



BROUWER 4000-R

Self Propelled Sod Harvester

Operator's Manual





Kesmac Inc. 23324 Woodbine Avenue, Keswick Ontario Canada L4P 0N1 Tel (905) 476-6222 Fax (905) 476-6744 Web Site www.brouwerkesmac.com Email info@kesmac.com

> KM.99188 April 2019

BROUWER4000-16/24R Sod Harvester

Operator's Manual

Contents.

Foreword. Serial Number Plate.	i i
Patent Label. Service Access; Keyed Safety Guards.	ii ii
Specifications.	iii
Caterpillar Service Center Locations.	iv
Section 1.	Safety.
Section 2.	Cab Controls.
Section 3.	Operation.
Section 4.	Hydraulic System.
Section 5.	Electrical System.
Section 6.	Maintenance Schedule. Lubrication.
Section 7.	Electronic Auto-Steer.
Section 8.	Cab Maintenance. Radio - Owners Manual.
Section 9.	Engine Operation and Maintenance Manual.
Section 10.	Engine Information Center User Manual.

BROUWER-16/24R

Self Propelled Sod Harvester

Foreword

IMPORTANT

The Owner and Operator, must assume responsibility for the safe operation of the machine, their own safety, and the safety of others, by reading, understanding, and following all of the safety instructions and operating procedures as outlined in the machines Operator's Manual. Failure of the Owner or Operator to adhere to the recommended safety instructions and operating procedures, indemnifies Brouwer Turf Inc. against any claims that may arise, due to accidents resulting in personal injury or property damage.

It is not possible to list all situations that may affect the safety of the machine or the operator, and therefore Brouwer Turf Inc. cannot list all precautions, and identify all potential hazards, that may prevent accidents.

IF YOU DO NOT UNDERSTAND....ASK

BE A QUALIFIED OPERATOR BY ;

- Reading and obeying the instructions in this manual, and the safety decals on the machine.
- Receiving operational training on the sod harvester.
- Asking your supervisor or equipment dealer to explain anything you do not understand.
- Explaining the written instructions in the operator's manual and safety decals to user/operators who cannot read or understand them.



🗛 WARNING -

Brouwer Sod Harvesters are designed for safe efficient operation and must not be used for any purpose other than that for which they are designed.

Prior to being shipped from the manufacturer the machines are inspected to insure that all safety guards, shields and warning/safety/operating decals are correctly positioned and secure

Before operating the machine the operator must check that all of the above items are correctly located.

The machine must not be used if any guards, shields or warning/operating decals are damaged or missing.

Brouwer Sod Harvesters are designed and built to give many years of outstanding performance.

The service and reliability you receive from this product will be affected by the proper maintenance and operation of the machine.

Use only genuine factory placement parts. Parts not supplied by Brouwer may not meet the factory engineering specifications or standards of manufacture and may void warranty. The use of non-approved parts may result in component failure causing damage to the machine and possibly result in an accident to the operator or others.



MODEL NUMBER

The Model Number appears on sales literature technical manuals and price lists.

SERIAL NUMBER

The serial number applies only to the machine to which it is allocated. The serial number **MUST** be quoted when ordering parts or calling for service or warranty



This machi more of the	ine is covered e following pa	by one or tents:
U.S. Patents		
3,590,927	4,345,659	5,775,436
3,790,096	4,621,696	6,056,064
4,015,566	4,832,130	
4,018,287	4,944,352	
4,029,152	4,903,778	
Other patents Also patented THIS MACHIN	pending. in other countries. E CANNOT BE COPI	ED IN WHOLE
OR IN PAR	T FOR OWN USE OF	RESALE



Maintenance and Service Access.



Keyed Locks are fitted to the Safety Guards : Gripper Head 'A'; Roll-Up Area 'B'; and Index Conveyor 'C'. These keys must be kept with the ignition key at all times.

Under no circumstance should the keys be left in the locks.

A WARNING -

Do not operate the machine if any of the safety guards are damaged or missing. In this manual for illustration purposes only, some guards may not be shown.

Brouwer4000-16/24R Sod Harvester

4000 Harvester Specifications.

Conveyor	Rubber Mat
Cutting Head	Full Floating Cutter Head
Width of Cut	. 16 in.(406mm) /23 in.(584mm) /24 in.(610mm).
Length of Cut	up to 100 in.(2540mm).
Thickness of Cut	. Hydraulically Adjustable
Standard Pallet Size	. 48in.(1219mm).
Cutter Drive	Variable Hydraulic
Conveyor Drive	. Variable Hydraulic
Cutting Blades	Standard with Fingers / V-Blade
Construction	High Strength Steel Weldment
Total Weight	16in18641lbs.(8455kg). 24in20900lbs.(9480kg)
Overall Length	. 296in,(7518mm)Less Ski.
Overall Width	. 124in.(3150 mm) Less Toe Guard.
Shipping Width	91in.(2312mm). Machine is taken apart for container.
Overall Height	104in.(2642mm)Less Strobe.(112.5in.w/mast sensor).
Pallet Configuration	Pyramid or Flat Top
	Upper Level Squeeze Function
Flap Control	. Automatic

Tire Specifications

Front Tires . 550/45 R22.5 Flotation (Optional 380/75 R20) Rear Tires . 650/55 R22.5 Flotation Radial

Cab

Cab Deluxe Cab Seat..... Adjustable Suspension Swivel Seat

NOTE

Refer to Section 9 for the engine operating/maintenance manual. Refer to the following page for your nearest Caterpillar Dealer/Service location.

Due to constant program of product development, specifications may change without notice or obligation.

Customer Service

102097871

Customer Assistance

SMCS Code: 1000

USA and Canada

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

Your satisfaction is a primary concern to Caterpillar and to Caterpillar dealers. If you have a problem that has not been handled to your complete satisfaction, follow these steps:

- 1. Discuss your problem with a manager from the dealership.
- If your problem cannot be resolved at the dealer level without additional assistance, use the phone number that is listed below to talk with a Field Service Coordinator:

1-800-447-4986

The normal hours are from 8:00 to 4:30 Monday through Friday Central Standard Time.

If your needs have not been met still, submit the matter in writing to the following address:

> Caterpillar Inc. Manager, Customer Service, Engine Division Mossville Bldg AC P.O. Box 610 Mossville, Illinois 61552-0610

Please keep in mind: probably, your problem will ultimately be solved at the dealership, using the dealership's facilities, equipment, and personnel. Therefore, follow the steps in sequence when a problem is experienced.

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 Phone: 305-476-6800 Fax: 305-476-6801

Europe, Africa, and Middle East Caterpillar Overseas S.A. 76 Route de Frontenex P.O. Box 6000 CH-1211 Geneva 6 Switzerland Phone: 22-849-4444 Fax: 22-849-4544

Far East Caterpillar Asia Pte. Ltd. 7 Tractor Road Jurong, Singapore 627968 Republic of Singapore Phone: 65-662-8333 Fax: 65-662-8302

China Caterpillar China Ltd. 37/F., The Lee Gardens 33 Hysan Avenue Causeway Bay G.P.O. Box 3069 Hong Kong Phone: 852-2848-0333 Fax: 852-2848-0440

Japan Shin Caterpillar Mitsubishi Ltd. SBS Tower 10-1, Yoga 4-Chome Setagaya-Ku, Tokyo 158-8530 Japan Phone: 81-3-5717-1150 Fax: 81-3-5717-1177

Japan Caterpillar Power Systems, Inc. SBS Tower (14th floor) 4-10-1, Yoga Setagaya-Ku, Tokyo 158-0097 Phone: 81-3-5797-4300 Fax: 81-3-5797-4359

Australia and New Zealand Caterpillar of Australia Ltd. 1 Caterpillar Drive Private Mail Bag 4 Tullamarine, Victoria 3043 Australia Phone: 03-9953-9333 Fax: 03-9335-3366

SECTION 1

Warning Symbols. Safe Operation. General Operating Safety. Maintenance Safety.	1-01 1-02 1-03/1-04 1-04/1-06
Transport and Storage.	1-07
Tire Service Procedure.	1-07
Handling Chemicals.	1-07
Safe Welding.	1-08
Battery Isolator Switch	1-08
Fuel Filler Access & Fuel Gauge.	1-08
To move machine with no engine power.	
Towing /Transporting.	1-09
Release Torque Hub Brake.	1-09
Remove Conveyor.	1-09
Cab – Rear View Screen.	1-10
Rear View Camera.	1-10
Optional Camera-Piling/Cavity Area.	1-10
Back-Up Alarm.	1-10
Service & Maintenance Access Panels.	1-11
Battery Location.	1-11
Transport Tie-Down Locations.	1-11
Decals.	1-12/13/14/15/16
Optional Camera – Installation.	1-17

Unauthorized modifications may result in **extreme safety hazards** to operators and bystanders, and could result in damage to the machine.

Brouwer Turf Inc. warns against and strongly rejects and disclaims against any modifications, add-on accessories or product modifications that are not designed, developed, tested and approved by Brouwer Engineering Department.

Any Brouwer product that is altered or modified in anyway that is not authorized, after original manufacture, including after market accessories or component parts that are not approved by Brouwer Turf Ltd. will result in the machines warranty being voided.

All liability for personal injury and/or property damage caused by any unauthorized modifications, add-on accessories or products not approved by Brouwer Ltd. will be considered the responsibility of the individual(s) or Company designing and/or making such changes.

Brouwer Turf Inc. will vigorously pursue full indemnification and costs, from any party responsible for unauthorized post manufacture modifications and/or accessories, should personal injury and/or property damage result from any of the above.



