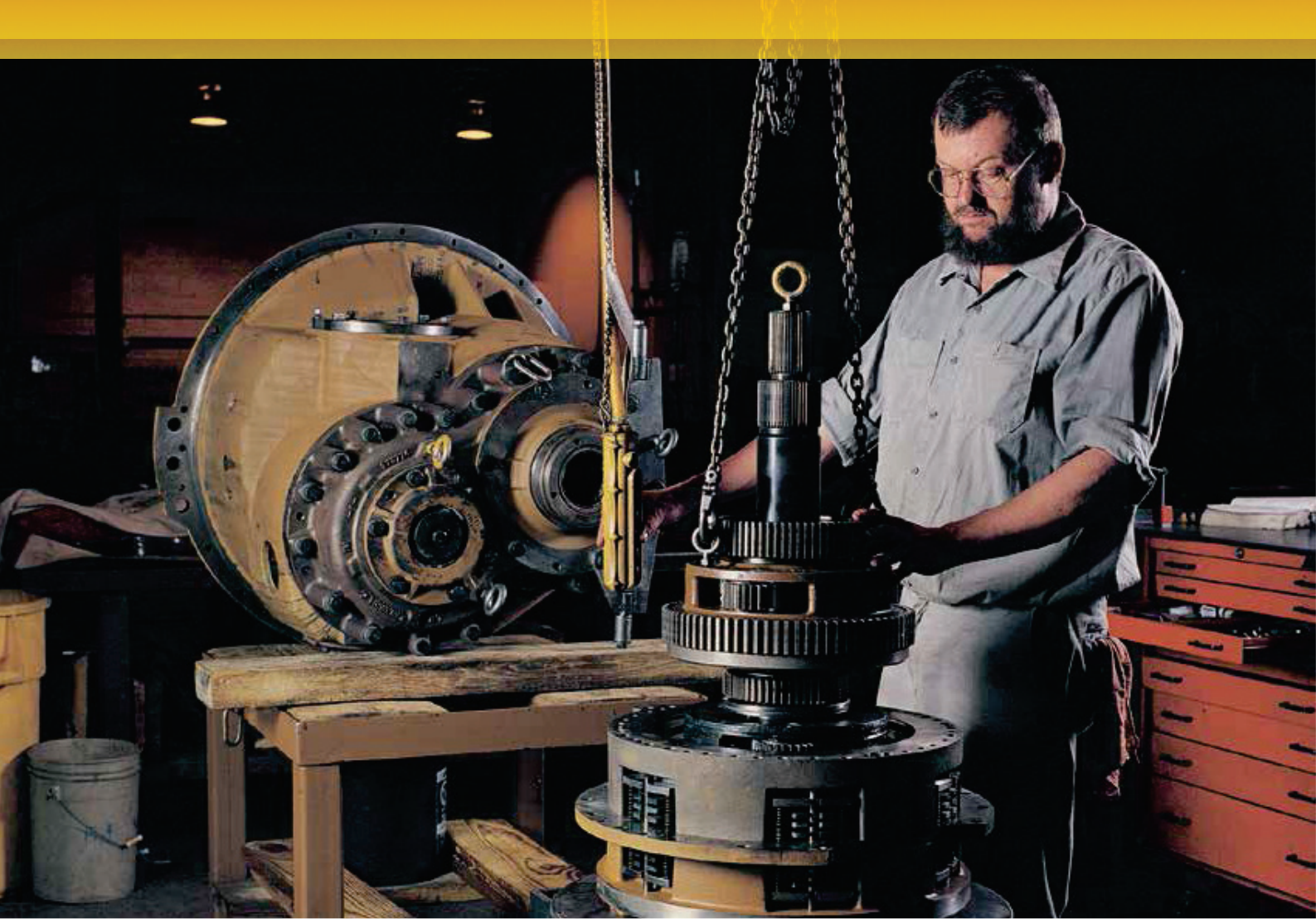


Cat[®] Transmission Maintenance



Management Guide

- System Overview
- Importance of S•O•SSM Fluid Analysis
- Preventive Maintenance
- Thorough Inspections
- Transmission Maintenance Tips
- Training, Scheduling, and Record Keeping
- FAQs



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The transmission is a critical part of a machine's power train. Its function is to take the output from the engine and manipulate it to control speed, direction, and torque. Following a planned maintenance program and Caterpillar recommended maintenance guidelines can help ensure longer life for your transmission and reduce machine downtime.

