



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.

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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 is 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.

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.

Note: Refer to the Tables in this publication, "Lubricant Viscosities for Ambient Temperatures" topic in order to determine the appropriate oil viscosity grades.

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

ECF-1 Specification Diesel Engine Oils

The Engine Crankcase Fluid - 1 (ECF-1) specification has been introduced by Caterpillar in order to provide additional performance to the oils that are marketed under the American Petroleum Institute (API) categories of oil. The API Engine Oil Licensing and Certification System is recognized by Caterpillar. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API. The ECF-1 specification is applicable to those oil manufacturers whose products meet the specification requirements.

Table 1

Diesel Engine Oil Specifications/Categories		
Oil Specification/Category	Precombustion Chamber	Direct Injection ⁽¹⁾
Cat ECF-1 ⁽²⁾	Recommended	Recommended
CG-4 ⁽³⁾	Acceptable at Reduced Drain Interval	Acceptable at Reduced Drain Interval
CF-4 ⁽⁴⁾ , CF-2 ⁽⁵⁾	Not Acceptable	Not Acceptable
CF ⁽⁶⁾	Acceptable	Not Acceptable
CE, CD, CC, and CD-2 ⁽⁷⁾	Obsolete	Obsolete

(1) Most Caterpillar machines built after 1991 have Direct Injection (DI) diesel engines. Single viscosity grade diesel engine oils are not acceptable for use in Caterpillar DI machine diesel engines. Multigrade diesel engine oils are required.

(2) API CI-4, API CI-4 PLUS, and API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 specification are met. CI-4, CI-4 PLUS, and CH-4 oils that have not met the requirements of Caterpillar's ECF-1 specification may cause reduced engine life.

(3) API CG-4 oils are acceptable for all Caterpillar diesel engines. When API CG-4 oils are used, the oil drain interval should not exceed 250 hours.

(4) API CF-4 oils are not recommended for Caterpillar machine diesel engines.

(5) API CF-2 and API CD-2 oils are categories for two-cycle diesel engines. Caterpillar does not sell engines that utilize API CF-2 and API CD-2 oils.

(6) API CF oils are not recommended for Caterpillar Direct Injection (DI) machine diesel engines.

(7) Diesel engine oils CC, CD, CD-2, and CE have not been API authorized categories since 1 January 1996.

Note: When oil meets more than one API category, the applicable footnote is determined by the highest API category that is met.

Example - An oil meets both the API CG-4 and the API CF oil categories. In this case, the API CG-4 footnote applies.

Transmission/Drive Train Oil

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

NOTICE

The Caterpillar 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.

Final Drive and Axle Oil

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

Gear Oil

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

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 SYN (SAE 5W-40 Synthetic Diesel Engine Oil)
- Cat Arctic DEO SYN (SAE 0W-30 Synthetic Diesel Engine Oil)
- Cat TDTO (Transmission/Drive Train Oil)
- Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend)
- Cat Arctic TDTO (SAE 0W-20 Transmission/Drive Train Oil) (synthetic blend)
- Cat FDAO (Final Drive and Axle Oil)

- Cat MTO (Multipurpose Tractor Oil)
- Cat HYDO (Hydraulic Oil)
- Cat BIO HYDO (HEES) (Biodegradable 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.

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Engine Oil

SMCS Code: 1348; 7581

Applications

Caterpillar machine diesel engines

Caterpillar DEO (Diesel Engine Oil)

Caterpillar oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Cat DEO exceeds the requirements of the ECF-1 specification by passing four additional proprietary tests of diesel engine oil. Caterpillar oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

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

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

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

Cat DEO multigrade is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. In order to choose the correct oil viscosity to use for the ambient temperature, refer to the tables for "Lubricant Viscosities for Ambient Temperatures" (Maintenance Section). 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 can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended categories/specifications. Compare the categories/specifications to the categories/specifications of Cat DEO multigrade. The current industry standards for Cat DEO are listed on the product label and on the data sheets for the product.

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

Note: Cat DEO multigrade exceeds the requirements of the ECF-1 specification. Cat DEO SAE 15W-40 exceeds the performance requirements for the following API categories: API CI-4, API CH-4, API CG-4, and API CF. Cat DEO SAE 15W-40 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 Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Caterpillar multigrade oil exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets. **True high performance oil is produced by using a combination of the following factors: industry standard tests, proprietary tests, field tests, and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.**

Commercial Oils

Engine Crankcase Fluid Recommendations for all Caterpillar machine diesel engines.

Note: If Caterpillar DEO multigrade is not used, use only commercial oils that meet the following categories/specifications:

- Only commercial oils that meet the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid - 1 specification) are acceptable for use in Caterpillar machine diesel engines. API CH-4, API CI-4, and API CI-4 PLUS oils that have not met the requirements of Caterpillar's ECF-1 specification may cause reduced engine life.
- API CG-4 multigrade oils are acceptable for all Caterpillar diesel engines. When API CG-4 oils are used, the oil drain interval should not exceed 250 hours.

Note: Do not use API CF-4 oils in Caterpillar machine diesel engines.

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 choice of a commercial oil, refer to the "Lubricant Viscosities for Ambient Temperatures" table in this publication, "Lubricant Viscosities" topic (Maintenance Section).

NOTICE

API CH-4, CI-4, and CI-4 PLUS oils that have not met the requirements of Caterpillar's ECF-1 specification may cause reduced engine life.

NOTICE

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

NOTICE

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

API CF oils are only recommended for Caterpillar Series 3600 diesel engines and Caterpillar engines that have precombustion chamber (PC) fuel systems.

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

SMCS Code: 1348; 7581

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN of the new oil must be 10 times the fuel sulfur level. The TBN is defined by "ASTM D2896". The minimum TBN of the oil is five (5) regardless of fuel sulfur level. Illustration 1 demonstrates the TBN.

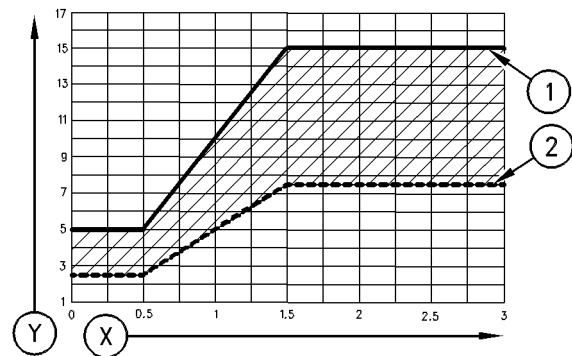


Illustration 1

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(Y) TBN by "ASTM D2896"

(X) Percentage of fuel sulfur by weight

(1) TBN of new oil

(2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

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

1. Choose a multigrade oil with the highest TBN that meets one of these specifications/categories: Caterpillar ECF-1 or API CG-4.

Note: API CH-4, CI-4, and CI-4 PLUS oils that meet the requirements of the Caterpillar ECF-1 (Engine Crankcase Fluid - 1) specification are acceptable for use in Caterpillar machine diesel engines. API CH-4, CI-4, and CI-4 PLUS oils that do not meet the requirements of the Caterpillar ECF-1 specification may cause reduced engine life.

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

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

NOTICE

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

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Total Base Number (TBN) and Fuel Sulfur Levels for Precombustion Chamber (PC) Diesel Engines

SMCS Code: 1348; 7581

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For precombustion chamber engines that use distillate fuel, the minimum TBN of the new oil must be 20 times the fuel sulfur level. The TBN is defined by "ASTM D2896". The minimum TBN of the oil is five (5) regardless of fuel sulfur level. Illustration 2 demonstrates the TBN.

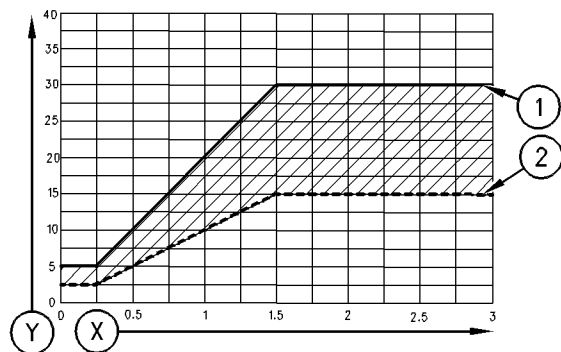


Illustration 2

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(Y) TBN by "ASTM D2896"

(X) Percentage of fuel sulfur by weight

(1) TBN of new oil

(2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

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

1. Choose an oil with the highest TBN that meets one of these specifications/categories: Caterpillar ECF-1, API CF, or API CG-4.

Note: API CH-4, CI-4, and CI-4 PLUS oils that meet the requirements of the Caterpillar ECF-1 (Engine Crankcase Fluid - 1) specification are acceptable for use in Caterpillar machine diesel engines. API CH-4, CI-4, and CI-4 PLUS oils that do not meet the requirements of the Caterpillar ECF-1 specification may cause reduced engine life.

