viscosity grade of 10W. **Cat HYDO Advanced 10 has a 50% increase in the standard oil drain interval** for machine hydraulic systems (3000 hours versus 2000 hours) over second and third choice oils - without requiring oil analysis. 6000 hour oil drain intervals are possible when using S-O-S Services oil analysis. Contact your Cat dealer for details. In order to gain the most benefit from the improved performance designed into Cat HYDO Advanced 10, when switching to Cat HYDO Advanced 10, cross contamination with the previous oil should be kept to less than 10%.
- (3) **Second choice** oils are Cat HYDO, Cat MTO, Cat DEO, Cat DEO-ULS, Cat TDTO, Cat Arctic TDTO, Cat TDTO-TMS, Cat DEO SYN, Cat Arctic DEO SYN. **Third choice** oils are commercial oils that meet Cat ECF-1-a, Cat ECF-2, Cat ECF-3, Cat TO-4, or the Cat TO-4M specifications, and that have a minimum zinc additive level of 0.09 percent (900 ppm). Commercial biodegradable hydraulic oil must meet the Cat BF-1 specification. Refer to the machine Operation and Maintenance Manual and/or contact your local Caterpillar dealer before using commercial oils that meet Cat BF-1 in Cat Hydraulic Excavators. The minimum viscosity for commercial alternative oils used in most Cat machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) ("ASTM D445").
- (4) Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements)
- (5) In cases where hammer utilization is above 10%, higher viscosity oil is recommended. Cat TDTO-TMS or SAE 15W-40 viscosity grade diesel engine oil is recommended for high severity applications and/or for high ambient temperature operation. Refer to the Operation and Maintenance Manual for the Hammer for further information. SAE 0W- and SAE 5W- viscosity grade oil is not acceptable for use in Hydraulic Hammers.
- (6) This table section is also applicable to the Track Feller Buncher hydraulic hood tilt system.
- (7) Off-Highway Truck (OHT) Steering Systems only, do not use this table section for other OHT compartments.
- (8) Asphalt Compactors with the split-drum option and with the FGH serial number prefix require the use of CAT MTO or a commercial oil that meets the Ford/New Holland M2C134-D specification. The oil viscosities for ambient temperatures recommendation for CAT MTO from this section of the table apply.
- (9) Series B Telehandlers require Cat TDTO, Cat Arctic TDTO, Cat TDTO-TMS, or commercial oil that meets either the Cat TO-4 or the CAT TO-4M specification. The oil viscosities for ambient temperature recommendations from this section of the table apply.
- (10) Only use the oil viscosity grades that are shown for this system.
- (11) Cat HYDO Advanced 10 is the preferred oil for use in Cat M Series Motor Grader hydraulic systems when ambient temperature is between 0 °C (32 °F) and 40 °C (104 °F). Cat HYDO Advanced 10 has an SAE viscosity grade of 10W. **Cat HYDO Advanced 10 has a 50% increase in the standard oil drain interval** for machine hydraulic systems (3000 hours versus 2000 hours) over second and third choice oils - without requiring oil analysis. 6000 hour oil drain intervals are possible when using S-O-S Services oil analysis. Contact your Cat dealer for details. In order to gain the most benefit from the improved performance designed into Cat HYDO Advanced 10, when switching to Cat HYDO Advanced 10, cross contamination with the previous oil should be kept to less than 10%.
- (12) **Second choice** oils are Cat HYDO (SAE 10W), Cat MTO (SAE 10W-30), Cat Arctic TDTO (SAE 0W-20) and Cat Arctic DEO SYN (SAE 0W-30). **Third choice** oils are commercial oils that have a minimum zinc additive level of 0.09 percent (900 ppm) and that meet Cat ECF-1-a, Cat ECF-2, Cat ECF-3, or the Cat TO-4 specification AND have an SAE viscosity grade of SAE 10W, SAE 0W-20 or SAE 0W-30. Commercial biodegradable hydraulic oil must meet the Cat BF-1 specification AND have an SAE viscosity grade of SAE 10W, SAE 0W-20, or SAE 0W-30. The minimum viscosity for commercial oils used in Cat M Series Motor Grader hydraulic systems is 6.6 cSt at 100 °C (212 °F) ("ASTM D445").

Special Compartments

The information provided in this "Lubricant Viscosities for Ambient Temperatures" article and Tables should be used in conjunction with the information provided in the "Lubricant Specifications" section (Maintenance Section) of this Special Publication.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the "Oil Viscosity Grade" column when determining the recommended oil for a machine compartment. The "Oil Type and Specification" column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 11

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Equalizer Bar End, Pin Joint, Bogie Cartridge Pins, Track Pins, and Motor Grader Circle Drives	Cat GO (Gear Oil) ⁽¹⁾ Cat Synthetic GO ⁽²⁾ commercial API GL-5 gear oil	SAE 75W-90	-30	40	-22	104
		SAE 75W-140	-30	45	-22	113
		SAE 80W-90	-20	40	-4	104
		SAE 85W-140	-10	50	14	122
		SAE 90	0	40	32	104
Track Roller Frame Recoil Spring and Pivot Shaft Bearings	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽³⁾	-40	0	-40	32
		SAE 0W-30 ⁽⁴⁾	-40	10	-40	50
		SAE 5W-20 ⁽⁴⁾	-35	0	-31	32
		SAE 10W	-30	0	-22	32
		SAE 30	-20	25	-4	77
		SAE 40	-10	40	14	104
		SAE 50	0	50	32	122
		Cat TDTO-TMS ⁽⁵⁾	-25	25	-13	77
Track Idlers and Track Rollers, Wheel Tractor-Scrapers Elevator Lower Rollers	Cat DEO Cat DEO SYN Cat ECF-1-a, Cat ECF-2, Cat ECF-3 ⁽⁶⁾ API CF	SAE 30	-20	25	-4	77
		SAE 40	-10	40	14	104
		SAE 5W-40	-35	40	-31	104

(1) Cat GO (Gear Oil) is available in SAE 80W-90 and SAE 85W-140 viscosity grades.

(2) Cat Synthetic GO is an SAE 75W-140 viscosity grade oil.

(3) First Choice: Cat Arctic TDTO - SAE 0W-20. Second Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Third Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.

(4) First Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Second Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.

(5) TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements).

(6) Cat Engine Crankcase Fluid specifications.

Wheel Loader and Certain Other Axles

The information provided in this "Lubricant Viscosities for Ambient Temperatures" article and Tables should be used in conjunction with the information provided in the "Lubricant Specifications" section (Maintenance Section) of this Special Publication.

NOTICE

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NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the "Oil Viscosity Grade" column when determining the recommended oil for a machine compartment. The "Oil Type and Specification" column MUST also be used.

NOTICE

The footnotes are a key part of the "Lubricant Viscosities for Ambient Temperatures" tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) ("ASTM D445").

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) ("ASTM D445").

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 12

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Drive Axles for: Small (910-930) and Medium (938-980) Wheel Loaders and Dozers (814, 824), IT12-IT62 Machines, Medium Compactors (815-826), Wheel Log Skidders (515-545) and Wheel Feller Bunchers (533, 543) Vibratory Soil Compactor model numbers with the "E" or higher suffix ⁽¹⁾	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾	-40	0	-40	32
		SAE 0W-30 ⁽³⁾	-40	10	-40	50
		SAE 5W-30 ⁽³⁾	-35	10	-31	50
		SAE 10W	-25	15	-13	59
		SAE 30	-20	43	-4	110
		SAE 50	10	50	50	122
		Cat TDTO-TMS ⁽⁴⁾	-30	43	-22	110
Drive Axles for: Large Wheel Loaders (988-993) and Dozers (834-854), and Large Compactors (836)	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾	-40	-10	-40	14
		SAE 0W-30 ⁽³⁾	-40	0	-40	32
		SAE 5W-30 ⁽³⁾	-35	0	-31	32
		SAE 10W	-25	0	-13	32
		SAE 30	-20	20	-4	68
		SAE 50	-10	50	14	122
		Cat TDTO-TMS ⁽⁴⁾	-25	22	-13	72
Drive Axles for: 994 Wheel Loader	Cat TDTO Cat TDTO-TMS commercial TO-4	SAE 10W	-25	0	-13	32
		SAE 30	-20	20	-4	68
		SAE 50	-10	43	14	110
		SAE 60	-5	50	23	122
		Cat TDTO-TMS ⁽⁴⁾	-25	22	-13	72
Drive Axles for: Load Haul Dumps (R2900 ⁽⁵⁾ , R1300, R1600, R1700G)	Cat TDTO Cat TDTO-TMS commercial TO-4	SAE 30	-20	20	-4	68
		SAE 50	-10	43	14	110
		SAE 60	-5	50	23	122
		Cat TDTO-TMS ⁽⁴⁾	-25	22	-13	72

(1) "Axle - Differential and Planetaries" For the Series 500 Vibratory Soil Compactor models with a "D" suffix or lower refer to Table 13 in this Special Publication (example: CS-533D). For the CP-323, CP-323C, CS-323, and CS-323C model's axle lubricant recommendations refer to Table 5 in this Special Publication.

(2) First Choice: Cat Arctic TDTO - SAE 0W-20. Second Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Third Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.

(3) First Choice: Oils of full synthetic basestock that do not have viscosity index improvers and do meet the performance requirements of the Cat TO-4 specification for the SAE 30 viscosity grade. Typical lubricant viscosity grades are SAE 0W-20, SAE 0W-30, and SAE 5W-30. Second Choice: Oils that contain a TO-4 additive package and a lubricant viscosity grade of SAE 0W-20, SAE 0W-30, or SAE 5W-30.

(4) TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the Cat TO-4M multigrade specification requirements).

(5) Uses SAE 50 if equipped with axle oil cooling.

Note: Refer to the "Specialty Lubricants" article in this Special Publication for Special Additive Requirements for Axles on Wheel Loaders, IT machines, Wheel Dozers, and Compactors.

Special Applications

The information provided in this “Lubricant Viscosities for Ambient Temperatures” article and Tables should be used in conjunction with the information provided in the “Lubricant Specifications” section (Maintenance Section) of this Special Publication.

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NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the “Oil Viscosity Grade” column when determining the recommended oil for a machine compartment. The “Oil Type and Specification” column MUST also be used.

NOTICE

The footnotes are a key part of the “Lubricant Viscosities for Ambient Temperatures” tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

Table 13

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Final Drives and Axles for certain Wheel Excavators and for certain Wheel Material Handlers ⁽¹⁾ , Axle for the Series 500 Vibratory Soil Compactor - models with the "D" suffix or lower ⁽²⁾	Cat MTO ⁽³⁾		-25	40	-13	104
Vibratory Compactor ⁽⁴⁾ Eccentric Weight Housing, Final Drive Planetary Drum, and Vibratory Support	Cat Synthetic Compactor Oil ⁽⁵⁾	⁽⁶⁾	-40	21	-40	70
		⁽⁵⁾	-20	50	-4	122
Final Drives, Differentials, and Transfer Drives for 906H, 907H, and 908H Compact Wheel Loaders ⁽⁷⁾	Cat TDTO commercial TO-4	SAE 30	-20	43	-4	110
Starting Engine	API SH API SJ API SL API SM	SAE 0W-20	-40	40	-40	104
		SAE 0W-30	-40	40	-40	104
		SAE 5W-20	-30	10	-22	50
		SAE 10W	-20	50	-4	122
Starting Engine Transmission	Cat HYDO Advanced 10 Cat DEO Cat DEO-ULS Cat Arctic DEO SYN Cat TDTO Cat Arctic TDTO Cat MTO Cat ECF-1-a, Cat ECF-2, Cat ECF-3 ⁽⁸⁾ commercial TO-4	SAE 0W-20	-40	10	-40	50
		SAE 0W-30	-40	10	-40	50
		SAE 5W-20	-30	10	-22	50
		SAE 10W	-30	20	-22	68
		SAE 30	-10	25	14	77

(continued)

(Table 13, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Specification	Oil Viscosity Grade	°C		°F	
			Min	Max	Min	Max
Variable Pitch Fan	Cat DEO SYN commercial full synthetic multigrade diesel engine oil meeting Cat ECF-1-a, Cat ECF-2, or Cat ECF-3	SAE 0W-40 ⁽⁹⁾	-40	50	-40	122
		SAE 5W-40 ⁽⁹⁾	-40	50	-40	122
	Cat TDTO commercial TO-4	SAE 30 ⁽¹⁰⁾	-15	25	5	77
		SAE 50 ⁽¹⁰⁾	-10	50	14	122

- (1) Refer to table 15 in this Special Publication for guidance on selecting the proper oil type for the final drives and axles for Wheel Excavators and for Wheel Material Handlers by machine model number and/or by machine model number and serial number range.
- (2) "Axle - Differential and Planetaries" Refer to Table 12 in this Special Publication for axle lubricant recommendations for models with an "E" or higher suffix (example: CS-683E). For the CP-323, CP-323C, CS-323, and CS-323C model's axle lubricant recommendations refer to Table 5 in this Special Publication.
- (3) Use Cat MTO (Multipurpose Tractor Oil) or commercial oil that meets the "Ford/New Holland M2C134-D" specification.
- (4) The CS-323, CS-323C, CP-323, CP-323C, and large soil compactors (non current models) may use the lubricants listed in this section of the table, but do not require the use of full synthetic lubricants. Refer to the Operation and Maintenance Manual that came with your machine for alternative oil selection for the machines that are listed in this footnote.
- (5) 4C-6767 (185-4759) Synthetic Oil is a premium PAO (Polyalphaolefin) synthetic gear and bearing lubricant with no viscosity improvers. This lubricant has an ISO viscosity grade of 220, and a minimum viscosity index of 152. Commercial oil selected for this application should have a full synthetic basestock with no viscosity improvers, an ISO viscosity grade of 220, and a minimum viscosity index of 150.
- (6) Select a commercial full synthetic gear and bearing lubricant with no viscosity improvers and with an ISO 68 viscosity grade. This lubricant should have a minimum viscosity index of 145, and have a minimum pour point of -47 °C (-53 °F).
- (7) Refer to Table 5 in this Special Publication for the lubricant type and for the "Lubricant Viscosities for Ambient Temperatures Recommendations" for the final drives, differentials, and transfer drives for the 902, 904B, 906, and 908 Compact Wheel Loaders.
- (8) Cat Engine Crankcase Fluid specifications. Commercial diesel engine oil must meet one or more of these Cat ECF specifications.
- (9) First Choice Oil: Full synthetic oils are recommended. Synthetic oils may provide longer service life for the fan. Synthetic oils allow for increased service intervals over non-synthetic oils.
- (10) Second Choice Oil: Cat TDTO or commercial oils that meet the Cat TO-4 specification. Cat TDTO is non-synthetic. Commercial TO-4 oils are typically non-synthetic.

Backhoe Loader Rear Axles

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

NOTICE

Not following the recommendations found in these tables and associated footnotes can lead to reduced performance and compartment failure.

NOTICE

Do NOT use only the "Oil Viscosity Grade" column when determining the recommended oil for a machine compartment. The "Oil Type and Specification" column MUST also be used.

NOTICE

The footnotes are a key part of the "Lubricant Viscosities for Ambient Temperatures" tables. Read ALL footnotes that pertain to the machine compartment in question.

Note: Some machine models and/or machine compartments do NOT allow the use of all available oil viscosity grades.

Note: Only use the oil type and the specification that is recommended for the various machine compartments.

Note: Some machine compartments allow the use of more than one oil type. For the best results, do not mix oil types.

Note: Different brand oils may use different additive packages to meet the various machine compartment performance specification recommendations. For the best results, do not mix oil brands.

Note: The availability of the various Caterpillar oils will vary by region.

Note: SAE 10W viscosity grade oil used in most Caterpillar machine compartments must have a minimum viscosity of 5.8 cSt at 100 °C (212 °F) ("ASTM D445").

Note: The minimum acceptable viscosity for commercial alternative oils in most Caterpillar machine hydraulic and hydrostatic transmission systems is 6.6 cSt at 100 °C (212 °F) (“ASTM D445”).

Note: After considering the information found in the associated footnotes, Caterpillar oils are the **preferred** oils. ALL other oil types and specifications that are listed in the applicable section are acceptable oils.

These recommendations are for backhoe loaders with a fixed rear axle (2 wheel steering). For backhoe loaders with All Wheel Steering (AWS) rear axles, refer to the lubricant recommendations in the machine Operation and Maintenance Manual.

There are two types of rear brake disks available for the B, C, and D Series Backhoe Loaders. All of the B and C Series loaders were manufactured with the 133-7234 brake disk. The early production D Series loaders were also manufactured with the 133-7234 brake disk. The later production D Series loaders were manufactured with the 230-4017 brake disk. All of the B, C, and D Series Backhoe Loaders can be upgraded to the 230-4017 brake disk. Consult your Caterpillar dealer for more information on these brake disks.

Cat TDTO or a commercial TO-4 SAE 30 grade oil may be used in all backhoe loaders with a fixed rear axle. All of these backhoe loader rear axles require the 197-0017 oil additive. The correct volume of 197-0017 oil additive is dependent on the brake disk. Use the chart below in order to determine the correct volume of 197-0017.

NOTICE

MTO or a commercial Ford/New Holland M2C134-D specification oil cannot be used in backhoe loader rear axles that contain the 230-4017 brake disk.

NOTICE

MTO or a commercial Ford/New Holland M2C134-D specification oil cannot be used in E series backhoe loader rear axles.

