CATERPILLAR®

Operation & Maintenance Manual

Original Instructions
Keep this manual with machine at all times.

Models
TH336C, TH337C, TH406C, TH407C, TH414C, TH514C, TH417C

S/N MJR00150 & After, S/N THM00150 & After
S/N DJB00150 & After, S/N SXJ00150 & After
S/N GAT00150 & After, S/N RCH00150 & After
S/N MLH00150 & After, S/N JJT00150 & After
S/N KEK00150 & After, S/N RWW00150 & After
S/N MWC00150 & After, S/N KKW00150 & After
S/N RRJ00150 & After, S/N RRW00150 & After

31200752
SEBU9285-04

Revised
June 27, 2016

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Inspection, Maintenance and Repair Log

Lifting Personnel

OW0171

- When lifting personnel, **USE ONLY** an approved personnel work platform, with proper capacity chart displayed in the cab.

OD0921

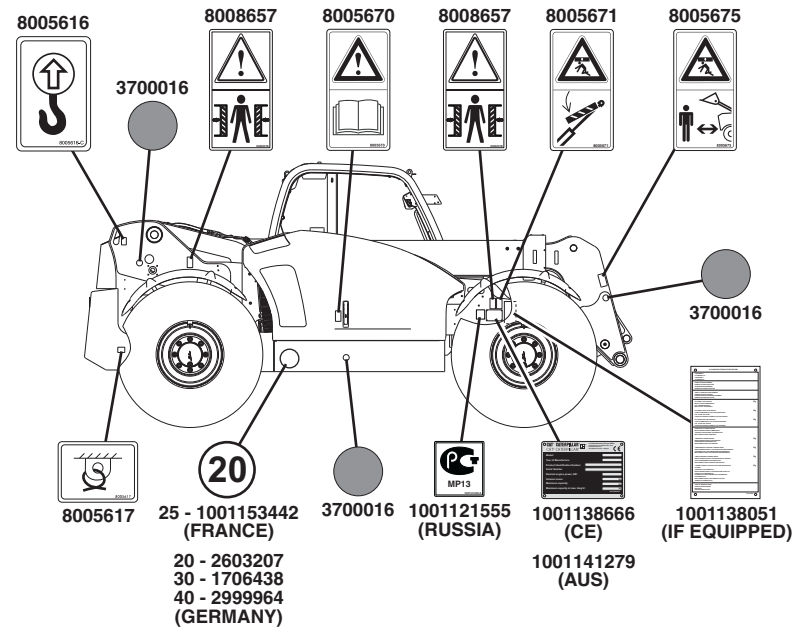
- **DO NOT** drive machine from cab when personnel are in platform.

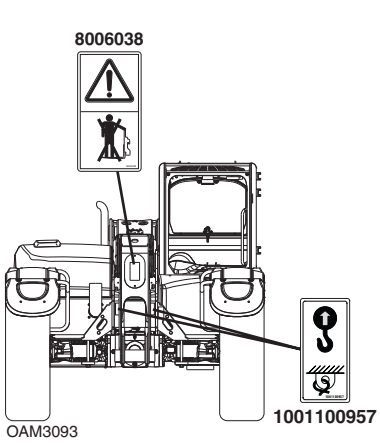
2.2 SAFETY DECALS

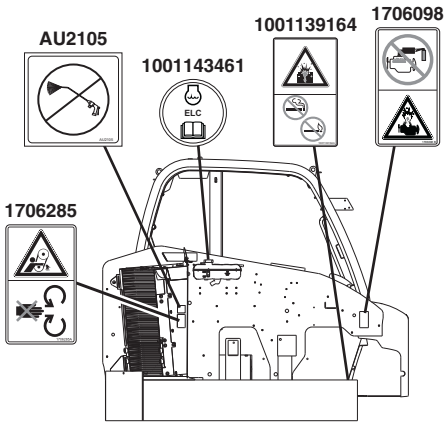
Ensure all **DANGER**, **WARNING**, **CAUTION** and instructional decals and proper load charts are legible and in place. Clean and replace as required.

Note: *Part numbers referenced are for inspection and identification purposes only. Refer to the Parts Manual when ordering replacement parts.*

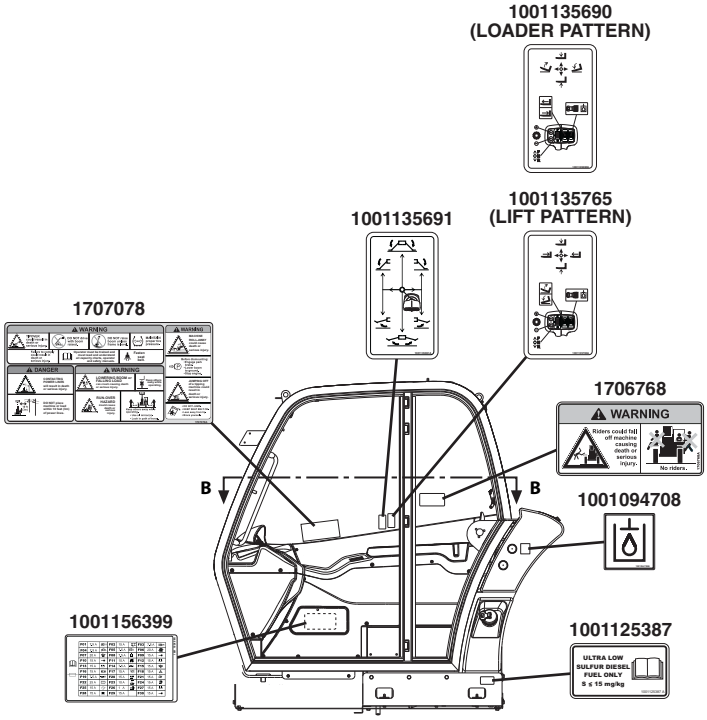
TH336C, TH337C, TH406C & TH407C (CE & AUS)

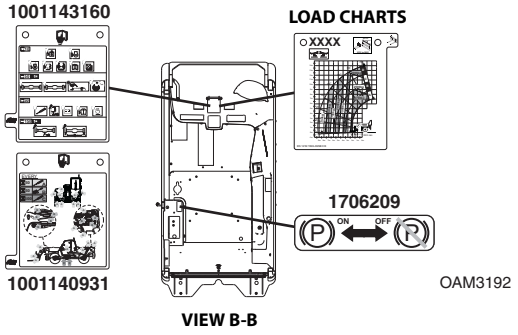






VIEW OF ENGINE COMPARTMENT
(COMPONENTS REMOVED FOR CLARITY)


1001135690
(LOADER PATTERN)
1001135765
(LIFT PATTERN)
1001135691
1707078
1706768
WARNING
B
B
1001094708
1001156399
1001125387
ULTRA LOW SULFUR DIESEL FUEL ONLY 5 ≤ 15 mg/kg


1001143160
LOAD CHARTS
XXXX
1706209
ON
OFF
1001140931
OAM3192

VIEW B-B

10. Frame Level Indicator: Enables operator to determine the left to right level condition of the telehandler.

11. Keypad: See page 3-8.

12. LSI Indicator (CE & AUS): See page 3-14.

13. Accessory Control Lever (if equipped): See page 3-28.

14. Power/Emergency Stop Switch (if equipped for platform): Push down to shut off power and stop engine.

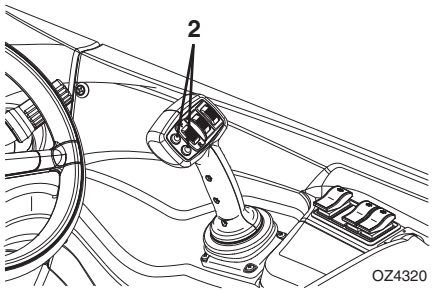
15. Boom Joystick and Transmission Control: See page 3-18.

16. Longitudinal Level Indicator (AUS): Enables operator to determine the front to back level condition of the telehandler.

17. Power Outlet: 12V receptacle.

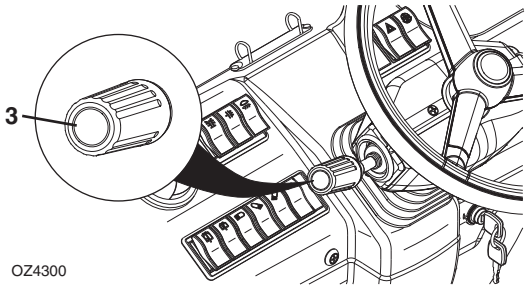
18. Right Console Switches: See page 3-26.

Gear Selection



Gear selection is made with joystick buttons (**2**). See page 3-20 or page 3-23 for details.

Horn



Horn button (**3**) is located on the end of transmission control lever.

- Depress to sound horn.

Transmission Control

Note: *Transmission control lever (see page 3-12) takes priority over joystick transmission controls.*

Transmission switch (**8**) engages forward or reverse travel.

- Depress top of switch for forward travel; Depress bottom of switch for reverse travel. Move switch to centered position for neutral.
- Forward or reverse travel can be selected while in any gear.
- When traveling in reverse, the back-up alarm will automatically sound.
- Travel at slow rates of speed when making turns and driving in reverse.

⚠ WARNING

TIP OVER/CRUSH HAZARD. Bring telehandler to a complete stop before shifting transmission. A sudden change in direction of travel could reduce stability and/or cause load to shift or fall.

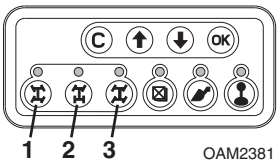
Gear selection is controlled by buttons (**9** & **10**).

- Depress upshift button (**9**) to select a higher gear; Depress downshift button (**10**) to select a lower gear.
- The Transmission is equipped with either six forward and three reverse gears or four forward and three reverse gears. Default gear at start-up is third gear.
- Select the appropriate gear for the task being performed. **Use a lower gear when transporting a load**. Use a higher gear only when driving unloaded for longer distances.
- Slow down prior to downshifting. **Do not downshift more than one gear at a time.**

All Wheel Assisted Steering Alignment Mode Change

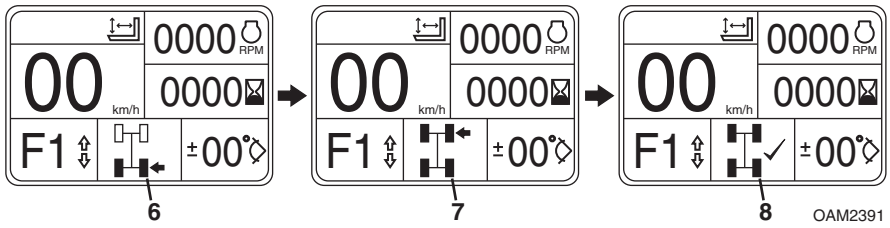
If all wheel assisted steering alignment mode is active under the Operator Tools menu (see page 3-7), use the following procedure for steer mode change.