Note: Most Caterpillar machines built after 1991 have Direct Injection (DI) diesel engines. API CF oils and single grade oils are not acceptable for use in Caterpillar DI machine engines. Excessive piston deposits will occur when oils that meet only the API CF oil classification are used in Caterpillar Series 3500 and smaller DI diesel engines.

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

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

NOTICE

Operating PC engines at fuel sulfur levels over 1.0 percent may require shortened oil change intervals to maintain adequate wear protection.

i02296997

Hydraulic Oil

SMCS Code: 5095; 7581

Applications

- Hydraulic Systems
- Hydrostatic Transmissions

Cat HYDO (Hydraulic Oil)

Cat HYDO is formulated with a balanced additive system. The system includes the following agents: detergents, rust inhibitors, antiwear agents, and defoamers. Cat HYDO offers the following benefits: protection against mechanical wear, rusting, corrosive wear in hydraulic systems, and wear in hydrostatic transmission systems. Cat HYDO should be used to achieve maximum life and maximum performance from hydraulic system components and from hydrostatic transmissions. Cat HYDO is recommended in most hydraulic systems and in most hydrostatic systems.

- Cat HYDO

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

- Cat DEO
- 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

If Caterpillar oils cannot be used, the following commercial classifications can be used in hydraulic systems and in hydrostatic transmission systems:

- Engine oils that meet the Caterpillar ECF-1 specification and have a minimum zinc additive of 0.09 percent (900 ppm)
- API CG-4 engine oils that have a minimum zinc additive of 0.09 percent (900 ppm)
- API CF engine oils that have a minimum zinc additive of 0.09 percent (900 ppm)
- 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 in Caterpillar machine hydraulic systems.

Cat BIO HYDO (HEES) (Biodegradable Hydraulic Oil)

Caterpillar has a biodegradable hydraulic oil that is available for use in machine hydraulic systems. This fluid is recommended for the hydraulic systems when environmental compliance is required or desired.

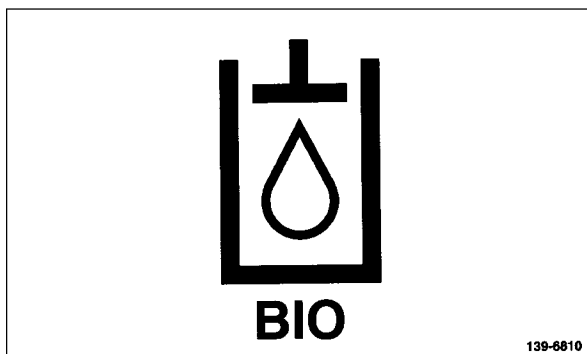


Illustration 3

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

This fluid is formulated with the following components: a saturated HEES (Hydraulic Environmental Ester Synthetic), synthetic base stock, and selected additives.

Note: Use this oil only in hydraulic systems where recommended.

Cat BIO HYDO (HEES) may become darker in color throughout the service life of the oil. Analysis is required to determine the quality of the oil.

The maximum recommended water content for hydraulic systems that are filled with Cat BIO HYDO (HEES) is 0.10 percent. If the water levels exceed 0.10 percent, the water should be removed or the oil should be replaced.

Consult your Caterpillar dealer for additional information on this product and on the potential use.

NOTICE

Do not use Cat BIO HYDO (HEES) or 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 Caterpillar dealer for guidance before using Cat BIO HYDO (HEES) or commercial oils that meet the BF-1 specification in Hydraulic Excavators.

Commercial Biodegradable Hydraulic Oil

If Cat BIO HYDO (HEES) is not used, commercial oils that meet the Caterpillar BF-1 specification should be used.

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Transmission/Drive Train Oil

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

Applications

The information relates to the following products:

- Power Shift Transmissions
- Direct Drive Transmissions
- Winches

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
- 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

Cat TDTO (Transmission/Drive Train Oil)

Cat TDTO is balanced in order to give maximum frictional material life in power shift transmissions. Cat TDTO also helps eliminate brake chatter in wet brake applications in Caterpillar machines. This oil has passed 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.

Note: Do not use the Caterpillar GO (Gear Oil) or commercial gear oil in the machines that are listed above. 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

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

Note: Commercial multigrade oils must meet the requirements of the Caterpillar 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 Caterpillar TO-4M specification includes a test for the shear stability of multigrade oil.

Final Drive and Axle Oil

Use this oil in the following applications.

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 except for the D5M, D6M, D5N, and D6N)
- Pipelayers (Machines with steel tracks that have Elevated Final Drives except for the 561M and the 561N)
- 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 Caterpillar final drives and axles that formerly specified 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 Caterpillar 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

Commercial Final Drive and Axle Oil

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

i02320469

Gear Oil

SMCS Code: 7000; 7551; 7581

Applications

- Direct Drive Transmissions for Pavement Profilers

- Differentials and Final Drives for: Wheel Tractor-Scrapers, Auger and Elevator Speed Reducers, Wheel Type Excavators, 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)
- Certain Vibratory Compactor Drum Bearings
- 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, 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. Caterpillar 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 edges of the components. For these applications, Cat GO provides the extra protection.

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

NOTICE

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

NOTICE

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

Commercial Gear Oils

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

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Multipurpose Tractor Oil

SMCS Code: 7000; 7581

Application

- Backhoe Loader Rear Drive Axle
- Axle for the Series 500 Vibratory Soil Compactor (models with “D” suffix or lower)

Cat MTO (Multipurpose Tractor Oil)

Cat MTO is available for use in the backhoe loader rear drive axle. This oil provides the proper frictional requirement for the brakes that require oil cooling in this compartment.

This oil is also used in Caterpillar Challenger Agricultural Tractors for the implement hydraulic system and for the steering control mechanism. Many agricultural tractors have hydraulic systems that are common with the transmission and with the drive train. By using Cat MTO, you will be able to interchange hydraulically actuated tools. This oil provides the performance that is required of these multifunction compartments that use a single fluid.

NOTICE

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

NOTICE

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

Commercial Multipurpose Tractor Oils

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

Synthetic Base Stock 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.

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 section in this publication.

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Re-refined Base Stock Oils

SMCS Code: 1300; 1348; 7581

Re-refined 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 requirements for lubrication and requirements for lubrication specifications in order to ensure proper lubrication and life of the system. Re-refined base oils can be used exclusively in finished oil or in a combination with new base oils. The U.S. military specifications and the specifications of other heavy equipment manufacturers generally allow the use of re-refined base oils that meet the same type of criteria.

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

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 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 to allow the grease to stay in place. In addition, many of these greases do not have the performance 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 (MoS_2 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, 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 $-50\text{ }^{\circ}\text{C}$ ($-58\text{ }^{\circ}\text{F}$). 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 (MoS_2 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 $-50\text{ }^{\circ}\text{C}$ ($-58\text{ }^{\circ}\text{F}$). 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)

⁸ Note: For additional performance data on these greases refer to NEHP6621.

Grease Application Chart
(By Machine)

Vehicle	Application Point	Typical Applications (Load and Speed)	Load Factor	Ambient Temperature Range						NLGI Grade	Recommended Grease Type
				° C			° F				
				Min	Max	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				
				-20	40	-4	104				
Asphalt Pavers	Track Takeup Linkage, Takeup Idler Bearings	Low	Considerable idling or travel with no load.	-30	40	-22	104	2	Multipurpose Grease		
				-35	40	-31	104				
				-30	50	-22	122				
Asphalt Pavers	3-4 m (10'-12") width, 50-75mm (2"-3") lift	Medium	Wide width, deep lift paving.	-20	40	-4	104	2	Advanced 3Moly Grease		
				-30	40	-22	104				
				-30	50	-22	122				
Backhoe Loaders	Drive Shaft Spline, Kingpin Bearing, Universal Joint, Wheel Bearing	Low	Narrow width paving - low production.	-30	40	-22	104	2	Multipurpose Grease		
				-35	40	-31	104				
				-30	50	-22	122				
Backhoe Loaders	Production work with long cycles and/or constant flow implements.	High	General work with regular cycles in medium applications.	-20	40	-4	104	2	Advanced 3Moly Grease		
				-30	40	-22	104				
				-30	50	-22	122				
Backhoe Loaders	Utility work with intermittent cycles in light to medium applications.	Low	Utility work with intermittent cycles in light to medium applications.	-30	40	-22	104	2	Multipurpose Grease		
				-35	40	-31	104				
				-30	50	-22	122				
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				
				-20	40	-4	104				
Vibratory Soil and Asphalt Compactors	Vibration 50-80%, granular soil, 100mm-305mm (4"-12") lifts.	Medium	Vibration 30-50%, asphalt mix, 51mm - 100mm (2"-4") lifts.	-30	40	-22	104	2	Advanced 3Moly Grease		
				-30	40	-22	104				
				-30	50	-22	122				
Vibratory Soil and Asphalt Compactors	Most pipeline applications in hard rocky material. Digging 90-95% of the daily work schedule.	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				
				-20	40	-4	104				
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	Medium	Most residential sewer applications in natural bed clay. Digging 60-55% of the daily work schedule. Most log loading applications.	-20	40	-4	104	2	Advanced 3Moly Grease		
				-30	40	-22	104				
				-30	50	-22	122				
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				
				-30	50	-22	122				