Table 14

Lubricant Viscosities for Ambient Temperatures for Backhoe Loader Rear Axles ⁽¹⁾								
Backhoe Loaders	Brake Disk Part Number	Oil Type and Specification for Rear Axle	197-0017 Additive Volume	Oil Viscosity Grade	°C		°F	
					Min	Max	Min	Max
B, C, D Series	133-7234	Cat MTO or M2C134-D ⁽²⁾⁽⁴⁾	1 L (1.1 qt) ⁽³⁾	SAE 30	-25	40	-13	104
B, C, D Series	133-7234	Cat TDTO 30 or commercial TO-4 30	1 L (1.1 qt) ⁽³⁾					
B, C, D Series	230-4017	Cat TDTO 30 or commercial TO-4 30 ⁽⁴⁾	150 mL (5.1 oz) ⁽⁵⁾					
416E 420E 422E 428E 430E 432E 434E 444E	238-5291	Cat TDTO 30 or commercial TO-4 30 ⁽⁴⁾	500 mL (17.0 oz) ⁽⁶⁾					
450E	288-7303	Cat TDTO 30 or commercial TO-4 30 ⁽⁴⁾	200 mL (6.8 oz) ⁽⁷⁾					

⁽¹⁾ These recommendations are for backhoe loaders with a fixed rear axle (2 wheel steering). For backhoe loaders with All Wheel Steering (AWS) rear axles, refer to the lubricant recommendations in the machine Operation and Maintenance Manual.

⁽²⁾ A commercial fluid that meets Ford/New Holland M2C134-D specification.

⁽³⁾ Additional 197-0017 may be used in order to reduce brake noise. The maximum amount of 197-0017 for this brake is 2 L (2.1 qt).

⁽⁴⁾ Do not use Cat MTO or commercial M2C134-D specification oil with the 230-4017 brake disks. Do not use Cat MTO or commercial M2C134-D specification oil in any E Series Backhoe Loader rear axle.

⁽⁵⁾ Additional 197-0017 may be used in order to reduce brake noise. The maximum amount of 197-0017 for this brake is 300 mL (10.2 oz)

⁽⁶⁾ Additional 197-0017 may be used in order to reduce brake noise. The maximum amount of 197-0017 for this brake is 550 mL (18.7 oz)

⁽⁷⁾ Additional 197-0017 may be used in order to reduce brake noise. The maximum amount of 197-0017 for this brake is 250 mL (8.5 oz)

Wheel Excavators and Wheel Material Handler Final Drives and Axles

Table 15

Final Drives and Axles for Wheel Excavators and Wheel Material Handlers ⁽¹⁾								
A/B Series⁽²⁾								
Model	M312	M315	M318	M318	M320	M318MH	M320MH	Oil Type
Prefix	6TL	7ML	8AL	6ES	6WL	8SS	9PS	Cat GO (Gear Oil)
C-Series								
Model	M313C	M315C	M316C	M318C	M322C	M318C MH	M322C MH	Oil Type
Serial number 1 to 2000⁽²⁾								Cat GO (Gear Oil)
Prefix	BDR	BDM	BDX	BCZ	BDK	BEB	BDY	
Serial number 2001 & up								Cat MTO (Multi-Purpose Tractor Oil)
Prefix	BDR	BDM	BDX	BCZ	BDK	BEB	BDY	
Prefix	H2A	H2B	H2C	H2D	H2E	H2F	H2G	
D-Series								
Model	M313D	M315D	M316D	M318D	M322D	M318D MH	M322D MH	Oil Type
Prefix	W3H	W5M	W6A	W6P	W2S	W8R	W2T	Cat MTO (Multi-Purpose Tractor Oil)
M325 C-Series MH-Machines								
Model	M325CMH		M325CLMH		Oil Type			
Prefix	XJA	STA	PAN	NDA	Cat GO (Gear Oil)			
M325 and M330 D-Series MH-Machines								
Model	M325DMH		M325LDMH			Oil Type		
Prefix	EDF	EDC	KAY	KAE	KGG	Cat GO (Gear Oil)		
Model	M330DMH				Oil Type			
Prefix	MBR	NJK	ZZR	KRE	Cat GO (Gear Oil)			

⁽¹⁾ Refer to this table for basic oil type recommendations by machine model number and/or by machine model number and serial number range. For more detailed guidance concerning alternative oil choices and for "Lubricant Viscosities for Ambient Temperatures" recommendations, refer to table 5 in this Special Publication for those final drives that require gear oil, and refer to table 13 in this Special Publication for those final drives that require multi-purpose tractor oil.

⁽²⁾ Requires the use of limited-slip additive. Refer to your machine Operation and Maintenance Manual.

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S·O·S Services Oil Analysis

SMCS Code: 1000; 1348; 3080; 4070; 4250; 4300;
5095; 7000; 7542; 7581

NOTICE

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

Caterpillar has developed a maintenance management tool that evaluates oil degradation and 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 four categories:

- Component wear rate
- Oil condition
- Oil contamination

• Oil identification

Component wear rate analysis evaluates the wear that is taking place inside the lubricated compartment. The S·O·S analyst uses the results of elemental analysis and particle count tests to evaluate the wear. Trend analysis and proprietary wear tables are then used to determine if wear rates are normal or abnormal.

Oil Condition analysis is used to determine if the oil has degraded. Tests are done to look at the oxidation, sulfation, and viscosity of the oil. The S·O·S analyst uses established guidelines or trend analysis to determine if the oil has reached the end of its useful life.

Oil Contamination tests are performed to determine if anything harmful has entered the oil. This analysis relies on the results from the following tests: elemental analysis, soot, particle count, fuel dilution, water, and glycol. The S·O·S Services program has guidelines for the level of contamination that is allowed in the various compartments of a Cat machine.

Oil Identification is another very important part of the S·O·S Oil Analysis program. The wrong oil in a compartment can severely damage major components. The S·O·S analyst uses elemental analysis and viscosity results to identify key characteristics of the oils.

These four types of analysis are used to monitor the condition of your equipment, and to help you identify potential problems. A properly administered S·O·S Services 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, transmissions, and hydraulic systems. S·O·S Coolant Analysis together with S·O·S Oil Analysis provide a complete and accurate method for monitoring the health of all machine systems. Refer to the S·O·S Coolant Analysis information in this publication. A properly administered S·O·S Services program will reduce repair costs and lessen the impact of downtime.

Table 16

S·O·S Oil Analysis Guidelines	
Test Parameter	Guideline
Oxidation	(1)
Soot	(1)
Sulfation	(1)
Wear Metals	Trend Analysis and Cat Wear Table ⁽¹⁾ norms
Water	0.5% maximum
Glycol	0%
Fuel Dilution	based on viscosity ⁽¹⁾ and GC ⁽²⁾ fuel dilution in excess of 4%
Viscosity - engines: "ASTM D445" measured at 100° C (212° F)	+/-3 centistoke (cSt) change from new oil viscosity.
Viscosity - hydraulics & power train: "ASTM D445" measured at 100° C (212° F)	+/-2 cSt change from new oil viscosity
Particle Count/"ISO Code"	Trend Analysis ⁽³⁾

(1) Acceptable values for these parameters are proprietary to the S·O·S Oil Analysis program.
 (2) Gas Chromatograph
 (3) Refer to the "Contamination Control" article in this Special Publication for recommended fluid cleanliness targets.

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 machine 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 contamination 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.

In-line sampling valves cannot be used on nonpressurized oil systems such as differentials and final drives. Use of the sampling gun is the preferred method for nonpressurized oil systems.

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

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Oil Sampling Interval

SMCS Code: 1000; 3000; 4000; 4050; 4250; 4300; 5050; 7000; 7542

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 17

Compartment	Recommended Sampling Interval ⁽¹⁾⁽²⁾	Sampling Valve	Oil Type ⁽³⁾	Recommended Oil Change Interval
Engine	250 Hours ⁽⁴⁾	Yes	Cat DEO Cat DEO-ULS	⁽⁵⁾
Transmission	500 Hours	Yes	Cat TDTO Cat TDTO-TMS	⁽⁵⁾
Hydraulics	500 Hours	Yes	Cat HYDO Advanced	⁽⁵⁾
Differential and Final Drive	500 Hours	No	Cat TDTO Cat FDAO	⁽⁵⁾

(1) Consult the Operation and Maintenance Manual that came with your machine for the recommended oil sampling intervals for each compartment.

(2) Severe applications may require a more frequent oil sampling interval.

(3) For other acceptable oil types and specifications, refer to the "Lubricant Viscosities for Ambient Temperatures" Tables in this Special Publication.

(4) For best results, engine oil samples should be taken at 250 hour intervals. A 250 hour sampling interval can provide a timely indication of oil contamination and oil degradation. Under certain conditions, the Caterpillar dealer or the Operation and Maintenance Manual may allow a longer interval between oil samplings.

(5) Consult the Operation and Maintenance Manual that came with your machine for the recommended oil change intervals for each compartment.

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

More Frequent S-O-S Sampling Improves Life Cycle Management

Traditionally, S-O-S sampling intervals have been at 250 hours for engines and at 500 hours for all other compartments. However in severe service applications, more frequent oil sampling is recommended. Severe service for lubricated compartments occurs at high loads, in high temperatures, and in dusty conditions. If any of these conditions exist, sample the engine oil at 125 hour intervals and sample the other compartments at 250 hour intervals. These additional samples will increase the chance of detecting a potential failure.

Determining Optimum Oil Change Intervals

In some applications, the engine and hydraulic compartments on Caterpillar machines can be optimized in order to increase fluid life. Optimization programs can be established that evaluate fluid condition based on oil sample results. These optimization programs will require more frequent oil sampling and close monitoring by a trained analyst. For detailed information on optimizing 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

i02884481

General Fuel Information

SMCS Code: 1250; 1280

NOTICE

Every attempt is made to provide accurate, up to date information. By use of this document you agree that Caterpillar Inc. is not responsible for errors or omissions.

The information that is provided are the latest recommendations for the Caterpillar diesel engines that are covered by this Special Publication. This information supersedes all previous recommendations which have been published for the Caterpillar diesel engines that are covered by this Special Publication. Special fluids are required for some engines and it will be necessary to continue to use these special products. Refer to the applicable Operation and Maintenance Manual.

This publication is a supplement to the Operation and Maintenance Manual. This publication does not replace the engine specific Operation and Maintenance Manuals.

NOTICE

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

Note: Instructions for the installation of the filter are printed on the side of each Caterpillar spin-on filter. For non-Caterpillar filters, refer to the installation instructions that are provided by the supplier of the filter.

NOTICE

In order to meet expected fuel system component life, 4 micron(c) absolute or less secondary fuel filtration is required for all Caterpillar diesel engines that are equipped with common-rail fuel systems, and for all Caterpillar diesel engines that are equipped with unit injected fuel systems. For all other Caterpillar diesel engines (mostly older engines with pump, line and nozzle type fuel systems), the use of 4 micron(c) absolute or less secondary fuel filtration is strongly recommended. Note that all current Caterpillar diesel engines are factory equipped with Caterpillar Advanced Efficiency 4 micron(c) absolute fuel filters.

In order to obtain additional information on Caterpillar designed and produced filtration products, refer to the "Reference Material" article, "Filters" and "Miscellaneous" topics in this Special Publication, and then contact your Caterpillar dealer for assistance with filtration recommendations for your Caterpillar machine.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and filters.

Recommendations

Follow all applicable industry standards and all applicable governmental, environmental, and safety guidelines, practices, regulations, and mandates.

Note: Where recommendations for draining water and/or sediment and/or debris are stated, dispose of this waste according to all applicable regulations and mandates.

- Discuss application specific fuel concerns, needs, and requirements with a reputable fuel supplier.
- Purchase fuel from a reputable supplier.
- Use fuel that meets or exceeds Caterpillar requirements for distillate diesel fuel. Refer to the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" table in this Special Publication, "Distillate Diesel Fuel" article.
- Use a properly designed and maintained bulk storage fuel tank.
- Confirm with the filter manufacturer that the fuel filter/filters to be used are compatible with the fuel type that will be filtered.
- Filter the fuel coming into the bulk storage fuel tank to 20 microns(c) absolute or less.

- Follow all industry standard grounding and other safety practices.
- Test for microbial contamination on a regular basis and take proper corrective action if contamination is present. Properly dispose of cleanup waste according to all applicable regulations and mandates.
- Install and properly maintain a properly designed and grounded filtration system on bulk storage fuel tanks for continuous filtration of stored fuel. The filter element/elements should be rated at a maximum of 5 microns(c) absolute. Change fuel filters based on manufacturers recommendations.
- Every 3 months, or sooner if problems are suspected, have a complete analysis of the bulk storage fuel per the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” table in this Special Publication, “Distillate Diesel Fuel” article. Take corrective action if necessary. Corrective actions may include, but are not limited to, treating the fuel, cleaning of the fuel storage tank/system, and replacing the problematic fuel with fresh fuel.
- Keep the fuel storage tank clean of water, debris and sediment.
- Drain water and sediment from the fuel storage tank weekly. Drain water and sediment before the tank is refilled.
- Keep the area around the fuel tank filler neck clean of debris in order to prevent contamination of the fuel tank.
- As required, clean the inside of the engine’s fuel tank and the inside of the bulk storage fuel tank.
- Drain water and sediment from the engine’s fuel tank daily. Drain water and sediment from the tank at the start of each shift. After the fuel tank has been filled, allow the fuel to settle for ten minutes. This will allow the water and sediment to separate from the fuel. Then, drain the water and sediment from the tank.
- Install fuel/water separators at the bulk storage fuel tank dispensing point and install fuel/water separators on the engine. Wire mesh media is NOT recommended.
- Drain the water from the fuel/water separators daily.
- Caterpillar Advanced Efficiency fuel filters are required for distillate fueled diesel engines in order to provide maximum life to the fuel system.

- Change fuel filters at the scheduled interval. Never fill the new secondary fuel filter with fuel before installation. Use the fuel priming pump to remove air from the system.
- Install and properly maintain four micron(c) absolute breather filters on the engine fuel tank vent, and install and properly maintain four micron(c) absolute breather filters on the bulk storage fuel tank vent. Desiccant type breather vent filters are also recommended in order to remove moisture from air entering the fuel tank. Breather filters are typically changed every six months, and desiccant type breather filters are typically changed on saturation. Refer to the literature that was included with the filter.
- Top off fixed roof fuel tanks as often as practical in order to reduce tank breathing and in order to reduce the amount of condensation generated water.
- Protect fuel tanks from dirt and water entry.

Note: Caterpillar has four different size coalescer type fuel filters available for bulk storage fuel tank applications that filter both dirt and water. The filter elements are rated at four microns(c) absolute. Contact your Caterpillar dealer for information on the coalescer filters available through Cat.

Note: Fuel storage tanks should be thoroughly cleaned before converting to Ultra Low Sulfur Diesel (ULSD) (15 ppm or less sulfur) and/or biodiesel/biodiesel blends. Conversion to ULSD and/or biodiesel/biodiesel blends can loosen fuel system and fuel storage tank deposits. Bulk tank continuous filtration unit and dispensing point filters, and onboard engine filters change intervals may need to be shortened for an extended period of time in order to allow for this cleaning effect.

Note: Caterpillar strongly recommends the filtration of distillate diesel fuel and/or biodiesel/biodiesel blends through a filter with a rating of four microns(c) absolute or less. This filtration should be located on the device that dispenses the fuel to the fuel tank for the engine, and also on the device that dispenses fuel from the bulk storage tank. Series filtration is recommended.

Note: Even when all fuel storage maintenance practices that are relevant to your application are followed, Caterpillar recommends a maximum of one year from production for distillate fuel storage, and a maximum of six months from production for biodiesel and blended biodiesel storage. Storage life for biodiesel and biodiesel blends that are greater than B20 may be much shorter than six months.

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Fuel Information for Diesel Engines

SMCS Code: 1250; 1280

NOTICE

Model year 2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines REQUIRE the use of Ultra Low Sulfur Diesel (ULSD) fuel (≤ 15 ppm sulfur).

“Sulfur-free” diesel fuel (≤ 10 ppm sulfur) is strongly recommended for use in “EURO 4” certified on-highway diesel engines, while diesel fuel with ≤ 50 ppm sulfur is acceptable.

For additional on-highway diesel engine fluids requirements, refer to the most current revision level of Special Publication, SEBU6385, “Caterpillar On-Highway Diesel Engine Fluids Recommendations”.

The two basic types of distillate diesel fuel are No. 2 diesel fuel and No. 1 diesel fuel. No. 2 diesel fuel is the most commonly available summer grade diesel fuel. No. 1 diesel fuel is a winter grade diesel fuel. During the winter months fuel suppliers will typically blend No. 1 and No. 2 diesel fuel in various percentages in order to meet the historical low ambient temperature cold-flow needs for a given area or region. No. 2 diesel fuel is a heavier diesel fuel than No. 1 diesel fuel. In cold weather, heavier fuels can cause problems with fuel filters, fuel lines, fuel tanks, and fuel storage. Heavier diesel fuels such as No. 2 diesel fuel can be used in diesel engines that operate in cold temperatures with an appropriate amount of a well proven pour point depressant additive. For more information on fuels which include blends of No. 1 and No. 2 diesel fuel, consult your fuel supplier.

When you use No. 2 diesel fuel or other heavier fuels, some of the fuel’s characteristics may interfere with successful cold weather operation. Additional information about the characteristics of diesel fuel is available. This information contains a discussion on the modification to the characteristics of diesel fuel. There are several possible methods that can be used to compensate for the fuel qualities that may interfere with cold weather operation. These methods include the use of starting aids, engine coolant heaters, fuel heaters, and de-icers. In addition, the manufacturer of the fuel can add cold flow improvers and/or blend No. 1 and No. 2 diesel in various percentages.

Starting Aids

The use of a starting aid is a conventional method of assistance for cold starts in low temperature conditions. A variety of starting aids are available for Caterpillar engines. Follow the recommendations that are provided by the manufacturer of the starting aid. Refer to the foreword section in this Special Publication, “Aftermarket Products and Warranty” article.

Engine Coolant Heaters

These heaters heat the engine coolant. The heated coolant flows through the cylinder block. The flow of heated coolant keeps the engine warm. A warm engine is easier to start in cold weather. Most coolant heaters use electrical power. A source of electricity is necessary for this type of heater. Other heaters that burn fuel are available as a source of heat. These heaters may be used in place of the electrical heaters.