TO PREVENT POSSIBLE SERIOUS INJURY OR DEATH :

Under no circumstances is any service or maintenance work to be performed on the machine until :

- THE ENGINE IS SWITCHED OFF.
- THE IGNITION KEY IS REMOVED.
- THE CAB DOOR IS LOCKED.

Brouwer Turf Inc. cannot stress too strongly the importance of Owners/Operators adhering strictly to the safety recommendations as stated in this manual.



For illustration purposes only some safety guards and shields may not be shown.

The machine must not be operated if any guards or shields are damaged or missing. Failure to observe this warning could result in serious injury or death.



This Symbol means :

- ATTENTION !
- BECOME ALERT !

Your safety and that of others is involved.

Signal word definitions.

The signal words below are used to identify levels of 'hazard' seriousness. These words appear in this manual and on the safety decals that are placed on the machine.

For your safety and that of others, read and follow the information and instructions given with these signal words and/or the symbol shown above.

DANGER:

Indicates an imminently hazardous situation which if not avoided **WILL** result in death or serious injury.

A WARNING:

Indicates a potentially hazardous situation which if not avoided **COULD** result in death or serious injury.

A CAUTION:

Indicates a potentially hazardous situation which if not avoided **MAY** result in minor or moderate injury. It may also be used to alert against unsafe practices or property damage.

CAUTION:

Used without the safety alert symbol indicates a potentially hazardous situation which if not avoided **MAY** result in property damage.

Safe Operation Operator preparation and training.

Read the **Brouwer400024-R/400016-R** Operator's Manual. It must be kept on the machine at all times.

- If an operator or mechanic cannot read and understand English, it is the owners responsibility to explain the material contents to them.
- If any of the information or instructions in this manual are not clear, contact your dealer or the factory representative for clarification.
- Become familiar with the safe operation of the machine, the operating controls and the safety decals. If there are any questions concerning safety, do not operate the machine until they are clarified.

All safety guards and shields must be kept in place and in good condition. All interlock switches must be correctly adjusted.

- It is the owners responsibility to ensure that all operators and service personnel are trained in the proper operation and service procedures of the machine.
- Do not allow children or untrained persons to operate this equipment. Local regulations may restrict the age of the operator.
- Wear appropriate work clothing, safety equipment and work boots. Do not operate the machine with loose clothing, long hair, or any jewelry, that may get tangled in moving parts.

A CAUTION ·

Wear suitable hearing protection such as earmuffs or earplugs, to protect against hearing impairment or hearing loss.

Operating equipment safely requires the full attention of the operator. Do not wear radio or music headphones while operating the machine.

- Only the operator must be on the machine, never allow riders on the machine. Riders can be injured by foreign objects or can be thrown off the machine. Also they may obstruct the ability of the operator or the operators view resulting in unsafe operation of the machine.
- warning/safety decals must be kept clean, legible, and undamaged. Do not operate the machine if any decals are missing or damaged. Obtain new decals from the factory.

- Do not operate the machine if drugs, alcohol or medication are being used that can affect the alertness or co-ordination of the operator.
 Seek professional advice before operating the machine if there is any doubt about the side affects of any medication being taken that may put your safety and that of others at risk.
- Keep animals and bystanders clear of the machine, at a safe distance, when operating the machine.
- The owner/operator is responsible for accidents and/or injuries that may occur to themselves, bystanders, or property that may occur as a result of the operation of this machine.

Machine preparation

• Check that the 'operator presence' interlock switch is operating.

🖌 WARNING

If the operator leaves the operator's seat while the machine is moving, the system will automatically move the controls to neutral and the machine will stop.

- Do not tamper with, or defeat, safety devices. Keep guards, shields and interlock safety devices in place and in proper working condition. They are for your protection.
- Check regularly that all fasteners, nuts/ bolts, and retainer pins are secure.
- Check daily that the machine is in good working condition. Check all tires for damage or excessive wear.
- Use only accessories, attachments and replacement parts that are approved by the manufacturer.



To prevent unauthorized persons having access to the cab:

The cab door must be kept locked when in service, and the key in possession of the service person.

IF YOU DO NOT UNDERSTAND....ASK

General Operating Safety

- Ensure all persons are clear of the machine before starting the engine. Keep hands and feet clear of the cutting unit and all moving parts.
- Do not make sharp turns. Exercise care when reversing and maneuvering. Look behind the machine and downward when reversing.
- Keep all persons clear of the Robotic Arm operating areas and pallet cavity, the Arm may move suddenly and result in serious injury.
- Exercise caution when approaching or crossing roadways.

Never attempt to get on or off the machine when it is moving.

Before leaving the operating position, place the Control Handle in 'neutral', set the brake, lower the cutting head and pallet forks to the ground, stop the engine and remove the ignition key.

Starting the Engine.

Start only in accordance with the instructions in this manual

- Start only from the operator's seat, with System Power 'OFF', the Control Handle in 'NEUTRAL' and brake 'ON'.
- DO NOT use starting-aid fluid.

Transporting

• Exercise caution when loading or unloading the machine on or off a truck or trailer.

IMPORTANT

If the Conveyor is to be removed when transporting the machine refer to page 1-09 for the correct procedure.

• Ensure that the machine is properly 'blocked' and secured during transport.

Operating

 Do not change the engine governor setting, or over-speed the engine.

- 🔬 warning —

Work in a ventilated area. Never operate the machine without adequate engine exhaust ventilation.

Never run the engine in an enclosed area. Exhaust fumes contain carbon monoxide and can be fatal if inhaled.

- Inspect the area to harvested and remove any objects that may be hazardous or may cause an injury.
- Operate with adequate light and avoid any holes and other hazards.

Highway Operation

- Ensure that the 'Slow moving vehicle' sign is in place.
- To prevent collisions with other vehicles, slow moving tractors with attachments, towed equipment or self-propelled machines, frequently check for traffic from the rear, particularly when making turns. Always use the turn signal lights.
- Slow down and exercise caution when making turns and when crossing roads and railway tracks.
- Use headlights, flashing warning lights and turn signals day and night. Follow local regulations for equipment lighting and marking.
 Ensure that all lighting, signals and markings are visible, clean and in good working order.
 Repair or replace any lights, signals or marking that is damaged or is missing.

To prevent Tipping

• Avoid holes, ditches, slopes, and obstacles that may cause instability and the machine to tip.



Never drive close to the edge of a gully or steep embankment that may collapse and cave-in, causing the machine to tip.

Speed Control. 'HI' -'LOW'.

To change speed from 'HARVEST' (LOW) to 'ROAD' (HI). Stop the machine and operate the 2-Speed switch on the cab Switch Panel. See page 2-01. Reverse the procedure for 'HI' to 'LOW'.

- Reduce travel speed before descending a steep incline, to assist in braking and improving your control of the machine.
- Slow down and exercise caution when making turns and changing direction on a slope.

Stopping Operation

 Before stopping the engine: Reduce the engine speed to 'SLOW' and let it operate at 'no load' for five to ten minutes, to allow the engine to cool down.

To safely park the machine:

 Stop on level ground. Place all controls in the 'OFF' position. Lower the Cutter Head and the Forks to the ground. Put the Control Handle in the NEUTRAL position. Apply the brake and switch off the engine. Before leaving the operator's seat, wait for the engine and all moving/rotating parts to stop. Remove the ignition key.

To free a 'mired' machine.

- Check that all towing devices are of adequate size/strength to handle the load.
- Always attach to the Draw Bar of the towing unit. Do not use the front attachment point. Apply power smoothly to take up slack, a sudden pull could 'snap' the towing device causing it to 'whip' or 'recoil' dangerously.

The machine must not be towed any further than necessary to extricate it.

Caution should be exercised when attempting to free a machine that is stuck in mud.

Hazards that can occur when towing, and are to be avoided are:

• The towing tractor overturning.

rear of the machine.

- The tow chain failing and recoiling. (Use of a cable is not recommended).
- Tow-bar failing.
- The harvester becoming unstable and tipping. The following procedures are recommended;
 - If possible reverse the machine out, if it is 'mired' in mud.
 Dig mud out from behind the wheels. Place boards behind/under the wheels and reverse out 'slowly'. Keep bystanders clear of the

• Dig mud out from in front of the wheels and drive ahead '**slowly**'.

Maintenance Safety

Do not service or repair this machine with the attachments in the raised position, unless they are securely blocked, or the safety devices are engaged. Do not enter the Forks/Piling Cavity area when the engine is running Failure to follow these warnings could result in serious injury or death

- To attain maximum safety and the optimum harvesting results, maintain your Harvester according to the recommended schedules and instructions in this manual.
- When servicing or operating the machine do not wear loose clothing or jewelry that can entangle in machinery and cause personal injury.
- Never allow untrained persons to operate or service the machine.
- Allow the engine and rotating/moving parts to come to a complete stop before attempting any service or repair work.
- Turn the battery Isolator Switch 'OFF' before making any repairs, and before doing any welding on the machine.
- Carefully release pressure from components with 'stored' energy.
- Park the machine on smooth, firm, level ground.
- Replace worn, damaged, or faulty parts only with ones supplied by the manufacturer.
- Before working on the machine, lower the Cutter Head and the Forks to the ground and lower the Gripper Head onto sod rolls on the Index Conveyor.

If the machine is to be raised, use jack stands. If left in a raised position hydraulic supports can settle or 'leak' down.

Maintenance Safety

Do not support the machine on cinder blocks, hollow tiles, or props that may crumble under continuous load.

Do not work under a machine that is supported solely by a hydraulic jack.

- To reduce fire hazards: Keep the engine, muffler, battery area and fuel storage area free of grass, leaves, debris or grease build-up.
- Clean-up any fuel or oil spillage.