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This management guide offers information, tips, and ideas but is not intended as a technical manual or a substitute for the advice and recommendations of our parts and service experts. By referencing this manual and following the recommendations in your Operations and Maintenance Manual, you can maximize the productivity, service life, and value of your Cat® machines.

Manage it well. Make it last.

This guide will give you the tools to get the most value from your transmission.
Understanding your transmission will help you develop an effective management program.

Using the information in this guide along with the recommendations in your Operations and Maintenance Manual can help you maximize the productivity and service life of your Cat machines.



System Overview

Because of the wide variety of work they do, Caterpillar products use several types of transmissions, including planetary powershift, countershaft powershift, direct drive, and hydrostatic. Each is designed to convert engine power into the exact combination of speed, direction, and torque required for the particular application. Transmissions do this by various means such as hydraulic clutches or a hydrostatic/hydraulic drive.

Transmissions rely on the engagement of gear groups to provide the transfer of power to your machine components. Caterpillar designs all parts, including these gear groups, to fall within three wear categories. Understanding which parts wear faster will allow you to inspect for signs of wear and keep your transmission running smoother and longer.

For example, gears and shafts, if properly maintained, are designed to last through multiple transmission rebuilds. But components such as friction material, seals, gaskets and bearings are faster wearing. Monitor them for abnormal wear and replace when needed.

To increase productivity and prevent downtime, it's vital to make sure that all drive train components are constantly monitored. Look at their condition to ensure contamination isn't entering their systems and to check that correct operating techniques are being used. This brochure focuses on how to identify problem indicators and how to maximize the performance and life of your transmission.



Importance of S•O•S Fluid Analysis

Many years ago it became apparent that the oil used to achieve maximum engine life would not perform satisfactorily in transmissions. Consequently, Caterpillar developed specifications for transmission oil just as the Company has done with engine oil for many decades.

Caterpillar developed transmission oil specifications to maximize the performance and life of Caterpillar products. Since only Caterpillar engineers know exactly what metallurgical specifications were designed into each part and component, they were also able to develop an oil analysis program to help accomplish these goals. When selecting lab instruments and tests for S•O•S fluid analysis, Caterpillar engineers begin by asking what information from used oil samples would best identify the transmission's condition.

Surveys show major benefits for users who regularly use S•O•S fluid analysis. A 10:1 payback is common when comparing the amount saved on repair costs to the amount invested in S•O•S fluid analysis. This figure is probably conservative when you consider reduced downtime, greater productivity and increased used-machine value.

S•O•S fluid analysis testing is quick and easy to do. Sample test analysis is done in your Cat dealer laboratories by trained technicians using the most modern technology. These experts know what's happening inside the transmission and how it relates to sample findings. They draw on a large database of information and wear tables developed through years of testing and evaluations. The following wear table outlines transmission failures and their common indicators using the S•O•S fluid analysis.

S•O•S Transmission Fluid Analysis

Friction Material

- Si, Cu, Pb (friction materials)
- Fe (separator plates)
- ISO Code (larger particles)
- Oxidations (caused by overheating the oil)
- Incorrect fluid (difficult to identify)

Sticking Control Valves

- ISO Code (larger particles)
- Fe (debris)
- Oxidation (caused by overheating the oil)

Bearing or Bushing Failure

- Cu, Pb and/or Sn (bronze bushing or thrust washer)
- Cr (rolling element bearing)
- Fe (rolling element bearing, shaft, iron housing)
- ISO Code (larger particles)

Dirt Entry

- Si & Al (dirt)
- Fe (separator plates, gears)
- Cu, Pb, Sn (bronze bushings or thrust washers)

Importance of S•O•S Fluid Analysis

Indicators

If excessive amounts of silicate (Si) and aluminum (Al) are found in the transmission fluid, it means the oil is contaminated with dirt. The S•O•S fluid analysis experts might recommend you change your oil right away and to change it more frequently in the future. High levels of copper (Cu), iron (Fe) and lead (Pb) could indicate abnormal wear of the bronze friction discs (if equipped) and steel separator plates.

Recommendations would include stopping the machine and inspecting the transmission. Also, you would be advised to cut open and inspect the oil filter for large particles.

S•O•S Fluid Analysis Tests

S•O•S fluid analysis consists of four standard tests:

Component Wear Rate—What components are wearing and at what rate?

Oil Contamination—What contaminants are showing up in the oil?

Oil Condition—Is the correct transmission oil being used? Has the oil been exposed to excessive heat?

Oil Identification—Is there coolant or water leaking into the oil? Is the right oil being used?