With either type of heater, starting aids and/or fuels with higher cetane numbers are less important because the engine is warm. Problems with fuel cloud point can cause the plugging of fuel filters. Problems with fuel cloud point cannot be corrected by engine coolant heaters. This is especially true for fuel filters that are cooled by air flow during operation.

Fuel Heaters

The fuel cloud point is related to problems with fuel filters. The fuel heater heats the fuel above the cloud point before the fuel enters the fuel filter. This prevents wax from blocking the filter. Fuel can flow through pumps and lines at temperatures below the cloud point. The cloud point is often above the pour point of a fuel. While the fuel can flow through these lines, the wax in the fuel can still plug the fuel filter.

In some engine installations, small modifications can prevent problems that are caused by the cloud point. One of the following changes can prevent problems in many conditions: a change in the location of fuel filters and/or supply lines and the addition of insulation. In extreme temperatures, heating of the fuel may be required to prevent the filters from plugging. There are several types of fuel heaters that are available. The heaters typically use either engine coolant or exhaust gas as a heat source. These systems may prevent filter waxing problems without the use of de-icers or cold flow improvers. These systems may be ineffective when the fuel contains a large amount of dirt or of water. Use of a fuel heater can help eliminate some cold weather problems. A fuel heater should be installed so that the fuel is heated before flowing into the fuel filter.

Note: A fuel heater is not effective for cold-soaked starts unless the fuel heater can be powered from an external power source. External fuel lines may require the use of heaters that circulate the fuel.

Note: Only use properly sized fuel heaters that are controlled by thermostats or use fuel heaters that are self-regulated. Thermostatically controlled fuel heaters generally heat fuel to 15.5 °C (60 °F). Do not use fuel heaters in warm temperatures.

Note: Fuels with a high viscosity might require fuel heaters in order to lower the viscosity to either 4.5 cSt or less for rotary fuel injection pumps or 20 cSt viscosity or less for all other fuel injection pumps.

NOTICE

Do not allow the fuel to get too warm, because fuel above 52°C (125°F) will affect the power output of the engine. Never exceed 75°C (165°F) with straight distillate fuel. The high fuel temperatures also affect the fuel viscosity. When the fuel viscosity falls below 1.4 cSt, pump damage may occur.

WARNING

Overheating the fuel or the fuel filter can result in personal injury and/or damage to the engine. Use extreme care and caution for heating of the fuel filter.

Select a fuel heater that is mechanically simple, yet adequate for the application. The fuel heater should also prevent overheating of the fuel. Disconnect the fuel heater or deactivate the fuel heater in warm weather. An unacceptable loss of fuel viscosity and engine power will occur if the fuel supply temperature is allowed to become too hot.

For additional information on fuel heaters, see your Caterpillar dealer.

De-icers

De-icers lower the freezing point of the moisture in the fuel. De-icers are not generally needed when fuel heaters are used. If you experience trouble, consult your fuel supplier for recommendations of a compatible commercial de-icer.

Characteristics of Diesel Fuel

SMCS Code: 1250; 1280

Lubricity and Low Sulfur Diesel (LSD) and Ultra Low Sulfur Diesel (ULSD) Fuel

In the United States (U.S.), LSD will have 0.05 percent (500 ppm) maximum sulfur. ULSD will have 0.0015 percent (15 ppm) maximum sulfur. Refer to this Special Publication, “Distillate Diesel Fuel” article for additional information. Also, refer to the most current revision level of “ASTM D975 (Standard Specification for Diesel Fuel Oils)” for additional information.

In Europe, the commonly available diesel fuel will have 0.005 percent (50 ppm) maximum sulfur. In Europe, ULSD fuel will have 0.0010 percent (10 ppm) maximum sulfur, and is typically referred to as “sulfur-free”. Refer to the most current revision level of “European Standard EN 590 (Automotive Fuels - Diesel - Requirements and Test Methods)” for additional information.

Note: “EN 590” currently allows up to 5 percent biodiesel blends. Refer to the “Fuel Specifications” section and the “Biodiesel” topic in this Special Publication for guidance when biodiesel will be used.

Note: The fuel lubricity is important. You should consider the fuel’s lubricity whenever you operate the equipment in arctic weather. Also, you should consider the fuel’s lubricity whenever you use fuels that are lower in viscosity or that have been hydro-treated. There are many aftermarket additives that are available to treat fuel. If the fuel’s lubricity is an issue, consult your fuel supplier for proper recommendations regarding fuel additives. Also, refer to this Special Publication, “Distillate Diesel Fuel” article, “Aftermarket Fuel Additives” and “Cat Diesel Fuel Conditioner” topics.

The fluid’s lubricity describes the ability of the fluid to reduce the friction between surfaces that are under load. This ability reduces the damage that is caused by friction. Fuel injection systems rely on the lubricating properties of the fuel. Until fuel sulfur limits were mandated, the fuel’s lubricity was generally believed to be a function of fuel viscosity.

The process that is most commonly used to remove sulfur from fuel is called hydro-treatment. This process is also the most economical process. Each source of crude oil contains different amounts of sulfur. Crude oils typically require hydro-treatment to obtain the 0.0015 percent maximum sulfur limit. Crude oils with high sulfur require a more severe treatment.

The hydro-treatment removes the fuel's sulfur as well as other components. The treatment removes nitrogen compounds, polar materials, bicyclic aromatics, polycyclic aromatics, and oxygen compounds. While the removal of sulfur has shown no detrimental effects to the engine, the removal of other compounds have lowered the lubricity of the fuel. As a result of the lowered lubricity, the fuel is less tolerant of contamination by water and dirt. The lower fuel lubricity can be seen as abrasive wear of fuel system components. Fuels that have a low lubricity may not provide adequate lubrication to plungers, to barrels, and to injectors. This problem may be compounded in areas that require winter blends of fuel. The lighter winter fuel blend has the following characteristics: lower viscosity, lower cloud point, and lower pour point.

When required, the fuel's lubricity may be enhanced with additives. Many fuel suppliers treat the fuel with these additives. Do not use a fuel lubricity additive before you consult the fuel's supplier. Some aftermarket additives may not be compatible with the additives that are already in the fuel, and some may damage emission control systems. Some additive packages that are supplied by the aftermarket manufacturer may not be compatible with the seals that are used in fuel systems of some diesel engines. Other additive packages that are supplied by aftermarket manufacturers cannot provide proper performance in high temperature conditions. These additives may leave deposits because of the high temperatures that exist in the fuel systems of diesel engines.

Maximum life of the fuel system can be achieved by performing the following tasks: using a preferred distillate diesel fuel (refer to the "Fuel Recommendations" article in this Special Publication), using a reliable fuel supplier, and performing proper maintenance of the fuel system. Caterpillar Advanced Efficiency fuel filters are required for diesel engines that run on diesel fuel in order to provide maximum life to the fuel system.

Note: Lighter fuels are frequently used in arctic temperatures. Lighter fuels may include the following fuels: Jet A, Jet A-1, JP-8, JP-5, and kerosene. The specifications that apply to these fuels do not include a minimum lubricity requirement. Do not assume that a fuel meets the minimum Caterpillar specification. Contact the fuel supplier for proper recommendations on fuel lubricity additives.

Note: The sulfur levels for Jet A, Jet A-1, JP-8, JP-5, and kerosene fuels typically far exceed 15 ppm, and the sulfur levels for these fuels typically far exceed 50 ppm.

Note: For best results, your fuel supplier should treat the fuel when additives are required.

Refer to this Special Publication, "Distillate Diesel Fuel" article, "Aftermarket Fuel Additives", "Cat Diesel Fuel Conditioner", and "Alternative Fuels - Arctic Applications" topics for guidance.

Viscosity

The viscosity of the fuel is significant because the fuel serves as a lubricant for fuel system components. Fuels need to have sufficient viscosity. The fuel must lubricate the fuel system in both extremely cold and in extremely hot temperatures. If the kinematic viscosity of the fuel is lower than 1.4 cSt as supplied to the fuel injection pump or to the unit injectors, excessive scuffing and seizure can occur.

For distillate fuel configured engines, Caterpillar recommends a fuel viscosity as delivered to rotary fuel injection pumps of between 1.4 cSt and 4.5 cSt, and between 1.4 cSt and 20 cSt for all other fuel injection pumps.

If a fuel with a low viscosity is used, cooling of the fuel may be required in order to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require heaters in order to lower the viscosity to either 4.5 cSt or less for rotary fuel injection pumps or 20 cSt or less for all other fuel injection pumps.

Cetane Number

The cetane number of the fuel has an effect on the ability of the engine to start. Also, the cetane number has an effect on the interval of time before the engine runs smoothly. Generally, an increase of ten in the cetane number will allow the engine to be started at a lower temperature. The starting temperature can be improved approximately 7 to 8°C (12 to 15°F) for every increase of ten in the cetane number. After the engine reaches the normal operating temperature, a change in the cetane from 40 to 50 will have a minimal effect on engine performance.

Most fuels that have a cetane number above 40 will permit acceptable engine starts in warmer outside temperatures. The engine will start satisfactorily with this fuel when the engine is kept warm. The engine can be kept warm by using either a heated enclosure or a properly sized coolant heater.

During average starting conditions, direct injection diesel engines require a minimum cetane number of 40. A higher cetane value may be required for operation in high altitudes or for cold weather operation. The minimum fuel cetane number that is required for the precombustion chamber (PC) diesel engine is 35.

Modifying the Cetane Number

The cetane number of a fuel can be changed if the fuel is mixed with a fuel that has a different cetane number. Generally, the cetane number of the mixture will be in direct relation to the ratio of the fuels that were mixed. Your fuel supplier can provide the information about the cetane number of a particular fuel.

Additives can also be used to improve the cetane number of a fuel. Additives are evaluated through testing in special engines. However, the fuel characteristics of additives are not identical to a natural product. While both fuels may be rated as having the same cetane number, starting may be different.

Cloud Point

It is important to understand that the cloud point of a fuel is different from the pour point. There is no relationship between cloud point and the pour point. The cloud point is the temperature that allows some of the heavier components in the wax to solidify in the fuel. This wax is not a contaminant in the fuel. The wax is an important element of No. 2 diesel fuel. The wax has a high fuel energy content and the wax has a very high cetane value. Removal of the heavier wax lowers the cloud point of the fuel. Removal of the wax also increases the cost because less fuel can be made from the same amount of crude oil. Basically, a No. 1 diesel fuel is formulated by removing the wax from a No. 2 diesel fuel.

The cloud point of the fuel is important because the cloud point can limit the performance of the fuel filter. The wax can alter the fuel characteristics in cold weather. Solid wax can fill the fuel filters. The solidified wax will stop the flow of fuel. Fuel filters are necessary in order to remove dirt from the fuel. The filters block foreign material, and the filters protect the parts for the fuel injection system. Since fuel must flow through the filters, installing a fuel heater is the most practical way to prevent the problem. A fuel heater will keep the fuel above the cloud point as the fuel flows through the fuel system. The fuel heater will permit the wax to flow through the filters with the fuel.

Modifying the Cloud Point

You can lower the cloud point of a diesel fuel by mixing the diesel fuel with a different fuel that has a lower cloud point. No. 1 diesel fuel or kerosene may be used to lower the cloud point of a diesel fuel. The efficiency of this method is not good, because the ratio of the mixture does not have a direct relation to the improvement in cloud point. The amount of fuel with low cloud point that is required makes the process less preferable to use.

The following illustration contains a table that can be used to find the necessary mixture for two fuels with different cloud points. In order to use the table, you must know the exact fuel cloud point of each fuel. This specification can change from one purchase of fuel to the next purchase of fuel. This specification is normally available from personnel at the source of the fuel supply. When fuels that have a lower cloud point are not available, this method cannot be used.

The manufacturer of the fuel can add cold flow improvers to the fuel. Cold flow improvers modify the wax crystals in the fuels. The cold flow improvers do not change the fuel's cloud point. However, the cold flow improvers keep the wax crystals small enough to pass through standard fuel filters. For mixing precautions, see the section "Pour Point".

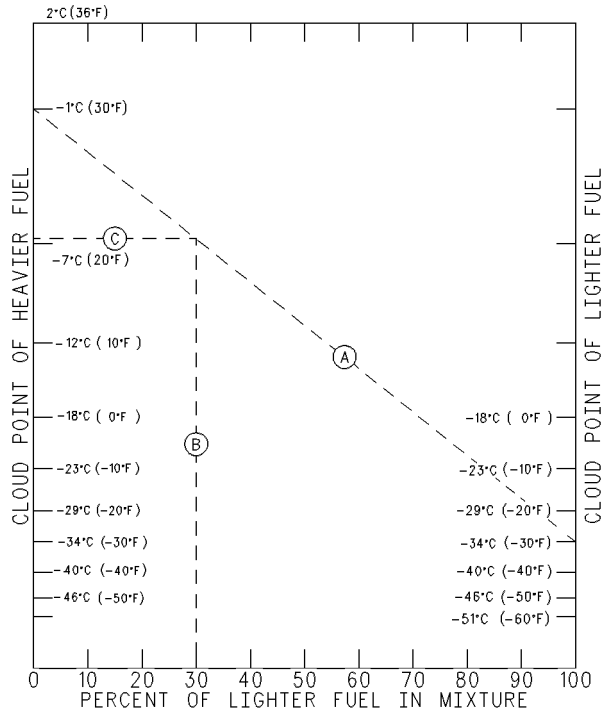


Illustration 7

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Cloud point of fuel mixtures

Generally, the most practical method that is used to prevent problems that are caused by fuel cloud point at low temperatures is the use of fuel heaters. In most applications, fuel heaters can be used at a lower cost than fuel mixtures.

Pour Point

The fuel's pour point is a temperature below the fuel's cloud point. Fuel stops flowing below the pour point. The pour point is the temperature which limits movement of the fuel inside of the pumps.

To measure the pour point, the fuel temperature is lowered below the cloud point in steps of 3°C (5°F) at a time. The temperature is lowered until the fuel does not flow. The pour point is the last temperature that is shown before the flow stops. At the pour point, the wax has solidified out of the fuel. This makes the fuel more solid than liquid. The pour point of the fuel can be improved. This does not require the removal of important elements. This process is the same process that is used to improve the cloud point of a fuel.

A fuel's pour point should be at least 6°C (10°F) below the lowest ambient temperature that is required for engine start-up and for engine operation. To operate the engine in extremely cold weather, No. 1 fuel or No. 1-D fuel may be necessary because of these fuels' lower pour points.

Modifying the Pour Point

You can lower the fuel's pour point by using additives. You can also lower the pour point of a diesel fuel by mixing the diesel fuel with a different fuel that has a lower pour point. No. 1 diesel fuel or kerosene may be used to lower the pour point of a diesel fuel. The amount of fuel with low pour point that is required makes the process less preferable to use.

The following illustration contains a table that can be used to find the necessary mixture for two fuels with different pour points. This is true only if the fuels do not have additives which change the pour point. In order to use the table, you must know the exact pour point of each fuel. This specification can change from one purchase of fuel to the next purchase of fuel. This specification is normally available from personnel at the source of the fuel supply. When fuels that have a lower pour point are not available, this method cannot be used.

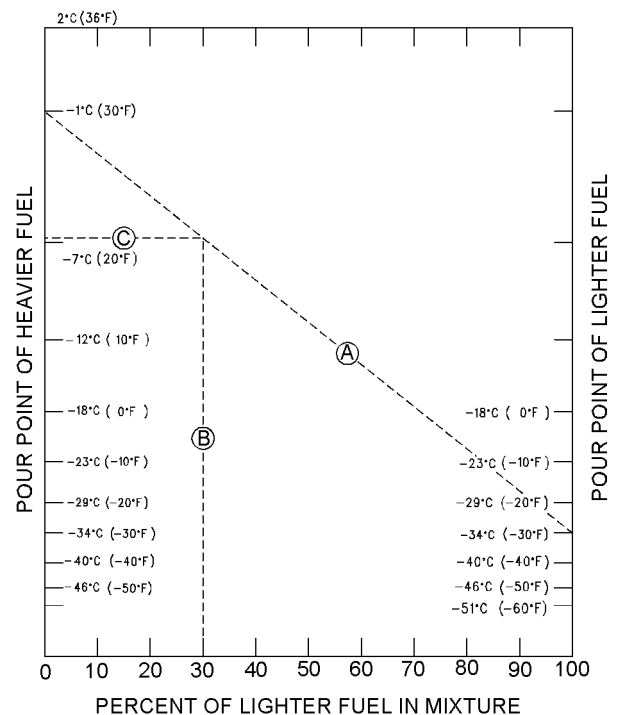


Illustration 8

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Pour point of fuel mixtures

In order to calculate the amount of lighter fuel that is required to be blended with the heavier fuel, perform the following steps:

1. Obtain the specification for the cloud point or the pour point of both fuels from your fuel supplier.

2. Locate the cloud point or the pour point of the heavier fuel on the left side of the table. Mark the point on the table.
3. Locate the cloud point or the pour point of the lighter fuel on the right side of the table. Mark the point on the table.
4. Draw a line between the two points that were established. Label this line "A".
5. Determine the lowest outside temperature for machine operation. Find this point on the left side of the table. Mark this point. Draw a horizontal line from this point. Stop the line at the intersection of line "A". Label this new line "C".
6. Line "C" and line "A" intersect. Mark this point. Draw a vertical line from this point. Stop the line at the bottom of the table. Label this line "B". The point at the bottom of line "B" reveals the percentage of lighter fuel that is required to modify the cloud point or the pour point.

The above example shows that the blending will require a thirty percent mixture of lighter fuel.

Additives are a good method to use in order to lower the pour point of a fuel. These additives are known by the following names: pour point depressants, cold flow improvers, and wax modifiers. When the additives are used in the proper concentration, the fuel will flow through pumps, lines, and hoses.

Note: These additives must be thoroughly mixed into the fuel at temperatures that are above the cloud point. The fuel supplier should be contacted in order to blend the fuel with the additives. The blended fuel can be delivered to your fuel tanks.