1. Bring machine to a stop using service brake.



2. Select desired steer mode: circle steer (**1**), front steer (**2**) or crab steer (**3**).

Note: *Selected steer mode LED will flash and display will show steering alignment screens until the change is complete. After steering alignment is complete, steer mode LED will illuminate solid.*



3. Turn the steering wheel until the rear wheels are centered (**6**). This step will be skipped if changing from front steer mode and rear wheels are already centered.
4. Turn the steering wheel until the front wheels are centered (**7**). This step will be skipped if changing to front steer mode.
5. Wheels are now aligned and steer mode change is complete (**8**).

Note: *Avoid turning steering wheel while machine is shut down. If wheels are not correctly aligned, manual adjustment may be required. See page 3-32.*

Normal Engine Operation

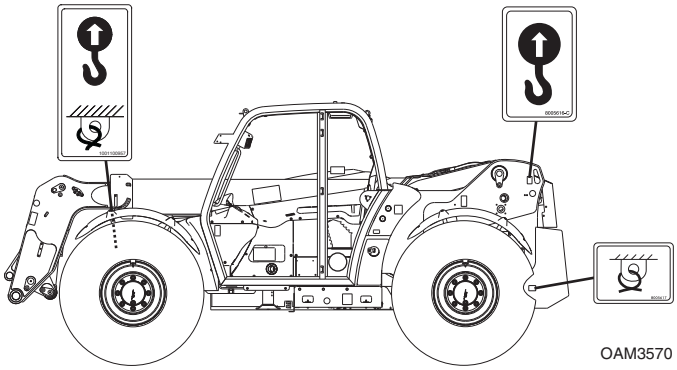
- Observe instrument panel and display frequently to be sure all systems are functioning properly.
- **Be alert for unusual noises or vibration.** When an unusual condition is noticed, park machine in safe position and perform shut-down procedure. Report condition to your supervisor or local Caterpillar dealer.
- **Avoid prolonged idling.** If the engine is not being used, turn it off.

Shut-Down Procedure

When parking the telehandler, park in a safe location on flat level ground and away from other equipment and/or traffic lanes.

1. Apply the park brake.
2. Shift the transmission to Neutral.
3. Lower forks or attachment to the ground.
4. Operate engine at low idle for 3 to 5 minutes. **DO NOT over rev engine.**
5. Shut off engine and remove ignition key.
6. If equipped for platform, push the power/emergency stop switch down.
7. Exit telehandler properly.
8. Turn off electrical master switch (if equipped).
9. Block wheels (if necessary).

4.6 LOADING AND SECURING FOR TRANSPORT



Tiedown

1. If equipped, level the telehandler prior to loading.
2. Using a spotter, load the telehandler with boom as low as possible.
3. Once loaded, apply parking brake and lower boom until boom or attachment is resting on deck. Move all controls to "Neutral," stop engine and remove ignition key.
4. Secure machine to deck by passing chains through the designated tiedown points as shown in the figure.
5. Do not tiedown front of boom.

Note: *The user assumes all responsibility for choosing the proper method of transportation and tie-down devices, making sure the equipment used is capable of supporting the weight of the vehicle being transported and that all manufacturer's instructions and warnings, regulations and safety rules of their employer, the Department of Transportation and/or any other local, state or federal/provincial laws are followed.*

⚠ WARNING

TELEHANDLER SLIDE HAZARD. Before loading telehandler for transport, make sure deck, ramps and telehandler wheels are free of mud, snow and ice. Failure to do so could cause telehandler to slide.

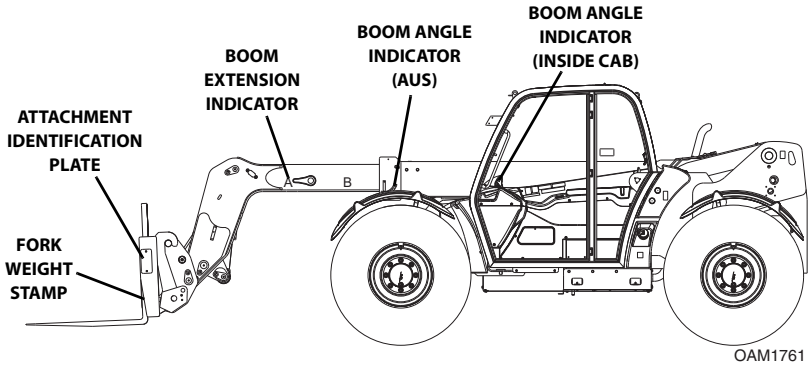
5.5 USE OF THE LOAD CHART

To properly use the load chart (see page 5-10), the operator must first determine and/or have the following:

1. An approved attachment. See *"Approved Attachments"* on page 5-1.
2. The proper Load Chart.
3. Weight of the load being lifted.
4. Load placement information:
   a. HEIGHT where the load is to be placed.
   b. DISTANCE from the front tires of the telehandler where the load is to be placed.
5. On the load chart, find the line for the height and follow it over to the distance.
6. The number in the load zone where the two cross is the maximum capacity for this lift. If the two cross at a division between zones, the smaller number must be used.

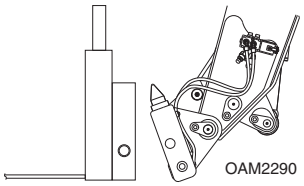
The number in the load zone must be equal to or greater than the weight of the load to be lifted. Determine the limits of the load zone on the load chart and keep within these limits.

Capacity Indicator Locations

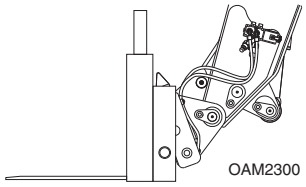


This installation procedure is designed for one-person operation.

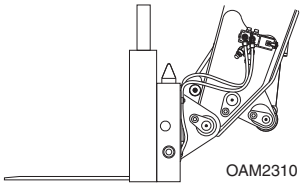
1. Tilt coupler forward to provide clearance. Check to be sure lock pin is disengaged.



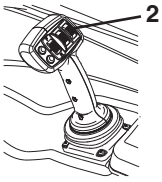
2. Align coupler point with opening in attachment. Raise boom slightly to engage coupler point in opening.



3. Tilt coupler back to engage attachment.



4. Press and hold button (**1**) and at the same time push roller switch down (**2**) to engage lock pin or push roller switch up to disengage lock pin.



5. Raise boom to eye level and visually check that the lock pin protrudes through the attachment hole. If the pin does not protrude through the attachment hole, place the attachment on the ground and return to step 2.
6. If attachment is equipped, connect auxiliary hydraulic hoses. See *"Hydraulic Operated Attachment"* on page 5-26.

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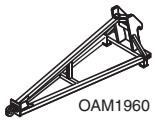
Operation:

- Raise or lower boom to appropriate height for loading material from stockpile.
- Align telehandler with face of stockpile and drive slowly and smoothly into pile to load bucket.
- Tilt bucket up far enough to retain load and back away from pile.
- Travel in accordance with requirements set forth in Section 1—General Safety Practices.
- Tilt bucket down to dump load.

Equipment Damage Precautions

- Except for lifting or dumping a load, the boom must be fully retracted for all bucket operations.
- Do not corner-load bucket. Distribute material evenly within the bucket. Bucket load charts are for evenly distributed loads only.
- Do not use bucket as a lever to pry material. Excessive prying forces could damage bucket or machine structure.
- Do not attempt to load material which is hard or frozen. This could cause severe damage to quick coupler or machine structure.
- Do not use bucket for "back dragging." This could cause severe damage to quick coupler.

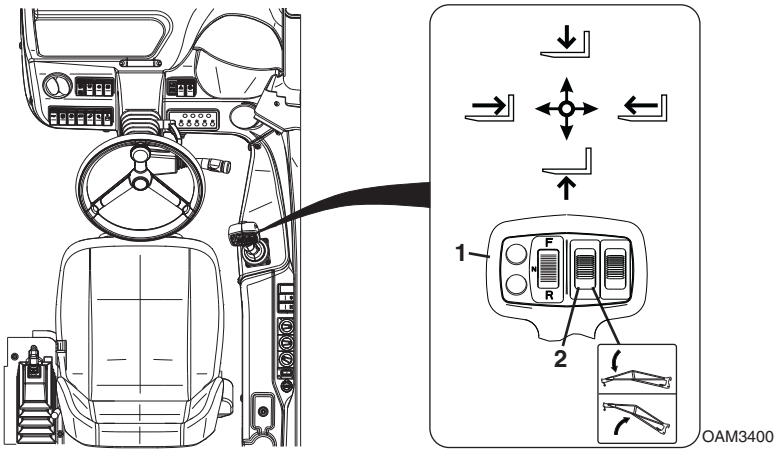
Truss Boom


OAM1960

Use Truss Boom Load Chart

To determine maximum capacity, refer to *"Telehandler/Attachment/Fork Capacity"* on page 5-8.

Suspend loads in accordance with requirements set forth in Section 1—General Safety Practices.



The joystick (**1**) controls movement of the boom.

The attachment tilt roller switch (**2**) controls truss boom tilt.

- Push roller switch down to tilt up.
- Push roller switch up to tilt down.

Installation Procedure:

- Refer to *"Attachment Installation"* on page 5-15.

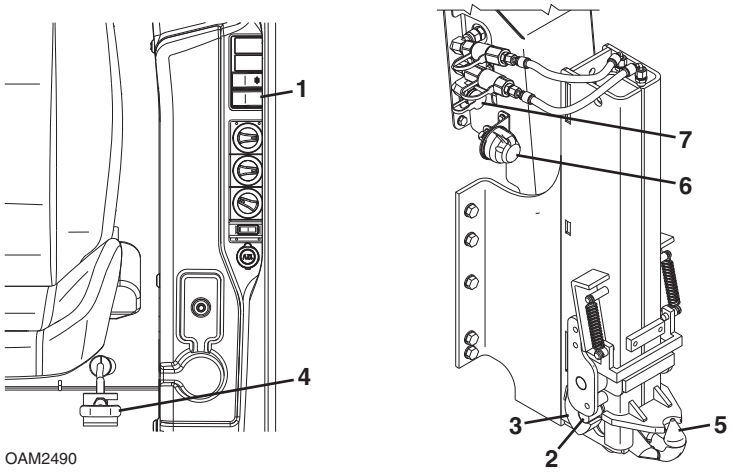
Operation:

- Weight of rigging must be included as part of total load being lifted.