Advantages of Using S•O•S Fluid Analysis

Surveys constantly show major benefits for regular users of S•O•S fluid analysis:

- Experts can provide analysis and interpretation of trends and can forecast any wear problems.
- S•O•S fluid analysis test results are available within 24 hours after receipt of the sample.
- Evaluation is supplied in an easy-to-understand test report, which calls for specific action and/or makes carefully outlined recommendations.
- Reports can identify problem areas such as careless maintenance or an operator who rides the brakes too much.
- Using S•O•S fluid analysis saves time and money because potential trouble spots can be identified before they become major problems.

Consult your Cat dealer for complete information and assistance on the S•O•S fluid analysis program.



Preventive Maintenance

Regular preventive maintenance is the most cost-effective way to keep your transmission operating at peak performance. Preventive maintenance focuses on transmission and drive train oils, filters, S•O•S fluid analysis and contamination control. Benefits include:

- Ability to schedule downtime and plan for maintenance and repair costs.
- Help prevent major failures, including failures of related parts.
- Save money by driving more repair before failure.
- Maximize parts reusability.
- Optimize equipment life to keep your machine on the job.
- Increase machine resale value.

Following a good preventive maintenance plan can significantly increase transmission life.

Oil Use

Oil helps to perform three main functions: cleaning, cooling and lubricating the transmission. Today's transmissions feature new metals, elastomers, and friction materials that require advanced lubrication. You must use the right oil and change it regularly and properly to achieve top performance.

Use the Right Drive Train Oil

Cat Transmission/Drive Train Oil (TDTO) is specially formulated to increase the life and performance of your Cat drive train components. This oil reduces transmission slippage, controls brake chatter, provides greater machine rimpull and increases friction material life up to 45 percent. Cat TDTO surpasses the TO-4 specification requirements and is specified as factory fill for all Cat machine compartments where TO-4 oils are the primary recommendation.

Caterpillar also offers a multi-season formulation of TDTO called TDTO (TMS). This Caterpillar exclusive is a partially synthetic lubricant that eliminates the need to change oil at seasonal intervals. As a result you use the oil for its full life, so there's less used oil disposal and less downtime for maintenance.

Cat TDTO (TMS) has shown improved transmission performance in cold weather for machines with electronic controls. TDTO (TMS) is recommended in climates with widely ranging ambient temperatures to avoid unnecessary oil changes.

For extreme cold climates, Caterpillar offers Cat TDTO Cold Weather™ oil. This oil is a synthetic blend that provides superior performance and protection in transmissions, torque converters, final drives, hydraulics, and/or wet brakes at temperatures down to -40°F (-40°C). The special formulation creates optimal friction performance and controls transmission slippage while eliminating clutch glazing.

Some Cat machines call for the use of multipurpose tractor fluid in the transmission. For these applications Caterpillar offers Cat MTO oil.

Change Oil Properly

Changing oil properly and at correct intervals is critical to realizing maximum component life. Actual oil life is determined by many factors such as operating conditions and applications or contamination control. You can reduce contamination by:

- Washing the transmission tank and drain before removing cap.
- Draining oil as quickly as possible and doing so when it is agitated and warm.
- Using a filtered transfer cart to add new oil.
- Installing and removing filters carefully.
- Keeping filters in the package until ready for use.
- Cutting open and inspecting used filters before installing new ones.



Preventive Maintenance

Filters

Cat filters are specifically designed around key factors such as sediment capacity, collapsibility, burst strength, and pressure fatigue. By properly and regularly changing filters and by selecting the right filters, you maintain drive train system cleanliness, reduce component wear, and lower costs.

Caterpillar recently introduced a new line of Cat transmission filters which have been designed to meet the specific needs of transmission applications. These new filters feature synthetic media which provides significantly higher dirt holding capacity and better cold weather performance. Prior to this line of filters, Cat transmissions systems had used the same filter as the hydraulic system.

Caterpillar also offers Ultra High Efficiency Filters which can be used as a cleanout filter after any maintenance, rebuild, or debris invasion, or when suggested by particle count data from S•O•S fluid analysis. If a cleanout filter is used, remember to switch back to a standard filter within the recommended hour interval.

When replacing an old transmission filter it's extremely important to cut open the filter and inspect for signs of component wear or clogging. Pieces of metal may be found in or around the magnetic screen and can indicate a certain component is failing.

Possible Sources of Metal Pieces:

- Aluminum—torque converter
- Bronze colored—transmission clutches
- Gray iron—transmission housing or pistons



- Brass—rings in rotating clutches
- Shiny metals—gear teeth
- Shiny flaky material—bearings

Breathers

Breathers are extremely important in transmission preventive maintenance. If breathers become plugged and temperatures dip down during the evening, the transmission becomes a vacuum because the cool air inside the transmission case shrinks. As it shrinks, it draws in air, dirt and other contaminants through the gaskets and seals.