Moisture Content

Problems with fuel filters can occur at any time. The cause of the problem can be water in the fuel or moisture in the fuel. At low temperatures, moisture causes special problems. There are three types of moisture in fuel: dissolved moisture (moisture in solution), free and dispersed moisture in the fuel, and free and settled at the bottom of the tank.

Most diesel fuels have some dissolved moisture. Just as the moisture in air, the fuel can only contain a specific maximum amount of moisture at any one temperature. The amount of moisture decreases as the temperature is lowered. For example, a fuel could contain 100 ppm (0.010 percent) of water in solution at 18°C (65°F). This same fuel can possibly hold only 30 ppm (0.003 percent) at 4°C (40°F).

After the fuel has absorbed the maximum possible amount of water, the additional water will be free and dispersed. Free and dispersed moisture is fine droplets of water that is suspended in the fuel. Since the water is heavier than the fuel, the water will slowly become free and settled at the bottom of the tank. In the above example, when the fuel temperature was lowered from 18°C (65°F) to 4°C (40°F), 70 ppm of water became free and dispersed in the fuel.

The small drops of water cause a cloudy appearance in the fuel. If the change in temperature is slow, the small drops of water can settle to the bottom of the tank. When the fuel temperature is lowered rapidly to freezing temperature, the moisture that comes out-of-solution changes to very fine particles of ice instead of small drops of water.

The particles of ice are lighter than the fuel, and the particles of ice will not settle to the bottom of the tank. When this type of moisture is mixed in the fuel, this moisture will fill the fuel filters. The ice crystals will plug the fuel filters in the same way as wax plugs the fuel filters.

If a filter is plugged and fuel flow is stopped, perform the following procedure to determine the cause:

1. Remove the fuel filters.
2. Cut the fuel filters open.
3. Inspect the fuel filter before the filter warms. This inspection will show that the filter is filled with particles of either ice or wax.

The moisture which is free and settled at the bottom of the tank can become mixed with the fuel. The force of any pumping action will mix the moisture with the fuel whenever fuel is transferred. This moisture then becomes free and dispersed water. This moisture can cause ice in the filters. This moisture can cause other problems with filters at any temperature. Generally, the same force that mixes the water into the fuel will also mix dirt and rust from the bottom of the tank with the water. The result is a dirty mixture of fuel and water which can also fill the filters and stop fuel flow.

Specific Gravity / API Gravity

The specific gravity of diesel fuel is the weight of a fixed volume of fuel in comparison to the weight of the same volume of water at the same temperature. A higher specific gravity correlates into a heavier fuel. Heavier fuels have more energy or power per volume for the engine to use.

Note: The settings for the fuel mixture should not be adjusted in order to compensate for a loss of power with fuels that are lighter. The life of fuel system components can be decreased with fuels that are very light because lubrication will be less effective as a result of the lower viscosity. This is compounded if the fuel does not have sufficient lubricity. Refer to the “Lubricity and Low Sulfur Fuel Diesel (LSD) and Ultra Low Sulfur Diesel (ULSD) Fuel” topic in this Special Publication, “Characteristics of Diesel Fuel” article.

The API gravity of a fuel is also a measure of the density of the fuel or the relationship of the weight to the volume. The scale for API gravity is inverse to the scale for specific gravity. The API gravity will become higher as the fuel becomes lighter.

Lighter fuels will not produce the rated power. Lighter fuels may also be a blend of ethanol or methanol with diesel fuel. Blending alcohol or gasoline with diesel fuel will create an explosive atmosphere in the fuel tank. In addition, water condensation in the tank can cause the alcohol to separate in the tank.

WARNING

Mixing alcohol or gasoline with diesel fuel can produce an explosive mixture in the engine crankcase or fuel tank.

Personal injury and damage to the engine may result. Caterpillar recommends against this practice.

NOTICE

Mixing alcohol or gasoline with diesel fuel may cause damage to the engine. Caterpillar recommends against this practice. Water condensation in the fuel tank can cause the alcohol to separate which could cause damage to the engine.

Heavier fuels tend to create more deposits from combustion. Deposits from combustion can cause abnormal cylinder liner and ring wear. This is most noticeable in smaller diesel engines that operate at higher speeds.

Gums and Resins

The gums and resins that occur in diesel fuel are the result of dissolved oxidation products in the fuel that do not evaporate easily. The products that are dissolved in the fuel also do not burn cleanly. Excessive gum in the fuel will coat the inside of fuel lines, pumps, and injectors. Excessive gum will also interfere with the close tolerances of the moving parts of the fuel systems. Gum and resin in the fuel will also cause the filter to plug rapidly. Oxidation of the fuel will occur and the formation of additional gums and resins will occur during fuel storage. The storage time for fuel needs to be minimized in order to help reduce the formation of gums and resins.

Note: Even when all fuel storage maintenance practices that are relevant to your application are followed, Caterpillar recommends a maximum of one year from production for distillate diesel fuel storage, and a maximum of six months from production for biodiesel and blended biodiesel storage. Storage life for biodiesel and biodiesel blends that are greater than B20 may be much shorter than six months.

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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 recommendations.

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace oil, gas oil, or kerosene. These fuels must meet the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” found in this Special Publication, “Distillate Diesel Fuel” article.

Note: The permissible fuels are some crude oils, some blends of crude oil with distillate fuel, some biodiesel, and some marine diesel fuel. **These fuels are not suitable for use in all engine applications.** The acceptability of these fuels for use is determined on a case by case basis. A complete fuel analysis is required. Consult your Caterpillar dealer for further information. For information concerning biodiesel/biodiesel blends, refer to this Special Publication, “Distillate Diesel Fuel” article, “Biodiesel” topic.

Note: With the exception of some biodiesel, permissible fuels are not acceptable for use in on-highway applications.

NOTICE

Use of permissible fuels can result in higher maintenance costs and reduced engine service life.

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Distillate Diesel Fuel

SMCS Code: 1280

Caterpillar is not in the position to continuously evaluate and monitor all of the many worldwide distillate diesel fuel specifications and their on-going revisions that are published by governments and technological societies.

The “Caterpillar Specification for Distillate Fuel for Off-Highway Diesel Engines” provides a known, reliable baseline to judge the expected performance of distillate diesel fuels that are derived from conventional sources (crude oil, shale oil, oil sands, etc.) when used in Caterpillar diesel engines.

Using the Caterpillar distillate diesel fuel specification as the baseline, it is much easier to determine any potential economic and/or performance trade-offs, and overall acceptability when using fuels of varying characteristics and quality levels.

- When required, have the diesel fuel that either is being used or is planned to be used, tested per the Caterpillar distillate diesel fuel specification.
- Use the Caterpillar distillate diesel fuel specification as a fuel quality baseline for comparison of distillate diesel fuel analysis results to, and/or a baseline for comparison of other distillate diesel fuel specifications to.
- Typical fuel characteristics can be obtained from the fuel supplier.

Fuel parameters outside of the Cat fuel specification limits have explainable consequences.

- Some fuel parameters that are outside of the specification limits can be compensated for (e.g. fuel can be cooled to address low viscosity; etc.).
- Some fuel parameters that are outside of specification limits may be able to be improved with the use of appropriate amounts of well proven fuel additives. Refer to this Special Publication, “Distillate Diesel Fuel” article, “Aftermarket Fuel Additives” and “Cat Diesel Fuel Conditioner” topics for guidance.

To help ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in the “Caterpillar Specification for Distillate Fuel for Off-Highway Diesel Engines”, Table 18.

Note: The diesel fuel cannot have any visually apparent sediment, suspended matter, or undissolved water.

Diesel Fuels that meet the specifications in table 18 will help provide maximum engine service life and performance.

In North America, diesel fuel that is identified as “ASTM D975-07b Grades No. 1-D or No. 2-D”(all listed sulfur levels) generally meet the table 18 requirements.

In Europe, diesel fuel that is identified as “European Standard EN590:2004” generally meet the table 18 requirements.

Table 18 is for diesel fuels that are distilled from conventional sources (crude oil, shale oil, oil sands, etc.). Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

NOTICE

Ultra Low Sulfur Diesel (ULSD) fuel will have ≤ 15 ppm (0.0015%) sulfur using the “ASTM D5453”, “ASTM D2622”, “ISO 20846”, or “ISO 20884” test methods. Certain applications and/or governments/localities MAY require the use of ULSD fuel. Emission controlled diesel engines and/or diesel engines equipped with exhaust aftertreatment devices MAY require the use of ULSD fuel. Diesel engines equipped with a Diesel Particulate Filter (DPF) require the use of ULSD. Consult federal, state, and local authorities for guidance on fuel requirements for your area. Also, consult the specific engine Operation and Maintenance Manual for guidance.

Caterpillar does not mandate the across the board use of ULSD fuel in non-road and stationary applications, but does allow its use. When ULSD is not properly additized by the fuel supplier, there are concerns with fuel lubricity and thermal stability. The fuel lubricity and thermal stability limits stated in the “Caterpillar Specification for Distillate Fuel for Off-Highway Diesel Engines” address these concerns. In North America, diesel fuel that is identified as “ASTM D975 Grade No. 1-D S15” or “ASTM D975 Grade No. 2-D S15” and meet the “ASTM D975-07b Thermal Stability Guideline X3.10.2.2”, generally meet the Caterpillar requirements for ULSD fuel.

In Europe, diesel fuel that meets “European Standard EN590:2004” requirements for ≤ 10 ppm sulfur fuel (typically referred to as “sulfur-free”) generally meet Caterpillar requirements for ULSD fuel.

NOTICE

Model year 2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines REQUIRE the use of Ultra Low Sulfur Diesel (ULSD) fuel (≤ 15 ppm sulfur).

“Sulfur-free” diesel fuel (≤ 10 ppm sulfur) is strongly recommended for use in “EURO 4” certified on-highway diesel engines, while diesel fuel with ≤ 50 ppm sulfur is acceptable.

For additional on-highway diesel engine fluids requirements, refer to the most current revision level of Special Publication, SEBU6385, “Caterpillar On-Highway Diesel Engine Fluids Recommendations”.

Note: Caterpillar strongly recommends the filtration of distillate fuel and/or biodiesel/biodiesel blends through a fuel filter with a rating of four microns(c) absolute or less. This filtration should be located on the device that dispenses the fuel to the fuel tank for the engine, and also on the device that dispenses fuel from the bulk storage tank. Series filtration is recommended.

NOTICE

Operating with fuels that do not meet Caterpillar’s recommendations can cause the following effects: starting difficulty, reduced fuel filter service life, 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.

NOTICE

The footnotes are a key part of the “Caterpillar Specification for Distillate Diesel Fuel” Table. Read ALL of the footnotes.

Table 18

Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines⁽¹⁾			
Specifications	Requirements	ASTM Test	ISO Test
Aromatics	35% maximum	“D1319”	“ISO 3837”
Ash	0.01% maximum (weight)	“D482”	“ISO 6245”
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	“D524”	“ISO 4262”
Cetane Number ⁽²⁾	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.	“D2500”	“ISO 3015”
Copper Strip Corrosion	No. 3 maximum	“D130”	“ISO 2160”
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 80% reflectance after aging for 180 minutes at 150 °C (302 °F)	“D6468”	No equivalent test

(continued)

(Table 18, contd)

Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines⁽¹⁾			
Specifications	Requirements	ASTM Test	ISO Test
API Gravity	30 minimum (875.7 kg/m ³) ⁽³⁾	"D287"	No equivalent test
	45 maximum (801.3 kg/m ³) ⁽³⁾		
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"	"ISO 3016"
Sulfur ⁽¹⁾⁽⁴⁾	1% maximum	"D5453" or "D2622"	ISO 20846 or ISO 20884
Kinematic Viscosity ⁽⁵⁾	1.4 cSt minimum and 20.0 cSt maximum as delivered to the fuel injection pumps	-	-
	1.4 cSt minimum and 4.5 cSt maximum as delivered to the rotary 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"
Gums and Resins ⁽⁶⁾	10 mg per 100 mL maximum	"D381"	"ISO 6246"
Lubricity ⁽⁷⁾	0.52 mm (0.0205 inch) maximum at 60 °C (140 °F)	"D6079"	No equivalent test

(1) This specification includes the requirements for Ultra Low Sulfur Diesel (ULSD). ULSD fuel will have ≤ 15 ppm (0.0015%) sulfur using the "ASTM D5453", "ASTM D2622", or "ISO 20846, ISO 20884" test methods. This specification includes the requirements for Low Sulfur Diesel (LSD). LSD fuel will have ≤500 ppm (0.05%) sulfur using the "ASTM 5453, ASTM D2622" or the "ISO 20846", "ISO 20884" test methods. Aftertreatment devices can be permanently damaged by the use of high sulfur fuels. Diesel engines that are equipped with a Diesel Particulate Filter (DPF) require the use of ULSD.

(continued)

(Table 18, contd)

- (2) 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 44.2 (DI engines) when the ASTM D4737-96a test method is used. A fuel with a higher cetane number may be required for operation at higher altitudes or in cold weather.
- (3) Via standards tables, the equivalent kg/m³ (kilograms per cubic meter) using the "ASTM D287" test method temperature of 15.56 °C (60 °F) for the minimum API gravity of 30 is 875.7 kg/m³, and for the maximum API gravity of 45 is 801.3 kg/m³.
- (4) Certain Caterpillar fuel systems and engine components can operate on fuels with a maximum sulfur content of 3%. Refer to the specific engine Operation and Maintenance Manual for more information. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1% may significantly shorten the oil change interval. Caterpillar requires that Cat S-O-S Services oil analysis be used to determine oil change intervals when fuel sulfur levels are above 1%. Caterpillar strongly recommends that Cat S-O-S Services oil analysis be used to determine oil change intervals when fuel sulfur levels are above 0.5%. Contact your Caterpillar dealer for guidance when fuel sulfur levels are above 0.5%. For additional information, see this Special Publication, "Engine Oil" article. Model year 2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines are required to use fuel with 15 ppm or less sulfur. ULSD fuel will have ≤ 15 ppm (0.0015%) sulfur using "ASTM D5453", "ASTM D2622", or "ISO 20846, ISO 20884" test methods. It is strongly recommended that "EURO 4" certified on-highway diesel engines use ULSD. Aftertreatment devices can be permanently damaged by the use of high sulfur fuels. Diesel engines that are equipped with a Diesel Particulate Filter (DPF) require the use of ULSD.
- (5) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. For ease of comparison, fuels should also meet the minimum and maximum viscosity requirements at 40 °C (104 °F) that are stated by the use of either the "ASTM D445" test method or the "ISO 3104" test method. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to lower the viscosity to either 4.5 cSt or less for rotary fuel injection pumps or 20 cSt viscosity or less for all other fuel injection pumps.
- (6) Follow the test conditions and procedures for gasoline (motor).
- (7) The lubricity of a fuel is a concern with low sulfur and ultra low sulfur fuel. To determine the lubricity of the fuel, use 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.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", Table 18. To help ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", Table 18.

⚠ WARNING

Mixing alcohol or gasoline with diesel fuel can produce an explosive mixture in the engine crankcase or fuel tank.

Personal injury and damage to the engine may result. Caterpillar recommends against this practice.

Heavy Fuel Oil, Residual Fuel, Blended Fuel

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.

Ultra Low Sulfur Diesel (ULSD)

Caterpillar recommends that all distillate diesel fuel, including ULSD fuel (fuel ≤ 15 ppm sulfur using ASTM D5453, ASTM D2622 or ISO 20846, ISO 20884) meet the requirements of the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" that are specified in Table 18.

Note: ULSD has less electrical conductivity than LSD. Follow all industry standard grounding and safety practices.

NOTICE

Ultra Low Sulfur Diesel (ULSD) fuel will have ≤ 15 ppm (0.0015%) sulfur using the "ASTM D5453", "ASTM D2622", "ISO 20846", or "ISO 20884" test methods. Certain applications and/or governments/localities MAY require the use of ULSD fuel. Emission controlled diesel engines and/or diesel engines equipped with exhaust aftertreatment devices MAY require the use of ULSD fuel. Diesel engines equipped with a Diesel Particulate Filter (DPF) require the use of ULSD. Consult federal, state, and local authorities for guidance on fuel requirements for your area. Also, consult the specific engine Operation and Maintenance Manual for guidance.

Caterpillar does not mandate the across the board use of ULSD fuel in non-road and stationary applications, but does allow its use. When ULSD is not properly additized by the fuel supplier, there are concerns with fuel lubricity and thermal stability. The fuel lubricity and thermal stability limits stated in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" address these concerns. In North America, diesel fuel that is identified as "ASTM D975 Grade No. 1-D S15" or "ASTM D975 Grade No. 2-D S15" and meet the "ASTM D975-07b Thermal Stability Guideline X3.10.2.2", generally meet the Caterpillar requirements for ULSD fuel.

In Europe, diesel fuel that meets "European Standard EN590:2004" requirements for ≤ 10 ppm sulfur fuel (typically referred to as "sulfur-free") generally meet Caterpillar requirements for ULSD fuel.

NOTICE

Model year 2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines REQUIRE the use of Ultra Low Sulfur Diesel (ULSD) fuel (≤ 15 ppm sulfur).

"Sulfur-free" diesel fuel (≤ 10 ppm sulfur) is strongly recommended for use in "EURO 4" certified on-highway diesel engines, while diesel fuel with ≤ 50 ppm sulfur is acceptable.

For additional on-highway diesel engine fluids requirements, refer to the most current revision level of Special Publication, SEBU6385, "Caterpillar On-Highway Diesel Engine Fluids Recommendations".

Note: Caterpillar strongly recommends the filtration of distillate fuel and/or biodiesel/biodiesel blends through a fuel filter with a rating of four microns(c) absolute or less. This filtration should be located on the device that dispenses the fuel to the fuel tank for the engine, and also on the device that dispenses fuel from the bulk storage tank. Series filtration is recommended.