Grease Application Chart
(By Machine)

Vehicle	Application Point	Typical Applications (Load and Speed)	Load Factor	Ambient Temperature Range				NLGI Grade	Recommended Grease Type
				°C		°F			
				Min	Max	Min	Max		
Forest P 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
				-30	50	-22	122	2	
				-20	40	-4	104	2	
Motor Graders	Fan Drive Bearings Articulation Bearings, Articulation Pins, Blade Lift Cylinder Socket, Center Shift Cylinder Socket, Fan Drive Belt Tightener, Pump Drive Shaft	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.	-20	40	-4	104	2	High Speed Ball Bearing Grease
				-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	Advanced 3Moly 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
				-30	50	-22	122	2	Advanced 3Moly Grease
				-20	40	-4	104	2	Multipurpose Grease
Autolube System	Autolube System	Low	20-30% load factor.	-30	40	-22	104	2	Multipurpose Grease
				-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122	2	High Speed Ball Bearing Grease
Fan Drive Bearings	Fan Drive Bearings	Low	Finish grading, light maintenance, road travel.	-20	40	-4	104	2	High Speed Ball Bearing Grease
				-30	40	-22	122	2	Multipurpose Grease
				-20	40	-4	104	2	High Speed Ball Bearing Grease

Grease Application Chart
(By Machine)

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

**Grease Application Chart
(By Machine)**

Vehicle	Application Point	Typical Applications (Load and Speed)	Load Factor	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 tight truck loading, hard bank excavation, and shot rock loading from a face.	-35	40	-31	104	1	Ultra 5Moly Grease
				-30	50	-22	122		
	Medium	Maximum productivity in aggregate truck loading and hopper charging. Assumes the normal framing 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		
Integrated Toolcarriers	Fan Drive Bearings	High	Continuous and aggressive tight truck loading, hard bank excavation, and shot rock loading from a face.	-20	40	-4	104	2	High Speed Ball Bearing Grease
				-35	40	-31	104		
	Medium	Maximum productivity in aggregate truck loading and hopper charging. Assumes the normal framing and load and carry associated with the high productivity stockpile load-out and batch plant applications.	-30	50	-22	122	2	Ultra 5Moly 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.	-20	40	-4	104	2	Advanced 3Moly Grease	
			-30	40	-22	104			2
High	Continuous high total resistance conditions with steady cycling.	-20	40	-4	104	2	High Speed Ball Bearing Grease		
		-35	40	-31	104			1	
Wheel Tractor-Scrapers	Brake Camshaft Bearings, Drive Shaft Spine, Ejector Carrier and Support Rollers, Sprocket Shaft Support Bearings	Medium	Typical road building use.	-20	40	-4	104	2	Advanced 3Moly Grease
				-30	40	-22	104		
	Low	Average use but with considerable idling, favorable grades, low rolling resistance and easy loading material.	-20	40	-4	104	2	Multipurpose Grease	
			-30	40	-22	104			2
Hammers	Fan Drive Bearings Hammer Lubrication			-20	40	-4	104	2	High Speed Ball Bearing Grease Hammer Paste
Extreme Temperature Conditions - All Applications Except Hammers		High, Medium, and Low		-50	20	-58	68	0	Arctic Platinum
				-20	60	-4	140		

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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 (910-928) 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	5

⁽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

US Department Of Transportation (DOT) DOT-3 or DOT-5 fluids are used as brake actuation fluids on certain types of equipment that use dry brake shoes.

NOTICE

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

Do not mix DOT-3 and DOT-5 fluids.

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

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

Refer to the machine Operation and Maintenance Manual for guidance when DOT-3 or DOT-5 brake circuit actuation fluids are required.

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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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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

Cleanliness can be measured by taking fluid samples. These samples are obtained from hydraulic components and from drive train components. These samples can then be 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 in the ISO Code system. Each code has a given range of particles per milliliter. The smaller code number designates fewer particles.

Standards for Machine Systems

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

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. 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 5 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.

Note: High pressure fuel injectors (EUI) require 5 micron(c) absolute or less filtration. This filtration is available with Caterpillar Advanced Efficiency Fuel Filters.

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 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.

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Cold Weather Lubricants

SMCS Code: 1300; 1348; 7581

Before attempting to start the engine, make sure that the oil in the engine, oil in the transmission, and the oil in the hydraulic system are fluid enough to flow. Check the oil by removing the dipsticks. If the oil will drip from the dipstick, then the oil is fluid enough to start the engine. 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. 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. Drain all hydraulic cylinders and lines. After you change the oil, operate the equipment in order to circulate the thinner oil.

When you start an engine or when you operate an engine in ambient temperatures that are below -20°C (-4°F) use base oils that can flow in low temperatures. These oils have lubricant viscosity grade of SAE 0W or of SAE 5W.

When you start a machine or when you operate a machine in ambient temperatures that are below -30°C (-22°F), use a synthetic base stock 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).

Because the number of acceptable lubricants is limited in arctic conditions, Caterpillar has special recommendations for arctic conditions. Caterpillar recommends the lubricants that are listed in this article for use in arctic conditions. The lubricants are listed by preference.

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 tables for "Lubricant Viscosities for Ambient Temperatures", use the viscosity grade that is specified in the table for "Lubricant Viscosities for Ambient Temperatures". In arctic applications, the preferred method of lubrication is to use machine compartment heaters that are the correct size, and to use an oil that is a higher viscosity grade. Refer to the "Selecting Lubricant Viscosities" section for further details (Maintenance Section).

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

Units 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.

Example: The oil viscosity recommended for use in Caterpillar machine diesel engines for "cold soaked" starts at -40°C (-40°F) is multigrade oil of the SAE 0W viscosity grade (SAE 0W-20, 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

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 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 publication and to the "Warm-up Procedures for Machines that are used in Cold Weather - (Generic)" topic (Maintenance Section) in this publication.

• Engine Oils

NOTICE

Use of oils that are not recommended as first choice oils could result in reduced performance and shortened life of the engine.

First Choice – use a Cat DEO multigrade or a commercial diesel engine oil that meets the Cat ECF-1 specification with one of the following lubricant viscosity grades: SAE 0W-20, SAE 0W-30, SAE 0W-40, SAE 5W-30, and SAE 5W-40.

Second Choice – use a commercial oil that is API CI-4 (API CI-4 PLUS), API CH-4, or API CG-4 licensed. The oil must have one of the following lubricant viscosity grades: SAE 0W-20, SAE 0W-30, SAE 0W-40, SAE 5W-30, and SAE 5W-40.

Note: Do not use API CF-4 oils in Caterpillar machine diesel engines.

- **Transmission/Drive Train Oils**

NOTICE

Use of oils that are not recommended as first choice oils could result in reduced performance and shortened life to the transmission, differential, and final drive.

First Choice – use Cat Arctic TDTO or commercial oil that meets the following requirements: formulated from a full synthetic base stock without the viscosity index improvers, meets the performance requirements of the TO-4 specification, and requirements for the SAE 30 lubricant viscosity grade. Typical lubricant viscosity grades are listed below: SAE 0W-30, SAE 5W-30, and SAE 0W-20.

Second Choice – use a commercial oil with a TO-4 type additive package and use one of the following lubricant viscosity grades: SAE 0W-30, SAE 5W-30, and SAE 0W-20. These oils have not been tested against the TO-4 specifications.

Note: For maximum service life, use an oil with the highest lubricant viscosity grade that is allowed for the ambient temperature. **Refer to the “Lubricant Viscosities for Ambient Temperatures” tables and the associated footnotes in order to determine the recommended oil viscosity.**

- **Hydraulic Oils**

Any of the oils that have a minimum zinc additive of 0.09 percent (900 ppm) are acceptable. These oils are listed under the heading of “Engine Oils” or “Transmission/Drive Train Oils”.

- **Final Drive and Axle Oil**

First Choice – Cat FDAO (Final Drive and Axle Oil) of the recommended viscosity grade.

Second Choice – commercial oil of the recommended viscosity grade that meets the Caterpillar FD-1 specification.

NOTICE

Cat FDAO or commercial oil meeting the Caterpillar FD-1 specification should not be used in compartments that contain friction material unless otherwise specified, because they do not develop sufficient friction coefficient to satisfy the requirements of most clutches and brakes.

- **Multipurpose Tractor Oil**

Cat MTO (Multipurpose Tractor Oil) is available for use in the following systems for the Caterpillar Challenger tractor: implement steering, hydraulic systems, and steering control mechanisms. Cat MTO is also recommended for use in the rear drive axles of the Caterpillar Backhoe Loader and certain 500 Series Vibratory Soil Compactors. This oil has an ambient temperature range of -25°C (-13°F) to 40°C (104°F) for these applications.