If this occurs regularly, the gaskets and seals may sustain enough damage to allow water and other contaminants into the transmission. Dirt and water can be especially harmful to the electronics. Solenoids in your electronics control when and how quickly your clutches engage. When the solenoids become contaminated they become sluggish and your clutches may engage too quickly or they may slide.

To get the most use out of this filter, cover the transmission breather before washing your equipment and check your breather for clogging when inspecting other machine components.

Contamination Control

You demand more power, faster cycle times and easier operation. Caterpillar is responding with higher system pressures and more sophisticated, productive machines.

Controlling contamination is more critical than ever because these high-tech machines require tighter clearances and fluid systems that are more sensitive to contamination. Contamination leads to reduced efficiency, increased cycle times, shortened component and fluid life, and catastrophic failure causing costly downtime and repairs.

As an example, only **1/2 teaspoon** of “dirt” is allowed in a **55-gallon drum** of oil before quality standards are exceeded.

Causes of Contamination

Contamination can be introduced at the refinery, during machine operation or during maintenance. Contaminates include:

- Dirt
- Sealing material
- Metals
- Grease
- Products from oil oxidation
- Weld spatter
- Heat
- Air
- Paint flakes
- Water
- Rag fibers

Effects of Contamination in Transmissions

- Shifting problems from plugged control valves
- Premature clutch wear from spinning
- Leaks or premature wear
- Premature bearing wear or bearing failure
- Premature gear wear

Preventing Contamination

Good Housekeeping Practices:

- Sweep floors daily.
- Clean up spills immediately.
- Keep workbenches uncluttered and free of debris.
- Limit use of floor storage.

Proper Oil Storage and Transfer Methods:

- Filter new oil.
- Store oil drums on their sides.
- Use drum covers.
- Use “kidney loop” system.
- Use high efficiency filters for extra filtration.

Repair and Assembly:

- Place covers over open compartments.
- Ensure that root cause of failure has been identified and repaired.
- Properly clean components before reassembly
- Use standard parts kits for all component installations.

Particle Count Monitoring:

- Strive for oil cleanliness.
- Test oil in new machines after field assembly or after adding new attachments.
- Test oil before and after service repairs.

Thorough Inspection

A good inspection program combines your daily inspections with our periodic in-depth analysis.

- Locate potential problems before they become major repairs.
- Schedule transmission maintenance and service.
- Plan and control your operating costs and downtime.

Your daily visual inspection routine should include a complete visual and operational check of your transmission. The following chart summarizes planned and problem indicators that are associated with the transmission.

Cat Transmission Repair Indicators

Planned Indicators	Description
S•O•S Fluid Analysis	S•O•S fluid analysis provides the best insight into internal transmission wear and potential failure.
Service Meter Hours	Cat dealers use service meter hours as a repair indicator.
Operator Discussion	Talking with your machine operator can reveal many potential transmission problems.

Problem Indicators	Possible Causes	Options
Hesitation/Slippage	Worn plates and discs Linkage out of adjustment Low fluid level Linkage not free Incorrect pressure settings Wrong oil used	Technical analysis inspection Repair determination discussion S•O•S fluid analysis Customer/dealer discussion
Unusual Noises	Worn gears/bearings Dirt entry Aeration/cavitation Low fluid levels	Technical analysis inspection Repair determination discussion S•O•S fluid analysis Customer/dealer discussion
Vibration	Bent/damaged drive shaft Gear failure Bearing failure	Technical analysis inspection Repair determination discussion S•O•S fluid analysis Customer/dealer discussion
Overheating	Wrong oil used Plugged radiator Worn pump/pressure relief valve Worn or damaged seals Low fluid level Worn or dirty control valve	Technical analysis inspection Repair determination discussion S•O•S fluid analysis Customer/dealer discussion
Debris in Filter and/or on Magnetic Screen	Dirt entry Wrong oil used Extended oil change period Worn gears/bearings Disc disintegration	S•O•S fluid analysis Customer/dealer discussion
Leaks	Worn, hard, cracked seals	Repair determination discussion Customer/dealer discussion

Transmission Maintenance Tips

DO

1. Use proper Contamination Control guidelines.
2. Make sure the fluid meets ISO standards before pouring it in your machine.
3. Use the correct transmission oil—Caterpillar recommended fluids found in the Operation & Maintenance Manual.
4. Use Cat filters—Recommended filters found in the Operation & Maintenance Manual.
5. Cut open old filters to inspect for indications of a problem.
6. Keep accurate records.
7. Follow the proper service hours guidelines.