Hydraulic Hitch

Hitch Capacities

Maximum combined weight of trailer and load .....12 000 kg (26 450 lb)
Maximum vertical load at hitch interface.....2000 kg (4400 lb)

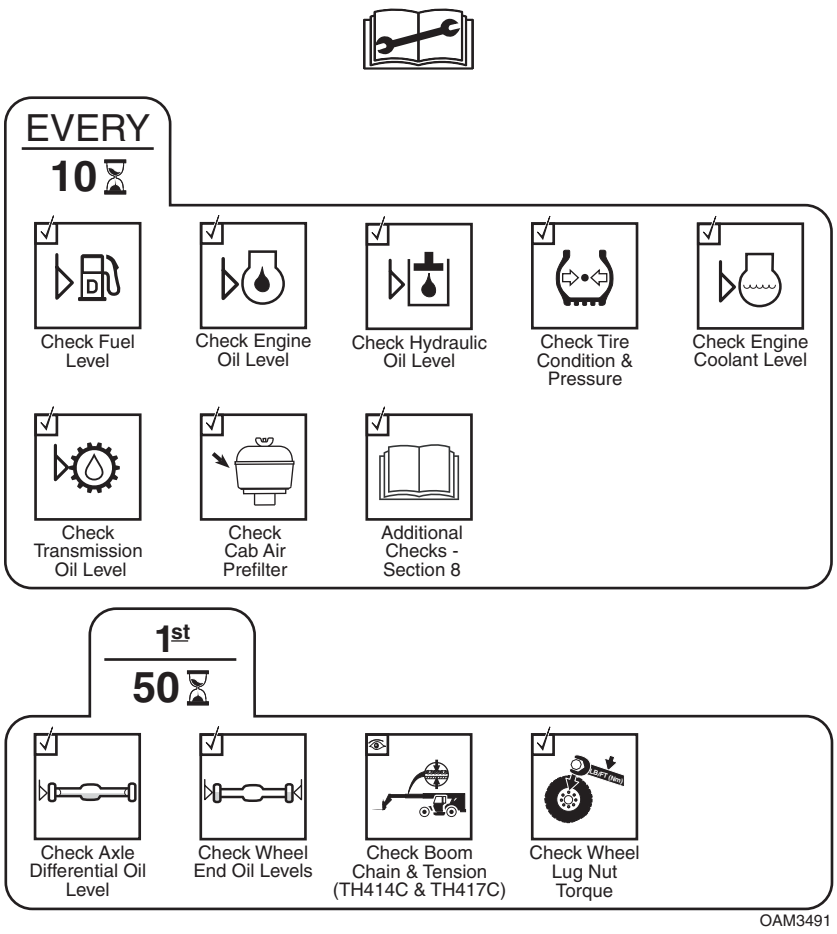


Connecting trailer for towing:

1. Depress and hold right side of hydraulic hitch switch (**1**) to raise hitch safety posts (**2**) off safety hooks (**3**).
2. Pull safety hook release (**4**).
3. Depress and hold left side of hydraulic hitch switch to lower the hitch (**5**) to the required height.
4. Reverse machine until the hitch is under the center of the tow eye.
5. Depress and hold right side of hydraulic hitch switch to raise hitch until the safety hooks are engaged.
6. If equipped, connect trailer harness to trailer plug (**6**).
7. If equipped, connect trailer brake line to trailer coupling (**7**). See page 5-60.

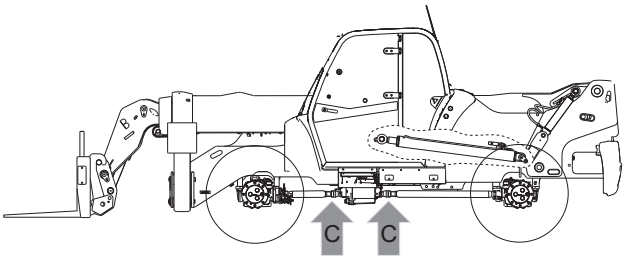
7.3 SERVICE AND MAINTENANCE SCHEDULES

10 & 1st 50 Hour Maintenance Schedule



TH414C, TH514C & TH417C

EVERY
500



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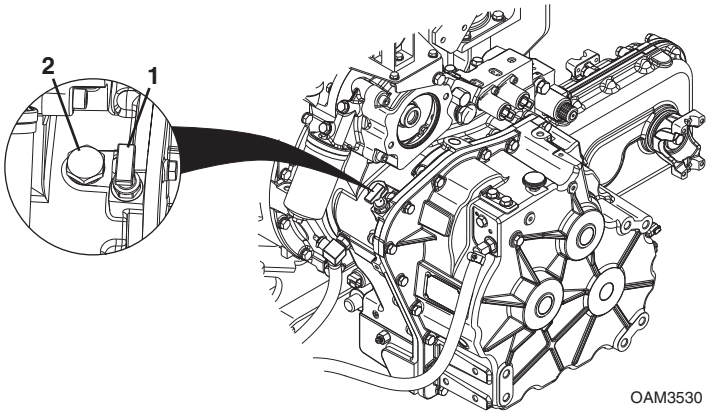
Transmission Oil

A. Transmission Oil Level Check

10 OW0970 OW1050



1. Check transmission oil level with engine at idle and transmission oil cold.
2. Apply park brake, shift transmission to "Neutral" and lower forks or attachment to the ground.
3. Open the engine cover.
4. Remove the transmission dipstick (**1**) and check oil level. The oil level should be between the Min and Max marks.
5. Replace transmission dipstick.
6. If oil is low, remove plug (**2**) and add fluid as required.
7. Replace plug.
8. Close and secure the engine cover.

SECTION 9 - SPECIFICATIONS

9.1 PRODUCT SPECIFICATIONS

Fluids

S/N MJR00150 & After, S/N DJB00150 & After, S/N GAT00150 & After, S/N MLH00150 & After, S/N KEK00150 & After, S/N MWC00150 & After, S/N RRJ00150 & After

Compartment or System	Type and Classification	Viscosities	Ambient Temperature Range			
			°F		°C	
			Min	Max	Min	Max
Engine Crankcase	CAT DEO ULS API CJ-4	SAE 0W-20	-22	50	-30	10
		SAE 0W-30	-22	86	-30	30
		SAE 0W-40	-22	104	-30	40
		SAE 5W-30	-13	86	-25	30
		SAE 5W-40	-13	122	-25	50
		SAE 10W-30	-4	104	-20	40
		SAE 10W-40	-4	122	-20	50
		SAE 15W-40	14	122	-10	50
Hydraulic System	CAT HYDO Advanced	SAE 10W	-4	104	-20	40
		SAE 30	50	122	10	50
Transmission and Transfer Case	CAT TDTO	SAE 10W	0	95	-18	35
		SAE 30	32	95	0	35
		SAE 50	50	122	10	50
		SAE 5W-30	-22	68	-30	20
		SAE 0W-20	-40	68	-40	20
Axle Differential* and Wheel End	CAT TDTO TO-4	SAE 30	-4	104	-20	40
Cylinder, Boom Wear Pad and Axle Grease	CAT Multipurpose Grease	NLGI Grade 2	-22	104	-30	40
Engine Coolant	CAT Extended Life Coolant (ELC)	50/50 Mix				
Fuel	#2 Diesel	Ultra Low Sulfur (S ≤ 15 mg/kg)				
Air Conditioning	Refrigerant R-134a	Tetrafluoroethane				

Note: *Friction Modifier* (197-0017) *required for front axle differential.*

Maximum Ground Bearing Pressure
- TH336C & TH406C
  - Pneumatic
    - 15.5-25 L-2 ..... 7,9 kg/cm² (112 lb/in²)
    - 15.5/80-24 TR01 ..... 9,3 kg/cm² (132 lb/in²)
    - 15.5/80-24 SGI ..... 10,7 kg/cm² (152 lb/in²)
    - 460/70 R24 XMCL ..... 11,5 kg/cm² (164 lb/in²)
    - 460/70 R24 TL ..... 10,0 kg/cm² (142 lb/in²)
    - 400/80-24 ..... 11,5 kg/cm² (164 lb/in²)
  - Foam (ANSI)
    - 15.5-25 L-2 ..... 9,0 kg/cm² (128 lb/in²)
- TH337C & TH407C
  - Pneumatic
    - 15.5-25 L-2 ..... 7,9 kg/cm² (112 lb/in²)
    - 15.5/80-24 TR01 ..... 9,3 kg/cm² (132 lb/in²)
    - 15.5/80-24 SGI ..... 10,7 kg/cm² (152 lb/in²)
    - 15.5 R25 XHA TL ..... Not Available at Publication
    - 460/70 R24 XMCL ..... 11,5 kg/cm² (164 lb/in²)
    - 460/70 R24 TL ..... 10,0 kg/cm² (142 lb/in²)
    - 460/70 R24 Bibload ..... Not Available at Publication
    - 500/70 R24 ..... 10,5 kg/cm² (149 lb/in²)
    - 400/80-24 ..... 11,5 kg/cm² (164 lb/in²)
    - 440/80-24 ..... 9,6 kg/cm² (137 lb/in²)
  - Foam (ANSI)
    - 15.5-25 L-2 ..... 9,0 kg/cm² (128 lb/in²)
- TH414C
  - Pneumatic
    - 15.5/80-24 TR01 ..... 9,6 kg/cm² (137 lb/in²)
    - 15.5-25 L-2 ..... 8,0 kg/cm² (114 lb/in²)
    - 400/80-24 ..... 12,7 kg/cm² (181 lb/in²)
    - 440/80-24 ..... 10,8 kg/cm² (154 lb/in²)
- TH514C & TH417C
  - Pneumatic
    - 14-24 TG02 ..... 9,0 kg/cm² (128 lb/in²)
    - 14-24 SGG-2A ..... 11,2 kg/cm² (159 lb/in²)
    - 400/80-24 ..... Not Available at Publication
    - 460/80 R24 ..... Not Available at Publication
  - Foam (TH514 - ANSI)
    - 14-24 TG02 ..... 10,3 kg/cm² (147 lb/in²)
    - 14-24 SGG-2A ..... 12,9 kg/cm² (183 lb/in²)

Serial Number ______________________________________

Date	Comments

This product must comply with all safety related bulletins. Contact JLG Industries, Inc. or the local Caterpillar dealer representative for information regarding safety-related bulletins which may have been issued for this product.

JLG Industries, Inc. sends safety related bulletins to the owner of record of this machine. Contact JLG Industries, Inc. to ensure that the current owner records are updated and accurate.

JLG Industries, Inc. must be notified immediately in all instances where JLG products have been involved in an accident involving bodily injury or death of personnel or when damage has occurred to personal property or the JLG product.

FOR:

- Accident Reporting and Product Safety Publications
- Current Owner Updates
- Questions Regarding Product Applications and Safety
- Standards and Regulations Compliance Information
- Questions Regarding Product Modifications

CONTACT:

Product Safety and Reliability Department
JLG Industries, Inc.
13224 Fountainhead Plaza
Hagerstown, MD 21742
USA

In USA:
Toll Free: 1-877-JLG-SAFE (1-877-554-7233)

Outside USA:
Phone: +1-717-485-6591

E-mail:
ProductSafety@JLG.com

Load Falling Hazard

- Never suspend load from forks or other parts of carriage.
- **DO NOT** burn or drill holes in fork(s).
- Forks must be centered under load and spaced apart as far as possible.