For ambient conditions that are below -25°C (-13°F), check with your supplier. The multipurpose tractor transmission fluids that are commercially available must meet the required ambient temperature capability for your area. These fluids must also meet the Ford/New Holland specification of “M2C134-D”.

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

NOTICE

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

NOTICE

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

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.

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 outside ambient temperature. 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. 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/category 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. 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

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 publication, “Procedures for Machines that are Used in Cold Weather - (Generic)” topic (Maintenance Section). Some of the “Lubricant Viscosities for Ambient Temperatures” tables in this publication include footnotes that address compartment warm-up.

Lubricant Viscosities for Ambient Temperatures

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 categories that are listed in the applicable section are acceptable oils.

Table 4

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°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 Except for: 793C Torque Converter ⁽¹⁾ 797 Torque Converter ⁽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⁾ commercial FD-1⁽⁶⁾	SAE 50 ⁽⁷⁾	⁽⁷⁾	32	⁽⁷⁾	90
		SAE 60 ⁽⁷⁾	⁽⁷⁾	50	⁽⁷⁾	122
Differentials and Final Drives for E Series II Articulated Trucks 700 Series Articulated Trucks	Cat TDTO Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾⁽⁸⁾	-40	-10	-40	14
		SAE 50 ⁽⁹⁾	-15	40	5	104
		SAE 60 ⁽⁹⁾	-10	50	14	122
Output Transfer Gear for E Series II Articulated Trucks 700 Series Articulated Trucks	Cat TDTO Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽²⁾⁽⁸⁾	-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 ⁽¹⁰⁾	-10	32	14	90
		SAE 60 ⁽¹⁰⁾	-5	50	23	122
Nondriven Scraper Wheels	Cat TDTO commercial TO-4	SAE 50 ⁽⁹⁾	⁽⁹⁾	32	⁽⁹⁾	90
		SAE 60 ⁽⁹⁾	⁽⁹⁾	50	⁽⁹⁾	122

(continued)

(Table 4, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Direct Drive Transmissions for Pavement Profilers, Differentials and Final Drives for Wheel Tractor-Scrapers, Auger and Elevator Speed Reducers, Wheel Type Excavators ⁽¹¹⁾ , Mini Hydraulic Excavators, certain Backhoe Loaders, 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, 906, and 908 Compact Wheel Loaders ⁽¹²⁾	Cat GO (Gear Oil) Cat SYNTHETIC GO 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) The 793C and 797 Off-Highway Truck torque converters have a common sump with the transmission. Therefore, the 793C and 797 torque converters will use the same fluid recommendations as the transmission.
- (2) First Choice: Cat Arctic TDTO SAE 0W-20. Second Choice: Oils of full synthetic base stock that do not have viscosity index improvers and do meet the performance requirements of the 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) 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 (Final Drive and Axle Oil) (exceeds the FD-1 specification requirements)
- (6) Cat TDTO or a commercial TO-4 oil may be used as a second choice in place of the recommended Cat FDAO or commercial FD-1 oil.
- (7) 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), consult your Caterpillar dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (8) Do NOT use when the typical daily maximum ambient temperature is above -10 °C (14 °F).
- (9) Cat TDTO SAE 50 or 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, "Differential Warm-up and Break-in" prior to operation. If the ambient temperature is below -25 °C (-13 °F), consult your Caterpillar dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (10) 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, "Differential Warm-up and Break-in" prior to operation. If the ambient temperature is below -25°C (-13°F), consult your Caterpillar dealer for instructions. Failure to warm up the oil prior to operation will cause damage to the machine.
- (11) Certain Wheel Type Excavators require the addition of Caterpillar Limited Slip (LS) additive. Refer to the machine's Operation and Maintenance Manual.
- (12) Add 0.5 L (0.53 qt) of 1U-9891 Hydraulic Oil Additive to the front axle differential on all 902, 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, 906, and 908 Compact Wheel Loaders.

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 type and categories that are listed in the applicable section are acceptable oils.

Table 5

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Engine Crankcase for all Machines⁽¹⁾⁽²⁾ and Splitter Box (Pump Drive Gearbox) for Track Type Loaders	Cat DEO Multigrade Cat DEO SYN Cat Arctic DEO SYN⁽³⁾ Cat ECF-1⁽⁴⁾ API CG-4 Multigrade⁽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) API CF oils are not recommended for Caterpillar 3500 Series and smaller Direct Injection (DI) diesel engines. API CF-4 oils are not recommended for Caterpillar machine diesel engines.
- (3) Cat Arctic DEO SYN is an SAE 0W-30 viscosity grade oil.
- (4) API CI-4, API CI-4 PLUS, and API CH-4 oils are acceptable if the requirements of Caterpillar's ECF-1 (Engine Crankcase Fluid specification - 1) are met. API CI-4, API CI-4 PLUS, and API CH-4 oils that have not met the requirements of Caterpillar's ECF-1 specification may cause reduced engine life.
- (5) API CG-4 oils are acceptable for use in all Caterpillar machine diesel engines. When API CG-4 oils are used, the oil change interval should not exceed 250 hours. API CG-4 oils that also meet API CI-4, API CI-4 PLUS, or API CH-4 must also meet the requirements of the Caterpillar ECF-1 specification.
- (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).

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 type and categories that are listed in the applicable section are acceptable oils.

Table 6

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Power Shift, Manual Transmissions, and Winch Gear Case (including Track-Type Tractors) 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
Power Shift 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
Power Shift Transmission in 797 Off-Highway Truck	Cat TDTO commercial TO-4	SAE 30	⁽⁶⁾	50	⁽⁶⁾	122
Power Shift 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
Hydrostatic Transmission Except for: Pneumatic Compactors PS-150B, PS-200B, PS-360B, PS-150C, and PS360C ⁽⁷⁾	Cat HYDO Cat DEO Cat MTO Cat TDTO-TMS Cat TDTO Cat DEO SYN Cat Arctic DEO SYN Cat Arctic TDTO Cat ECF-1 API CG-4 API CF commercial TO-4 commercial BF-1⁽⁸⁾⁽⁹⁾	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 10W-30	-20	40	-4	104
		SAE 15W-40	-15	50	5	122
		Cat MTO	-25	40	-13	104
		Cat BIO HYDO (HEES) ⁽⁸⁾⁽⁹⁾	-40	43	-40	110
		Cat TDTO-TMS ⁽⁵⁾	-20	50	-4	122

(continued)

(Table 6, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Hydraulic Systems, Hydraulic Excavator Swing Motor and Travel Motor Systems, Hydraulic Hammers,⁽¹⁰⁾ Track Feller Bunchers⁽¹¹⁾ Off-Highway Truck Steering Systems⁽¹²⁾ Except for the following machines: E Series II Articulated Trucks, 700 Series Articulated Trucks, Pneumatic Compactors PS-150B, PS-200B, PS-360B, PS-150C, and PS360C ⁽⁷⁾ Series B Telehandlers ⁽¹³⁾	Cat HYDO Cat DEO Cat MTO Cat TDTO Cat TDTO-TMS Cat DEO SYN Cat Arctic DEO SYN Cat Arctic TDTO Cat ECF-1 Cat BIO HYDO (HEES) API CG-4 API CF commercial TO-4 commercial BF-1⁽⁸⁾⁽⁹⁾	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	-25	40	-13	104
		Cat BIO HYDO (HEES) ⁽⁸⁾⁽⁹⁾	-40	43	-40	110
		Cat TDTO-TMS ⁽⁵⁾	-20	50	-4	122
		Equalizer Bar End, Pin Joint, Bogie Cartridge Pins, Track Pins, and Motor Grader Circle Drives	Cat GO (Gear Oil) Cat Synthetic GO⁽¹⁴⁾ commercial API GL-5 gear oil	SAE 75W-90	-30	40
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 ⁽¹⁾	-40	0	-40	32
		SAE 0W-30 ⁽²⁾	-40	10	-40	50
		SAE 5W-20 ⁽²⁾	-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

(continued)

(Table 6, contd)

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Track Idlers and Track Rollers, Wheel Tractor-Scrapers Auger Lower Bearings and Elevator Lower Rollers	Cat DEO Cat DEO SYN Cat ECF-1 API CG-4 API CF	SAE 30	-20	25	-4	77
		SAE 40	-10	40	14	104
		SAE 5W-40	-35	40	-31	104

- (1) First Choice: Cat Arctic TDTO - SAE 0W-20. Second Choice: Oils of full synthetic base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 the 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) Do not use SAE 50 viscosity grade oil in ICM controlled transmissions. Do not use SAE 50 viscosity grade oil for the hydraulic drive winch case.
- (5) Cat TDTO-TMS (Transmission Multi-Season) (synthetic blend that exceeds the 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).
- (7) Some of the PS-150B, PS-200B, and PS-360B Pneumatic Compactors hydrostatic drive/hydraulic systems require Cat TDTO-TMS or commercial oil that meets the TO-4M specification requirements. Refer to the machine Operation and Maintenance Manual for hydrostatic transmission oil requirements. The PS-150C and PS-360C hydrostatic drive/hydraulic systems require Cat TDTO-TMS or commercial oil that meets the TO-4M specification. The oil viscosities for ambient temperature recommendations from this section of the table apply.
- (8) Commercial biodegradable hydraulic oil must meet the Caterpillar BF-1 specification. The listed ambient temperature range is for the current Cat BIO HYDO (HEES), not for commercial BF-1 oil.
- (9) Refer to the machine Operation and Maintenance Manual or contact your local Caterpillar dealer before using Cat BIO HYDO (HEES) or commercial BF-1 oil in Caterpillar Hydraulic Excavators.
- (10) 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.
- (11) This table section is also applicable to the Track Feller Buncher hydraulic hood tilt system.
- (12) Off-Highway Truck (OHT) Steering Systems only, do not use this table section for other OHT compartments.
- (13) Series B Telehandlers require Cat TDTO, Cat Arctic TDTO, Cat TDTO-TMS, or commercial oil that meets either the TO-4 or the TO-4M specification. The oil viscosities for ambient temperature recommendations from this section of the table apply.
- (14) Cat Synthetic GO is an SAE 75W-140 viscosity grade oil.