Handling Fuel.



- Exercise caution when refueling do not over-fill. Fuels are flammable and vapors are explosive. If using fuel cans use only approved containers and a funnel. Avoid spillage. Cleanup spills immediately.
- Do not smoke, allow naked flame, or cause sparks near the fuel.
 - Never drain or fill the fuel tank indoors.
- Never remove the Fuel Tank Cap or add fuel when the engine is running or if it is hot.
- Never handle or store fuel containers near an open flame or any device that may create sparks and ignite the fuel or vapors.
- Ensure that the Closure Caps on the Fuel Tank, and any containers, are replaced securely.



To prevent sparks from static discharge:

- Do not fill containers in a vehicle, on a truck, or a trailer bed that has a plastic liner.
 Fill the containers on the ground, away from the vehicle.
- Always keep the fuel dispenser nozzle in contact with the rim of the fuel tank, or container opening, until fueling is completed.
- Do not use a nozzle lock-open device.
- Always be prepared in case of fire. Keep a firstaid kit and fire extinguisher close to hand.
- Keep emergency numbers for fire, hospital, ambulance services, and doctors close to your telephone.

Refer to page 1-08 for fuel filler and fuel gauge locations.

Hydraulic System



The Hydraulic System operates under high pressure.

To prevent serious injury from hot, high pressure oil:

- Never check for leaks with bare hands. Use cardboard, paper or wood.
- High pressure oil can penetrate the skin. If it is injected into the skin it must be surgically removed within a few hours, by a doctor familiar with this type of injury. Failure to do so may result in gangrene.
- Relieve high pressure before disconnecting hydraulic lines or fittings.
- Fully tighten fittings and connections before pressurizing the system.
- Before inspecting or disconnecting hydraulic lines or fittings. Lower Cutter Head and the Forks to the ground. Disengage all drives, apply the brake/inch/clutch pedal. Stop the engine and remove the ignition key,
- Visually check daily all hydraulic hoses, tubes and fittings for leaks. Replace any worn or damaged hoses, tubes or fittings before operating the machine.
- Replacement hoses or tubes must be routed in the same location and path. Do not move clamps, brackets or ties to new locations.
- Thoroughly inspect all hoses, tubes and fittings every 300 hours.

IMPORTANT

To prevent serious damage to the hydraulic system components, do not allow any contaminants to enter the hydraulic system. Clean thoroughly around all fittings and areas to be worked on. Cap and plug any connections that are disconnected.

- Before disconnecting, tag or mark the location of the connection.
- Check that 'O-Rings' are clean and hose fittings are properly seated before tightening.
- Align the hoses without twisting. Twisted hoses can cause couplings to loosen as the hose flexes during operation resulting in oil leaks.
- Kinked or twisted hoses can restrict the oil flow causing the oil to overheat, the system to malfunction, possible hose failure,

SAFETY

Cooling System

WARNING -

To prevent serious injury from hot coolant and steam, **DO NOT** remove the radiator cap when the engine is running and/or hot. Allow the engine and system to cool. Use caution when removing the radiator cap.

- Do not operate the engine without the recommended coolant mixture.
- Add top-up coolant into the recovery tank NOT directly to the radiator
- Ensure that the radiator cap is tight and secure.
- If the radiator cap must be removed, stop the engine and allow the cooling system to cool, until the cap is cool to the touch. Loosen it slowly to relieve pressure, before removing completely.

Battery Service

🛃 WARNING

The sulfuric acid in the battery electrolyte is poisonous. It can cause serious skin burns and blindness if splashed in the eyes.

Always wear protective glasses/goggles, and protective clothing and use insulated tools when working with batteries. Read, understand, and obey the battery manufacturers instructions and warnings. Battery posts, terminals and related accessories contain lead, lead compounds and chemicals. Wash your hands after handling them.

Avoid Hazards By:

- Fill/top-up batteries in a well ventilated area.
- Wearing eye protection and rubber gloves.
- Avoid breathing fumes.
- Avoid spilling, splashing or dripping electrolyte.
- Follow proper 'jump-start' procedure.

If acid is splashed on your person:

- Flush the affected skin with water.
- Apply baking soda, or lime, to help neutralize the acid.
- Flush your eyes with water for 15 to 30 minutes. Get medical help immediately.

If acid is swallowed:

- Do not induce vomiting
- Drink large quantities of water or milk, but do not exceed 2 liters (2 Quarts).
- Get medical help immediately.

Battery Charging

- Charge batteries in an open well ventilated area, away from sparks or open flame.
- Unplug the charger before connecting or disconnecting the battery.

Jump Starting

- Check that the Jumper cables are in good condition.
- Turn the ignition and all electrical accessories 'OFF', on both machines.
- Position the machine with the 'charged' battery close to, but not touching, the machine with the dead battery, to ensure that the cables will easily reach.

Connecting the Cables

- Do not allow the cable clamps to touch any metal parts except those intended.
- Never connect the **positive '+'** (red) terminal to the **negative '-'** (black) terminal.
- Ensure that the cables cannot get caught in moving engine parts when starting.
- Connect one end of the **positive '+'** (red) cable to the **positive '+'** terminal on one battery.
 Connect the other end to the **positive '+'** terminal on the other battery
- Connect one end of the negative '-' (black) cable to the negative '-' terminal on the 'charged' battery. Connect the other end of the cable to the engine block on the machine with the 'dead' battery.
- Start the machine that has the 'charged' battery, then start the machine that has the 'dead' battery.
- Remove the jumper cables in the exact reverse order of connecting. Do not allow the cable clamps to touch any metal parts while the other end is connected to a battery terminal.

IMPORTANT

Keep the battery terminals clean. Smear them with white grease to prevent corrosion. The positive terminal (red) protective cover must be kept in place.

Transporting and Storage

If the machine should become disabled, and cannot be moved under its own power, refer to page 1-09 for the recommended procedure for towing and transporting.

Storage

– IMPORTANT -

If the Harvester is to be stored 'inside' keep the doors open to ensure good ventilation until the procedure below is complete.

- Stop the engine and allow it to fully cool down.
- Evacuate the fuel from the tank into an approved container and shut off the fuel.
- Store the fuel in a cool dry location.
- Turn the Battery Isolator Switch to 'OFF'.
- Keep the Harvester and fuel containers in a locked, secure storage place, to prevent tampering, and children from playing in the area.
- Do not store the Harvester or fuel containers close to heating appliances with an open flame, such as a water heater with a pilot light.

Safe Service Procedures



Do not service the harvester when it is moving or the engine is running. Failure to follow this warning could result in minor injury as moving parts can crush.

- If servicing a four wheel drive machine, when necessary raise **front and rear wheels** off the ground. This is to prevent the machine being pulled of the jack stands if power is applied to the wheels.
- Tighten the wheel lug nuts to the correct torque as specified in specifications section, page 6-13.
- Refit all safety guards and shields that may have been removed during service.

Tire Service

🚹 WARNING-

Do not operate the harvester if any of the tires are badly worn or damaged. See Page 6-13 for tire pressures

The front tires are loaded with liquid ballast, and are extremely heavy. Exercise caution when removing or replacing them. Use suitable tools, equipment and hoists with adequate lift capacity. Only qualified and experienced personnel must service the wheel assemblies. Operating the machine with loose wheel lug nuts will result in damage to, and require the replacement of, wheel assembly components.

SAFETY

- Always maintain the correct tire pressures.
- Do not inflate tires above the recommended operating pressure shown on the side wall.



Never weld or heat a wheel/tire assembly. The heat can cause increased air pressure and result in the tire exploding. Explosive separation of tire and rim components will result in serious injury or death

• When inflating tires use a clip-on chuck, and a air hose that is long enough to allow you to stand to one side of the wheel, not in front or over it. Use a safety cage if one is available.

Handling Chemical Products

To prevent serious personal injury avoid direct exposure to hazardous chemicals. Potential hazardous chemicals include: fuels, lubricants, coolants, paints and adhesives.

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets provide specific details on chemical products that affect:

- Physical and personal health hazards.
- Safety procedures.
- Emergency response techniques

It is recommended that the MSDS data is checked before a job is started that involves a hazardous chemical. This informs of the possible risks and the safest way to proceed. Follow carefully the recommendations.

Proper Waste Disposal

- Improper disposal of waste material is harmful to the environment. Some potentially harmful products used on machines are: oil, fuel, filters coolant, brake fluid, and batteries.
- Use leak proof containers when draining fluids. Do not use food or beverage containers that someone may mistakenly drink from.
- Do not pour waste fluids onto the ground, down a drain or into any natural water source.
- Air conditioning refrigerants are harmful to the atmosphere. Government regulations may require a certified technician to service and properly recover and recycle refrigerants.

SAFETY

• Before disposing of waste material, enquire at your local environmental or recycling facility for instructions on proper waste disposal.

Welding on Painted Areas



Hazardous fumes are generated when paint is heated when welding, soldering, or using a torch. The use of an approved respirator is recommended when welding, sanding or grinding on painted areas to avoid the inhalation of fumes or dust.

- It is recommended that paint be removed a minimum of 4 inches (100mm) from around the area to be affected by heating.
- If solvent or stripper is used, wash them off with soapy water before doing any welding. Remove any stripper or solvent containers and other flammable material from the area. Allow a minimum of 15 minutes for fumes to disperse before welding.
- Do not use chlorinated solvent in areas where welding will be done. Do all work in an area that is well ventilated to allow fumes and/or dust to disperse.



Do not weld, solder or use a torch close to pressurized fluid lines, that may cause them to burst. Flammable spray can be generated by burst fluid lines resulting in severe burn injury to yourself and bystanders.