In the United States (U.S.), 0.0015 percent (15 ppm) sulfur diesel fuels have been used in most on-highway truck engines since 15 October 2006. This ultra low sulfur diesel fuel (ULSD) was mandated as a means of directly reducing particulate emissions from on-highway diesel engines. This ultra low sulfur fuel may also be used in Caterpillar commercial diesel engines and in Caterpillar machine engines. ULSD fuel will be used when low emissions are required. This fuel will also be used when the fuel supplier can only provide this type of fuel.

Note: In Europe, ultra low sulfur diesel fuel will have a maximum of 0.0010 percent (10 ppm) sulfur and is typically referred to as “sulfur-free”.

For additional ULSD fuel information, refer to the “Reference Materials” article, “Frequently Asked Questions (Ultra Low Sulfur Diesel (ULSD) Fuel)” topic in this Special Publication.

NOTICE

Operating with fuels that do not meet Caterpillar’s recommendations can cause the following effects: starting difficulty, reduced fuel filter service life, 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.

Alternative Fuels - Arctic Applications

In extreme cold ambient conditions, you may choose to use the distillate fuels that are specified in Table 19. However, the fuel that is selected must meet the requirements that are specified in the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines”, Table 18. These fuels are intended to be used in operating temperatures that are down to -54 °C (-65 °F).

Note: The fuels that are listed in Table 19 typically have much higher sulfur levels than the 15 ppm maximum sulfur allowed for ULSD . The sulfur levels for these fuels typically far exceed 15 ppm.

Note: The fuels that are listed in Table 19 typically have much higher sulfur levels than the 50 ppm maximum sulfur allowed in the European Standard “EN 590:2004”. The sulfur content of these fuels typically far exceeds 50 ppm.

Table 19

Distillate Fuels ⁽¹⁾	
Specification	Grade
“MIL-DTL-5624U”	JP-5
“MIL-DTL-83133E”	JP-8
“ASTM D1655-07”	Jet A ⁽²⁾ , Jet A-1 ⁽²⁾

(1) The fuel that is selected must meet the requirements that are specified in the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” table, Table 18. Cooling of the fuel may be required to maintain 1.4 cSt or greater viscosity at the fuel injection pump. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

(2) Jet A is the standard fuel used by U.S. commercial airlines when operating within the U.S. Jet A-1 is the standard fuel used by commercial airlines worldwide. Per “ASTM D1655-07, Table 1 (Detailed Requirements of Aviation Turbine Fuels)”, Jet A and Jet A-1 have identical requirements except for freezing point. Jet A has a freeze point requirement of -40 °C (-40 °F) versus the Jet A-1 has a freeze point requirement of -47 °C (-52.6 °F), but other freezing points may be agreed on by the fuel purchaser and the fuel supplier.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 18 must be at least 40. If the viscosity is below 1.4 cSt at 40 °C (104 °F), use the fuel only in temperatures below 0 °C (32 °F). Do not use any fuels with a viscosity of less than 1.2 cSt at 40 °C (104 °F).

Note: Fuel cooling may be required in order to maintain the minimum viscosity of 1.4 cSt at the fuel injection pump.

Note: These fuels may not prove acceptable for all applications.

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. Some additives may plug fuel filters. Some additives may be corrosive, and some additives may be harmful to the elastomers in the fuel system. Some additives may damage emission control systems. Some additives may raise fuel sulfur levels above the maximum allowed by the United States (U.S.) Environmental Protection Agency (EPA) and/or, as appropriate, other regulatory agencies. 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.

Note: Metallic fuel additives can cause fuel system/injector fouling and after treatment device fouling. Caterpillar discourages the use of metallic fuel additives in most applications. Metallic fuel additives should only be used in applications where their use is specifically recommended by Caterpillar.

Note: The U.S. EPA bans the use of metallic fuel additives in on-highway applications.

Note: Diesel fuel additives/conditioners may not improve markedly poor diesel fuel properties enough to make them acceptable for use.

Note: For best results, your fuel supplier should treat the fuel when additives are needed.

Cat Diesel Fuel Conditioner

Note: Cat Diesel Fuel Conditioner, part number 256-4968, is the only fuel conditioner/additive available to the end user that is tested and approved by Caterpillar for use in Caterpillar diesel engines.

Cat Diesel Fuel Conditioner is a proprietary metal and ash free formulation that has been extensively tested for use with distillate diesel fuels for use in Caterpillar diesel engines. Cat Diesel Fuel Conditioner helps address many of the challenges that various fuels worldwide present in regards to fuel life/stability, engine startability, injector deposits, fuel system life, and long term engine performance.

Note: Diesel fuel additives/conditioners may not improve markedly poor diesel fuel properties enough to make them acceptable for use.

Note: For maximum overall benefits, ask your fuel supplier to add Cat Diesel Fuel Conditioner at the recommended treat rate before fuel delivery, or you may add Cat Diesel Fuel Conditioner at the recommended treat rate during the early weeks of fuel storage.

Cat Diesel Fuel Conditioner is a proven high performance, multipurpose diesel fuel conditioner that is designed to improve:

- Fuel economy (through fuel system cleanup)
- Lubricity
- Oxidative stability
- Detergency/dispersancy
- Moisture dispersancy
- Corrosion protection
- Cetane (typically 2-3 cetane numbers)

Cat Diesel Fuel Conditioner has been validated through lab and field tests to improve/reduce diesel fuel consumption and emissions for typical fleets through fuel system/injector cleanup, and to help maintain new engine performance by keeping fuel systems clean. Note that while fuel system/injector cleanup takes place over time, maintaining fuel system/injector cleanliness is an ongoing process.

Data indicates that average fuel economy improvements across typical fleets may be in the 2-3+ percentage range. Note that improvements may vary based on factors such as engine model, age and condition of the engine, and application.

Cat Diesel Fuel Conditioner also reduces the formation of gums, resins, and sludge, and disperses insoluble gums. This can dramatically improve fuel storage life, reduce fuel related engine deposits and corrosion, and extend fuel filter life.

Note: Use of Cat Diesel Fuel Conditioner does not lessen the engine owner and/or fuel suppliers responsibility to follow all industry standard maintenance practices for fuel storage and for fuel handling. Refer to the “General Fuel Information” article in this Special Publication for additional information. Additionally, use of Cat Diesel Fuel Conditioner does NOT lessen the engine owners responsibility to use appropriate diesel fuel. Refer to the “Fuel Specifications” section in this Special Publication (Maintenance Section) for guidance.

Cat Diesel Fuel Conditioner is suitable for use with biodiesel/biodiesel blends that meet Caterpillar’s biodiesel recommendations and requirements. Note that not all fuel additives are suitable for use with biodiesel/biodiesel blends. Read and follow all applicable label usage instructions. Also, refer to this Special Publication, “Distillate Diesel Fuel” article, which includes Caterpillar’s biodiesel recommendations and requirements.

When used as directed, Cat Diesel Fuel Conditioner has proven to be compatible with existing and U.S. EPA 2007 on-highway certified diesel engine emission control catalysts and particulate filters.

Note: When used as directed, Cat Diesel Fuel Conditioner won’t raise fuel sulfur levels measurably in the final fuel/additive blend. In the U.S. the current formulation of Cat Diesel Fuel Conditioner must be blended in at the recommended treat-rate at the fuel supplier/distributor level for use in on-highway or other applications where use of ULSD fuel is mandated (15 ppm or less fuel sulfur). Follow all applicable national, regional, and local laws, mandates, and regulations concerning the use of diesel fuel conditioners/additives.

NOTICE

When used as directed Cat Diesel Fuel Conditioner won't raise fuel sulfur levels measurably in the final fuel/additive blend. But, in the U.S., aftermarket fuel additives (retail consumer level versus bulk fuel additives used at the fuel supplier/distributor level) with more than 15 ppm sulfur are **NOT** allowed to be used in applications where ULSD usage is mandated (15 ppm or less fuel sulfur). The current formulation of Cat Diesel Fuel Conditioner has more than 15 ppm sulfur. Follow all applicable national, regional, and local laws, mandates and regulations concerning the use of diesel fuel conditioners/additives.

Biodiesel

NOTICE

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

Biodiesel is a fuel that can be made from a variety of feedstock. Soybean oil or rapeseed oil are the primary feedstocks. Without esterification, these oils gel in the crankcase and the fuel tank. These fuels may not be compatible with many of the elastomers that are used in engines. In original forms, these oils are not suitable for use as a fuel in compression engines. Alternate base stocks for biodiesel may include animal tallow, waste cooking oils, or a variety of other feedstocks. **To use any of the oils listed above as fuel, the oil must be esterified.**

Engines that are manufactured by Caterpillar are certified by use of the prescribed U.S. EPA and European Certification fuels. Caterpillar does not certify engines on any other fuel.

Note: The user of the engine has the responsibility of using the correct fuel that is recommended by the manufacturer and allowed by the U.S. EPA and other appropriate regulatory agencies.

Warranty and the Use of Biodiesel 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 and the long term effects on performance, durability, or compliance to emissions standards for Caterpillar products. The use of biodiesel does not affect the Caterpillar warranty for materials and the warranty for workmanship.

NOTICE

Failures that result from the use of any fuel are not Caterpillar factory defects. Therefore, the cost of repair would NOT be covered by a Caterpillar warranty.

Recommendation for the Use of Biodiesel in Caterpillar Engines

For Caterpillar off-highway, and for Caterpillar model year 2006 and older on-highway ACERT Technology diesel engine model numbers C7, C9, C11, C13, C15, C18, C27, C32, and also for Caterpillar 3114, 3116, 3126, 3176, 3196, 3208, 3306, C-9, C-10, C-12, 3406, C-15, C-16, C-18, 3456, 3408, 3412, 3500 Series, C175 Series, 3600 Series, C280 Series, CM20, CM25 and CM32 engines, biodiesel that meets the requirements that are listed in the "Caterpillar Specification for Biodiesel Fuel", ASTM D6751, or EN 14214 are acceptable blendstock. Biodiesel may be blended in amounts up to a maximum of 30 percent with an acceptable diesel fuel. This blend is acceptable provided that the biodiesel constituent meets the requirements that are outlined in Table 20 prior to blending. In addition, the final blend must meet the requirements for distillate diesel fuel that are listed in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", Table 18.

The most commonly available biodiesel blends are B20 which is 20 percent biodiesel, and B5 which is 5 percent biodiesel.

Note: Diesel fuels that meet the requirements of the most current versions of the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines", the National Conference on Weights and Measures (NCWM) Premium Diesel definition, EN 590 and/or ASTM D975 (No.1-D, No.2-D), are examples of fuels that are acceptable for creating biodiesel blends. These biodiesel blends must meet Caterpillar's recommendations and requirements for biodiesel.

Note: A complete Caterpillar S-O-S Services oil analysis program is **strongly recommended** when using biodiesel blends above 5 percent.

Note: For blends of biodiesel above 30 percent, contact your Caterpillar dealer for guidance. **A complete Caterpillar S-O-S Services oil analysis program is required when biodiesel or blends of biodiesel that are above 20 percent are used.** Biodiesel or blends of biodiesel as used in the engine must meet the requirements that are stated in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" in Table 18.

For Caterpillar model year 2007 and newer C13 and C15 on-highway diesel engines, and for Caterpillar C0.5 through C2.2 and for C4.4 mechanical fuel injection equipped engines that meet both Tier 3 and Stage 3a (Tier3/Stage 3a) emissions regulations, biodiesel that meets the requirements that are listed in the "Caterpillar Specification for Biodiesel Fuel", ASTM D6751, or EN 14214 may be blended with an acceptable diesel fuel. This blend should be to a maximum ratio of 20% biodiesel to 80% of an acceptable diesel fuel. The biodiesel must meet the requirements that are listed in table 20 prior to blending. Use of more than 20% biodiesel can cause premature failures. The repair for these failures would not be covered under the Caterpillar warranty.

For Caterpillar model year 2007 and newer C7 and C9 on-highway diesel engines, and for Caterpillar C0.5 through C2.2 and for C4.4 mechanical engines that meet Tier2/Stage2 or earlier emissions regulations, for C4.4 and C6.6 ACERT engines, and for C3.4, 3003 through 3034, 3044, 3046, 3054, 3056, 3064, and 3066 engines, biodiesel that meets the requirements that are listed in the "Caterpillar Specification for Biodiesel Fuel", ASTM D6751, or EN 14214 may be blended with an acceptable diesel fuel. This blend should be a maximum ratio of 5% biodiesel to 95% of an acceptable diesel fuel. The biodiesel must meet the requirements that are listed in Table 20 prior to blending. Use of more than a 5% biodiesel can cause premature failures. The repair for these failures would not be covered under the Caterpillar warranty.

Note: When biodiesel, or any blend of biodiesel is used, the user has the responsibility for obtaining the proper local exemptions, regional exemptions, and/or national exemptions, if required, for the use of biodiesel in any Caterpillar engine that is regulated by emissions standards. Biodiesel that meets the requirements that are listed in the "Caterpillar Specification for Biodiesel Fuel", ASTM D6751, or EN 14214 are not expected to pose major problems when blended with an acceptable distillate diesel fuel at the maximum stated percentages. However, the following recommendations must be followed:

Recommendations

Note: For the purpose of these recommendations, the cautions, guidelines and recommendations applicable to biodiesel (B100) are also applicable to biodiesel blends (B2, B5, B20, etc.).

Note: Fuel storage tanks should be thoroughly cleaned before converting to biodiesel/biodiesel blends. Conversion to biodiesel/biodiesel blends can loosen fuel system and fuel storage tank deposits. Bulk tank continuous filtration unit and dispensing point filters, and onboard engine filters change intervals may need to be shortened for an extended period of time in order to allow for this cleaning effect.

Note: In the U.S., biodiesel that does not meet the most current revision level of "ASTM D6751" in effect at the time of registration will be subject to civil penalties of up to \$32,500 per day, per violation.

In North America, the use of biodiesel from BQ-9000 accredited producers and BQ-9000 certified marketers is required. Look for the "BQ-9000" biodiesel quality accreditation program certification logo that is available to distributors that meet the requirements of BQ-9000. For more information on the "BQ-9000" program, go to www.BQ-9000.org.

In other areas of the world, the use of biodiesel that is BQ-9000 accredited and certified, **or** that is accredited and certified by a comparable biodiesel quality body to meet similar biodiesel quality control standards, is required.

- The oil change interval can be negatively affected by the use of biodiesel. Use S·O·S Services oil analysis in order to monitor the condition of the engine oil. Use S·O·S Services oil analysis also in order to determine the oil change interval that is optimum.
- Confirm with the filter manufacturer that the fuel filter/filters to be used are compatible with biodiesel.
- Conversion to biodiesel can loosen fuel system deposits. Fuel filter change intervals may need to be shortened for an extended period of time in order to allow for this cleaning effect when converting used engines to biodiesel.
- Filter biodiesel and biodiesel blends through a fuel filter with a rating of four microns(c) absolute or less. This filtration should be located on the device that dispenses the fuel to the fuel tank for the engine, and also on the device that dispenses fuel from the bulk storage tank. Series filtration is recommended.
- In a comparison of distillate fuels to biodiesel, biodiesel typically provides less energy per gallon by 5% to 8%. Do NOT change the engine rating in order to compensate for the power loss. This will help avoid engine problems when the engine is converted back to 100 percent distillate diesel fuel.

- Compatibility of the elastomers with biodiesel is currently being monitored. The condition of seals and hoses should be monitored regularly.
- Biodiesel 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 attaining of the proper cloud point for the fuel.
- Biodiesel has poor oxidation stability, which can result in long term storage problems. Biodiesel should be used within six months of production. Storage life for biodiesel and biodiesel blends that are greater than B20 may be much shorter than six months. The poor oxidation stability may accelerate fuel oxidation in the fuel system. This is especially true in engines with electronic fuel systems because these engines operate at higher temperatures. Refer to this Special Publication, “Distillate Diesel Fuel” article, “Aftermarket Fuel Additives” and “Cat Diesel Fuel Conditioner” topics for information concerning oxidation stability and other fuel additives.
- Biodiesel can be produced using various feedstock. The feedstock used can affect product performance. Two of the fuel characteristics affected are cold flow and oxidation stability. Contact your fuel supplier for guidance.
- Due to poor oxidation stability and other potential issues, it is strongly recommended that engines with limited operational time either not use biodiesel/biodiesel blends or, while accepting some risk, limit biodiesel to a maximum of B5. Examples of applications that should limit the use of biodiesel are the following: Standby Generator sets and certain emergency vehicles.
- Biodiesel is an excellent medium for microbial contamination and growth. Microbial contamination and growth can cause corrosion in the fuel system and premature plugging of the fuel filter. Consult your supplier of fuel and additive for assistance in selecting appropriate anti-microbial additives.
- Care must be taken in order to remove water from fuel tanks. Water accelerates microbial contamination and growth. When biodiesel is compared to distillate fuels, water is naturally more likely to exist in the biodiesel.
- Refer to this Special Publication, “General Fuel Information” article for additional recommendations.

Seasonal Operation

It is strongly recommended that seasonally operated engines have the fuel systems, including fuel tanks, flushed with conventional diesel fuel before prolonged shutdown periods. An example of an application that should seasonally flush the fuel system is school buses (U.S.).

Perform the following items in order before shutting down the engine for prolonged periods:

- Operate the engine until the fuel level in the tank is very low.
- Refill the fuel tank with high quality conventional distillate diesel fuel.
- Repeat the previous steps a minimum of two times before the engine is shut down for prolonged periods.

Biodiesel Specification

Note: The final blend of biodiesel as used in the engine must meet the requirements that are stated in the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” in Table 18.

NOTICE

The footnote is a key part of the “Caterpillar Specification for Biodiesel Fuel” Table. Read the footnote.