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 type and categories that are listed in the applicable section are acceptable oils.

Table 7

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 Category	Oil Viscosities	°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⁾ commercial FD-1⁽²⁾ Cat TDTO Cat TDTO-TMS 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
	Severe Usage or Continuous Operation (Multiple Shifts/Day)	Cat FDAO⁽²⁾⁽³⁾ commercial FD-1⁽²⁾ Cat TDTO Cat TDTO-TMS commercial TO-4	SAE 60	-25 ⁽⁴⁾	50	-13 ⁽⁴⁾	122
			SAE 50	-33 ⁽⁴⁾	14	-27 ⁽⁴⁾	58
			SAE 30	-40 ⁽⁴⁾	0	-40 ⁽⁴⁾	32
			Cat TDTO-TMS	-40 ⁽⁴⁾	0	-40 ⁽⁴⁾	32

- (1) Cat TDTO is the first choice for the D5M, D6M, D5N, D6N, 561M and 561N models. Refer to Table 8 in this publication for guidance. Cat FDAO and FD-1 specification oils are also acceptable for these models.
- (2) Cat FDAO or commercial FD-1 are the preferred oil types to maximize gear and bearing life. Do not use Cat FDAO or FD-1 in compartments containing clutches and/or brakes. Cat TDTO, Cat TDTO-TMS, or commercial TO-4 oil types must be used in any compartment containing friction material unless specified otherwise by Caterpillar.
- (3) Cat FDAO (Final Drive and Axle Oil) (exceeds the FD-1 specification requirements)
- (4) 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 8

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Final Drive (Differential Gearboxes) including Oval Track-Type Tractors, D5M, D6M, D5N, D6N, 561M and 561N Track Type Hydraulic Excavators, Motor Grader Tandem Drives NOTE: This table is for machine final drives, differentials, and drive axles that require the use of oil that meets the TO-4 specification that are not specifically addressed by other tables in this 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 base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 TO-4M multigrade specification requirements).

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 type and categories that are listed in the applicable section are acceptable oils.

Table 9

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Drive Axles for: Small (910-928) 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 (988-992) and Dozers (834-854), and Large Compactors (836)	Cat TDTO Cat TDTO-TMS Cat Arctic TDTO commercial TO-4	SAE 0W-20 ⁽¹⁾	-40	-10	-40	14
		SAE 0W-30 ⁽²⁾	-40	0	-40	32
		SAE 5W-30 ⁽²⁾	-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 ⁽³⁾	-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 ⁽³⁾	-25	22	-13	72
Drive Axles for: Load Haul Dumps (R2900 [®] , 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 ⁽³⁾	-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 10 in this publication (example: CS-533D). For the CP-323, CP-323C, CS-323, and CS-323C model's axle lubricant recommendations refer to Table 4 in this publication.

(2) First Choice: Cat Arctic TDTO - SAE 0W-20. Second Choice: Oils of full synthetic base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 base stock that do not have viscosity index improvers and do meet the performance requirements of the 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 TO-4M multigrade specification requirements).

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

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

Special Applications

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 Viscosities” column when determining the recommended oil for a machine compartment. The “Oil Type and Category” 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: Only use the oil type and category 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 category/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 Caterpillar machine compartments must have a minimum viscosity of 5.6 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 type and categories that are listed in the applicable section are acceptable oils.

Table 10

Lubricant Viscosities for Ambient Temperatures						
Compartment or System	Oil Type and Category	Oil Viscosities	°C		°F	
			Min	Max	Min	Max
Rear Axle of the Backhoe Loader ⁽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
Starting Engine	SH SJ SL	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 Cat DEO Cat Arctic DEO SYN Cat TDTO Cat Arctic TDTO Cat MTO Cat ECF-1 API CG-4 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
Variable Pitch Fan	Cat DEO SYN commercial full synthetic multigrade diesel engine oil meeting Cat ECF-1, or API CG-4	SAE 0W-40 ⁽⁷⁾	-40	50	-40	122
		SAE 5W-40 ⁽⁷⁾	-40	50	-40	122
	Cat TDTO commercial TO-4	SAE 30 ⁽⁸⁾	-15	25	5	77
		SAE 50 ⁽⁸⁾	-10	50	14	122

(1) Except All Wheel Steer (AWS). See the Operation and Maintenance Manual for AWS requirements.

(2) "Axle - Differential and Planetaries" Refer to Table 4 in this 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 4 in this 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 base stock 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) 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.

(8) 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.

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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 11

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	4% maximum
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
Hydraulic System Cleanliness	"ISO 18/15" maximum ⁽²⁾
Transmission System Cleanliness without electro-hydraulic valves	"ISO 21/17" maximum ⁽²⁾
Transmission System Cleanliness with electro-hydraulic valves	"ISO 18/15" Maximum ⁽²⁾

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

(2) Refer to the "Contamination Control" section in this publication.

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 contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

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

- Use an in-line sampling valve for pressurized oil systems.
- Use a sampling gun that is inserted into the sump.

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

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

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 12

Compartment	Recommended Sampling Interval	Sampling Valve	Oil Type	Recommended Oil Change Interval
Engine	250 Hours ⁽¹⁾	Yes	DEO	⁽²⁾
Transmission	500 Hours	Yes	TDTO	⁽²⁾
Hydraulics	500 Hours	Yes	HYDO	⁽²⁾
Differential and Final Drive	500 Hours	No	TDTO FDAO	⁽²⁾

⁽¹⁾ 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.

⁽²⁾ 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

i02162470

General Fuel Information

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.

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.

- Purchase fuel from a reputable supplier.
- Use fuel that meets the minimum Caterpillar specifications for diesel fuel. The specifications are included in the table Caterpillar Specifications for Distillate Fuel. This table is included in the recommendations for diesel fuel. These fuels have a minimum requirement for lubricity. This requirement is determined by conducting a "High Frequency Reciprocating Rig (HFRR) Test (ASTM Test Method-D6079)". The maximum allowable wear scar is 0.52 mm (0.0205 inch) at 60 °C (140 °F).
- 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.
- Drain water and sediment from the engine's fuel tank daily. Drain the tank at the start of a 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 water separators.
- Drain the water from the water separator daily.

- Caterpillar Advanced Efficiency Fuel Filters are required in order to provide maximum life to the fuel system.
- Change fuel filters at the scheduled interval. Never fill the new fuel filter with fuel before installation. Use the fuel priming pump to remove air from the system.
- Install breather filters on the fuel tanks.

i02162492

Fuel Information for Diesel Engines

SMCS Code: 1250; 1280

The two basic types of distillate diesel fuel are No. 2 diesel fuel and No. 1 diesel fuel. No. 2 diesel fuel is a heavier diesel fuel than No. 1 diesel fuel. Heavier fuels can cause problems with fuel filters, fuel lines, fuel tanks, and fuel storage in cold weather.

When diesel fuel is stored outdoors during cold weather, the water will freeze after the water separates from the diesel fuel. Any effect that is caused by storing the fuel outdoors should immediately appear in the fuel. Fuel that is stored in underground tanks or fuel that is stored in a heated area will be easier to pump. However, moisture in the fuel will not freeze until the fuel is in the machine. Any effect that is caused by cold weather will not appear until the fuel has cooled to the outside temperature. It is preferable to determine any detrimental effects of temperature before the fuel is in the machine.

Heavier diesel fuels such as No. 2 diesel fuel may be able to be used in diesel engines that operate in cold temperatures with a minimum amount of 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.

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.

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 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 that are designed for use on operating machines use either engine coolant or the heaters use exhaust gas as a heat source. These systems may prevent filter waxing/plugging 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. Two fuel heaters may be required: one fuel heater that is powered externally for use when the engine is not operating and one fuel heater that uses either engine coolant or uses exhaust gas as a heat source when the machine is moving.