To prevent damage to the Electronic Controllers : Do not do any welding on the machine until the Battery Isolator Switch is turned 'OFF'

Fuel Tank and Fuel Gauge.

Fuel Tank.



Fuel Gauge.



To move the machine with no engine power:

If the engine cannot be started, and it is necessary that the machine has to be moved, follow the procedure below.

- Jack-up the conveyor frame at 'A', sufficient to allow the cutter blades 'B' to be removed.
- To prevent the conveyor frame from dropping while removing the cutter blades, place a suitable support under the front ground roller '**C**'.
- Remove the cutter blades 'B'.
- Remove the roller support and lower the conveyor to place the Front Roller '**C**' on the ground.

Release the Torque Hub Brakes on all wheels:

- Remove the Bolts 'A' securing the 'Top Hat' Plate.
- Reverse the 'Top Hat' Plate and replace the bolts.

The machine can now be towed to another location. Extreme caution must be exercised. It will **not be possible to steer or apply brakes during** this operation. **Do not move the machine onto an incline as it may 'run-away'.**

If the problem with the engine is investigated and not resolved then a call to your Caterpillar Engine service representative is necessary.

If the problem cannot be resolved 'on site' and is such that the engine has to be repaired at a Caterpillar Service Center, it is recommended that the main conveyor is removed from the machine to enable easier transportation.

To remove the Main Conveyor:

Position a fork lift under the rear end of the conveyor frame, or use slings, to support it when it is disconnected from the main frame.

IMPORTANT

To prevent loss of function calibration when disconnecting the sensor cables: Turn the ignition '**ON**'; Switch the system power '**ON**'; Go to System Screen 'select'; Select 'Set-Up'; Activate 'Shipping Mode'. (**See Section 5**).

- Switch off system power and ignition.
- Turn battery isolator switch '**OFF**'.(See P1-11).
- Disconnect the hydraulic fittings at the bulkhead 'A', and 'B' at the Roll Eject motor.
 Plug and cap all hydraulic fittings.
- Remove the Conveyor Drive Chain 'C'.
- Remove the Bearing Bolts 'D', both sides of the frame.
- Unplug the cables 'E' from the: Cut-off, Slab End,
- Tooth Count , Auto-Steer and Down Pressure Sensors.
 Remove the three Soc.Hd cap screws 'G', and remove Outer Tracking Rod 'F'.
- Carefully lift the conveyor clear of the main frame.

The machine can then be 'winched' onto a flatbed. Using the **four tie-down rings**, (see page 1-11), chain down the machine and block the wheels.









SAFETY _____

Standard Rear View Camera.

The Rear View Camera is '**ON**' at all times when the engine is running.

Keep the camera lens clean to ensure a clear picture on the rear view screen.

Optional Camera. Piling/Cavity Area.

The Optional Camera is located on the rear beam. The camera can be adjusted to show the area that the operator prefers.

Keep the lens clean to ensure a clear picture on the rear view screen.

NOTE

If the camera is retro-fitted in the field, installation instructions, included in the Kit, are also shown on page 1-17.

Interior Rear View Screen.

The operator must pay particular attention to the screen when reversing.



To prevent possible personal injuries or damage: The operator must be alert at all times to any persons or obstructions that may be in the vicinity of the machine.







Back-Up Alarm

The Back-Up Alarm 'Warning Beeper' sounds when reverse is selected.



The operator must be aware of the warning. If it fails to sound, the problem must be resolved before operating the machine.



SAFETY

Convenient access panels at the front of the machine allow for easy maintenance and service.



The Front Hood and Engine Access Cover must be secured when raised, with the safety supports provided - '**A**' and '**B**'.

IMPORTANT To prevent overheating:

Check regularly, particularly in dusty conditions, that the radiator and coolers are free of dust or debris.

Service and Maintenance Access.









Battery Access.

To access the battery remove Panel.



Safe Transport.

Use the Tie-Down Rings when transporting the machine.

Rear Tie-Down Rings are located on the left and right side of the frame ahead of the rear wheels.



DECALS





DECALS



DECALS



OPTIONAL CAMERA INSTALLATION Piling Cavity and Gripper Head area.

Fig.1

Place the Camera Mounting Bracket '**A**' on the beam, positioned to the operator's preference. Mark the location of two holes '**B**'. Drill and tap the two holes to 10-32.





Fig.2

Put Blue Loctite on the threads and screw the two Stand-offs into place.

Attach Camera to the Stand-Offs.(fasteners in kit). Feed the camera cable down to the removable panel at the lower right side of the cab. (See Fig.3).



Fig.2

Fig.3

Remove the lower rear panel and drill a 13/16in. hole in the *center* of the panel. Feed the camera cable through the panel into the cab.

Put silicone sealant on the cable grommet and fit it into the panel. Refit the panel.



Fig.4

Remove the two bolts '**C**' attaching the Cup-holder. Pull the Closing Panel 'D' forward to remove it. Remove Finishing Piece 'E', (held in place with Velcro).



Fig.4

Fig.5

Pull the Cable up from the lower panel, (See Fig 3), sufficient to connect it to the plug 'F' in the harness, labeled 'CAMERA 2'

Pug labeled 'CAMERA 1' is for the standard back-up camera.



Fig.5 Replace the closing panel and finishing piece. Re-attach the Cup-holder.

SECTION 2

Cab Harvesting Controls

System Control Display (Controller ' A ').	2-01
Console Controls.	2-01
System Power 'ON-OFF' Switch. Emergency 'E-STOPS'. Auto-Steer Fine Adjust. Control Handle. See page 2-02. Cutter Speed and Conveyor Speed Control Switches. Engine RPM. E-STOP Switches.	2-01 2-01 2-01 2-01 2-01 2-01
Cab Switch Panel: Harvest/Road; Brake; and Reverse Lights Switches.	2-01
Control Handle. (Euro Spec see P2-05).	2-02
Console 8 Pad and Cab 20 Pad Controls. (Euro Spec see P2-05).	2-02
Cab Controls.	2-03
Road Lights. Work lights. Field Lights. A/C Control. Rear View Screen. Washer /Wiper. Radio. Refer to Section 8 – Owners Manual.	2-03 2-03 2-03 2-03 2-03
Steering Pedestal. Ignition Switch. Horn. Engine 'START' Button. Turn Indicators. Brake/Inch/Clutch Pedal. Pedestal Adjust.	2-03 2-03 2-03 2-03 2-03 2-03
Fuel Gauge.	2-03
Engine Information Center. (See Section 10).	2-03
Cab Controls – EURO SPEC. machines.	2-05

- 1. System Display. Controller 'A'. See Section 3. for Operation.
- 2. Emergency 'STOP' Push to 'STOP'.
 Pull to 'RESET'.
 2a, 2b, 2c. 'Outside' E-STOPS.
- 3. Conveyor Speed.
- 4. Control Handle. See page 2-02.
- 5. Auto Steer Fine Adjust.
- 1. Cab System Display. Controller 'A'.





Cab Console.

- 6. Cutter Speed.
- 7. Engine RPM.
- 8. 8-Pad Control Panel. See Page 2-02.
- 9. 20 Pad Control Panel. See Page 2-02.
- 10. Brake/Clutch/Inch Pedal.
- 11. Switch Panel.



20-Pad Control.







'Outside' E-STOPS.

Control Handle Operating Buttons & Trigger. Auto Mode :

- A. Auto Steer. 'ON-OFF'
- B. Head/Conveyor 'Up/Down'.
- C. Flap Position 'Up'. (Increase).
- D. Eject Bad Roll./Increased Engine RPM.**
- E. Flap Position 'Down'. (Decrease).
- F. Conveyor 'ON/OFF'.
- G. Cutter. 'ON-OFF'.
- H. Trigger System 'ON'/Roll Advance.
- Trigger System 'OFF'. Ι.

** Conveyor 'UP' & Auto Mode 'OFF - when in harvest mode.

H

ON

dvance

OFF

NOTE 1. In 'Roading' Mode: 'D' will be High Speed 'ON/OFF'.

2. For Euro-Spec machines refer to page 2-05.



Control Handle

Console Control - 8 Pad.

- 1. Depth of Cut 'Decrease'.
- 2. Depth of Cut 'Increase'.
- 3. Roll Size 'Decrease'
- 4. Roll Size 'Increase'.
- 5. Auto Drive Speed 'Decrease'.
- 6. Auto Drive Speed 'Increase'.
- 7. Hold/Release Pallet Unload.
- 8. Auto Drive 'ON-OFF' & Hold to Save Speed.



- **1.** Arm Lift 'UP'.
- **2.** Arm Lift 'DOWN'...
- 3. Arm Reach 'OUT'
- **4.** Arm Reach 'IN'.
- 5. Arm Slide 'BACK'.
- 6. Arm Slide 'FORWARD'. 16. Paddles 'DOWN'.
- **7.** Gripper Turn 'CW'.
- 8. Gripper Turn 'CCW'...
- **9.** Multi Grip 'ON/OFF'.
- 10. Single Grip 'ON/OFF'.
- ** Stop Eject Conveyor (Auto Mode).

NOTE: For Euro Spec machines refer to page 2-05.

12. Forks 'DOWN'./** 13. Injector 'UP'.

11. Forks 'UP'.

- 14. Injector 'DOWN'.
- 15. Paddles 'UP'.
- 17. Push Bar 'FORWARD'.
- 18. Push Bar 'REV'.
- 19. Squeeze 'ON/OFF'.
- 20. Index Conveyor 'REV'.