DON'T

1. Don't open your transmission system in a dirty environment.
2. Don't abuse your machine (application, operation, etc.).
3. Don't pre-fill filters (fuel or oil).



Training, Scheduling, and Record Keeping

Training

Operating technique has a direct impact on transmission wear life. Proper training is important to identify good and bad operator techniques.

Avoid:

- High-speed direction changes.
- Backing over stumps or off a lowboy.
- Operating with a frozen undercarriage.
- Extreme braking.

Implement:

- Adequate warm-up.
- Periodic and proper shifting.
- Attention to warning signs.
- Daily walkaround inspections.

Transmission life is also impacted by the applications in which a machine operates throughout the year.

Operating Environment:

- Seasonal temperatures often affect fluid choices, change intervals, inspection, and operating practices.

Jobsite Layout:

- Well-paved and maintained haul roads reduce the jarring impact on the transmission and other machine systems.
- Repetitive and high-speed load and carry applications can impact transmission life.

Scheduling

Good maintenance and repair scheduling practices are important when trying to optimize transmission life.

Effective scheduling means maintenance, inspections and planned repairs are done on time so you can prevent any transmission failures caused by overlooked maintenance.

Record Keeping

An accurate record-keeping system documents transmission history by detailing component life and cost information.

By developing an accurate machine record-keeping system, you can identify high-cost or problem areas, track work flow, control costs and increase machine sale value.



Frequently Asked Questions

What are some of the subtle signs that you may have transmission problems?

Overheating, slippage, or jerky shifting can signify a problem within a transmission. If this occurs, contact your local dealer to arrange for a thorough inspection and S•O•S fluid analysis.

What are some of the primary causes of transmission failure and/or reduced power output or performance?

Low oil pressure can cause clutch slippage. Check your transmission filter and oil levels in the transmission. They may need to be replaced.

Incorrect pressure may cause transmission failure or reduced power output or performance. Transmissions are designed to run at around 200 lbs of pressure. Check all pressures to ensure correct levels.

Contamination from other failing parts can cause plugged filters. Check all parts for contamination.

Are oil additives usually recommended?

Caterpillar doesn't recommend any additives; they are already in the lubricant.

What have been the major technological changes to transmission design in recent years and how have these affected the maintenance and upkeep of transmissions?

As the expectations of life and durability of machines increase, Caterpillar engineers have responded by making many mechanical and electrical changes that allow increased productivity and longer life of your product. However, these changes require smaller tolerances and increases in pressure in your machine that make maintenance and the upkeep of your transmission essential. Because these mechanical and electrical changes are advanced, they often require unique testing and repair that only your local Cat dealer can provide accurately.

When a company with a diverse fleet uses just one or two lubricating oils, what is the effect?

Using the incorrect lubricating oil can cause incorrect pressure, faster wear, or slippage. It is also possible the oil additive packages may not be compatible with all of the materials used in various components.

Do different types of equipment wear out transmissions at different times? For example, how does a transmission wear in load-and-carry operations vs. stay-at-home operations?

Transmissions do wear out at different intervals due to the applications they are in. If you are constantly shifting from gear to gear or from forward to reverse, your clutches and gears may wear out faster. Extended high speed operation in a single gear can also lead to premature wear within that gear set.

Can cutting open a filter help you diagnose a problem?

Yes. Cutting open a filter is very important to determine the root cause of a problem. By finding pieces of metal in the filter, you can determine what is failing. Refer to the filter section of planned maintenance.

What happens to the transmission when fluid becomes too hot?

The transmission oil additives deteriorate and lose their ability to control wear. Oil samples results will show high oxidation and an increase in viscosity.

Expect more from the experts

Maximize the life of your transmission

For any machine to be safe, reliable, and productive, regular preventive maintenance is vital. It is the most cost-effective way to keep your transmission operating at peak performance. If you take care of your transmission, then gears and shafts can last through multiple rebuilds and the overall transmission life increases. Take a proactive approach by planning for scheduled downtime, maintenance, and repair costs. When you plan, you save money and time—and who couldn't use more of each?

Your Cat dealer is ready to help—with parts and service solutions, or just some advice along the way. We're built to put you in control.

Call your Cat dealer with questions about system operation, maintenance, or service.

BUILT FOR IT.™



PEGJ0039-01

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