Table 20

Caterpillar Specification for Biodiesel Fuel ⁽¹⁾				
Property	Test Method	Test Method	Units	Limits
	United States	International	Specific Properties of Fuel	
Density at 15°C	"ASTM D1298"	"ISO 3675"	g/cm ³	0.86-0.90
Viscosity at 40°C	"ASTM D445"	"ISO 3104"	mm ² /s (cSt)	1.9-6.0
Flash Point	"ASTM D93"	"ISO 3679"	°C	93 minimum
Pour Point - Summer - Winter	"ASTM D97"	"ISO 3016"	°C	6 °C (10 °F) minimum below ambient temperature
Cloud Point	"ASTM D2500"		°C	Report
Sulfur Content	"ASTM D5453"	"ISO 20846" "ISO 20884"	% weight	0.0015 maximum
Distillation - 10% Evaporation - 90% Evaporation	"ASTM D1160"		°C	To Be Determined 360
Carbon Residue, Conradson (CCR)	"ASTM D4530"	"ISO 10370"	% weight	0.05 maximum
Cetane Number	"ASTM D613"	"ISO 5165"		45 minimum
Sulfated Ash	"ASTM D874"	"ISO 3987"	% weight	0.02 maximum
Water/Sediment Content	"ASTM D2709"	"ISO 12937"	% volume	0.05 maximum
Copper Corrosion	"ASTM D130"	"ISO 2160"		No. 1
Oxidation Stability	"EN 14112"	"EN 14112"	hours	3 minimum
Esterification	"EN 14103"	"EN 14103"	% volume	97.5 minimum
Acid Value	"ASTM D664"	"EN 14104"	mg NaOH/g	0.5 maximum
Methanol Content	"EN 14110"	"EN 14110"	% weight	0.2 maximum
Monoglycerides	"ASTM D6584"	"EN 14105"	% weight	0.8 maximum
Diglycerides	"ASTM D6584"	"EN 14105"	% weight	0.2 maximum
Triglycerides	"ASTM D6584"	"EN 14105"	% weight	0.2 maximum
Free Glycerine	"ASTM D6584"	"EN 14105"	% weight	0.02 maximum
Total Glycerine	"ASTM D6584"	"EN 14105"	% weight	0.240 maximum
Phosphorus Content	"ASTM D4951"	"EN 14107"	% weight	0.001
Calcium and Magnesium combined	"EN 14538"	"EN 14538"	ppm	5 maximum
Sodium and Potassium combined	"EN 14538"	"EN 14538"	ppm	5 maximum

⁽¹⁾ The final blend of biodiesel as used in the engine must meet the requirements that are stated in the "Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines" in Table 18.

Note: Fuels that meet the most current revision level of "ASTM D6751" or "EN 14214" may be used for blending with an acceptable distillate fuel. The conditions, recommendations, and limits that are noted in this biodiesel section apply.

Cooling System Specifications

i02885404

General Coolant Information

SMCS Code: 1350; 1395

NOTICE

Every attempt is made to provide accurate, up to date information. By use of this document you agree that Caterpillar Inc. is not responsible for errors or omissions.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids and greases.

The information that is provided are the latest recommendations for the Caterpillar diesel engines that are covered by this Special Publication. This information supersedes all previous recommendations which have been published for the Caterpillar diesel engines that are covered by this Special Publication. Special fluids may be required for some engines and it will be necessary to continue to use these special products. Refer to the applicable Operation and Maintenance Manual.

NOTICE

These recommendations are subject to change without notice. Contact your local Caterpillar dealer for the most up to date 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 caused by freezing coolant.

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. The maximum recommended cooling system fill rate for some smaller engine models will be less. Refer to the engine's Operation and Maintenance Manual for exceptions.

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 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.

Note: Refer to the specific engine Operation and Maintenance Manual, "Maintenance Interval Schedule" for the correct interval for the replacement of the cooling system water temperature regulator.

Consult your Caterpillar dealer 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. In addition, water alone does not provide adequate protection against boiling or freezing.

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

Note: Caterpillar recommends a minimum of 30 percent glycol in diesel engine cooling systems. Refer to the Operation and Maintenance Manual for your engine for exceptions.

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 that meets or exceeds the minimum acceptable water requirements that are listed in Table 21.

Table 21

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (Cl)	40 mg/L (2.4 grains/US gal)	"D512", "D4327"
Sulfate (SO ₄)	100 mg/L (5.9 grains/US gal)	"D516", "D4327"
Total Hardness	170 mg/L (10 grains/US gal)	"D1126"
Total Solids	340 mg/L (20 grains/US gal)	"D1888" "Federal Method 2540B" ⁽¹⁾
Acidity	pH of 5.5 to 9.0	"D1293"

⁽¹⁾ Total dissolved solids dried at 103 - 105°C, "Standard Method for the Examination of Water and Wastewater", American Public Health Association, et al, 1015 15th Street, N.W. Washington, DC 20005

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 Cat SCA (Supplemental Coolant Additive) to Cat DEAC (Diesel Engine Antifreeze/Coolant) or by adding ELC Extender to Cat ELC (Extended Life Coolant).

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
- Water pump cavitation (ATAAC equipped engines)

For optimum performance, Caterpillar recommends a 1:1 mixture of properly inhibited distilled or deionized water and glycol.

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

Note: 100 percent pure ethylene glycol will freeze at a temperature of -23 °C (-9 °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 22 and 23.

Table 22

Ethylene Glycol Concentration		
Concentration	Freeze Protection	Boil Protection ⁽¹⁾
50 Percent	-37 °C (-34 °F)	106 °C (223 °F)
60 Percent	-52 °C (-62 °F)	111 °C (232 °F)

⁽¹⁾ Boiling protection is increased with the use of a pressurized radiator.

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. Do not use ethylene glycol in concentrations that exceed 60 percent glycol.

Table 23

Propylene Glycol Concentration		
Concentration	Freeze Protection	Boil Protection ⁽¹⁾
50 Percent	-32 °C (-26 °F)	106 °C (223 °F)

⁽¹⁾ Boiling protection is increased with the use of a pressurized radiator.

Note: Propylene glycol coolant that is used in the cooling systems for Caterpillar diesel engines must meet the most current revision level of ASTM D6210, "Fully-Formulated Glycol-Based Engine Coolant for Heavy-Duty Engines". When propylene glycol coolant is used in heavy-duty diesel engines, a regular addition of SCA is required for protection against liner cavitation. Consult your Caterpillar dealer for additional information.

Testing the Concentration of Glycol

To check the concentration of glycol, use the 245-5829 Coolant/Battery Tester/Refractometer. The tester gives readings that are immediate and accurate in both degrees Celsius and degrees Fahrenheit. The tester can be used with ethylene or propylene glycol.

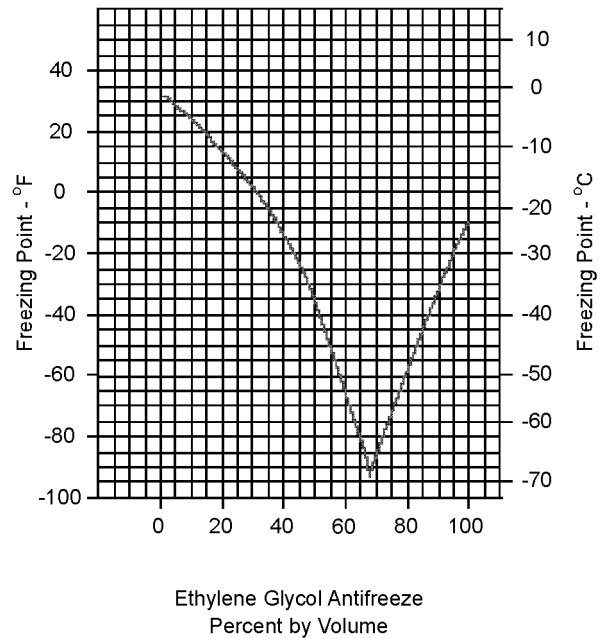


Illustration 9

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Curve of the freezing point for a typical ethylene glycol solution.

Table 24

Freeze Protection for Antifreeze Concentrations ⁽¹⁾	
Protection to:	Concentration
-15 °C (5 °F)	30% glycol 70% water
-24 °C (-12 °F)	40% glycol 60% water
-37 °C (-34 °F)	50% glycol 50% water
-52 °C (-62 °F)	60% glycol 40% water

⁽¹⁾ Ethylene glycol based antifreeze.

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Coolant Recommendations

SMCS Code: 1350; 1352; 1395

The following two types of coolants may be used in Caterpillar diesel engines:

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

Acceptable – Cat DEAC (Diesel Engine Antifreeze/Coolant) or a commercial heavy-duty antifreeze/coolant that meets the most current revision level of “ASTM D4985” or “ASTM D6210” specifications.

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.

Use only the coolant/antifreeze that is recommended.

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

Note: Cat DEAC does not require a treatment with an SCA at the initial fill. However, a commercial heavy-duty coolant/antifreeze that only meets the “ASTM D4985” specification WILL require a treatment with an SCA at the initial fill. A commercial heavy-duty coolant/antifreeze that meets the “ASTM D6210” specification WILL NOT require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the manufacturer of the commercial heavy-duty coolant/antifreeze.

Note: These coolants WILL require a treatment with a supplemental coolant additive on a maintenance basis.

Note: When recycled coolants are used, use only coolants that have been recycled from extended life, conventional heavy-duty, or automotive coolants that were originally manufactured from virgin ethylene or propylene glycol. Recycled coolants should meet the most current revision level of “ASTM D6210”.

NOTICE

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

Note: Caterpillar recommends a minimum of 30 percent glycol in diesel engine cooling systems. Refer to the engine’s Operation and Maintenance Manual for exceptions.

Table 25

Coolant Service Life	
Coolant Type	Service Life ⁽¹⁾⁽²⁾
Cat ELC	12000 Service Hours or Six Years ⁽³⁾
Commercial coolant that meets the Caterpillar EC-1 Specification	6000 Service Hours or Six Years ⁽⁴⁾
Cat DEAC	3000 Service Hours or Three Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D6210”	3000 Service Hours or Two Years
Commercial Heavy-Duty Coolant/Antifreeze that meets “ASTM D4985”	3000 Service Hours or One Year

- (1) Use the interval that occurs first. The cooling system must also be flushed out at this time.
- (2) Refer to the engine’s Operation and Maintenance Manuals, “Maintenance Interval Schedule” for the correct interval for replacement of the cooling system water temperature regulator.
- (3) Cat ELC Extender must be added at 6000 service hours or one half of the service life of the Cat ELC. Refer to your machine Operation and Maintenance Manual for exceptions.
- (4) An extender must be added at 3000 service hours or one half of the service life of the coolant.

Note: These coolant change intervals are only achievable with annual S-O-S Services Level 2 coolant sampling and analysis.

Cat ELC, Cat DEAC, Cat Extender, and Cat SCA are available in several container sizes.

Table 26

Part Numbers of Coolant		
Description	Size	Part Number ⁽¹⁾
Cat DEAC (Concentrate)	Bulk	2P-9868 or 156-2649
	208.2 L (55 US gal)	8C-3686 238-8653 ⁽²⁾
	3.8 L (1 US gal)	8C-3684 238-8651 ⁽²⁾
Cat ELC (50/50 Premix)	Bulk	156-2653
	208.2 L (55 US gal)	101-2845 238-8650 ⁽²⁾
	18.9 L (5 US gal)	129-2151 238-8649 ⁽²⁾
	3.8 L (1 US gal)	101-2844 238-8648 ⁽²⁾
Cat ELC (Concentrate)	3.8 L (1 US gal)	119-5150 238-8647 ⁽²⁾
Cat ELC Extender	0.946 L (1 qt) 3.8 L (1 US gal)	119-5152 210-0786

⁽¹⁾ The availability of part numbers will vary by the region. Consult your Caterpillar dealer.

⁽²⁾ With embitterment. Embitterment makes the coolant taste bad. This is done in order to deter accidental human or animal ingestion of the coolant/antifreeze.

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Extended Life Coolant

SMCS Code: 1350; 1352; 1395

Cat ELC

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

- Heavy-duty diesel engines
- Automotive applications

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

Cat ELC extends the service life of the coolant to 12000 service hours or six years. Cat ELC does not require the frequent addition of a SCA (Supplemental Coolant Additive). An Extender is the only additional maintenance that is needed at 6000 service hours or one half of the Cat ELC service life.

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

Cat ELC Concentrate is also available. Cat ELC Concentrate can be used to lower the freezing point to -52°C (-62°F) for arctic conditions.

Containers of several sizes are available. Refer to this Special Publication, "Coolant Recommendations" article for available quantities and part numbers.

Note: Caterpillar developed the EC-1 specification. The Cat EC-1 specification is an industry standard. The Cat 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. Cat ELC meets the performance requirements of "ASTM D4985" and "ASTM D6210" for heavy-duty low silicate antifreeze/coolants, but does not require treatment with a conventional SCA. Cat ELC also meets the performance requirements of "ASTM D3306" for automotive applications.

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Extended Life Coolant Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

Proper Additions to the Cat ELC (Extended Life Coolant)

NOTICE

Use only Caterpillar products or commercial products that have passed Caterpillar's EC-1 specification for pre-mixed or concentrated coolants.

Use only Cat ELC Extender with Cat ELC.

Do NOT use conventional SCA with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Do NOT mix brands or types of coolant. Do NOT mix brands or types of SCA and/or brands or types of extenders. Different brands or types may use different additive packages to meet the cooling system requirements. Different brands or types may not be compatible.

Failure to follow the recommendations can reduce cooling system component life unless appropriate corrective action is performed.

In order to maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of Cat ELC. Lowering the proportion of antifreeze lowers the proportion of additive. This will lower the ability of the coolant to protect the system from pitting, from cavitation, from erosion, and from deposits.

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 245-5829 Coolant/Battery Tester/Refractometer. This tester gives readings that are immediate and accurate in both degrees Celsius and degrees Fahrenheit. Use Cat 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 that is filled with Cat ELC.

Do not use conventional SCA. Only use Cat ELC Extender in cooling systems that are filled with Cat ELC.

Cat ELC Extender

Cat ELC Extender is added to the cooling system halfway through the Cat ELC service life. Treat the cooling system with Cat ELC Extender at 6000 hours or one half of the coolant service life. Refer to your machine Operation and Maintenance Manual for exceptions. Refer to the "Part Number of Coolant" table in this Special Publication, "Coolant Recommendations" article for available quantities and part numbers.

Use the formula in Table 28 to determine the proper amount of Cat ELC Extender for your cooling system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations" in order to determine the capacity of the cooling system.

Table 27

Formula For Adding Cat ELC Extender To Cat ELC
$V \times 0.02 = X$
V is the total capacity of the cooling system.
X is the amount of Cat ELC Extender that is required.

Table 28 is an example for using the formula that is in Table 27.

Table 28

Example Of The Equation For Adding Cat ELC Extender To Cat ELC ⁽¹⁾		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of Cat ELC Extender that is Required (X)
92 L (24.3 US gal)	× 0.02	1.8 L (0.5 US gal) or (64 fl oz)

⁽¹⁾ This example is based on the capacity of a D8R Track-Type Tractor with a cooling system capacity of 92 L (24.3 US gal).

NOTICE

When using Cat ELC, do not use conventional SCAs, or, if equipped, SCA maintenance elements. To avoid SCA contamination of an ELC system, remove the SCA element base and plug off or bypass the coolant lines.

Cat 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 a properly maintained cooling system.

After the cooling system is drained and after 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 until the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

Recycling Cat ELC

Cat ELC can be recycled into conventional coolants. The drained coolant mixture can be distilled in order to remove the ethylene glycol and the water. The ethylene glycol and the water can be reused. The distilled material does not contain the additives that are required to be classified as either Cat ELC or Cat DEAC. Consult your Caterpillar dealer for more information. Recycled coolants should meet the most current revision level of "ASTM D6210".

Changing to Cat ELC

To change from heavy-duty coolant/antifreeze to the 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 Dealer Service Tool Catalog" and to Special Publication, PECJ0003, "Cat Shop Supplies and Tools" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to applicable regulations and mandates.

1. Drain the coolant into a suitable container.
2. Dispose of the coolant according to local regulations.
3. If equipped, remove the empty SCA maintenance element and remove the element base. Plug the coolant lines or bypass the coolant lines.

NOTICE

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

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

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

4. Flush the system with clean water in order to remove any debris.
5. Use Caterpillar cleaner for cooling systems in order 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 Cat 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. Refer to Specifications, SENR3130, "Torque Specifications" for the proper torques. 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 °C to 66 °C (120 °F to 151 °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.
-

NOTICE

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 the 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, PMEP5027, "Label" to the cooling system filler for the engine in order to indicate the use of Cat ELC.

Note: Clean water is the only flushing agent that is required when Cat ELC is drained from a properly maintained cooling system.

Cat ELC Cooling System Contamination

NOTICE

Mixing Cat ELC with other products reduces the effectiveness of the Cat ELC and shortens the Cat 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 Cat ELC Extender with Cat ELC. Do NOT mix brands or types of coolants. Failure to follow these recommendations can result in shortened cooling system component life.

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

- If the cooling system contamination is caused by cooling system damage, follow the procedures under the "Changing to Cat ELC" heading. Also follow the procedures under the "Changing to Cat ELC" heading if the engine has been operated since being contaminated with more than ten percent conventional heavy-duty coolant/antifreeze and/or SCA. Certain types of cooling system contamination may require disassembly of the cooling system and manual cleaning of system components.
- If the cooling system is contaminated with more than ten percent conventional heavy-duty coolant/antifreeze and/or SCA, but the engine has not been operated, drain the cooling system into a suitable container. Dispose of the coolant according to local regulations. Thoroughly flush the system with clean water. Fill the system with the Cat ELC.

- Maintain the system as a conventional DEAC (Diesel Engine Antifreeze/Coolant) or other conventional coolant. If the SCA concentration is less than three percent, treat the system with an SCA. Maintain a three to six percent SCA concentration in the coolant. Change the coolant at the interval that is recommended for Cat DEAC or at the interval that is recommended for the conventional commercial coolants.

Commercial Extended Life Coolant

If Cat ELC is not used, then select a commercial extended life coolant that meets the Cat EC-1 specification and the "ASTM D6210" specification. Do not use an extended life coolant that does not meet the Cat EC-1 specification. Follow the maintenance guidelines 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.