Note: *To change display brightness, depress ESC for 2-3 seconds.* As the display cycles through various levels of brightness, depress ENT when the desired brightness is reached.

Alarm Code	Description	What To Do
12	Reading pressure of the Lift cylinder (rod side) lower than minimum value.	• Verify that the cable or the connector wiring are not in short circuit. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
13	Reading pressure of the Lift cylinder (rod side) higher than maximum value.	• Verify that the cable or the connector wiring are not open. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
14	Reading pressure of the Compensation cylinder (bottom side) lower than minimum value.	• Verify that the cable or the connector wiring are not in short circuit. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
15	Reading pressure of the Compensation cylinder (bottom side) higher than maximum value.	• Verify that the cable or the connector wiring are not open. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
16	Reading pressure of the Compensation cylinder (rod side) lower than minimum value.	• Verify that the cable or the connector wiring are not in short circuit. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
17	Reading pressure of the Compensation cylinder (rod side) higher than maximum value.	• Verify that the cable or the connector wiring are not open. • Verify the pressure transducer integrity. • If the alarm persists, please, contact Technical Assistance
50	ByPass LMIS active.	• Advise that the external BYPASS of LMIS it's active.
60	Redundance alarm of the output shut-off LMIS.	• Verify connection. • Verify CLS integrity. • If the alarm persists, please, contact Technical Assistance

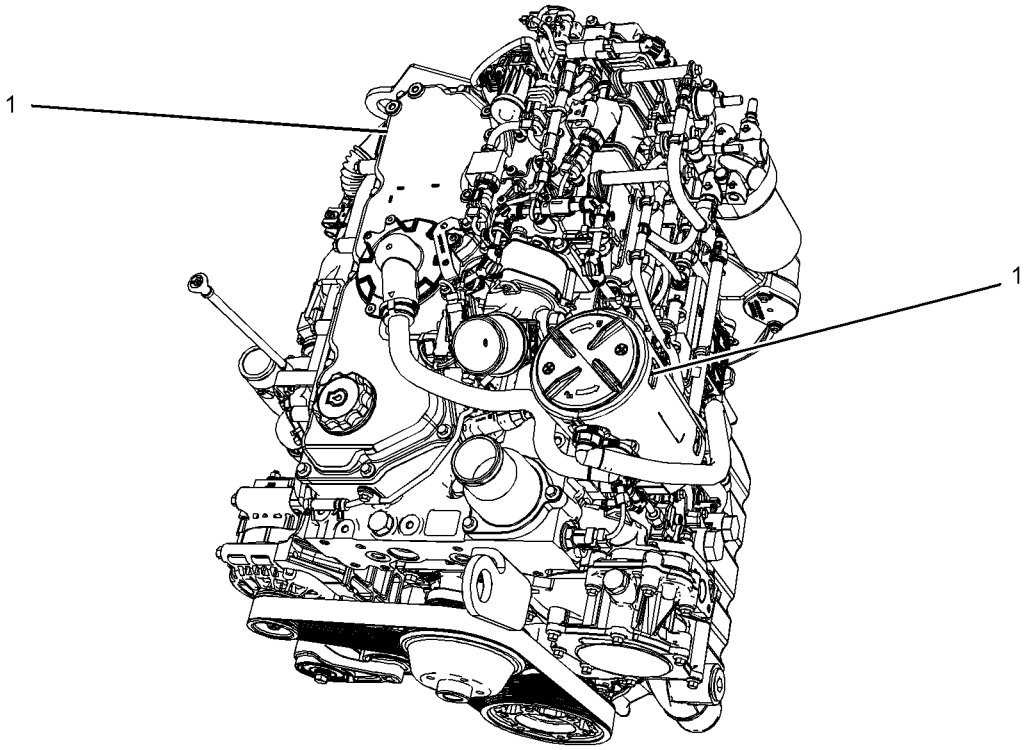


Illustration 2 g02406137

(1) Universal Warning

(2) Hand (High Pressure)

⚠ WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

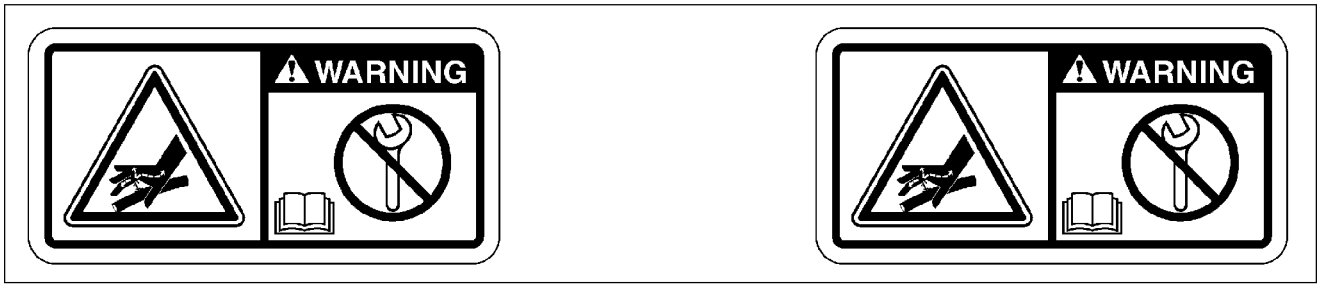


Illustration 3 g02382677

Typical example

i03635086

Engine Starting

SMCS Code: 1000

⚠ WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury.

If a warning tag is attached to the engine start switch or to the controls DO NOT start the engine or move the controls. Consult with the person that attached the warning tag before the engine is started.

All protective guards and all protective covers must be installed if the engine must be started in order to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Start the engine from the operator's compartment or from the engine start switch.

Always start the engine according to the procedure that is described in the Operation and Maintenance Manual, “Engine Starting” topic in the Operation Section. Knowing the correct procedure will help to prevent major damage to the engine components. Knowing the procedure will also help to prevent personal injury.

To ensure that the jacket water heater (if equipped) and/or the lube oil heater (if equipped) is working correctly, check the water temperature gauge and/or the oil temperature gauge during the heater operation.

Engine exhaust contains products of combustion which can be harmful to your health. Always start the engine and operate the engine in a well ventilated area. If the engine is started in an enclosed area, vent the engine exhaust to the outside.

These engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air in order to improve starting. Some Caterpillar engines may have a cold starting system that is controlled by the ECM that allows a controlled flow of ether into the engine. The ECM will disconnect the glow plugs before the ether is introduced. This system would be installed at the factory.

i03648639

Engine Stopping

SMCS Code: 1000

To avoid overheating of the engine and accelerated wear of the engine components, stop the engine according to this Operation and Maintenance Manual, “Engine Stopping” topic (Operation Section).

Use the Emergency Stop Button (if equipped) ONLY in an emergency situation. DO NOT use the Emergency Stop Button for normal engine stopping. After an emergency stop, DO NOT start the engine until the problem that caused the emergency stop has been corrected.

On the initial start-up of a new engine or an engine that has been serviced, make provisions to stop the engine if an overspeed condition occurs.

i04231629

Electrical System

SMCS Code: 1000; 1400

Never disconnect any charging unit circuit or battery circuit cable from the battery when the charging unit is operating. A spark can cause the combustible gases that are produced by some batteries to ignite.

To help prevent sparks from igniting combustible gases that are produced by some batteries, the negative “**−**” cable should be connected last from the external power source to the primary position for grounding.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical connections before the engine is started. Repair all frayed electrical wires before the engine is started. See the Operation and Maintenance Manual for specific starting instructions.

Table 1

C4.4 Engine Specifications	
Operating Range (rpm)	800 to 2200 (1)
Number of Cylinders	4 In-Line
Bore	105 mm (4.13 inch)
Stroke	127 mm (4.99 inch)
Power	Single turbocharger charge cooled 60 to 110 kW (80.46 to 147.51 hp)
	Series turbochargers charge cooled 105 to 129.5 kW (140.80 to 173.65 hp)
Aspiration	Single Turbocharged charge cooled Series turbochargers charge cooled
Compression Ratio	16.5:1
Displacement	4.4 L (268.504 cubic inch)
Firing Order	1-3-4-2
Rotation (flywheel end)	Counterclockwise

(1) The operating rpm is dependent on the engine rating, the application, and the configuration of the throttle.

Electronic Engine Features

The engine operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine monitoring
- Engine speed governing
- Control of the injection pressure
- Cold start strategy
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics
- Low temperature regeneration

For more information on electronic engine features, refer to the Operation and Maintenance Manual, “Features and Controls” topic (Operation Section).

Engine Diagnostics

The engine has built-in diagnostics in order to ensure that the engine systems are functioning correctly. The operator will be alerted to the condition by a “Stop or Warning” lamp. Under certain conditions, the engine horsepower and the vehicle speed may be limited. The electronic service tool may be used to display the diagnostic codes.

There are three types of diagnostic codes: active, logged, and event.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, “Engine Diagnostics” topic (Operation Section).

The ECM provides an electronic governor that controls the injector output in order to maintain the desired engine rpm.

Engine Cooling and Lubrication

The cooling system and lubrication system consists of the following components:

- Gear-driven centrifugal water pump
- Water temperature regulator which regulates the engine coolant temperature
- Gear-driven rotor type oil pump
- Oil cooler

The engine lubricating oil is supplied by a rotor type oil pump. The engine lubricating oil is cooled and the engine lubricating oil is filtered. The bypass valve can provide unrestricted flow of lubrication oil to the engine if the oil filter element should become plugged.

Engine efficiency, efficiency of emission controls, and engine performance depend on adherence to proper operation and maintenance recommendations. Engine performance and efficiency also depend on the use of recommended fuels, lubrication oils, and coolants. Refer to this Operation and Maintenance Manual, “Maintenance Interval Schedule” for more information on maintenance items.

Aftertreatment System

The aftertreatment system is approved for use by Caterpillar. In order to be emission-compliant only the approved Caterpillar aftertreatment system must be used on a Caterpillar engine.

For information on the operation of the warning lamps and the shutdown lamp, refer to this Operation and Maintenance Manual, “ Monitoring System (Table for Indicator Lamps)”. For each of the programmed modes, refer to Troubleshooting Guide, “Indicator Lamps” for more information on Indicator Lamps.

For more information or assistance for repairs, consult your Caterpillar dealer.