- 1. Hazard Lights. 2. Road Lights. 3. Field Lights. 4. Work Lights.
- 5. A/C Controls. 6. Rear View Screen. 7. Cab O/Head Light .
- 8. Windshield Washer/Wiper. 9. Radio.(See Section 8. Owners Manual).
- **10.** Switch Panel. (See page 2-01).





- 11. Ignition Switch. 12. Horn. 13. Turn Signals. 14. Engine 'START'.
- 15. Brake/Inch/Clutch. 16. Pedestal Adjust. 17. Engine Information Center.
- 18. Fuel Gauge.



This page left blank

Control Handle Operating Buttons & Trigger. Auto Mode :

- A. Auto Steer. 'ON-OFF'
- B. Head/Convevor 'Up/Down'.
- **C**. Flap Position 'Up'. (Increase).
- D. Eject –Bad Roll./Increased Engine RPM.**
- E. Flap Position 'Down'. (Decrease).
- *F. Conveyor 'ON/OFF'.
- ***G.** Cutter. 'ON-OFF'.
- H. Trigger System 'ON'/Roll Advance.
- Trigger System 'OFF'. Ι.

*EURO SPEC machines when in 1.0mx1.2m stacking configuration.

Manual Mode: F. Shift position for: 1, 2, 4, 5, 'ON/OFF'. G. Mid Grip 3. ON/OFF'.

ON

ince

** Conveyor 'UP' & Auto Mode 'OFF' when in harvest mode.

NOTE: In 'Roading' Mode 'D' will be High Speed 'ON/OFF'.



Control Handle

Cab Control - 20 Pad.

- **1.** Arm Lift 'UP'.
- 2. Arm Lift 'DOWN'.
- 3. Arm Reach 'OUT'
- 4. Arm Reach 'IN'.
- 5. Arm Slide 'BACK'.
- 6. Arm Slide 'FORWARD'.
- **7.** Gripper Turn 'CW'.
- 8. Gripper Turn 'CCW'.
- 11. Forks 'UP'. 12. Forks 'DOWN'/ Stop Eject Conveyor (Auto Mode).
- 13. Injector 'UP'.
- 14. Injector 'DOWN'.
- 15. Paddles 'UP'.
- 16. Paddles 'DOWN'.
- 17. Push Bar 'FORWARD'.
- 18. Push Bar 'REV'.
- 9. EURO SPEC. See below. 19. EURO SPEC. See below. 10. EURO SPEC. See below. 20. Index Conveyor - 'REV'.

EURO SPEC Machines - 20 Pad Control.

9. When in1.2mx1.2m stacking configuration Multi Grip 2, 3, 4, 5, ON/OFF.

When in 1.0m x 1.2m stacking configuration Multi Grip 2, 4, 5, ON/OFF.

- **10.** When in 1.2m x 1.2m or 1.0mx1.2m stacking configuration Single Grip ON/OFF.
- **19.** When in 1.2m x 1.2m or 1.0m x 1.2m configuration Sqeeze postion for 1, 2, 4, 5.'ON/OFF.

Cab Control - 20 Pad
OPERATION SECTION 3.

Initial Set-Up and Adjustment: Robotic Arm and Pallet Dispenser.

Main Conveyor. 4 Inch Feed Roller Starter Tray Starter Gate Roll-Up Conveyor Index Conveyor Bad Roll Ejection Roll Position	3-01 3-01 3-02 3-02 3-02 3-02 3-02
Robotic Arm.	
Gripper Head	3-03
Pallet Injection.	
Pallet Lift Forks. (See Pages 3-25/26). Pallet Dispenser Pallet Specification	3-03 3-04 3-04
Operating Instructions.	
Harvest Main Screen – Functions. Pre-operation Warm – Up procedure. Recommended Harvesting Speed.	3-05 3-06 3-07
Driving.	
Start Up Screen Navigation. Prepare machine to harvest. Machine Adjustments. Harvest Initializing. Harvesting – Auto Mode System ON. Machine Adjustments. Harvesting Features. Auto Drive System.	3-08 3-08 3-09 3-09 3-10 3-11 3-11 3-12
Operating Screens. Main Operating Screen. Pallet Injector Screen. Arm Screen. Conveyors Screen. Cutter Screen. Propel Screen. Auto Steer Screen. Set Up Screen. Warm Up Screen. Fault Screens. Sod End Sensor – IR type. Calibration. Sod End Sensor – Mechanical Type. Set up and adjustment.	3-12/13 3-13/14 3-14/15 3-15 3-16 3-16 3-16 3-17 3-17 3-17 3-17 3-18 3-18A
Setting Positions. Arm Calibration. (Used when training Operator).	3-19/20/21
Pallet Weight Indicator – Option	3-23/24



Safety Guards may have been removed for clarity. Do not operate the Harvester if safety guards are missing or damaged. To do so could result in serious personal injury.

4-inch Feed Roller

Roller **'A'** helps in feeding the sod into the Starter Gate. It should be kept free of grass and mud. It is driven by the Mid-Idler Sprocket Shaft..

To adjust the Roller:

 Place a piece of sod under the Roller. With the Roller resting on the sod, adjust the Bump Stops
 'B' to allow 1/8 inch clearance between the Bump Stops and the Frame.

For weak, or thin turf, requiring less roller pressure, adjust the Bump Stops '**down**', onto the frame raising the Roller to reduce pressure on the turf.

Starter Tray

When the end of a slab of sod '**C**' passes under Sensor '**D**', (see note), it signals the computer to :

- count the number of teeth, ('tooth count'), that the operator has pre-set
- 'stop' the Roll Eject Mat, (that ejects the scrap roll onto the Scrap Conveyor as the Index Conveyor moves back).

NOTE: Refer to page 3-18 for sensor calibration. If the unit has a mechanical sod end sensor installed, see page 3-18A for set-up and adjustment

Starter Tray Bars 'E', behind the Starter Gates 'F', have Pins 'G' that protrude 1/4 in. below the Bar. The pins grip the turf as it starts to 'roll-up'. If the turf passes through, but does not 'roll-up', tap the pins 'IN' until they protrude 1/2 to 5/8 in. The pins wear with use and must be adjusted or replaced as required.

In tender sod the pins may hold the underside of the sod too long, causing a loose roll, incorrect roll flap position, partially rolled or 'incomplete' rolls, in this case the pins should be 'raised'.

Trial will determine the best pin positions.

- Maintain 4 to 6 inches between the sod pieces
- Do not allow dirt to build up on the Conveyor, it will cause the Starter Gate to open early.

Double Starter Gates.

The Starter Gates **'F'** must be positioned approximately 1/8 inch clear of the Conveyor Mat, measure at the join 'splice' in the Mat, ie. **its thickest point.**

Gate clearances are set with the adjustable straps 'H'. The Gate must not touch the mat.

The Starter Gate Stops 'J', prevent the bottom edge of the Gates lifting higher than the top face of the Bars 'E'.

Main Conveyor -Set-up and adjustments.

WARNING

To prevent possible serious injury : No one should step on the conveyor, or attempt to free any jammed turf rolls or debris, while the engine is running.







OPERATION

Roll-Up Conveyor

The Roll–Up Conveyor '**A**' continues the Roll–Up action after the Roll has passed through the Starter Trays '**B**'. Adjust the Hanger Chain '**C**' to allow 2 to 2 $\frac{1}{2}$ inches clearance between the bottom of the Roll-Up Frame '**D**' and the upper Starter Tray '**B**'.

Index Conveyor

The Index Conveyor 'E' is synchronized to the Main Conveyor, Robotic Arm and Bad Roll 'Ejection' Cylinder 'H'. When a Roll is ready to be transferred to the Index Conveyor, the Index Conveyor automatically rolls back 'one position', to accept the completed roll.

Bad Roll Ejection.

To '**eject**' a bad roll of sod, the Roll Eject mat starts and the Idler End Assembly '**F**' is pulled back on Guide Rods '**G**' by Cylinder '**H**', allowing the reject roll to drop onto the ground. To activate the Roll Ejection refer to the Controls Section, page 2-02.

WARNING

Do not attempt to clear jammed rolls or debris while the machine is running. Keep all bystanders well clear of the Index Conveyor, Gripper Head and Pallet Injection area. Failure to do so could result in serious injury or death.

Roll Position Sprockets.

IMPORTANT_

The Roll Position Sprockets are adjusted with the Lift Arms Adjuster to 'just' hold the Roll. They must not 'compress' it.

The Roll Position Sprockets hold the sod roll as it is transferred to the Index Conveyor.

The sprockets automatically lift when a bad roll is ejected.

CAUTION

To prevent possible personal injury:

If the Roll Position Arms are raised manually, to clear debris or jammed rolls from the Index conveyor, ensure that the Locking Pin 'K' is pushed in and fully engaged against the Lift Arm 'L'.

Roll Flap Position.

The position of the Roll Flap is set using the control buttons on the Control Handle, (see page 2-02).

The sensing 'teeth' are on a Sprocket located at the right rear of the Main Conveyor. (See page 5-08).

The Proximity Sensor senses and counts the teeth. Increasing the 'tooth count' moves the Roll Flap '**counter**clockwise'.

Decreasing 'tooth count' moves the Roll Flap 'clock-wise'.

Adjust the location of the Roll Position Sprockets to suit the selected position of the Roll Flap.









Robotic Arm and Gripper Head

The hydraulic functions of the Robotic Arm '**A**' and Gripper Head '**B**' are controlled by a Controller in the Main Control Box. See Section 5. The Arm 7-Bank Arm Control Valves '**C**', are located ahead of the left rear wheel. See Section 4. P4-09/10.

The relevant Controller provides positioning co-ordinates for:

- Robotic Arm 'Lift'
- 'Reach'
 - 'Slide'
- Gripper Head 'Rotation'

The Robotic Arm '**A**', responding to Controller signals, picks up and transfers the rolls from the Index Conveyor '**D**', to the Pallet.