Note: Only use fuel heaters that are controlled by thermostats or use fuel heaters that are self-regulated. Do not use fuel heaters in warm temperatures.

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.

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

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.

i02162481

Fuel Information for Gasoline Engines

SMCS Code: 1250; 1280

Use a regular grade of fuel or use an unleaded grade of fuel. These fuels must have a minimum octane rating of 87.

i02162487

Fuel Information for LP Gas Engines

SMCS Code: 1250; 1280

Use grade HD5 LPB. LP Gas is a highly volatile fuel. LP Gas has an octane rating of 100 to 140. Follow local ordinances regarding the storage of tanks of LP Gas. Follow local ordinances regarding the filling of tanks for LP Gas.

i02321495

Diesel 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.

The permissible fuels are some crude oils and some blends of crude oil with distillate 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.

NOTICE

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

Diesel fuels that meet the specifications in Table 13 will help to provide maximum engine service life and performance. In North America, diesel fuel that is identified as No. 1-D or No. 2-D in "ASTM D975" generally meet the specifications. Table 13 is for diesel fuels that are distilled from crude oil. Diesel fuels from other sources could exhibit detrimental properties that are not defined or controlled by this specification.

Note: The Caterpillar Specification for Distillate Diesel Fuel 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 DIN 51400 test methods.

NOTICE

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

Table 13

Caterpillar Specification for Distillate Diesel Fuel ⁽¹⁾			
Specifications	Requirements	ASTM Test	ISO Test
Aromatics	35% maximum	"D1319"	"ISO 3837"
Ash	0.02% maximum (weight)	"D482"	"ISO 6245"
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	"D524"	"ISO 4262"
Cetane Number ⁽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 13, contd)

Caterpillar Specification for Distillate Diesel Fuel ⁽¹⁾			
Specifications	Requirements	ASTM Test	ISO Test
API Gravity ⁽³⁾	30 minimum	"D287"	No equivalent test
	45 maximum		
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"	"ISO 3016"
Sulfur ⁽⁴⁾	1% maximum	"D5453" or "D2622"	"DIN 51400"
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"

(continued)

(Table 13, contd)

Caterpillar Specification for Distillate Diesel Fuel ⁽¹⁾			
Specifications	Requirements	ASTM Test	ISO Test
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 DIN 51400 test methods.

(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 a higher altitude 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) Caterpillar fuel systems and engine components can operate on fuels with a maximum sulfur content of 3%. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. For additional information, see this publication, "Engine Oil" topic (Maintenance Section). ULSD fuel will have ≤ 15 ppm (0.0015%) sulfur using the ASTM D5453, ASTM D2622, or DIN 51400 test methods.

(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 bring down 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 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.

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 DIN 51400) meet the requirements of the Caterpillar Specifications for Distillate Diesel Fuel.

Note: Caterpillar recommends the filtration of fuel through a fuel filter with a rating of five microns(c) absolute or less. This filter should be located on the device that dispenses the fuel to the fuel tank for the engine.

NOTICE

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

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

NOTICE

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

In extreme cold ambient conditions, you may use the distillate fuels that are specified in Table 14. However, the fuel that is selected must meet the requirements that are specified in Table 13. These fuels are intended to be used in operating temperatures that are down to $-54\text{ }^{\circ}\text{C}$ ($-65\text{ }^{\circ}\text{F}$).

Table 14

Distillate Fuels ⁽¹⁾	
Specification	Grade
"MIL-DTL-5624U"	JP-5
"MIL-DTL-83133E"	JP-8
"ASTM D1655-04a"	Jet-A-1

⁽¹⁾ The fuels that are listed in this table may not meet all of the requirements that are specified in table 13. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 13 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.

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 this specification. To 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 Table 13.

⚠ 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.

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 be corrosive, and some additives may be harmful to the elastomers in the fuel system. 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: For best results, your fuel supplier should treat the fuel when additives are needed.

Biodiesel

Biodiesel is a fuel that can be made from a variety of sources. Soybean oil or rapeseed oil are the primary sources. 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 that are manufactured today. In original forms, these oils are not suitable for use as a fuel in compression engines. To use these oils as fuel, the oil must be esterified. Alternate base stocks for biodiesel may include animal tallow, waste cooking oils, or a variety of other feedstocks.

Engines that are manufactured by Caterpillar are certified by use of the prescribed 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 EPA or other local 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 biodiesel in any Caterpillar engine that is regulated by emissions standards.

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 ACERT Technology engine model numbers C7, C9, C11, C13, C15, C18, and also for Caterpillar 3046, 3064, 3066, 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, 3600 Series, CM20, CM25 and CM32 engines, biodiesel that meets the requirements that are listed in the Caterpillar specification for biodiesel, ASTM D6751, or EN 14214 are acceptable. 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 15 prior to blending. In addition, the final blend must meet the requirements for distillate diesel fuel that are listed in Table 13.

Note: A complete Caterpillar S-O-S Services Oil Analysis program is recommended when using biodiesel blends of up to 30 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/biodiesel blends above 30 percent are used. Biodiesel/biodiesel blends as used in the engine must meet the requirements that are stated in the "Caterpillar Specification for Distillate Diesel Fuel" in Table 13.

For Caterpillar 3003 through 3034, 3054 and 3056 engines, biodiesel that meets the requirements that are listed in Caterpillar's biodiesel specification, 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 15 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 that are 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 Caterpillar's specification for biodiesel, ASTM D6751, or EN 14214 should pose no problems when blended with an acceptable distillate diesel fuel at the maximum stated percentages, however, the following recommendations must be followed:

Recommendations

- The oil change interval can be 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.
- In a comparison of distillate fuels to biodiesel, biodiesel provides less energy per gallon by 5% to 7%. 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 attainment of the proper cloud point for the fuel.
 - Biodiesel has poor oxidation stability, which can result in long term storage problems. 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. Consult the fuel supplier for oxidation stability additives.
 - 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. The effectiveness of conventional anti-microbial additives when used in biodiesel is not known. Consult your supplier of fuel and additive for assistance.
 - 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.

Caterpillar Biodiesel

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” in Table 13.

NOTICE

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

Table 15

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	4.0-6.0
Flash Point	"ASTM D93"	"ISO 2719"	°C	130 minimum
Cold Filter Plugging - Summer - Winter	"ASTM D4539"	"DIN EN 116"	°C	0 6 below ambient
Pour Point - Summer - Winter	"ASTM D97"	"ISO 3016"	°C	-9 maximum -20 maximum
Sulfur Content	"ASTM D2622"	"DIN 51400"	% weight	0.0015 maximum
Distillation - 10% Evaporation - 90% Evaporation	"ASTM D1160"	"ISO 6616"	°C	To Be Determined 345
Carbon Residue, Conradson (CCR)	"ASTM D189"	"ISO 6615"	% weight	0.05 maximum
Cetane Number	"ASTM D613"	"ISO 5165"		45 minimum
Sulfated Ash	"ASTM D874"	"DIN 51575" "ISO 3987"	mg/kg	0.02 maximum
Water/Sediment Content	"ASTM D1796"	"ISO 3734"	g/m ³	500 maximum
Particulate Matter	"DIN 51419"	"DIN 51419"		15
Copper Corrosion	"ASTM D130"	"ISO 2160"		No. 1
Oxidation Stability	"ASTM D2274"	"ISO 12205"	mg/100mL	15 maximum
Esterification			% volume	98.0 minimum
Acid Value	"ASTM D664"	"ISO 6619"	mg NaOH/g	0.5 maximum
Methanol Content	GC Method	"DIN 51608"	% weight	0.2 maximum
Monoglycerides	"ASTM D6584"	"DIN 51609"	% weight	0.8 maximum
Diglycerides	"ASTM D6584"	"DIN 51609"	% weight	0.2 maximum
Triglycerides	"ASTM D6584"	"DIN 51609"	% weight	0.2 maximum
Free Glycerine	"ASTM D6584"	"DIN 51609"	% weight	0.02 maximum
Total Glycerine	"ASTM D6584"	"DIN 51609"	% weight	0.240 maximum
Iodine Number	"DIN 53241 or IP 84/81"	"DIN 53241 or IP 84/81"	cg I ₂ /g	110 maximum
Phosphorus Content	"DGF C-VI4"	"DIN 51440-1"	mg/kg	0.2

(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" in Table 13.

Note: Fuels that meet "ASTM D6751" or "EN14214" may be used for blending with distillate fuel. The conditions, recommendations, and limits noted in this biodiesel section apply.

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Characteristics of Diesel Fuel

SMCS Code: 1250; 1280

Lubricity and Low Sulfur Fuel

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. 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.