(Table 3, contd)

Fuel rail pressure sensor out of range	159
Fuel temperature sensor out of range	165
Engine coolant temperature sensor out of range	168
Low Engine Coolant Level - Shutdown	169
Turbo wastegate drive out of range	177
Intake manifold pressure sensor out of range	197
Glow plug start aid relay current above normal	199
Diesel Particulate Filter DPF Intake temperature sensor out of range	224
DPF Soot sensors out of range	226
Exhaust gas recirculation temperature/pressure out of range	227
Exhaust gas recirculation valve control current out of range	228
Exhaust gas recirculation valve control voltage out of range	229
Exhaust gas recirculation pressure sensor out of range	231
Air inlet temperature sensor voltage out of range	232
Ether injection control solenoid out of range	233
Idle validation switch #1 erratic, intermittent, or incorrect	245
Idle validation switch #2 erratic, intermittent, or incorrect	246
Exhaust Gas Recirculation Outlet Pressure Sensor out of range	247
Exhaust back pressure regulator position voltage out of range	249
Engine Fuel Supply Lift Pump Relay out of range	253
Personality module erratic, intermittent, or incorrect	415
Machine security system module abnormal update rate	426
Ignition key switch loss of signal	429
Electrical System Voltage fault	511
SAE J1939 Data Link abnormal update rate	514
5 Volt sensor DC power supply voltage out of range	516

(continued)

(Table 3, contd)

8 V DC Supply voltage out of range	517
Programmed parameter fault erratic, intermittent, or incorrect	527
5 Volt Sensor DC Power Supply #2 out of range	528
No diagnostic code detected	551

Refer to Troubleshooting, “Diagnostic Flash Code Cross Reference” for more information.

i03554529

Fault Logging

SMCS Code: 1000; 1900; 1901; 1902

The system provides the capability of Fault Logging. When the Electronic Control Module (ECM) generates an active diagnostic code, the code will be logged in the memory of the ECM. The codes that have been logged in the memory of the ECM can be retrieved with electronic service tools. The codes that have been logged can be cleared with electronic service tools. The codes that have been logged in the memory of the ECM will be automatically cleared from the memory after 100 hours. The following faults can not be cleared from the memory of the ECM without using a factory password: overspeed, low engine oil pressure, and high engine coolant temperature.

Engine Stopping

i02334873

Stopping the Engine

SMCS Code: 1000; 7000

NOTICE
Stopping the engine immediately after it has been working under load, can result in overheating and accelerated wear of the engine components.

Avoid accelerating the engine prior to shutting it down.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life.

Note: Individual applications will have different control systems. Ensure that the shutoff procedures are understood. Use the following general guidelines in order to stop the engine.

1. Remove the load from the engine. Reduce the engine speed (rpm) to low idle. Allow the engine to idle for five minutes in order to cool the engine.
2. Stop the engine after the cool down period according to the shutoff system on the engine and turn the ignition key switch to the OFF position. If necessary, refer to the instructions that are provided by the OEM.

i03554860

Emergency Stopping

SMCS Code: 1000; 7418

NOTICE
Emergency shutoff controls are for EMERGENCY use ONLY. DO NOT use emergency shutoff devices or controls for normal stopping procedure.

Ensure that any components for the external system that support the engine operation are secured after the engine is stopped.

Emergency Stop Button

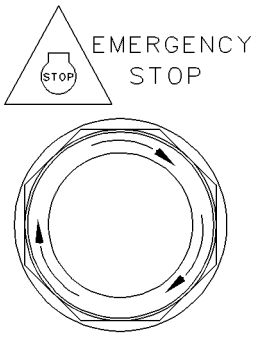


Illustration 40 g00104303
Typical emergency stop button

The emergency stop button is in the OUT position for normal engine operation. Push the emergency stop button. The engine will not start when the button is locked. Turn the button clockwise in order to reset.

Refer to Operation and Maintenance Manual, “Features and Controls” for the location and the operation of the emergency stop button.

i03648931

After Stopping Engine

SMCS Code: 1000

Note: Before you check the engine oil, do not operate the engine for at least 10 minutes in order to allow the engine oil to return to the oil pan.

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

Acceptable – A Cat DEAC (Diesel Engine Antifreeze/Coolant) or a commercial heavy-duty antifreeze that meets “ASTM D4985” or “ASTM D6210” specifications

NOTICE

The Caterpillar industrial engine must be operated with a 1:1 mixture of water and glycol. This concentration allows the NOx reduction system to operate correctly at high ambient temperatures.

NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM “D3306” or equivalent 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 an antifreeze.

Note: Cat DEAC does not require a treatment with an SCA at the initial fill. Commercial heavy-duty antifreeze that meets “ASTM D4985” or “ASTM D6210” specifications MAY require a treatment with an SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

A mixture of SCA and water is acceptable but will not give the same level of corrosion, boiling, and freezing protection as ELC. Caterpillar recommends a 6 percent to 8 percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

Table 8

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

(1) Use the interval that occurs first. The cooling system must also be flushed out at this time.
(2) Cat ELC Extender must be added at 6000 service hours or one half of the service life of the Cat ELC. Refer to your machine Operation and Maintenance Manual for exceptions.
(3) An extender must be added at 3000 service hours or one half of the service life of the coolant.

Note: Refer to Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engine Fluids Recommendations” for additional information that relates to coolant for your engine.

S·O·S Coolant Analysis

Table 9

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

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

S·O·S Coolant Analysis (Level 1)

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

The following properties of the coolant are tested:

- Glycol concentration for freeze protection and boil protection
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Visual analysis

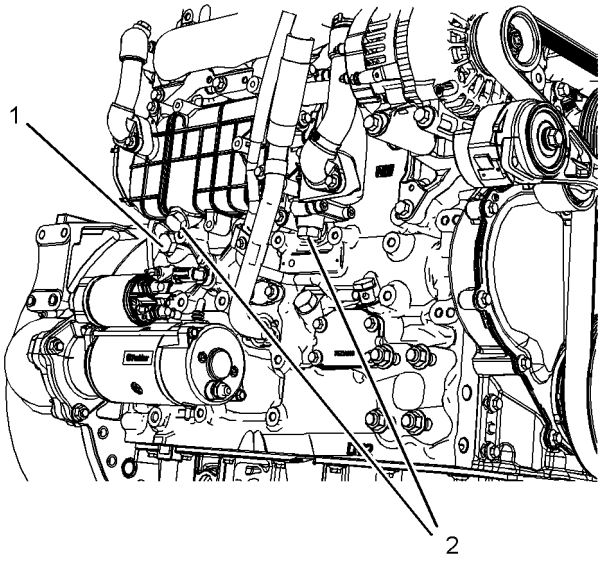


Illustration 45 g02119093
Typical example

2. Open the drain cock or remove the drain plug (1) on the engine. Also remove the drain plug (2). Open the drain cock or remove the drain plug on the radiator.

Note: Some applications have two drain plugs on the cooler, only one is required for draining.

Allow the coolant to drain into a suitable container.

3. Properly dispose of the drained material. Obey local regulations for the disposal of the material.

NOTICE
Dispose of used engine coolant properly or recycle. Various methods have been proposed to reclaim used coolant for reuse in engine cooling systems. The full distillation procedure is the only method acceptable by Caterpillar to reclaim the used coolant.

Flush

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valves (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.

4. Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °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.

5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Cooling Systems with Heavy Deposits or Plugging

Note: For the following procedure to be effective, there must be some active flow through the cooling system components.

1. Flush the cooling system with clean water in order to remove any debris.

2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

NOTICE
Do not fill the cooling system faster than 5 L (1.3 US gal) per minute to avoid air locks.

Cooling system air locks may result in engine damage.

3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 3.8 to 7.6 L (1 to 2 US gal) of the cooling system capacity. Install the cooling system filler cap.

Do not use paint, a waterproof cover, or plastic as a protective covering for storage. An airflow restriction may result. To protect against dirt and damage, wrap the primary air cleaner elements in Volatile Corrosion Inhibited (VCI) paper.

Place the primary air cleaner element into a box for storage. For identification, mark the outside of the box and mark the primary air cleaner element. Include the following information:

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01432811

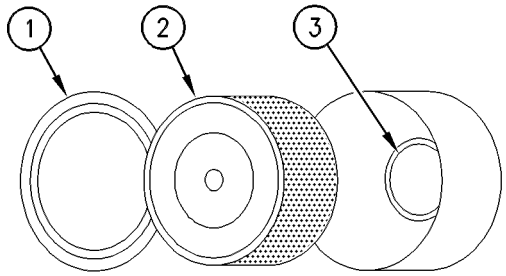
Engine Air Cleaner Element (Single Element) - Inspect/Replace

SMCS Code: 1054-040; 1054-510

Perform the Operation and Maintenance Manual, “Engine Air Cleaner Service Indicator-Inspect” procedure and perform the Operation and Maintenance Manual, “Engine Air Precleaner Check/Clean” procedure (if equipped) before performing the following procedure.

NOTICE
Never run the engine without an air cleaner element installed. Never run the engine with a damaged air cleaner element. Do not use air cleaner elements with damaged pleats, gaskets or seals. Dirt entering the engine causes premature wear and damage to engine components. Air cleaner elements help to prevent air-borne debris from entering the air inlet.

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.



g00310664

Illustration 53

(1) Air cleaner cover
(2) Air filter element
(3) Air inlet

1. Remove air cleaner cover (1) and remove air filter element (2).
2. Cover air inlet (3) with tape or a clean cloth so that debris cannot enter the air inlet.
3. Clean the inside of air cleaner cover (1). Clean the body that holds the air cleaner element.
4. Inspect the replacement element for the following items:damage, dirt, and debris.
5. Remove the seal from the opening of the air inlet.
6. Install a clean, undamaged air filter element (2).
7. Install air cleaner cover (1).
8. Reset the air cleaner service indicator.

i02242500

Engine Air Cleaner Element (Single Element) - Replace

SMCS Code: 1051; 1054-510

NOTICE
Never service the air cleaner element with the engine running since this will allow dirt to enter the engine.

1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the “ON” position.

2. Turn the keyswitch to the “RUN” position.

3. The keyswitch will allow the electric priming pump to operate. Operate the electric priming pump. The ECM will stop the pump after 2 minutes.

4. Turn the keyswitch to the “OFF” position. The fuel system should now be primed and the engine should be able to start.

5. Operate the engine starter and crank the engine. After the engine has started, operate the engine at low idle for a minimum of 5 minutes. Ensure that the fuel system is free from leaks.

Note: Operating the engine for this period will help ensure that the fuel system is free of air. **DO NOT loosen the high-pressure fuel lines in order to purge air from the fuel system. This procedure is not required.**

After the engine has stopped, you must wait for 10 minutes in order to allow the fuel pressure to be purged from the high-pressure fuel lines before any service or repair is performed on the engine fuel lines. If necessary, perform minor adjustments. Repair any leaks from the low-pressure fuel system and from the cooling, lubrication, or air systems. Replace any high-pressure fuel line that has leaked. Refer to Disassembly and Assembly Manual, “Fuel Injection Lines - Install”.

If you inspect the engine in operation, always use the proper inspection procedure in order to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, “General hazard Information”.

