

## **3-1 STARTING AND DRIVING**

## 3-1 Starting and Driving

### 3-1.1 General Information

The 450 LXi is equipped with a Caterpillar C13 Engine. The C13 engine is an in-line six cylinder arrangement. The engine has a bore of 130 mm (5.12 inch) and a stroke of 157 mm (6.18 inch). The displacement of the engine is 12.5 L (763 in<sup>3</sup>). Each cylinder has two inlet valves and two exhaust valves. The firing sequence of the engine is 1-5-3-6-2-4.

The engine has two turbochargers. The engine arranges the two turbochargers in a series. The two turbochargers allow the engine to have boost over the entire engine rpm range. The use of two turbochargers increases the maximum boost pressure to 310 kPa (45 psi). The engine also uses a precooler before the air-to-air aftercooler (ATAAC).

The Electronic Unit Injector (EUI) provides increased control of the timing and increased control of the fuel to air mixture. Engine speed is controlled by adjusting the injection duration. Engine timing is controlled by the precise control of fuel injection timing.

Modern electronic engines have the capability to perform self-diagnostic tests when the system detects an active problem, the operator will be alerted to the condition by the use of a check engine light and an event code will be stored in permanent memory in the Engine Control Module (ECM). Cat Electronic Technician ((ET) Caterpillar electronic service tool) can be connected to the engine in order to read any logged faults. Also, the cruise control switches and be used to flash the code on the check engine light. Intermittent faults are logged and stored in memory.

### 3-1.2 Starting the Engine

The engine's ECM will automatically provide the correct amount of fuel in order to start the engine. Do not hold the throttle down while the engine is cranking. If the engine fails to start in 30 seconds, release the starting switch. Allow the starting motor to cool for at least two minutes before attempting to use it again.

**NOTICE:** *Excessive ether (starting fluid) can cause piston and ring damage. Use ether for cold weather starting purposes only.*

#### 3-1.2.1 Cold Mode Operation

The ECM will set the cold start strategy when the coolant temperature is below 18°C (64°F).

When the cold start strategy is activated, low idle rpm will be increased to 1000 rpm and the engine's power will be limited until the engine reaches normal operation temperatures.

Cold mode operation will be deactivated when any of the following conditions have been met:

- Coolant temperature reaches 18°C (64°F).
- The engine has been running for fourteen minutes.

Cold mode operation varies the fuel injection amount for white smoke cleanup. Cold mode operation also varies the timing for white smoke cleanup. The engine operating temperature is usually reached before the walk-around inspection is completed. The engine will idle at the programmed low idle rpm in order to be put in gear.

**NOTICE:** *Do not move the vehicle with the engine in the cold mode condition. Engine power could be noticeably reduced. At a vehicle speed above 8 km/h (5 mph), low idle rpm will be reduced to the customer programmed low idle and the power will still be reduced.*

After the cold mode is completed, the engine should be operated at low rpm until normal operating temperature is reached. The engine will reach normal operating temperature faster when the engine is operated at low rpm and low power demand.

### 3-1.3 Remote Engine Starting

Because it may sometimes be necessary to start diesel engine remotely, a separate switch is located on the right side of the engine compartment. Toggle switch must be down (REAR) to start from the engine compartment. Engine will not start from front with rear engine door open. Front ignition key must be ON to start from rear.

## 3-1.4 Stopping Engine

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

*If the engine has been operating at high speed and/or high loads, run at low idle for at least three minutes to reduce and stabilize internal engine temperature before stopping the engine.*

*Avoiding hot engine shutdowns will increase turbocharger shaft and bearing life.*

Prior to stopping an engine that is being operated at low loads, operate the engine at low idle for 30 seconds before stopping. If the engine has been operating at highway speeds and/or at high loads, operate the engine at low idle for at least three minutes. This procedure will cause the internal engine temperature to be reduced and stabilized.

Ensure that the engine stopping procedure is understood. Stop the engine according to the shutoff system on the vehicle.

- To stop the engine, turn the ignition key switch to the OFF position.

### 3-1.4.1 After Stopping the Engine

- Check the crankcase oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level gauge.
- If necessary, perform minor adjustments. Repair any leaks and tighten any loose bolts.
- Note the service hour meter reading. Perform the maintenance that is in the "Maintenance Interval Schedule" section of this manual.
- Fill the fuel tank in order to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.

**NOTICE:** *Only use antifreeze/coolant mixtures recommended in the Coolant Specifications of this manual. Failure to do so can cause engine damage.*

- Allow the engine to cool. Check the coolant level. Maintain the cooling system at 13 mm (.5 inch) from the bottom of the pipe for filling.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment.

## 3-1.5 Cold Weather Operation

### 3-1.5.1 Radiator Restrictions

Caterpillar discourages the use of airflow restriction devices that are mounted in front of radiators. Airflow restriction can cause the following conditions:

- High exhaust temperatures
- Power loss
- Excessive fan usage
- Reduction in fuel economy

Shutters can be properly used for parking overnight, very cold temperatures, and high winds. In those particular cases, the coolant temperature and the inlet manifold temperature must be carefully monitored and controlled.

**NOTICE:** *Failure to open the winter fronts in the morning could cause engine damage and/or loss of fuel economy.*

### 3-1.5.2 Fuel and the Effect from Cold Weather

The following fuels are in the grades that are available for Caterpillar engines:

- No. 1
- No. 2
- 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 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 that the engine will be operated. 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 some means of minimizing problems in cold weather:

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

### 3-1.5.3 Fuel Related Components in Cold Weather

#### Fuel Tanks

Condensation can form in partially filled fuel tanks. Top off the fuel tanks after operating 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
- Oil changes
- Refueling of the fuel tank

This will help prevent water and/or sediment from being pumped from the fuel storage tank and into the engine fuel tank.

**Fuel Filters**

A primary fuel filter and/or a water separator is installed between the fuel tank and the engine mounted fuel filter. The primary fuel filter and the fuel supply line are commonly affected by cold fuel. The primary fuel filter is mounted in the engine compartment. The primary fuel filter will benefit from the radiant heat of the engine.

**Fuel Heaters**

Fuel heaters help to prevent fuel filters from plugging in cold weather due to waxing. If coach is going to be driven extensively in cold weather a fuel heater may want to be considered. If a fuel heater is purchased it should be installed so that the fuel is heated before the fuel enters the primary fuel filter.

To select a fuel heater, contact your Caterpillar dealer.

The following fuel heaters are recommended for use with Caterpillar engines:

- 7C-3557 Fuel Heater Group
- 7C-3558 Heater Kit

Your Caterpillar dealer can give you full information on the benefits of fuel heaters and which type would be best for you.