In the USA, a 0.05 percent limit on the amount of fuel sulfur in diesel fuel was mandated in January of 1994 for on-highway trucks. The removal of sulfur from diesel fuel helps to reduce particulate emissions from diesel engines. While limits for fuel sulfur have not generally been mandated for off-highway use, some local governments have regulations that include off-highway use. There is frequently no difference in the fuel that is sold for different applications. The same fuel is often used for both on-highway applications and off-highway applications. Other areas of the world are mandating similar limits. Regulations continue to become more stringent. Lower sulfur limits can be expected in the future.

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 with low sulfur require little hydro-treatment to obtain the 0.05 percent 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.

All low sulfur fuels do not have a low lubricity. 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. 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 reliable fuel supplier, performing proper maintenance of the fuel system, and installing Caterpillar Advanced Efficiency Fuel Filters in the fuel system.

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

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

Viscosity

The viscosity of the fuel is significant because the fuel serves as a lubricant for fuel system components. Arctic fuels and other “light” fuels need to have sufficient viscosity. The fuel must lubricate the fuel system at temperatures that are below freezing (below 0°C or 32°F). 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.

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 room or a coolant heater.

During average starting conditions, direct injection 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 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 topic “Pour Point”.

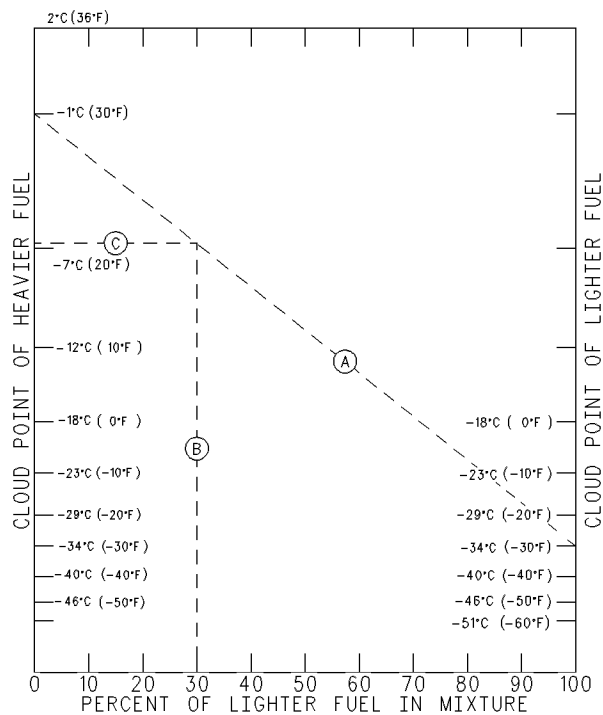


Illustration 10

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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 with 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.

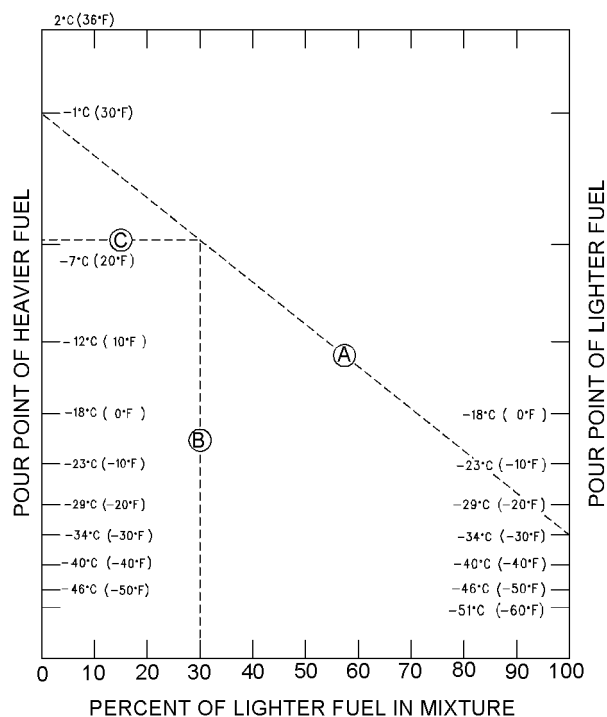


Illustration 11

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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 a low concentration, the fuel will flow through pumps, lines, and hoses. 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. See this publication, "Lubricity and Low Sulfur Fuel" under the "Characteristics of Diesel Fuel" section.

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: Caterpillar recommends a maximum of one year for fuel storage.

Cooling System Specifications

i02297486

General Coolant Information

SMCS Code: 1350; 1395

NOTICE

These recommendations are subject to change without prior notice. Contact your 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 machine 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 19 L (5 US gal) per minute.

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

NOTICE

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

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

Refer to Special Instruction, REHS1063, "Know Your Track-Type Tractor Cooling System" for more detailed information.

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

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

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

Water

NOTICE

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

NOTICE

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

Note: Caterpillar recommends a minimum of 30 percent glycol in machine diesel engine cooling systems.

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

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

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

If distilled water or deionized water is not available, use water with the properties that are listed in Table 16.

Table 16

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 grain/US gal)	"D1888" "Federal Method 2540B"
Acidity	pH of 5.5 to 9.0	"D1293"

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

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

Additives

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

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

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding SCA (Supplemental Coolant Additives) to Cat DEAC (Diesel Engine Antifreeze/Coolant) or by adding Cat 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 a water/glycol solution.

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

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

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 17 and 18.

Table 17

Ethylene Glycol		
Concentration	Freeze Protection	Boil Protection ⁽¹⁾
50 Percent	$-37\text{ }^{\circ}\text{C}$ ($-34\text{ }^{\circ}\text{F}$)	$106\text{ }^{\circ}\text{C}$ ($223\text{ }^{\circ}\text{F}$)
60 Percent	$-52\text{ }^{\circ}\text{C}$ ($-62\text{ }^{\circ}\text{F}$)	$111\text{ }^{\circ}\text{C}$ ($232\text{ }^{\circ}\text{F}$)

⁽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 glycol in concentrations that exceed 60 percent glycol.

Table 18

Propylene Glycol		
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.

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.

Note: Propylene glycol coolant that is used in the cooling systems for Caterpillar diesel engines must meet ASTM D6210-03, "Fully-Formulated Glycol-Base 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.

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Coolant Recommendations

SMCS Code: 1350; 1352; 1395

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

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

Acceptable – Cat DEAC (Diesel Engine Antifreeze/Coolant) or a commercial heavy-duty coolant/antifreeze that meets "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 water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

Note: Cat DEAC does not require a treatment with an Supplemental Coolant Additive (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.

NOTICE

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

Note: Caterpillar recommends a minimum of 30 percent glycol in machine diesel engine cooling systems.

Table 19

Coolant Service Life	
Coolant Type	Service Life ⁽¹⁾⁽²⁾
Cat ELC	12000 Service Hours or Six Years
Commercial Coolant that meets the Caterpillar EC-1 Specification	6000 Service Hours or Six Years
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.

(2) Refer to the specific machine Operation and Maintenance Manual, "Maintenance Interval Schedule" for the correct interval for replacement of the cooling system water temperature regulator.

Note: Add Cat ELC Extender at 6000 service hours or one half of the service life for the ELC.

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

Cat ELC can be recycled into conventional coolants.

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Extended Life Coolant

SMCS Code: 1350; 1352; 1395

Cat ELC (Extended Life Coolant)

Caterpillar provides Cat ELC 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 a 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 ELC service life.

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

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

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

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

Extended Life Coolant Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

Proper additions to the 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. 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 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 or an SCA maintenance element. 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. Use the formula in Table 20 to determine the proper amount of Cat ELC Extender that is required.

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

Use the formula in Table 20 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 20

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 21 is an example for using the formula that is in Table 20.

Table 21

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 SCA's or SCA maintenance elements. To avoid SCA contamination of an ELC system, remove the SCA element base and plug off or by-pass 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 the cooling system.

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. Consult your Caterpillar dealer for more information.

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.

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, GECJ0001, "Cat Shop Supplies and Tools" guide for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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

NOTICE

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

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

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

3. Remove the empty SCA maintenance element and remove the element base. Plug the coolant lines or bypass the coolant lines.
4. Flush the system with clean water in order to remove any debris.

5. Use Caterpillar 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, PEEP5027, "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 the cooling system.

Cat ELC Cooling System Contamination

NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for premixed or concentrate coolants. Use only 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 cooling system teardown 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 Caterpillar specification of EC-1 and the “ASTM D6210” specification. Do not use an extended life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial extended life coolant. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

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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.

Containers of several sizes are available. 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, see this publication, “General Coolant Information” (Maintenance Section).

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 Cat DEAC, adding more Cat SCA is not necessary until the concentration of Cat SCA has been depleted. 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’s, “Conventional Coolant/Antifreeze Cooling System Maintenance” article for the part numbers.

Note: Do not exceed a six percent maximum concentration of SCA.

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Conventional Coolant/ Antifreeze Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

NOTICE

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

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

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

Table 22 lists the amount of Cat SCA that is needed at the initial fill in order to treat coolant/antifreeze. These amounts of Cat SCA are for systems that use heavy-duty coolant/antifreeze.