If the engine will not start, refer to Troubleshooting, “Engine Cranks but will not Start”.

i03907006

Fuel System Primary Filter (Water Separator) Element - Replace

SMCS Code: 1260-510-FQ; 1263-510-FQ

⚠ WARNING

Fuel leaked or spilled onto hot surfaces or electrical components can cause a fire. To help prevent possible injury, turn the start switch off when changing fuel filters or water separator elements. Clean up fuel spills immediately.

Note: Refer to Systems Operation, Testing, and Adjusting, “Cleanliness of Fuel System Components” for detailed information on the standards of cleanliness that must be observed during ALL work on the fuel system.

NOTICE
Ensure that the engine is stopped before any servicing or repair is performed.

Remove the Element

1. Turn the fuel supply valve (if equipped) to the OFF position before performing this maintenance.

2. Place a suitable container under the water separator in order to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.

3. Make a temporary Mark (A) across the filter before the assembly is removed.

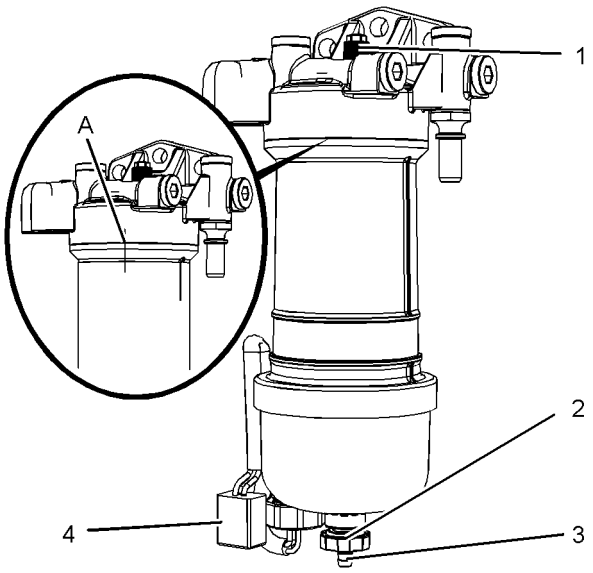


Illustration 68 g02148376
Typical example

4. Install a suitable tube onto drain (3). Open the drain valve (2). Rotate the drain valve counterclockwise. Two full turns are required.

Note: Two complete rotations of the drain valve will release the valve from the filter element.

5. Loosen the vent screw (1).

Due to individual applications, it is not possible to identify all of the factors which can contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that is necessary for the engine.

The operating environment, improper operating procedures and improper maintenance procedures can be factors which contribute to severe service conditions.

Environmental Factors

Ambient temperatures – The engine may be exposed to extended operation in extremely cold environments or hot environments. Valve components can be damaged by carbon buildup if the engine is frequently started and stopped in very cold temperatures. Extremely hot inlet air reduces engine performance.

Air Quality – The engine may be exposed to extended operation in an environment that is dirty or dusty, unless the equipment is cleaned regularly. Mud, dirt and dust can encase components. Maintenance can be very difficult. The buildup can contain corrosive chemicals.

Buildup – Compounds, elements, corrosive chemicals and salt can damage some components.

Altitude – Problems can arise when the engine is operated at altitudes that are higher than the intended settings for that application. Necessary adjustments should be made.

Improper Operating Procedures

- Extended operation at low idle
- Frequent hot shutdowns
- Operating at excessive loads
- Operating at excessive speeds
- Operating outside the intended application

Improper Maintenance Procedures

- Extending the maintenance intervals
- Failure to use recommended fuel, lubricants and coolant/antifreeze

i02348493

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar recommends a scheduled inspection of the starting motor. If the starting motor fails, the engine may not start in an emergency situation.

Check the starting motor for correct operation. Check the electrical connections and clean the electrical connections. Refer to the Systems Operation, Testing and Adjusting Manual, “Electric Starting System - Test” for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i04293330

Turbocharger - Inspect

SMCS Code: 1052-040; 1052

⚠ WARNING

Hot engine components can cause injury from burns. Before performing maintenance on the engine, allow the engine and the components to cool.

NOTICE
Turbocharger bearing failures can cause large quantities of oil to enter the air intake and exhaust systems. Loss of engine lubricant can result in serious engine damage.

Minor leakage of oil into a turbocharger under extended low idle operation should not cause problems as long as a turbocharger bearing failure has not occured.

When a turbocharger bearing failure is accompanied by a significant engine performance loss (exhaust smoke or engine rpm up at no load), do not continue engine operation until the turbocharger is renewed.

A visual inspection of the turbocharger or turbochargers can minimize unscheduled downtime. A visual inspection of the turbocharger or turbochargers can also reduce the chance for potential damage to other engine parts. Do not inspect the engine with the engine in operation.

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European classifications are established by the Counseil International Des Machines a Combustion (CIMAC) (International Council on Combustion Engines).

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i03989612

Decommissioning and Disposal

SMCS Code: 1000

When the product is removed from service, local regulations for the product decommissioning will vary. Disposal of the product will vary with local regulations. Consult the nearest Cat dealer for additional information.

i00912149

Maintenance Records

SMCS Code: 1000

Caterpillar Inc. recommends the retention of accurate maintenance records. Accurate maintenance records can be used for the following purposes:

- Determine operating costs.
- Establish maintenance schedules for other engines that are operated in the same environment.
- Show compliance with the required maintenance practices and maintenance intervals.

Maintenance records can be used for a variety of other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is well managed. Accurate maintenance records can help your Caterpillar dealer to fine tune the recommended maintenance intervals in order to meet the specific operating situation. This should result in a lower engine operating cost.

Records should be kept for the following items:

Fuel Consumption – A record of fuel consumption is essential in order to determine when the load sensitive components should be inspected or repaired. Fuel consumption also determines overhaul intervals.

Service Hours – A record of service hours is essential to determine when the speed sensitive components should be inspected or repaired.

Documents – These items should be easy to obtain, and these items should be kept in the engine history file. All of the documents should show this information: date, service hours, fuel consumption, unit number, and engine serial number. The following types of documents should be kept as proof of maintenance or repair for warranty:

Keep the following types of documents as proof of maintenance for warranty. Also, keep these types of documents as proof of repair for warranty:

- Dealer work orders and itemized bills
- Owner's repair costs
- Owner's receipts
- Maintenance log

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Do not store ether cylinders in living areas or in the engine compartment. Do not store ether cylinders in direct sunlight or in temperatures above 49 °C (120 °F). Keep ether cylinders away from open flames or sparks.

Dispose of used ether cylinders properly. Do not puncture an ether cylinder. Keep ether cylinders away from unauthorized personnel.

Do not spray ether into an engine if the engine is equipped with a thermal starting aid for cold weather starting.

Lines, Tubes, and Hoses

Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install any lines that are bent or damaged.

Repair any lines that are loose or damaged. Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

Check lines, tubes, and hoses carefully. Do not use your bare hand to check for leaks. Use a board or cardboard to check for leaks. Tighten all connections to the recommended torque.

Replace the parts if any of the following conditions are present:

- High-pressure fuel line or lines are removed.
- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible parts of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

Make sure that all clamps, guards, and heat shields are installed correctly. During engine operation, this will help to prevent vibration, rubbing against other parts, and excessive heat.

Regeneration

The exhaust gas temperature during regeneration will be elevated. Follow proper fire prevention instructions and use the disable switch function when appropriate.

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

Support the component properly when work beneath the component is performed.

Unless other maintenance instructions are provided, never attempt adjustments while the engine is running.

Stay clear of all rotating parts and of all moving parts. Leave the guards in place until maintenance is performed. After the maintenance is performed, reinstall the guards.

Keep objects away from moving fan blades. The fan blades will throw objects or cut objects.

When objects are struck, wear protective glasses in order to avoid injury to the eyes.

Chips or other debris may fly off objects when objects are struck. Before objects are struck, ensure that no one will be injured by flying debris.

i04016709

Mounting and Dismounting

SMCS Code: 1000; 7405

Do not climb on the engine or the engine aftertreatment. The engine and aftertreatment have not been designed with mounting or dismounting locations.

Refer to the OEM for the location of foot and hand holds for your specific application.

i04112191

High Pressure Fuel Lines

SMCS Code: 1274

WARNING

Contact with high pressure fuel may cause fluid penetration and burn hazards. High pressure fuel spray may cause a fire hazard. Failure to follow these inspection, maintenance and service instructions may cause personal injury or death.

Table 1

C3.4B Engine Specifications	
Operating Range (rpm)	800 to 2500[1]
Number of Cylinders	4 In-Line
Bore	99 mm (3.89763 inch)
Stroke	110 mm (4.33070 inch)
Power	Turbocharged 45 to 55.4 kW (60.345 to 74.3 hp) Turbocharged Charge Cooled 62 to 86 kW (83.142 to 115.326 hp)
Aspiration	Turbocharged Turbocharged charge cooled
Compression Ratio	17: 1
Displacement	3.4 L (207.48 cubic inch)
Firing Order	1-3-4-2
Rotation (flywheel end)	Counterclockwise

(1) The operating rpm is dependent on the engine rating, the application, and the configuration of the throttle.

Engine Type

There are three different types of C3.4B engines.

- Turbocharged engine with wall flow DPF
- Turbocharged, charge cooled with wall flow DPF
- Turbocharged, charge cooled with through flow DPF

Electronic Engine Features

The engine operating conditions are monitored. The Electronic Control Module (ECM) controls the response of the engine to these conditions and to the demands of the operator. These conditions and operator demands determine the precise control of fuel injection by the ECM. The electronic engine control system provides the following features:

- Engine monitoring
- Engine speed governing
- Control of the injection pressure
- Cold start strategy
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics
- Aftertreatment Regeneration

For more information on electronic engine features, refer to the Operation and Maintenance Manual, “Features and Controls” topic (Operation Section).

Engine Diagnostics

The engine has built-in diagnostics in order to ensure that the engine systems are functioning correctly. The operator will be alerted to the condition by a “Stop or Warning” lamp. Under certain conditions, the engine horsepower and the vehicle speed may be limited. The electronic service tool may be used to display the diagnostic codes.

There are three types of diagnostic codes: active, logged, and event.

Most of the diagnostic codes are logged and stored in the ECM. For additional information, refer to the Operation and Maintenance Manual, “Engine Diagnostics” topic (Operation Section).

The ECM provides an electronic governor that controls the injector output in order to maintain the desired engine rpm.

Engine Cooling and Lubrication

The cooling system and lubrication system consists of the following components:

- Belt driven centrifugal water pump
- Water temperature regulator which regulates the engine coolant temperature
- Gear-driven rotor type oil pump
- Multi plate oil cooler

The engine lubricating oil is cooled and the engine lubricating oil is filtered.

Engine Service Life

Engine efficiency and maximum utilization of engine performance depend on the adherence to proper operation and maintenance recommendations. In addition, use recommended fuels, coolants, and lubricants. Use the Operation and Maintenance Manual as a guide for required engine maintenance.