The Controller also controls :

• the multi-grip, single-grip and 'squeeze' functions of the Gripper Fingers 'E'.

Cab Control Handle.

For operating functions e.g. Auto-Steer ; Conveyor ; Flap Position, Cutter Head; etc...See pages 3-10/11.

Pallet Lift Forks.

There are two Proximity Sensors that sense the programmed positions of the Lift Forks Mast.

- Mast 'HEIGHT' Sensor 'F'.
- Mast 'BOTTOM' Sensor 'G'.

The Pallet Forks lower automatically, as layers of sod are added to the pallet.

When stacking is complete the loaded pallet is lowered to the ground.

The forks then return to the '**MID**' position of the Pallet Injector- ready for a new pallet.

See following page for Pallet Injector.

Sensor 'H' is the antenna for the optional GSM Remote System.











OPERATION_

Pallet Dispenser.



Keep all bystanders clear. Do not allow anyone to enter between the Pallet Dispenser and the Harvester. To do so could result in serious injury or death.

- NOTE -

A Pallet Weight Indicator is available as an option. This option allows the operator to check the weight of each pallet. The correct truck/trailer weight is necessary when the unit is passing through highway weight checking stations. See Pages 3-25/26.

Operating Position

The Pallet Dispenser holds up to 15 pallets for transfer to the Pallet Lift Forks.

Insertion of the *first* pallet is controlled by the operator with 'inputs' on the cab control handle Thereafter pallet insertion is automatic. (See Controls Section page 2-02).

Pallets 'B' are inserted with Push Bars 'C' that are attached to hydraulically driven Chains 'D'. Push Bar operation is controlled by Proximity Sensors through Multi Port block 'C5' to a Controller (D), in the main Electrical Control Box.

Pallet Lift/Drop Paddles.

The Lift/Drop Paddles 'E' are operated by Cylinder 'F', with Linkage 'G' to the front paddles. Pallet Dispenser height is controlled by two-stage Cylinders 'H'.

WARNING

The Pallet Dispenser will lower automatically when the machine is in 'Road' Mode and exceeds 8 kph. (5mph). If the operator observes that this does not occur – check that the Pallet Dispenser 'High', 'Mid', and 'Bottom' Proxy Sensors are functioning, and that there is no dirt or debris between the sensors and their targets. If after these checks the Dispenser does not lower a service call is necessary.

Pallet Specifications Standard Pallet.

To ensure proper operation of the Pallet Dispenser, pallets must conform to the dimensions shown. They must be in good condition, with no loose or damaged boards.

Pallets must be able to support 4000 lbs.



Pallet Dispenser – Operating Position



Lift/Drop Paddles



Standard Pallet Specifications

Harvest 'Power-Up' Screen.







Screen Buttons – Typical for all screens.

Pre-operation Warm-Up procedure.

IMPORTANT

Before operating the machine for harvesting it is important that the Hydraulic Oil is brought up to operating temperature. If the ambient temperature is **below 75 deg.F (24 C).** proceed as follows:

When carrying out the following procedures all bystanders *MUST BE KEPT CLEAR* of the machine. Failure to observe this precaution could result in serious injury or death.

To start the Engine:

IMPORTANT

Always start the engine with the System Power 'OFF'.

- Turn the ignition key to '**start**' position. Press the Horn Button to initiate 'Valid Engine Data' on the Diagnostic Display. Fig1.
 - Wait until the engine data is *fully loaded* then:
- Press and '**hold**' the Start Button until the engine has started. Allow the hydraulic pumps to operate and circulate the oil in the system. Use the Engine RPM Control to set engine speed. (See page 2-01).
- Switch the System Power 'ON'.
- Fig.2. Press Pad 2 to bring up 'Select Screen'
- Fig.3. Scroll with Arrows 'A'-'B' to Select 'Warm-Up'. Press Pad 'C' - 'OK', to bring up 'Warm-Up' screen.
- Press Button '1' to put machine in 'Ready' mode.
- Fig.4. Press Button '**B**' to run the Warm Up System until the normal operating temperature is indicated on the temperature 'read-out' on the Control Panel Screen.

To prevent damage to the Cut–off mechanism the Cut–off *must only be operated when the machine is harvesting.*

The above procedure will:

- Ensure that the machine will function efficiently, with the hydraulic oil at operating temperature.
- Prevent possible damage to components due to cold hydraulic oil.
- Will indicate that the machine is properly 'set-up' and ready to operate.
- Enable a check to be made for oil leaks.



Fig.1

Valid Engine Data. (Typical).









OPERATION



The operator must read the Operator's Manual thoroughly, to familiarize himself with the safe operation of the controls and the machine.

Recommended Harvesting Speed.

With the Control Handle '**A**' in the '**NEUTRAL**' position, and no pressure on the Brake/Inch/Clutch Pedal '**B**':

- Turn Ignition Key 'C' to the 'ON' position.
- Press Horn Button to validate engine data.
 See page 3-06
 Engine will not start if this is not done.
- Press Engine 'Start' Button 'D' until the engine is running, then release.
 Do not start the engine with system power 'ON'.
- Turn System Power 'ON'. Switch 'E'.
- Go to 'Start Up' Screen on Display (See previous page). Follow the warm up procedure.
- Ensure that Switch 'F' is in 'HARVEST' mode.
- Using Control 'G', increase the engine to maximum RPM.
- The following pages show the operating sequences and optimum settings for harvesting.

The Control Handle 'A' sets the Ground speed and the direction of travel.

Cutter Blade.

To reduce 'shock loads' to the Cutter Motor, when starting to harvest, the Cutter Blade should be started **before the Cutter Head is lowered to the ground.**

Cutter Blade - Speed Setting 'H'.

Initially, for best results, start cutting at maximum speed and work back to the lowest speed that gives the best results. Lower cutter speed results in less vibration.

The ground speed may have to be reduce when harvesting in rough or stony ground to avoid possible damage to the cutting components.

Main Conveyor Speed 'J'.

The Main Conveyor speed should be adjusted to provide a space of four to six inches between the sod pieces as they travel up the conveyor.

If the Space between the sod pieces is *less than four inches* the electronic sensor may not 'detect' the end of the sod piece.







NOTE

It may be necessary to adjust the Main Conveyor speed as the hydraulic oil reaches full operating temperature.

When setting the Main Conveyor Speed, operate in in the engine RPM that will be used when harvesting.

To maintain proper spacing between the sod pieces on the conveyor, keep a constant travel speed.

NOTE----

Refer to the Section 2 for the Controls Functions.



Before starting to cut the field, ensure that all bystanders are clear of the area, and that there are no foreign objects or obstacles that may possibly cause an accident.

Start the engine and follow the warm up procedure, see page 3-01.

- On Cab Switch Panel (page 3-07) turn System Power to 'ON'. This will 'enable' the harvester functions, except : Travel, Depth of Cut and Cutter Head Position.
- Ensure the Park Brake is switched 'OFF'.
 See Switch 'K' on Switch Panel page 3-07.
- Increase the engine RPM to the desired speed. (page 3-07).

CAUTION Do not drive the machine at Low Engine Idle, component damage will occur.

With the Mode Switch in '**Harvest Mode**' (page 3-07), the engine speed is limited to 1800 RPM. (Harvest Speed). In '**Road Mode**' the engine speed is limited to 2200 RPM and allows maximum speed for transport. For Auto Drive 'increase'/decrease' see the 8-Pad Console Control on page 2-02.

NOTE

The Control Handle must be in the 'NEUTRAL' position to turn the high speed mode 'OFF'.

- Raise the Cutting Head and Conveyor with Button 'B' on Control Handle. See page 2-02.
- The Control Handle controls the machines direction and ground speed. Increasing the forward direction increases the ground speed. Returned to neutral will stop the machine.
 If the Control Handle does not respond initially, return it to neutral to re-set it.
- The ground speed can be proportionately decreased by pressing the Brake/Clutch/Inch Pedal without moving the Control Handle. Releasing the foot pedal will return the machine to the control handle speed setting.

Fully depressing the foot pedal will '**STOP**' the machine immediately.

If driving the machine prolonged distances or on rough terrain, the Pallet Dispenser should be fully lowered and the Arm supported on the index conveyor with turf rolls under the Gripper Head. (To move the Dispenser and Arm to these positions see 20-Pad Control. Page 2-02). When stopped and leaving the cab it is recommended that the Cutter Head and the Conveyor are lowered to the ground.

Screen Navigation.

To navigate through the available screens:

- Select the 'Screen Select' Pop-Up Menu on the Harvest Screen, see page3-05, by pressing Button 2.
- Using the 'UP-Down' Arrow Buttons scroll through the available screens. See below.
- Press the 'OK' Button to go to the selected screen.
- Press the 'ESC' Button to exit a screen, return to 'Harvest Screen' or exit a 'Pop-Up' Menu.

Display Button Functions.



- To scroll 'Up or Down' or to enter sub-screens use the 'UP' or 'Down' buttons.
- To Increase or Decrease a value or setting, use the 'Right' and 'Left' arrows buttons.
- To Exit press 'ESC' button.

Harvesting.

Preparing Machine to Harvest.



Inserting Pallet onto Forks.

- Place machine into Harvest Mode.
- Position Count on Pallet must be'0'. To change the count, if not at '0': from Harvest Main Screen enter the 'Stack Select' Pop-Up Menu by pressing Button '3'. Scroll down using 'DOWN' Arrow Button to Position Count, and adjust to '0'. (Or select Empty Pallet. See P3-05). Decrease using left Arrow Button.