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

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Diesel Engine Antifreeze/Coolant

SMCS Code: 1350; 1352; 1395

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

Cat DEAC is formulated with the correct amount of Cat SCA (Supplemental Coolant Additive). Do not use Cat SCA at the initial fill when Cat DEAC is used at the recommended 1:1 or higher concentration with a recommended water.

Containers of several sizes are available. Refer to this Special Publication, "Coolant Recommendations" for available container sizes and part numbers, or consult your Caterpillar dealer for the part numbers.

If concentrated Cat 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, refer to this Special Publication, "General Coolant Information" article.

Note: The concentrated Cat DEAC and the recommended water must be thoroughly mixed prior to filling the cooling system.

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Supplemental Coolant Additive

SMCS Code: 1350; 1352; 1395

The use of SCA (supplemental coolant additive) helps to prevent the following conditions from occurring:

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

Cat DEAC (Diesel Engine Antifreeze/Coolant) is formulated with the correct level of Cat SCA. When the cooling system is initially filled with the recommended 1:1 or higher concentration of Cat DEAC and a recommended water, adding more Cat SCA is not necessary until the concentration of Cat SCA has been reduced to an unacceptable level. To ensure that the correct amount of Cat SCA is in the cooling system, the concentration of Cat SCA must be tested on a scheduled basis. Refer to the specific machine's Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).

Cat SCA maintenance elements and containers of Cat SCA are available in several sizes. Refer to the Table "Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze" and Table "Caterpillar Liquid SCA" in this Special Publication, "Conventional Coolant/Antifreeze Cooling System Maintenance" article for the part numbers.

Note: Do not exceed a six percent maximum concentration of SCA. Maintain a three to six percent SCA concentration in the coolant.

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Conventional Coolant/ Antifreeze Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

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.

NOTICE

Do NOT mix brands or types of coolant. Do NOT mix brands or types of SCA and/or brands or types of extenders. Different brands or types may use different additive packages to meet the cooling system requirements. Different brands or types may not be compatible.

Failure to follow the recommendations can reduce cooling system component life unless appropriate corrective action is performed.

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 245-5829 Coolant/Battery Tester/Refractometer. The tester gives readings in both degrees Celsius and degrees Fahrenheit that are immediate and accurate. The tester can be used with ethylene and/or with propylene glycol.

Caterpillar engine cooling systems should be tested at 250 hour intervals or at the PM Level 1 intervals for the concentration of SCA (Supplemental Coolant Additive). 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 intervals or at the intervals for PM Level 1. Refer to this Special Publication, "S·O·S Services Coolant Analysis" article 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 may be needed at 250 hour intervals or at the intervals for PM Level 1.

Note: Conventional heavy-duty coolant/antifreeze of all types REQUIRE periodic additions of SCA.

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 29 and refer to table 30 for part numbers and for the quantities of SCA maintenance elements and/or liquid SCA.

Table 29

Caterpillar Liquid SCA⁽¹⁾	
Part Number	Size of Container
6V-3542	0.24 L (8 oz)
8T-1589	0.47 L (16 oz)
3P-2044	0.94 L (32 oz)
217-0616	1 L (34 oz)
237-7673	5 L (1.3 US gal)
8C-3680	19 L (5.0 US gal)
217-0617	20 L (5.3 US gal)
5P-2907	208 L (55 US gal)
217-0618	208 L (55 US gal)

⁽¹⁾ The availability of part numbers will vary from one region to another region.

Table 30

Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze				
Cooling System Capacity	Initial Fill⁽¹⁾	250 hours or Intervals for PM Level 1 ⁽²⁾⁽³⁾	Spin-on Element at 250 hours or at Intervals for PM Level 1⁽²⁾⁽³⁾⁽⁴⁾	Quantity of Elements
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 Cat DEAC or with fully formulated coolants that meet the "ASTM D6210" specification.

⁽²⁾ Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit, or check the concentration of SCA with Cat S-O-S Services coolant analysis.

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

⁽⁴⁾ Spin-on elements may not be available for all applications.

Cooling Systems with Larger Capacities

Adding the SCA to Conventional Coolant/Antifreeze at the Initial Fill

Note: When the coolant system is first filled, the SCA is not required to be used with Cat DEAC or with fully formulated coolants that meet the “ASTM D6210” specification when used at the recommended 1:1 or higher concentration with a recommended water.

Note: Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit, or check the concentration of SCA with Cat S·O·S coolant analysis.

Commercial heavy-duty coolant/antifreeze that meets only the “ASTM D4985” specification WILL require adding supplemental coolant additive at the initial fill. Read the label or the instructions that are provided by the manufacturer of the commercial heavy-duty coolant/antifreeze.

Use the equation that is in Table 31 to determine the amount of Cat SCA that is required when the cooling system is initially filled with fluids that only meet the “ASTM D4985” specification.

Table 31

Equation For Adding The Cat SCA To Conventional Coolant/Antifreeze At The Initial Fill
$V \times 0.045 = X$
V is the total volume of the cooling system.
X is the amount of Cat SCA that is required.

Table 32 is an example for using the equation that is in Table 31.

Table 32

Example Of The Equation For Adding The Cat SCA To Conventional Coolant/Antifreeze At The Initial Fill		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of Cat SCA that is Required (X)
946 L (250 US gal)	× 0.045	43 L (11 US gal)

Adding the SCA to Conventional Coolant/Antifreeze For Maintenance

Heavy-duty coolant/antifreeze of all types REQUIRE periodic additions of a supplemental coolant additive.

Test the coolant/antifreeze periodically for the concentration of SCA. For the recommended testing interval, see the Operation and Maintenance Manual, “Maintenance Interval Schedule” for your engine or refer to this Special Publication, “S·O·S Services Coolant Analysis” article, “Recommended Interval” Table in this Special Publication. SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this Special Publication, “S·O·S Services Coolant Analysis” article.

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 33 to determine the amount of Cat SCA that is required, if necessary.

Table 33

Equation For Adding The Cat SCA To Conventional Coolant/Antifreeze For Maintenance
$V \times 0.014 = X$
V is the total volume of the cooling system.
X is the amount of Cat SCA that is required.

Table 34 is an example for using the equation that is in Table 33.

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

Table 34

Example Of The Equation For Adding The Cat SCA To Conventional Coolant/Antifreeze For Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of Cat SCA that is Required (X)
946 L (250 US gal)	× 0.014	9 L (4 US gal)

Table 30 lists part numbers and the sizes of containers for Cat SCA that is available from your Caterpillar dealer.

Cleaning the System of Heavy-Duty Coolant/Antifreeze

Before Caterpillar’s SCA can be effective, the cooling system must be free from rust, scale, and other deposits. Preventive cleaning helps avoid downtime caused by expensive out-of-service cleaning required for extremely dirty and neglected cooling systems.

Caterpillar Cooling System Cleaner - Standard:

- Dissolves or depresses mineral scale, corrosion products, light oil contamination, and sludge.
- Cleans the cooling system after used coolant is drained or before the cooling system is filled with new coolant.
- Cleans the cooling system whenever the coolant is contaminated or whenever the coolant is foaming.
- Cleans the engine while still in service.
- Reduces downtime and cleaning costs.
- Avoid costly repairs from pitting and other internal problems caused by improper cooling system maintenance.
- Can be used with glycol-based antifreeze.
- For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for your engine. Also, refer to this Special Publication, "Coolant Recommendations" article, "Coolant Service Life" table for the cooling system flush and fill schedule.

Caterpillar Standard Cooling System Cleaner is designed to clean the cooling system of harmful scale and corrosion without removing the engine from service. The cleaners, both "Standard" and "Quick Flush" can be used in all Caterpillar engine cooling systems. Contact your Caterpillar dealer for part numbers.

Note: These cleaners must not be used in systems that have been neglected or that have heavy scale buildup. These systems require a stronger commercial solvent that is available from local distributors.

Follow label directions for proper usage.

Recycling Cat DEAC

Cat DEAC can be recycled. The drained coolant mixture can be distilled in order to remove the ethylene glycol and water. The ethylene glycol and the water can be reused. The distilled material does not contain the additives that are required to be classified as either Cat ELC or Cat DEAC. Consult your Caterpillar dealer for more information.

When recycled coolants are used, use only coolants that have been recycled from extended life, conventional heavy-duty, or automotive coolants that were originally manufactured from virgin ethylene or propylene glycol.

Recycled coolants should meet the most current revision level of "ASTM D6210".

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Commercial Heavy-Duty Coolant/Antifreeze and SCA (Supplemental Coolant Additive)

SMCS Code: 1350; 1352; 1395

NOTICE

Caterpillar does not warrant the quality or performance of non-Caterpillar fluids.

If Cat DEAC (Diesel Engine Antifreeze/Coolant) is not used, select a coolant/antifreeze with low silicate content for heavy-duty applications that meets the most current revision level of "ASTM D6210" or "ASTM D4985" specifications.

Refer to this Special Publication, "Coolant Recommendations" article, "Coolant Service Life" table for the cooling system flush and fill schedule.

When a heavy-duty coolant/antifreeze is used, treat the cooling system with three to six percent Cat SCA by volume. Maintain a concentration level of SCA in the cooling system that is between three percent and six percent. For more information, see this Special Publication, "Conventional Coolant/Antifreeze Cooling System Maintenance" article.

If Cat SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 1400 mg/L or 1400 ppm (82 grains/US gal) of nitrites in the final coolant mixture.

Maintain a concentration level of nitrites in the cooling system that is between 1200 ppm (70grains/US gal) and 2400 ppm (140 grains/US gal).

Conventional coolant/antifreeze for heavy-duty applications that only meets the "ASTM D4985" specification WILL require treatment with SCA at the initial fill. These coolants WILL require treatment with SCA on a maintenance basis.

Conventional coolant/antifreezes for heavy-duty applications that meet the "ASTM D6210" specification do not require treatment with SCA at the initial fill when used at the recommended 1:1 or higher concentration with a recommended water. Treatment with SCA WILL be required on a maintenance basis.

When concentrated coolant/antifreeze is mixed, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, water which has the required properties may be used. For the water properties, see this Special Publication, "General Coolant Information" article.

Note: The concentrated coolant/antifreeze and the recommended water must be thoroughly mixed prior to filling the cooling system.

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S-O-S Services Coolant Analysis

SMCS Code: 1350; 1395; 7542

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and freezing. 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 separate pump for oil sampling and a separate pump for coolant sampling.

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

New Systems, Refilled Systems, and Converted Systems

Perform an S-O-S coolant analysis (Level 2) at the following maintenance intervals.

- Every Year
- Initial 500 service hours

Perform this analysis at the interval that occurs first for new systems, for refilled systems, or for converted systems that use Cat ELC (Extended Life Coolant) or use Cat DEAC (Diesel Engine Antifreeze/Coolant). This 500 hour check will also check for any residual cleaner that may have contaminated the system.

Recommended Interval for S-O-S Services Coolant Sample

Table 35

Recommended Interval		
Type of Coolant	Level 1	Level 2
Cat DEAC	Every 250 hours ⁽¹⁾⁽²⁾	Yearly ⁽¹⁾⁽²⁾⁽³⁾
Cat ELC	Optional ⁽³⁾	Yearly ⁽³⁾

⁽¹⁾ This is also the recommended sampling interval for all commercial coolants that meet Cat EC-1 (Engine Coolant specification - 1)

⁽²⁾ This is also the recommended sampling interval for all conventional heavy-duty coolant/antifreeze .

⁽³⁾ The Level 2 Coolant Analysis should be performed sooner if a problem is suspected or identified.

Note: Check the SCA (Supplemental Coolant Additive) of the conventional coolant at every oil change or at every 250 hours. Perform this check at the interval that occurs first.

S-O-S Services 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 and boil protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

S·O·S Services Coolant Analysis (Level 2)

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

The S·O·S coolant analysis (Level 2) has the following features:

- Full coolant analysis (Level 1)
- Identification 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 the possibility of electrolysis within the cooling system of the engine

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

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Frequently Asked Questions (Ultra Low Sulfur Diesel (ULSD) Fuel)

SMCS Code: 1000; 7000

NOTICE

Every attempt is made to provide accurate, up to date information. By use of this document, you agree that Caterpillar is not responsible for errors or omissions.

NOTICE

Model year 2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines REQUIRE the use of Ultra Low Sulfur Diesel (ULSD) fuel (≤ 15 ppm sulfur).

“Sulfur-free” diesel fuel (≤ 10 ppm sulfur) is strongly recommended for use in “EURO 4” certified on-highway diesel engines, while diesel fuel with ≤ 50 ppm sulfur is acceptable.

For additional on-highway diesel engine fluids requirements, refer to the most current revision level of Special Publication, SEBU6385, “Caterpillar On-Highway Diesel Engine Fluids Recommendations”.

Note: For additional information on ULSD, refer to this Special Publication, “Fuel Specifications” section.

1. What is ULSD and how is it different from Low Sulfur Diesel (LSD)?

The United States (U.S.) Environmental Protection Agency (EPA) defines Ultra-Low Sulfur Diesel (ULSD - S15) as a U.S. diesel fuel with a sulfur content not to exceed 15 parts per million (ppm) or 0.0015% by weight. Low Sulfur Diesel (LSD - S500) is defined as a U.S. diesel fuel with a sulfur content not to exceed 500 ppm or 0.05% by weight. The LSD fuel commonly available in North America normally does not exceed 350 ppm sulfur. Both ULSD and LSD should meet the fuel requirements outlined in the most current revision level of “ASTM D975”.

Note: In Europe, ultra low sulfur diesel fuel will have a maximum of 0.0010 percent (10 ppm) sulfur and is typically referred to as “sulfur-free”. Also, the most commonly available diesel fuel in Europe has a maximum sulfur content of 0.005 percent (50 ppm). These sulfur levels are defined in European Standard “EN 590:2004”.

2. Why is the sulfur content of diesel fuel in the U.S. reduced to 15 ppm?

ULSD is required by U.S. EPA regulations for highway vehicles to ensure that these vehicles will meet emissions standards to improve air quality. In California, other properties of vehicular diesel fuel are also controlled to help reduce smog.

For additional on-highway diesel engine fluids requirements, refer to the most current revision level of Special Publication, SEBU6385, “Caterpillar On-Highway Diesel Engine Fluids Recommendations”.

3. Can I use ULSD in the non-highway engines?

Yes. Refer to these “Frequently Asked Questions” and to the “Fuel Specifications” section in this Special Publication for guidance when ULSD will be used.

4. Should I be concerned with the lubricity of ULSD?

Diesel fuel lubricity is necessary to minimize wear on fuel pumps and injectors. ULSD fuel requires good lubricity and corrosion inhibitors in order to prevent unacceptable engine wear. In the U.S., as necessary, additives to increase lubricity and to inhibit corrosion will be added to ULSD fuel prior to its retail sale. With these additives, ULSD fuel is expected to perform as well as LSD fuel. All Caterpillar electronic engines produced since model year (MY) 2000 are qualified to run on ULSD fuel.

Note: Have the fuel supplier confirm that the ULSD fuel available meets the most current revision level of “ASTM D975” and/or “EN 590” lubricity requirements.

In North America, diesel fuel that is identified as “ASTM D975” Grade No. 2-D S15 or “ASTM D975” Grade No. 1-D S15 and meeting the “ASTM D975-07b” Thermal Stability Guideline X3.10.2.2 generally meet the “Caterpillar Specification for Distillate Diesel Fuel for Off-Highway Diesel Engines” requirements for ULSD fuel.

In Europe, diesel fuel that is identified as meeting “EN 590” 10 ppm or less sulfur requirements (“sulfur-free”), generally meet the Caterpillar requirements for ULSD fuel.

Note: “EN 590” currently allows up to 5 percent (B5) biodiesel. Refer to the “Fuel Specifications” section, and to the “Biodiesel” topic in this Special Publication for guidance when biodiesel will be used.

5. Will a special color or dye identify the ULSD fuel?

Due to the processing required to produce ULSD fuel, ULSD fuel color can vary widely from the traditional colorless to amber, to anything from a light toned green, yellow, orange, or pink. Under certain light conditions, the color may appear to be slightly fluorescent.

In the U.S., diesel fuel destined for off-highway use is required by law to be dyed red. Use of this red dyed fuel in on-highway applications is illegal. There are currently no regulations that require diesel fuel destined for on-highway use to be dyed.

There is no relationship between the natural diesel fuel color and such desirable diesel fuel qualities as heat content, viscosity, cloud point, cetane number or distillation range. Diesel fuel color varies with the crude source, refinery methods and the use of dyes. However, if the fuel color darkens appreciably during storage, this could indicate oxidation and/or contamination from dirt, water, algae, bacteria, or other sources that can cause operational problems.

6. Does ULSD affect the fuel system seals?

Caterpillar has completed the review of the engine fuel system technology and the system compatibility with ULSD fuel for on and off-highway products. Electronically controlled (ECM) engines, manufactured after 2000 and that have been properly maintained, are compatible with fuel with less than 50 ppm sulfur content and comply with “ASTM D975” Grade No. 2-D S15 or “ASTM D975” Grade No. 1-D S15 or “EN 590” “sulfur-free” (10 ppm or less sulfur). Refer to this Special Publication, “Fuel Specifications” section for more information.

Earlier engines including those with mechanical fuel systems should be watched for external leaks. The belief is that only a small number of fuel system seals may be affected. Leaks that do develop are expected to typically be experienced as minor seepage, slobber, or drips. If a leak should develop, a possible correction is to tighten the joint and/or connection to the proper torque. If a leak is detected, please contact your Caterpillar dealer or authorized service center as soon as possible and schedule a repair. Whenever possible, use Viton seal material and hoses that are compatible with diesel fuel as your best protection against fuel system leaks.

Note: Fuel additives will not stop or will not prevent seal leaks, seepage, slobber, or drips that may result from transitioning to ULSD fuel.

7. Can I use the current Caterpillar fuel filters?

Yes, ULSD fuel is fully compatible with current fuel filter technology. ULSD fuel has a tendency to clean fuel tanks and other fuel system parts efficiently, which may cause fuel filter plugging during the initial transition period. More frequent fuel filter changes may be required during the transition period from LSD to ULSD fuel.