For information on the operation of the warning lamps and the shutdown lamp, refer to this Operation and Maintenance Manual, “ Monitoring System (Table for Indicator Lamps)”. For each of the programmed modes, refer to Troubleshooting Guide, “Indicator Lamps” for more information on Indicator Lamps.

For more information or assistance for repairs, consult your Caterpillar dealer.

i04710837

Monitoring System (Table for the Indicator lamps)

SMCS Code: 1900; 7400; 7402; 7450; 7451

When in operation the amber warning indicator has three states, on solid, flashing and fast flashing. The sequence is to give a visual indication of the importance of the warning. Some application can have an audible warning installed.

Differential Pressure sensor

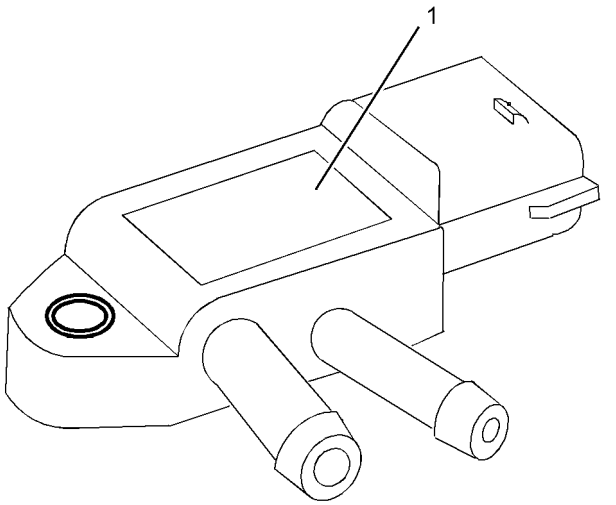

Illustration 33 g02477086

Typical example

(1) Differential pressure sensor

The location of the differential pressure sensor will depend on the application.

Through Flow Aftertreatment

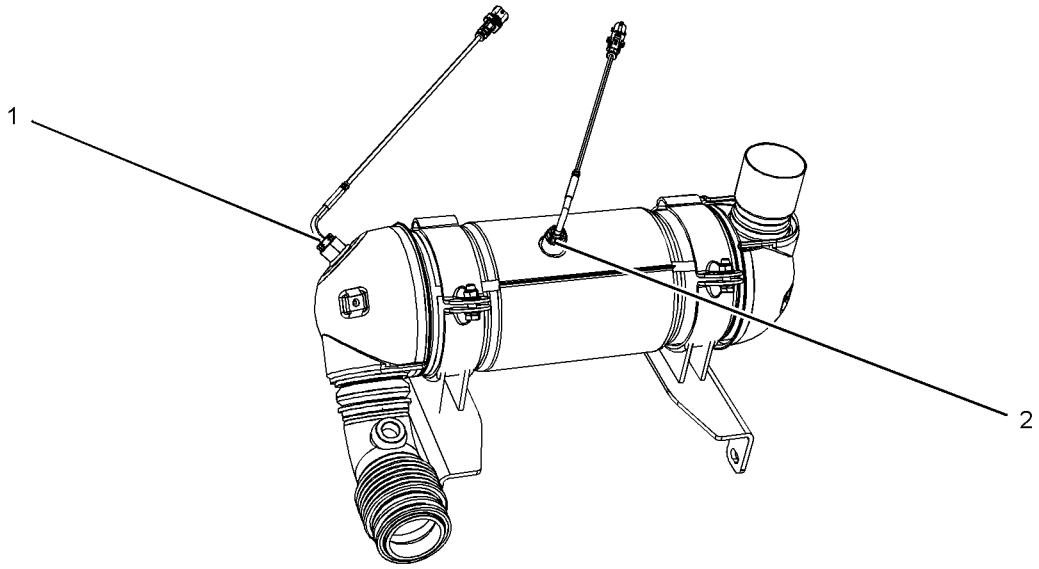

Illustration 34 g02477080

Typical example

(1) Diesel oxidation catalyst (DOC) temperature sensor
(2) Temperature sensor after DOC

Engine Operation

i04653132

Engine Operation

SMCS Code: 1000

Proper operation and maintenance are key factors in obtaining the maximum life and economy of the engine. If the directions in the Operation and Maintenance Manual are followed, costs can be minimized and engine service life can be maximized.

The time that is needed for the engine to reach normal operating temperature can be less than the time taken for a walk-around inspection.

The engine can be operated at the rated rpm after the engine is started and after the engine reaches operating temperature. The engine will reach normal operating temperature sooner during a low engine speed (rpm) and during a low-power demand. This procedure is more effective than idling the engine at no load. The engine should reach operating temperature in a few minutes.

Avoid excess idling. Excessive idling causes carbon buildup, engine slobber, and soot loading of the Diesel Particulate Filter (DPF). Excess idling can be harmful to the engine.

Gauge readings should be observed and the data should be recorded frequently while the engine is operating. Comparing the data over time will help to determine normal readings for each gauge. Comparing data over time will also help detect abnormal operating developments. Significant changes in the readings should be investigated.

System Check

During normal engine operation the Electronic Control Module (ECM) will elevate the fuel pressure to the injectors. This check will be at scheduled intervals of approximately 100 hours depending on the duty cycle of the engine. The check will be carried out automatically without the need of any input from the operator.

During the time of elevated fuel pressure, the operator may notice a change in the tone of the engine. The ECM will operate the check at low idle for approximately 5 minutes.

i04401459

Diesel Particulate Filter Regeneration

SMCS Code: 108F

Regeneration

Regeneration is the removal of soot from the Diesel Particulate Filter (DPF). There are two different types of DPF that can be installed The through flow DPF and the wall flow DPF. Engines with a power output of 56kW and above will have the wall flow DPF installed. Engines with a power output below 56kW have the option to use both types of DPF.

In table 4 titled **Indicator Operation** the operator will find information on the regeneration indicators. The table informs the operator why an indicator is illuminated and what action should be taken.

Through Flow DPF

The through flow DPF uses passive regeneration in order to remove the soot from the DPF. Passive regeneration is a chemical reaction within the system. Normal operation of the engine creates enough heat for a chemical reaction in order to regenerate the DPF. The regeneration occurs automatically during normal engine operation.

This system uses an amount of active regeneration in order to ensure that soot cannot exit the DPF. The through flow DPF will not require manual cleaning.

For a typical view of the through flow DPF, refer to this Operation and Maintenance Manual, “Sensors and Electrical Components (Aftertreatment)”

Wall Flow DPF

The wall flow DPF uses passive regeneration and active regeneration in order to remove the soot from the DPF. The ash is trapped within the DPF and must be removed by a manual cleaning process Refer to Operation and Maintenance Manual , “Diesel Particulate Filter- Clean”.

For a typical view of the wall flow DPF, refer to this Operation and Maintenance Manual, “Sensors and Electrical Components (Aftertreatment)”

Regeneration Indicators

Five indicators can be affected by the DPF regeneration. these indicators are, Regeneration Active, DPF, Disable Regeneration, Amber, or Yellow Warning Indicator and Red Stop Indicator.

- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold weather operation.

Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

There are three major differences between No. 1 and No. 2 diesel fuel. No. 1 diesel fuel has the following properties:

- Lower cloud point
- Lower pour point
- Lower rating of kJ (BTU) per unit volume of fuel

When No. 1 diesel fuel is used, a decrease in power and in fuel efficiency may be noticed. Other operating effects should not be experienced.

The cloud point is the temperature when a cloud of wax crystals begins to form in the fuel. These crystals can cause the fuel filters to plug. The pour point is the temperature when diesel fuel will thicken. The diesel fuel becomes more resistant to flow through fuel pumps and through fuel lines.

Be aware of these values when diesel fuel is purchased. Anticipate the average ambient temperature of the area. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

Before troubleshooting for low power or for poor performance in the winter, check the type of fuel that is being used.

When No. 2 diesel fuel is used the following components provide a means of minimizing problems in cold weather:

- Starting aids
- Engine oil pan heaters
- Engine coolant heaters
- Fuel heaters
- Fuel line insulation

For more information on cold weather operation, see Special Publication, SEBU5898, “Cold Weather Recommendations”.

i04004437

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after you operate the engine.

Fuel tanks should contain some provision for draining water and sediment from the bottom of the tanks. Some fuel tanks use supply pipes that allow water and sediment to settle below the end of the fuel supply pipe.

Some fuel tanks use supply lines that take fuel directly from the bottom of the tank. If the engine is equipped with this system, regular maintenance of the fuel system filter is important.

Drain the water and sediment from any fuel storage tank at the following intervals: weekly, service intervals, and refueling of the fuel tank. This procedure will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

Fuel Filters

After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

The micron rating and the location of a primary fuel filter is important in cold-weather operation. The primary fuel filter and the fuel supply line are the most common components that are affected by cold fuel.

NOTICE
In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, a four micron[c] absolute high efficiency fuel filter is required for all Caterpillar Electronic Unit Injectors. Caterpillar High Efficiency Fuel Filters meet these requirements. Consult your Caterpillar dealer for the proper part numbers.

Fuel Heaters

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. A fuel heater should be installed in the fuel system before the primary fuel filter.

i01807350

Aftercooler Core - Clean/Test (Air-To-Air Aftercooler)

SMCS Code: 1064-070; 1064-081

The air-to-air aftercooler is OEM installed in many applications. Please refer to the OEM specifications for information that is related to the aftercooler.

i04380914

Aftercooler Core - Inspect

SMCS Code: 1064-040

Note: Adjust the frequency of cleaning according to the effects of the operating environment.

Inspect the aftercooler for these items: damaged fins, corrosion, dirt, grease, insects, leaves, oil, and other debris. Clean the aftercooler, if necessary.

For air-to-air aftercoolers, use the same methods that are used for cleaning radiators.

⚠ WARNING

Personal injury can result from air pressure.

Personal injury can result without following proper procedure. When using pressure air, wear a protective face shield and protective clothing.

Maximum air pressure at the nozzle must be less than 205 kPa (30 psi) for cleaning purposes.

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fans air flow. Hold the nozzle approximately 6 mm (.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. The pressurized air will remove debris that is between the tubes.

Pressurized water may also be used for cleaning. The maximum water pressure for cleaning purposes must be less than 275 kPa (40 psi). Use pressurized water in order to soften mud. Clean the core from both sides.

Use a degreaser and steam for removal of oil and grease. Clean both sides of the core. Wash the core with detergent and hot water. Thoroughly rinse the core with clean water.

After cleaning, start the engine and accelerate the engine to high idle rpm. This will help in the removal of debris and drying of the core. Stop the engine. Use a light bulb behind the core in order to inspect the core for cleanliness. Repeat the cleaning, if necessary.