OPERATION

HARVESTING. ... cont

- Machine must be in 'READY' state. Increase engine RPM, then from the Harvest Screen press display Button '1'. Machine will now position/move components to their Home/ Ready positions and enter its 'READY' state.
- Press and hold display Button '4', from Harvest Screen, to insert pallet onto Forks. Release Button once sequence has started.

Machine Adjustments.

- Ensure the 'Position' and 'Index Counts' on the display match the machines current counts.
- To change the 'Position' and 'Index Counts' enter the 'STACK SELECT' Pop-Up Menu by pressing Button '3'.

Scroll '**UP**' or '**DOWN**' using the '**UP**' –'**DOWN** arrows buttons, to 'Position' or 'Index Count 'and adjust to correct value, or press Button 7.

To **Increase** – press right arrow button. **Decrease** – press left arrow button.





	STACKING ITE	MS	
* *	Empty Pallet		
	Roll Compression:	100 %	,
	Index Count:	4	
	Position Count:	12	
	Reset Pallet Counte Reset/Chg Total Ro	er Ils Coun	t

Harvest Initializing.

Aligning Machine to Cut Line.

- Lower the Conveyor, Pad 'A', until the Conveyor 'DOWN' Position Indicator on the display is 'ON', keeping the Cutter Head off the ground.
- Turn the Auto Steer 'ON', Button 'B'. When the Auto Steer Ski is adjacent to the Cut Line continue driving forward until the Cutter Head Blade is in the desired position.

NOTE -

The Auto Steer will not turn '**ON**' if the Conveyor '**DOWN**' position Indicator is '**OFF**'. Press Button '**B**' to toggle the Auto Steer '**ON-OFF**'.

Use Pad 'A' on Control Handle to raise the Conveyor/ Cutter Head.



Harvesting (Auto Mode System 'ON').

- Set engine RPM to maximum (1800). Harvesting must be done at max RPM.
- When in the 'READY' State, push the Control Handle Trigger Switch 'UP' and hold until the system is 'ON' (Auto Mode). The cab display will indicate that the system is 'ON'. The Cutter Head and Conveyor will then start to operate.
- Adjust the Cutter and Conveyor speeds with the control knobs on the Control Panel.
- Lower the Conveyor and the Cutter Head to the ground by pressing and holding Pad 'A' on Control Handle until the Head Down Pressure Indicator on the display is 'ON'. (See below).

NOTE -

When the Cutter Head is lifted the acquired/measured Cut Length is '**RESET**'.

 Move the Control Handle 'FORWARD' to the desired harvesting speed.

NOTE -

Pushing the Control Handle Trigger Switch '**UP**' with the System '**ON**' (Auto Mode), will index the Index Conveyor one position.

 Pulling the Trigger Switch 'DOWN' will stop the Auto Mode. The System is now 'OFF' and the Cutter Head and Conveyor will stop.

The Arm will also stop regardless of its position so, if possible, turn the System '**OFF**' when the Arm is over the Index Conveyor *(machine counts stacked position when the Arm Returns 'HOME')* at its Home position.

NOTE

Turning the System '**OFF**' will not stop the machine from driving, so it is recommended, if possible, to '**STOP**' the machine first, and process any turf on the conveyor before turning the System '**OFF**'.

To return to Harvesting - if the System is turned 'OFF'.

- Set engine at Max RPM. (1800 RPM).
- Return to '**READY**' State with Display Button '1'.(page 3-12).
- Push Trigger Switch 'UP and hold until System is 'ON'.
- Press and hold Control Handle Pad 'A' until the Head Down Pressure Indicator on the Display is 'ON'. Do not Lift Cutting Head, as it will reset the saved cut length, unless machine repositioning is required.
- Move the Control Handle 'FORWARD' to the desired harvesting ground speed.







OPERATION

Harvesting Adjustments.

Initially it is recommended to cut a few rolls of turf and then make the following adjustments:

- Stop the machines travel. Stop the Cutter Head with Control Handle Button 'G', and if required stop the Conveyor - Button 'F'.
- (**Some, if not all adjustments, may require more harvesting before adjustments can be made).
- Fig.3.Cut Depth : Increase- Pad 2.Decrease-Pad 1.
- Fig.3.Roll Dia.: Increase Pad 4. Decrease–Pad 3.
- Fig.2.Flap Position: Increase/Up Button 'C'.
 Decrease/Down Button 'E'.
- ** Head 'DOWN' Pressure Display Button'8' then Right Arrow to Increase and Left Arrow to Decrease.
- Cut Length, ** Index Conveyor Advance Count, **Bad Roll Flap Correction, and ** Bad Roll Open Time; are in the 'Adjustments' Pop-Up Menu, by pressing Display Button'6'. Fig.1. (see page 3-13), Scroll by using the display 'UP/DOWN' arrow Buttons. Right to Increase. Left to Decrease.

It is recommended that a 4 to 6 inches gap is left between the slabs on the conveyor.

Other Harvesting Features. Pallet Unload 'HOLD' Mode:

• While in the Harvesting Mode: Pressing the 8-Pad Control - Pad '7' will prevent a Full/Complete Pallet to be unloaded, and a new pallet to be inserted onto the forks.

Indicated on the Display when symbol is '**ON**' solid. Feature is used when the operator cannot unload Full Pallets 'In-Line' behind the harvester and has to unload the pallets clear of the Harvest/Cut-line. i.e. when reversing out.

When in this mode and the symbol is indicated 'ON' solid:

- Complete the Pallet. (Full Pallet).
- Stop travel, with System '**ON**'- Auto Mode.(Machine will automatically '**STOP**'. Reset the Control Handle to '**NEUTRAL**' to regain control.
- Lift the Cutter Head/Conveyor with Button 'B' on Control Handle (the Auto Steer will turn 'OFF' automatically. It can also be turned off with Button 'A' on Control Handle.
- The Cutter Head will turn 'OFF' automatically. (Control Handle Button 'G' will also turn it off). If desired Turn Conveyor 'OFF' with Button 'F'.
- Drive machine to unloading position. Stop if 'Stop to Unload' mode is '**ON**'. (See Pallet Injector section).
- Press 8-Pad Control Pad '7', to release the Full Pallet Hold. The Full Pallet will unload to the ground.
- 'Drive the machine forward to insert new pallet onto the forks.

- NOTE -

The Pallet Dispenser Box will not return to its Home position until there is one position on the pallet.



Fig.1

Cab Display. Controller 'A'.



Fig.2. Control Handle.



Fig.3. Console 8-Pad Control.

The operator can hold each pallet with Pad '**7**' while harvesting each pallet, or can enable the machine to automatically hold every pallet. To do this:

- Press and 'HOLD' Pad '7' until the Display symbol flashes, this indicates the Pallet 'HOLD' feature is 'Pending'.
- When the symbol is '**ON**' (solid) the pallet will be held until release to 'unload' by pressing Pad '7'.
- To turn this mode '**OFF**' press and 'HOLD' Pad '**7**'.

OPERATION _____ Auto Drive System.

Two advantages to using this feature are:

- Machine will return to last Saved/Set Harvest Ground Speed.
- Machine will maintain Saved/Set Harvest Ground Speed which would normally vary on grades in the field.

To Set/Save/Change Auto Drive Ground Speed:

- While in harvest (System ON/Auto Mode), at the desired ground speed, press and Hold Pad '8',(on 8-pad control). The system will save the current ground speed and turn the Auto Drive '**ON**'. (Indicated on Display).
- To increase speed ,with Auto Drive 'ON' press Pad '6'.
- To **decrease** speed press Pad '**5**'. After changing speed the system will save the new Auto Drive speed setting.
- To turn the Auto Drive '**OFF**', pull the Control Handle '**A**' '**BACK**', or press **Pad '8'**.
- To resume to the last Saved/Set speed, move the Control Handle to approximately the same speed and press Pad '8'. If Auto Drive has not turned on automatically it will now be 'ON'.
- Auto Drive will remain enabled but will not maintain ground speed if the RPM Control 'C' is not at 100%, or if the Foot Pedal 'B' is pressed.

Operation and Harvesting Modes(per Screen).

Harvest Main Screen.

- Button '1' will send the machine main components to their Home/Ready positions and enter its 'READY' state.
- Button '2' opens 'Select Screen' Pop-Up Menu to navigate to required screens.
- Button '3' opens 'Stacking Items' Pop-Up Menu to adjust the following actions :

Empty Pallet: Pressing and holding the '**OK**' Button will reset the positions on the pallet to '**0**'.

Roll Compression: Adjusting from '0' to 100% - determines
how much the Arm compresses the rolls
on the pallet , per layer, while stacking.
Increasing from 0% (1st layer) to
setting % (last layer), incrementally.Index Count:Adjustment of Rolls on Index Conveyor.

Position Count: Adjustment of Positions on Pallet. **Reset Pallet Counter:** Press and Hold the '**OK**' Button to reset the current Pallet Count on the Display.

• Button '4' – Press and hold to insert a Pallet onto the forks.

Machine has to be in '**READY**' State with Positions on Pallet at '**0**' (empty).

 Button '5' - only enabled when the Arm is at 'Home' position above Index Conveyor with the System 'ON' (Auto Mode). Pressing and Holding Button '5' completes the Pallet to its maximum positions and is considered 'FULL'.



Control Console.



Harvest Main Screen





- ...cont
 - Button'6' opens 'Adjustments' Pop-Up Menu with these options:

Index Advance Count:	Adjust	the value	as the Index Conveyor
	Indexe	s in compa	arison to the Flap Pos-
	ition Va	alue.	