Table 22 also lists additions of supplemental coolant additive for liquid and for maintenance elements at 250 hour intervals or at the intervals for PM Level 1. The additions are required for Cat DEAC (Diesel Engine Antifreeze/Coolant) and for commercial coolant/antifreezes.

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

Table 22

Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze				
Cooling System Capacity	Initial Fill⁽¹⁾	250 Service Hour or Intervals for PM Level 1⁽²⁾	Spin-on Element at 250 Service Hour or at Intervals for PM Level 1⁽³⁾	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 D6210-03" 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 Coolant Analysis.

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

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

Refer to Table 22 and Table 23 for part numbers and for quantities of SCA maintenance elements and/or liquid SCA.

Table 23

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.

Cleaning the System of Heavy-Duty Coolant/Antifreeze

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

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

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Commercial Heavy-Duty Coolant/Antifreeze and Supplemental Coolant Additive

SMCS Code: 1350; 1352; 1395

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

When a heavy-duty coolant/antifreeze is used, treat the cooling system with three to six percent Cat SCA (Supplemental Coolant Additive) 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 publication, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

If Cat SCA is not used, select a commercial supplemental coolant additive. The commercial supplemental coolant additive must provide a minimum of 1200 mg/L or 1200 ppm (70 grains/US gal) of nitrites in the final coolant mixture.

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

Coolant/antifreezes for heavy-duty applications that meet the "ASTM D6210" specification do not require treatment with supplemental coolant additive at the initial fill. Treatment with supplemental coolant additive 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 publication, "General Coolant Information" topic (Maintenance Section).

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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 Services Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S·O·S Services Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S·O·S Services Coolant Analysis is a program that is based on periodic samples.

NOTICE

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

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

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

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

New Systems, Refilled Systems, and Converted Systems

Perform an S·O·S Services Coolant Analysis (Level 2) at the following maintenance intervals.

- Every Year
- 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 24

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

⁽¹⁾ This is the recommended coolant sampling interval for all conventional heavy duty coolant/antifreeze. This is also the recommended coolant sampling interval for commercial coolants that meet Cat EC-1 (Engine Coolant specification - 1)

⁽²⁾ 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)

An S·O·S Services 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
- Water hardness

The results are reported, and appropriate recommendations are made.

S·O·S Services Coolant Analysis (Level 2)

An S·O·S Services Coolant Analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

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

- Full coolant analysis (Level 1)
- Identification of the source of metal corrosion and of contaminants
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of 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 Services Coolant Analysis, consult your Caterpillar dealer.

Reference Information Section

Reference Materials

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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.

Note: Refer to this publication, the respective product data sheet, and to the appropriate Operation and Maintenance Manual for product application recommendations.

Coolant

- Data Sheet, PEHJ0067, "Cat ELC (Extended Life Coolant)" (Worldwide)
- Special Publication, PEEP5027, "Label - ELC Radiator Label"
- Special Publication, PELJ0176, "Cat ELC (Extended Life Coolant) 223-9116 Dilution Test Kit"
- Data Sheet, PEHP9554, "Cat DEAC (Diesel Engine Antifreeze/Coolant) (Concentrate)"
- Special Publication, REHS1063, "Know Your Track-Type Tractor Cooling System"
- Special Publication, SEBD0970, "Coolant and Your Engine"

Diesel Engine Oil

- Special Publication, PELJ0179, "Caterpillar Engine Crankcase Fluid-1 Specifications (Cat ECF-1)" (All international markets)
- Data Sheet, PEHJ0059, "Cat DEO (SAE 10W-30 and SAE 15W-40)" (North America - Canada, Mexico, and United States)
- Data Sheet, PEHJ0021, "Cat DEO (SAE 10W-30 and SAE 15W-40)" (Worldwide - except North America, Egypt, Saudi Arabia, and Brazil)

- Data Sheet, PEHJ0072, "Cat DEO (SAE 10W-30 and SAE 15W-40)" (Brazil)
- Data Sheet, PEHJ0091, "Cat DEO (SAE 10W-30 and SAE 15W-40)" (Egypt and Saudi Arabia)
- Data Sheet, PEHP7062, "Cat DEO SYN (SAE 5W-40)"
- Data Sheet, PEHJ0093, "Cat DEO (SAE 30 and SAE 40)" (For use in 3600 Series diesel engines and for use in older precombustion chamber diesel engines. Do NOT use in direct injected machine diesel engines.)
- Data Sheet, PEHJ0008, "Cat Arctic DEO (SAE 0W-30)" (Canada and United States)

Machine Lubricants

Transmission/Drive Train Oil

- Data Sheet, PEHJ0007, "Cat Arctic TDTO (SAE 0W-20)" (synthetic blend) (Canada and United States)
- Data Sheet, PEHP7506, "Cat TDTO (SAE 10W, SAE 30, and SAE 50)" (Exceeds the Caterpillar TO-4 specification.)
- Data Sheet, PEHP8035, "Cat TDTO TMS (Transmission Multi-Season)" (synthetic blend - multigrade) (Exceeds the Caterpillar TO-4M specification.)

Final Drive and Axle Oil

- Data Sheet, PEHP9530, "Cat FDAO (SAE 60)" (Exceeds the Caterpillar FD-1 specification.)
- Data Sheet, PEHP9570, "Cat FDAO SYN (Multigrade)" (Exceeds the Caterpillar FD-1 specification.)

Multipurpose Tractor Oil

- Data Sheet, PEHP3050, "Cat MTO (Multigrade)"

Gear Oil

- Data Sheet, PEHJ0030, "Cat Synthetic GO (SAE 75W-140)"
- Data Sheet, PEHP7508, "Cat GO (SAE 80W-90 and SAE 85W-140)"

Hydraulic Oil

- Special Publication, PEGP6028, "Cat Hydraulic Systems Management Guide"

- Data Sheet, PEHJ0009, “Cat HYDO (SAE 10W)”
- Data Sheet, PEHP6047, “Cat BIO HYDO (HEES)” (Exceeds the Caterpillar BF-1 specification.)
- Data Sheet, PEHP9544, “Cat HYDO (SAE 30)” (Not available in North America)

Grease

- Special Publication, PEGJ0035, “Grease Selection Guide”
- Data Sheet, PEHP0002, “Cat Advanced 3Moly Grease” (NLGI grade 2)
- Data Sheet, NEHP6010, “Cat Ultra 5Moly Grease” (NLGI grades 1 and 2)
- Data Sheet, NEHP6011, “Cat Arctic Platinum Grease” (NLGI grade 0)
- Data Sheet, NEHP6012, “Cat Desert Gold Grease” (NLGI grade 2)
- Data Sheet, NEHP6015, “Cat High Speed Ball Bearing Grease” (NLGI grade 2)
- Data Sheet, PEHJ0088, “Cat Multipurpose Grease” (NLGI grade 2)

Filters

- Data Sheet, PEHP6028, “Cat Ultra High Efficiency Air Filters”
- Data Sheet, PEHP7032, “Radial Seal Air Filters”
- Data Sheet, PEHJ0092, “Cat Cabin Air Filters”
- Data Sheet, PEHP7077, “Cat Turbine Pre-Cleaners”
- Data Sheet, PEHP8033, “Radial Seal Air Filter Conversion Kit for Hydraulic Excavators”
- Data Sheet, PEHP8034, “Radial Seal Air Filter Conversion Kit for Backhoe Loaders”
- Data Sheet, PEHP9013, “Air Filter Service Indicator”
- Data Sheet, PEHJ0082, “Cat Fuel/Water Separators and Prime Time Priming Pumps”
- Data Sheet, PEHP7045, “Fuel Contamination Control For 3500 Series Cat Engines”
- Data Sheet, PEHP7046, “Fuel Contamination Control”

- Data Sheet, PEHJ0068, “Cat Advanced Efficiency Engine Oil Filter”
- Data Sheet, PEHJ0069, “Cat Hydraulic and Power Train Filters”

S·O·S Services

- Special Publication, PEDP7036, “S·O·S Services”
- Special Publication, PEHP7052, “Making the Most of S·O·S Services”
- Special Publication, PEHP7076, “Understanding S·O·S Services Tests”

Miscellaneous

- Special Publication, AECQ1042, “Caterpillar Product Line Brochure”
- Special Publication, PECP9067, “One Safe Source”
- Special Publication, PEDP9131, “Fluid Contamination - The Silent Thief”
- Special Publication, PEWJ0074, “Cat Filter & Fluid Application Guide”
- Special Publication, SEBD0345, “Caterpillar Performance Handbook (Edition 35)”
- Special Publication, SEBF1015, “Improving Component Durability - Final Drives and Differentials”
- Special Publication, SENR9620, “Improving Fuel System Durability”
- Video, PEVN4266, “Putting the Power in Powershift Transmissions” (VHS)
- Construction Equipment Magazine Article Reprint, PEWP8029, “Benefits of Multi-season Transmission/Drive Train Oil”

Additional Reference Material

Engine Manufacturers Association, “Engine Fluids Data Book”

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

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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: _____