Inspect the fins for damage. Bent fins may be opened with a “comb”.

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended. For more information, refer to OEM specification for the aftercooler.

Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

i03641972

Alternator - Inspect

SMCS Code: 1405-040

Caterpillar recommends a scheduled inspection of the alternator. Inspect the alternator for loose connections and proper battery charging. Inspect the ammeter (if equipped) during engine operation in order to ensure proper battery performance and/or proper performance of the electrical system. Make repairs, as required.

Check the alternator and the battery charger for proper operation. If the batteries are properly charged, the ammeter reading should be very near zero. All batteries should be kept charged. The batteries should be kept warm because temperature affects the cranking power of the battery. If the battery is too cold, the battery will not crank the engine.

When the engine is not run for long periods of time or if the engine is run for short periods, the batteries may not fully charge. A battery with a low charge will freeze more easily than a battery with a full charge.

i04407613

Alternator and Fan Belts - Replace

SMCS Code: 1357-510

1. Remove the guard that covers the alternator. Refer to the Original Equipment Manufacture (OEM) for the correct procedure.

- Glycol Concentration
- Concentration of SCA
- pH
- Conductivity

The results are reported, and recommendations are made according to the results. Consult your Caterpillar dealer for information on the benefits of managing your equipment with an S·O·S Coolant Analysis.

Level 2

This level coolant analysis is recommended when the engine is overhauled. Refer to this Operations and Maintenance Manual, “Overhaul Considerations” for further information.

Add the SCA, If Necessary

NOTICE
Do not exceed the recommended amount of supplemental coolant additive concentration. Excessive supplemental coolant additive concentration can form deposits on the higher temperature surfaces of the cooling system, reducing the engine's heat transfer characteristics. Reduced heat transfer could cause cracking of the cylinder head and other high temperature components. Excessive supplemental coolant additive concentration could also result in radiator tube blockage, overheating, and/or accelerated water pump seal wear. Never use both liquid supplemental coolant additive and the spin-on element (if equipped) at the same time. The use of those additives together could result in supplemental coolant additive concentration exceeding the recommended maximum.

⚠ WARNING

Pressurized System: Hot coolant can cause serious burns. To open the cooling system filler cap, stop the engine and wait until the cooling system components are cool. Loosen the cooling system pressure cap slowly in order to relieve the pressure.

NOTICE
When any servicing or repair of the engine cooling system is performed the procedure must be performed with the engine on level ground. This will allow you to accurately check the coolant level. This will also help in avoiding the risk of introducing an air lock into the coolant system.

1. Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap.

Note: Always discard drained fluids according to local regulations.

2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.

3. Add the proper amount of SCA. Refer to the Special Publication, SEBU6251, “Caterpillar Commercial Diesel Engines Fluids Recommendations” for more information on SCA requirements.

4. Clean the cooling system filler cap. Inspect the gaskets of the cooling system filler cap. If the gaskets are damaged, replace the old cooling system filler cap with a new cooling system filler cap. Install the cooling system filler cap.

i04403234

Diesel Particulate Filter - Clean

SMCS Code: 108F-070

⚠ WARNING

Wear goggles, gloves, protective clothing, and a National Institute for Occupational Safety and Health (NIOSH) approved P95 or N95 half-face respirator when handling a used Diesel Particulate Filter or Catalytic Converter Muffler. Failure to do so could result in personal injury.

⚠ WARNING

The muffler, catalytic converter/muffler, and diesel particulate filter will become extremely hot during engine operation. A hot muffler, catalytic converter/muffler and diesel particulate filter can cause serious burns. Allow adequate cooling time before working on or near the muffler, catalytic converter/muffler and diesel particulate filter.

After the oil has drained, the oil drain plugs should be cleaned and installed. If necessary, replace the O ring seal. Tighten the drain plug securely.

Replace the Oil Filter

NOTICE
Caterpillar oil filters are manufactured to Caterpillar specifications. Use of an oil filter that is not recommended by Caterpillar could result in severe damage to the engine bearings, crankshaft, etc., as a result of the larger waste particles from unfiltered oil entering the engine lubricating system. Only use oil filters recommended by Caterpillar.

1. Remove the oil filter.

Note: The following actions can be carried out as part of the preventive maintenance program.

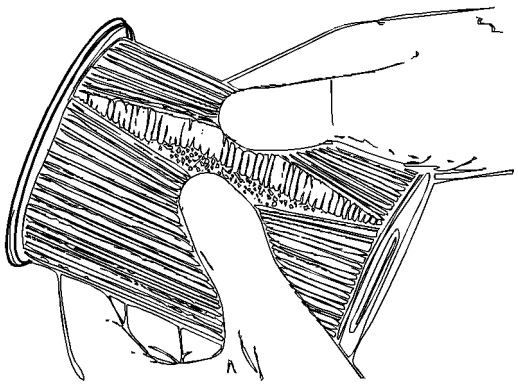

Illustration 58 g01999595
Element with debris

2. Cut the oil filter open with a 175-7546 Oil Filter Cutter . Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

Use a magnet to differentiate between the ferrous metals and the nonferrous metals that are found in the oil filter element. Ferrous metals may indicate wear on the steel and cast iron parts of the engine.

Nonferrous metals may indicate wear on the aluminum parts, brass parts, or bronze parts of the engine. Parts that may be affected include the following items: main bearings, rod bearings, turbocharger bearings, and cylinder heads.

Due to normal wear and friction, small amounts of debris is not uncommon to be found in the oil filter. Consult your Cat dealer in order to arrange for a further analysis if an excessive amount of debris is found in the oil filter.

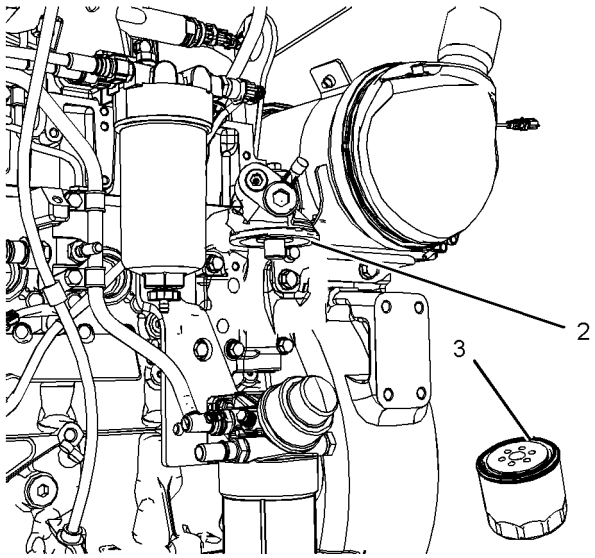

Illustration 59 g02516777

3. Clean the sealing surface of the oil filter base (2).

4. Apply clean engine oil to the O ring seal (3) for the new oil filter.

NOTICE
Do not fill the oil filters with oil before installing them. This oil would not be filtered and could be contaminated. Contaminated oil can cause accelerated wear to engine components.

5. Install the engine oil filter. The oil filter will require to be torqued to 30 N·m (22 lb ft) in order to secure the oil filter.

The need for an overhaul is indicated by increased fuel consumption, increased oil consumption, excessive engine blowby, and reduced power. Arctic temperatures, extreme high temperatures, corrosive environments, or extreme dusty conditions contribute to premature wear and the need for an overhaul.

The following factors are important when a decision is being made on the proper time for an engine overhaul:

- The need for preventive maintenance
- The quality of the fuel that is being used
- The operating conditions
- The results of the S·O·S analysis

Oil Consumption as an Overhaul Indicator

Oil consumption, fuel consumption, and maintenance information can be used to estimate the total operating cost for your Caterpillar engine. Oil consumption can also be used to estimate the required capacity of a makeup oil tank that is suitable for the maintenance intervals.

Oil consumption is in proportion to the percentage of the rated engine load. As the percentage of the engine load is increased, the amount of oil that is consumed per hour also increases.

The oil consumption rate (brake-specific oil consumption) is measured in grams per kW/h (lb per bhp). The brake-specific oil consumption (BSOC) depends on the engine load. Consult your Caterpillar dealer for assistance in determining the typical oil consumption rate for your engine.

When an engines oil consumption has risen to three times the original oil consumption rate due to normal wear, an engine overhaul should be scheduled. There may be a corresponding increase in blowby and a slight increase in fuel consumption.

Overhaul Options

Before Failure Overhaul

A planned overhaul before failure may be the best value for the following reasons:

- Costly unplanned downtime can be avoided.
- Many original parts can be reused according to the standards for reusable parts.
- The engines service life can be extended without the risk of a major catastrophe due to engine failure.
- The best cost/value relationship per hour of extended life can be attained.

After Failure Overhaul

If a major engine failure occurs and the engine must be removed, many options are available. An overhaul should be performed if the engine block or the crankshaft needs to be repaired.

If the engine block is repairable and/or the crankshaft is repairable, the overhaul cost will be less than the cost of a new engine with a similar exchange core.

This lower cost can be attributed to three aspects:

- Specially designed Caterpillar engine features
- Caterpillar dealer exchange components
- Caterpillar Inc. remanufactured exchange components

Overhaul Recommendation

To minimize downtime, Caterpillar Inc. recommends a scheduled engine overhaul by your Caterpillar dealer before the engine fails. This process will provide you with the best cost/value relationship.

Note: Overhaul programs vary according to the engine application and according to the dealer that performs the overhaul. Consult your Caterpillar dealer for specific information about the available overhaul programs and about overhaul services for extending the engine life.

Aftertreatment

The aftertreatment system can be expected to function properly for the useful life of the engine (emissions durability period), as defined by regulation, subject to prescribed maintenance requirements being followed.

Rebuild or Exchange

If an overhaul is performed without overhaul service from your Caterpillar dealer, be aware of the following maintenance recommendations.

Customer Service

i03996951

Customer Assistance

SMCS Code: 1000

USA and Canada

When a problem arises concerning the operation or the service of an engine, the problem will normally be managed by the dealer in your area.

Outside of the USA and of Canada

If a problem arises outside the USA and outside Canada, and if the problem cannot be resolved at the dealer level, consult the appropriate Caterpillar office.

Latin America, Mexico, Carribean
Caterpillar Americas Co.
701 Waterford Way, Suite 200
Miami, FL 33126-4670
USA
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Fax: 305-476-6801

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Tullamarine, Victoria 3043
Australia
Phone: 03-9953-9333
Fax: 03-9335-3366

i03655027

Ordering Replacement Parts

SMCS Code: 7567

⚠ WARNING

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.

Quality Caterpillar replacement parts are available from Caterpillar dealers throughout the world. Caterpillar dealers' parts inventories are up-to-date. The parts stocks include all of the parts that are normally needed to protect your Caterpillar engine investment.

When you order parts, please specify the following information:

- When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. Refer to this Operation and Maintenance Manual, “Plate Locations and Film Locations”.