ULSD fuel typically has a slightly higher wax content than LSD fuel. Have your fuel supplier confirm that the fuel is blended to flow at the ambient temperatures being experienced in your region. In the U.S., diesel fuels are typically blended to provide cold performance per the guidelines that are provided in the most current revision level of “ASTM D975”.

8. Are aftermarket fuel additives recommended with ULSD?

There are many different types of fuel additives. 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 and cause deposits in the fuel system. The deposits may cause seizure. Some additives may plug fuel filters. Some additives may be corrosive, and some additives may be harmful to the elastomers in the fuel system. Some additives may damage emission control systems. Some additives may raise fuel sulfur levels above the maximum allowed by the U.S. EPA and/or, as appropriate, other regulatory agencies. 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. Refer to the answer to question 4 for more information. Also, refer to this Special Publication “Distillate Diesel Fuel” article, “Aftermarket Fuel Additives” and “Cat Diesel Fuel Conditioner” topics.

9. Can biodiesel fuel be blended as ULSD?

Biodiesel can be blended as either LSD or as ULSD.

For additional information, refer to the “Fuel Specifications” section, and to the “Biodiesel” topics in this Special Publication.

The engine user has the responsibility of using the correct fuel that is recommended by the manufacturer and is allowed by the U.S. EPA and other appropriate regulatory agencies.

10. What effect does blending used lubricating oil into diesel fuel have on engine performance and fuel quality?

In general, this practice is **not** recommended. It may adversely affect fuel quality features and could lead to fuel system and piston deposits, increased exhaust emissions and fuel filter plugging. This practice may also result in the diesel fuel being out of compliance with U.S. EPA, state, and other appropriate regulatory agencies requirements.

Note: Blending lubricating oil with ULSD fuel may raise the sulfur level above 15 ppm.

Do **not** use diesel fuel that has been blended with lubricating oil in the following applications:

- MY2007 and newer (U.S. EPA 2007 certified) on-highway diesel engines and/or EURO 4 certified on-highway diesel engines. Use of oil/fuel blends in these on-highway diesel engines may cause engine damage.
- Engines that are equipped with a DPF. Use of oil/fuel blends in DPF equipped diesel engines may cause the need for more frequent cleaning cycles, contribute to DPF plugging and may cause DPF damage.

The user of the engine has the responsibility of using the correct fuel that is recommended by the manufacturer and allowed by the U.S. EPA and other appropriate regulatory agencies. The user also has the responsibility of obtaining the proper local exemptions, regional exemptions, and/or national exemptions that are required for the use of crankcase oil/fuel blends in any Caterpillar engine that is regulated by emissions standards.

11. What about special fuels (JP-5, JP-8, Kerosene, Jet A, Jet A-1)?

These fuels typically have a much higher sulfur content than is allowed by the U.S. EPA regulations for maximum sulfur content of ULSD. The sulfur content for these fuels typically far exceeds 15 ppm.

These fuels typically have a much higher sulfur content than the maximum fuel sulfur content allowed by the European Standard “590:2004”. The sulfur content of these fuels typically far exceeds 50 ppm.

12. Does ULSD affect engine performance and fuel economy?

Diesel fuel suppliers advise that the new ULSD fuel contains more wax, but will deliver 0% to 2% lower fuel economy (approximately 1% lower on average). How can this be?

Diesel engine operators often consider the waxes found in diesel fuel as delivering most of the fuel’s energy. This is assumed because lighter fuels such as No. 1D and kerosene do not typically have winter wax problems and because No. 1D and kerosene give lower fuel economy.

During desulfurization, a percentage of the fuels aromatic and naphthenic components are converted to less dense paraffinic waxes. There is now more wax, but the density of the fuel is lower. The lower fuel density of ULSD results in less energy per gallon.

13. What specification requirements of diesel fuel should concern me?

Cetane number (ignition quality), cleanliness, low-temperature operability, stability, and lubricity are the diesel fuel requirements of principal concern to the end user.

Note: ULSD has less electrical conductivity than LSD. Follow all industry standard grounding and safety practices.

Note: For applications where ULSD is required, have the fuel supplier confirm that the ULSD fuel available meets all Caterpillar requirements for distillate diesel fuel and/or the most current revision level of “ASTM D975 S15” and/or the “EN 590” (“sulfur-free”) requirements.

In North America, diesel fuel that is identified as “ASTM D975” Grade No. 2-D S15 or “ASTM D975 S15” Grade No. 1-D S15 and meet the “ASTM D975-07b” Thermal Stability Guideline X3.10.2.2 generally meet the Caterpillar requirements for ULSD fuel. Refer to this Special Publication, “Fuel Specifications” section.

In Europe, diesel fuel that is identified as meeting “EN 590”, 10 ppm or less sulfur requirements (“sulfur-free”), generally meet the Caterpillar requirements for ULSD fuel. Refer to this Special Publication, “Fuel Specifications” section.

Note: “EN 590” currently allows up to 5 percent (B5) biodiesel. Refer to the “Fuel Specifications” section, and to the “Biodiesel” topic in this Special Publication for guidance when biodiesel will be used.

14. Does ULSD fuel require a different storage procedure?

No. When properly treated by the fuel supplier with a fuel stability additive, both LSD and ULSD fuel can typically be stored for up to one year. The same commonly used and approved storage tank maintenance practices used for LSD fuel should also be used with ULSD fuel. The storage tanks and containers commonly used with LSD fuel are suitable for ULSD fuel.

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Reference Material

SMCS Code: 1000; 7000

The following publications are available for order through your Caterpillar dealer.

Note: The information that is contained in the listed publications is subject to change without notice. Consult your local Caterpillar dealer for the most current recommendations.

Note: Refer to this Special Publication, the respective product data sheet, and to the appropriate Operation and Maintenance Manual for product application recommendations.

Coolant

- Datasheet, PEHJ0067, “Cat ELC (Extended Life Coolant)” (Worldwide)
- Special Publication, PMP5027, “ Cat Label - ELC Radiator Label” (25 per package)
- Datasheet, PEHP9554, “Cat DEAC (Diesel Engine Antifreeze/Coolant) (Concentrate)”
- Special Publication, REHS1063, “Know Your Track-Type Tractor Cooling System”
- Special Publication, SEBD0518, “Know Your Cooling System”
- Special Publication, SEBD0970, “Coolant and Your Engine”

Diesel Engine Oil

- Datasheet, PEHJ0159, “Cat DEO-ULS (SAE 15W-40)” (North America - Canada, Mexico, and United States)
- Datasheet, PEHJ0059, “Cat DEO (SAE 10W-30 and SAE 15W-40)” (North America - Canada, Mexico, and United States)
- Datasheet, PEHJ0021, “Cat DEO (SAE 10W-30 and SAE 15W-40)” (Worldwide - except North America, Egypt, Saudi Arabia, and Brazil)
- Datasheet, PEHJ0072, “Cat DEO (SAE 10W-30 and SAE 15W-40)” (Brazil)
- Datasheet, PEHJ0091, “Cat DEO (SAE 10W-30 and SAE 15W-40)” (Egypt and Saudi Arabia)
- Datasheet, PEHP7062, “Cat DEO SYN (SAE 5W-40)”
- Datasheet, PEHJ0008, “Cat Artic DEO (SAE 0W-30)” (Canada and United States)
- Datasheet, PEHJ0093, “Cat DEO (SAE 30 and SAE 40)” (**For use in 3600 Series diesel engines, C280 Series diesel engines** and in older precombustion chamber diesel engines. Do NOT use in 3500 Series, C175 Series, and smaller direct injected diesel engines.)

Machine Lubricants

Transmission/Drive Train Oil

- Datasheet, PEHJ0007, “Cat Arctic TDTO (SAE 0W-20)” (synthetic blend) (Canada and United States)
- Datasheet, PEHP7506, “Cat TDTO (SAE 10W, SAE 30, and SAE 50)” (Exceeds the Cat TO-4 specification.)
- Datasheet, PEHP8035, “Cat TDTO TMS (Transmission Multi-Season)” (synthetic blend - multigrade) (Exceeds the Cat TO-4M specification.)

Final Drive and Axle Oil

- Datasheet, PEHP9530, “Cat FDAO (SAE 60)” (Exceeds the Cat FD-1 specification.)
- Datasheet, PEHP9570, “Cat FDAO SYN (Multigrade)” (Exceeds the Cat FD-1 specification.)

Multipurpose Tractor Oil

- Datasheet, PEHP3050, “Cat MTO (Multigrade)”

Gear Oil

- Datasheet, PEHJ0030, "Cat Synthetic GO (SAE 75W-140)"
- Datasheet, PEHP7508, "Cat GO (SAE 80W-90 and SAE 85W-140)"

Hydraulic Oil

- Datasheet, PEHJ0182, "Cat HYDO Advanced 10"
- Datasheet, PEHP9544, "Cat HYDO (SAE30)" (not available in North America)

Grease

- Special Publication, PEGJ0035, "Grease Selection Guide"
- Datasheet, PEHP0002, "Cat Advanced 3Moly Grease" (NLGI grade 2)
- Datasheet, NEHP6010, "Cat Ultra 5Moly Grease" (NLGI grades 1 and 2)
- Datasheet, NEHP6011, "Cat Arctic Platinum Grease" (NLGI grade 0)
- Datasheet, NEHP6012, "Cat Desert Gold Grease" (NLGI grade 2)
- Datasheet, NEHP6015, "Cat High Speed Ball Bearing Grease" (NLGI grade 2)
- Datasheet, PEHJ0088, "Cat Multipurpose Grease" (NLGI grade 2)

Filters

- Datasheet, PEHP6028, "Cat Ultra High Efficiency Air Filters"
- Datasheet, PEHP7032, "Radial Seal Air Filters"
- Datasheet, PEHJ0092, "Cat Cabin Air Filters"
- Datasheet, PEHP7077, "Cat Turbine Pre-Cleaners"
- Datasheet, PEHP9013, "Air Filter Service Indicator"
- Datasheet, PEHJ0082, "Cat Fuel/Water Separators and Prime Time Priming Pumps"
- Datasheet, PEHP7046, "Fuel Contamination Control"
- Datasheet, PEHJ0068, "Cat Advanced Efficiency Engine Oil Filter"

- Datasheet, PEHJ0069, "Cat Hydraulic and Power Train Filters"

S·O·S Services

- Special Publication, PEDP7036, "S·O·S Fluids Analysis Cornerstone"
- Special Publication, PEHP7052, "Making the Most of S·O·S Services"
- Special Publication, PEHP7076, "Understanding S·O·S Services Tests"
- Special Publication, PEHP6001, "How To Take a Good Oil Sample"
- Special Publication, PEHP7057, "S·O·S Coolant Analysis"

Miscellaneous

- Special Publication, PEDP9131, "Fluid Contamination - The Silent Thief"
- Video, PEVN4266, "Putting the Power in Powershift Transmissions" (VHS)
- Construction Equipment Magazine Article Reprint, PEWP8029, "Benefits of Multi-season Transmission/Drive Train Oil"
- Special Publication, AECQ1042, "Caterpillar Product Line Brochure"
- Special Publication, PEWJ0074, "Cat Filter and Fluid Application Guide"
- Special Publication, PECP9067, "One Safe Source"
- Special Publication, PEWJ0074, "Cat Filter and Fluid Application Guide"
- Special Publication, NENG2500, "Caterpillar Dealer Service Tool Catalog"
- Special Publication, PECJ0003, "Cat Shop Supplies and Tools" catalog
- Special Publication, SENR3130, "Torque Specifications"
- Special Publication, SENR9620, "Improving Component Durability - Fuel Systems" (Package of 10)
- Special Publication, SEBF1018, "Improving Component Durability - Engines" (Package of 10)

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- Special Publication, SEBF1020, "Improving Component Durability - Managing Fluid Cleanliness" (Package of 10)
 - Special Publication, SEBF1015, "Improving Component Durability - Final Drives and Differentials" (Package of 10)
 - Special Publication, SEBF1016, "Improving Component Durability - Pwoershift Transmissions" (Package of 10)
 - Special Publication, SEBF1017, "Improving Component Durability - Component Removal and Installation" (Package of 10)
 - Special Publication, SEBF1019, "Improving Component Durability - Hydraulics" (Package of 10)
 - Special Publication, SEBF1021, "Improving Component Durability" Boxed set (Includes one each of the 7 "Improving Component Durability" series.)
 - Special Publication, SEBD0348, "Caterpillar Performance Handbook" (Edition 38)

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Index

A

Aftermarket Oil Additives 16

C

Characteristics of Diesel Fuel 60
 Cetane Number 61
 Cloud Point 62
 Gums and Resins 65
 Lubricity and Low Sulfur Diesel (LSD) and Ultra
 Low Sulfur Diesel (ULSD) Fuel 60
 Moisture Content 64
 Pour Point 63
 Specific Gravity / API Gravity 64
 Viscosity 61
 Cold Weather Lubricants 28
 Engine 28
 Non-Engine Machine Compartments 29
 Warm-Up Procedures for Machines that are used
 in Cold Weather (Generic) 30
 Commercial Heavy-Duty Coolant/Antifreeze and SCA
 (Supplemental Coolant Additive) 87
 Contamination Control 27
 Defining Contamination 27
 Measuring Cleanliness 27
 Standards for Machine Systems 27
 Conventional Coolant/Antifreeze Cooling System
 Maintenance 84
 Cleaning the System of Heavy-Duty
 Coolant/Antifreeze 86
 Cooling Systems with Larger Capacities 86
 Recycling Cat DEAC 87
 Coolant Recommendations 78
 Cooling System Specifications 76

D

Diesel Engine Antifreeze/Coolant 83
 Distillate Diesel Fuel 66
 Aftermarket Fuel Additives 70
 Alternative Fuels - Arctic Applications 70
 Biodiesel 72
 Cat Diesel Fuel Conditioner 71
 Heavy Fuel Oil, Residual Fuel, Blended Fuel 69
 Ultra Low Sulfur Diesel (ULSD) 69
 Dry Brake Shoe Applications 26
 Dry Film Lubricant 26

E

Engine Oil 7
 Applications 7
 Cat DEO (Diesel Engine Oil) 7
 Commercial Oils 8
 Lubricant Viscosity Recommendations for Cat
 Machine Diesel Engines 10
 Total Base Number (TBN) and Fuel Sulfur Levels
 for Direct Injection (DI) Diesel Engines 9
 Extended Life Coolant 80
 Cat ELC 80
 Extended Life Coolant Cooling System
 Maintenance 81
 Cat ELC Cooling System Cleaning 81
 Cat ELC Cooling System Contamination 83
 Cat ELC Extender 81
 Changing to Cat ELC 82
 Commercial Extended Life Coolant 83
 Proper Additions to the Cat ELC (Extended Life
 Coolant) 81
 Recycling Cat ELC 82

F

Foreword 5
 Literature Information 4
 Maintenance 4
 Safety 4
 Frequently Asked Questions (Ultra Low Sulfur Diesel
 (ULSD) Fuel) 90
 Fuel Information for Diesel Engines 59
 Starting Aids 59
 Fuel Recommendations 65
 Fuel Specifications 57

G

Gear Oil 14
 Applications 14
 Cat GO (Gear Oil) 15
 Commercial Gear Oils 15
 General Coolant Information 76
 Additives 77
 Glycol 77
 Water 76
 General Fuel Information 57
 Recommendations 57

H

Hydraulic Oil	11
Applications.....	11
Cat HYDO (Hydraulic Oil)	11
Cat HYDO Advanced 10 (Hydraulic Oil)	11
Commercial Oils.....	11

I

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

L

Lubricant Information.....	6
Caterpillar Fluids	7
General Information	6
Lubricant Specifications.....	6
Lubricant Viscosities.....	31
Backhoe Loader Rear Axles	50
Engine Crankcase.....	37
Hydrostatic Transmissions and Hydraulic Systems	40
Lubricant Viscosities for Ambient Temperatures	32
Powershift Transmissions	38
Selecting the Viscosity	31
Special Applications.....	48
Special Compartments.....	43
Wheel Excavators and Wheel Material Handler Final Drives and Axles	53
Wheel Loader and Certain Other Axles	45
Lubricating Grease	17
Cat Advanced 3Moly Grease	18
Cat Arctic Platinum	19
Cat Desert Gold Grease	19
Cat High Speed Ball Bearing Grease	20
Cat Multipurpose Grease	17
Cat Ultra 5Moly Grease	18
Cat White Assembly Grease.....	17

M

Maintenance Section.....	6
Multipurpose Tractor Oil	15
Application	15
Cat MTO (Multipurpose Tractor Oil).....	15
Commercial Multipurpose Tractor Oils.....	15

O

Oil Sampling Interval	55
More Frequent S·O·S Sampling Improves Life Cycle Management.....	56

R

Re-refined Basestock Oils	16
Reference Information Section	90
Reference Material	93
Coolant.....	93
Diesel Engine Oil	93
Filters	94
Grease	94
Machine Lubricants.....	93
Miscellaneous	94
S·O·S Services.....	94
Reference Materials	90

S

S·O·S Services Coolant Analysis	88
New Systems, Refilled Systems, and Converted Systems	88
Recommended Interval for S·O·S Services Coolant Sample	88
S·O·S Services Coolant Analysis (Level 1).....	88
S·O·S Services Coolant Analysis (Level 2).....	89
S·O·S Services Oil Analysis	53
Obtaining S·O·S Oil Samples.....	54
Specialty Lubricants	26
Supplemental Coolant Additive	84
Synthetic Basestock Oils	16

T

Table of Contents.....	3
Transmission/Drive Train Oil	12
Applications.....	12–13
Cat FDAO (Final Drive and Axle Oil)	14
Cat FDAO SYN.....	14
Cat TDTO (Transmission/Drive Train Oil).....	13
Commercial Final Drive and Axle Oil	14
Commercial Transmission/Drive Train Oils.....	13
Final Drive and Axle Oil	13

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: _____