- Bad Roll Flap Correction: Value to Skew the Flap Position of the First Roll after a Bad Roll Ejection. The lower the value , the lower the Flap Position.
- **Bad Roll Open Time:** 5 to 95%. The percent of time the Bad Roll Section of the Index Conveyor remains '**Open**', before it closes to catch the first roll after a Bad Roll Ejection.
- Front Roller Down %:The percent the Front (Conveyor) Roller
Pressure is above the Cutter Head Roller
Down Pressure.Cut Length:Adjustment of the Ground Cut Length.
- Harvesting RPM: The maximum value the Engine Speed will reach in Harvest Mode. Recommended – 1800RPM.
- Button '7'. Enables the adjustment of the current number of rolls on Index Conveyor . Range is 0 to 8.

NOTE

At eight Rolls in Auto Mode, the Arm will pick up the rolls on the Index Conveyor and stack them on the pallet.

Button '8'. Enables the adjustment of the Cutter Head Roller Down Pressure Range. 0 to 100%, pressing and holding the Left Arrow Button (decrease) while at 0% will switch the Down Pressure Mode to 'FLOAT'.

Pallet Injector Screen.

- Button '1' will send the machines components to their Home/Ready positions and enter its '**Ready**' state.
- Button '2' turns the 'Pallet Box Down Override' ON and OFF. Typically used if the machine is 'Stopped' after unloading a full pallet with the full pallet below the Pallet Dispenser Box. When 'ON' the pallet box will not go down to its fully 'Down' and 'Ready/Home' position until one position is placed on new pallet.
- Button '3' will Empty/Clear the current position count on the pallet and set it to '0'. This allows the operator to Empty the pallet, go to the 'Ready State', and inject a New Pallet in this Screen Button'4'.





ADJUSTMENTS ** Index ADV Count: -1 Bad Roll Flap Corr: 30 Bad Roll Open Time: 95 95 Front Roller Down: 100 95 Cut Length: 54in. Harvesting RPM: 1800

Button 6.



Pallet Injector Screen

OPERATION _

cont.

Pallet Injector Screen.

• Button '5' will open the 'Pallet Injector Settings' Pop-Up Menu with the available options:

Stop to Unload: 'ON' or 'OFF'.

- **'ON'** the machine has to be Stopped to Unload a Full Pallet.
- 'OFF' The machine can be moving to unload a Full Pallet.

Unload Ground Speed Control: 'ON' or 'OFF'.

- 'ON' the machine will automatically slow down to the 'Unload Ground Speed' %, or automatically Stop if 'Stop to Unload' is 'ON' or 'Unload Ground Speed' % is '0%'
- '**OFF**' –the machine will not automatically override the ground speed to unload a full pallet. The operator has control of the ground speed or stopping to unload.

Inject Fork Height:

• Position of Forks when injecting a new Pallet. (While Harvesting).

Pallet Lift: 'ON' or 'OFF'.

- 'ON' Paddles in Dispenser will lift the stack of pallets above the bottom one when inserting a new pallet.
- 'OFF' Paddles in Dispenser will not lift the stack of Pallets above the bottom one when injecting a new pallet.

Tender Turf Mode:' ON' or 'OFF':

• **'ON'** – When the Unload Ground Speed control is **'ON'**, the Conveyor will slow down at the same percentage as the Unload Ground Speed is set at when unloading a full pallet.

'OFF': - The Conveyor will not slow down when unloading a full pallet.

Insert Fork Height: Positions of Forks when injecting pallet Manually. (Not Harvesting). See page 3-08.

Pallet Injector:

- 'ON' Machine will insert a new pallet, after unloading a full pallet.
- '**OFF**' Machine will unload the full pallet but will not insert a new pallet.(i.e. if using palletless forks).
- **Button '6.** Allows the operator to move the Pallet Dispenser Function, Forks, and some of the Arm functions manually using the 20-Pad Cab Control.
- Button '7'. Manually Opens the Piling Wall.
- Button '8'. Manually Closes the Piling wall.

Arm Screen.

- Button '1'. Will send the machines components to their Home/ Ready positions and enter its 'READY' state.
- Button '4'. Opens 'Arm Calibration' Screen. N/A with System 'ON'.
- **Button '8'.** Allows the operator to move the Arm Functions, Forks, and some of the Pallet Dispenser Functions manually with the 20 Pad Cab Control.



Pallet Injector Screen



Injector Settings





Arm Screen

Arm Calibration Screen.

NOTE

While in this screen the operator can move the Arm Functions, Forks, and some of the Pallet Dispenser Functions manually with the Cab 20-pad control. (See page 3-14).

- With the 'Position' Selected (selected item highlighted with green underline) use the Right and Left Arrow buttons to select the position to modify.
- The 'Up' and 'Down' Arrows select which Position or Co-ordinate to modify e.g. 'X'
- **Button '1'.** Loads the Arm's actual position into the new Co-ordinates.
- Button '2'. Loads the Arm's saved Co-ordinates into the New Position.
- Button '3'. Moves the Arm to the New or Saved Co-ordinates, whichever is last loaded into the New Position.
- **Button '4'.** Saves the New Position value whichever was last loaded into New Position.
- Button '5'. Enables the adjustment of the Maximum Arm Down Pressure Limit while stacking on the current pallet configuration.
- Button '6'. Opens the 'Single Grip' Pop-Up which allows the operator to select when the Arm picks up 4 or 5 rolls to be stacked on the current pallet configuration.
- Button '7'. Opens the 'Squeeze' Pop-Up which allows the operator to select which positions are to be 'Squeezed' on the pallet.
- Button '8'. Enables the adjustment of the Maxi-Mum Positions allowed on the current pallet configuration.

Conveyors Screen.

- Button '1'. Will send the machines components to their Home/Ready positions and enter its 'Ready' state.
- Button '3'. Will manually 'Open' the Bad Roll Section of the index Conveyor. Only availwhen the System is 'OFF'.(Auto Mode 'OFF'). Will 'Close' when machine returns to 'Ready' state.



Arm Calibration Screen





Conveyors Screen

OPERATON

Cutter Screen.

• Button '1'. Will send the machine's components to their Home/Ready positions and enter its 'Ready' state.



Cutter Screen.



Propel Screen.





Auto-Steer Fine Adjust Control.

Propel Screen.

• Button'8'. Press and Hold to turn the Traction Control 'ON' or 'OFF'.

NOTE Traction control is 'OFF' in 'Road' Mode.

Auto-Steer Screen.

- **Button '4'.** Allows the operator to adjust the 'centre' position of the front axle.
- Button '7'. Allows the operator to turn the Auto Steer 'ON' or 'OFF' while the machine is 'Stopped'.
- Button '8'. Enables the adjustment of the Auto Steer 'Left' and 'Right' Sensitivity '%'. Pressing Button '8' toggles between the Left and Right adjustments. When highlighted, adjustments are done with the Left and Right Arrows Buttons.

Adjusting these values with the Fine Adjust Control at the Neutral Position is recommended.

- i. **Increased Higher** numbers allow the Front Wheels to turn more in that direction.
- ii. **Decreased Lower** numbers restrict the Front Wheels Turning in that direction

OPERATION

Set-Up Screen.

- Button '2'. Allows the operator to Select the Current Pallet Configuration by using the Left and Right Arrow buttons. Selection only allowed when the current Positions on the Pallet are '0'.
- Button '3'. Selects the Units displayed. Imperial or Metric.
- Button '4'. Opens the Warm Up Screen.
- Button '5'. Key- backlight adjustment.
- Button '6'. Press and Hold to Toggle between Service/ Shipping Mode - 'ON' or 'OFF'.

Service/Shipping Mode:

- I. **Must be 'ON'.** When disconnecting any sensors for service or machine shipping purposes.
- II. 'OFF' Default. Normal operations. If 'OFF' and machine system power is 'ON', if there are any sensors disconnected they will 'Fault' and Lose Calibration Values, and will require recalibration.
- Button '7'. Opens the Strobe Light Menu which allows the operator to have the Strobe Lights 'ON' or 'OFF' during Harvest and Transport Modes.
- Button '8'. Enables the adjustment of Display Screen Brightness –'0' to '100%'. Pressing and holding the Right Arrow Button will switch the Brightness Control to Auto Mode.

Warm-Up Screen.

- Button '1'. Will send the machines components to their Home/Ready positions and enter its 'Ready' state.
- Button '4'. Enables the adjustment of the Warm Up time.
- Button '8'. Press and Hold to turn the Warm Up Function 'ON' or 'OFF'.

Fault Screens.

There are two Fault Screens.

- Page 1 of 2
 Displays the Fault Status of the machines

 Inputs and CAN Buses
- Page 2 of 2 Displays the Fault Status of the machines Outputs.
 - Green Box = OK Status
 - Red Box = Fault Active Status.
 - Not Cal. = Component Not calibrated.



Strobe Light ** Harvest Mode: OFF Roading Mode: ON

Strobe Light Menu







MAINTENANCE-

Sod End Sensor – Calibration. Field Installation.

Fig.1

- 'A' Sensitivity Range Adjustment.CW = Increase sensitivity.CCW = Decrease sensitivity.
- 'B' LED 'GREEN'. Power 'ON'.
- 'C' LED 'YELLOW'. Target 'In Range'. This must be 'ON' only when sod is passing under the Sensor.





FIG.2

Range adjustment may be required when a new Sensor is installed, or to allow for any change in sod thickness, particularly if the sod being cut is very thin.

- Place a piece of 3/16 in. thick cardboard under the Sensor to act as a target.
- Switch system power (harvesting mode), 'ON'. The 'GREEN' LED should light-up.
- The 'YELLOW' LED will light-up when the Target is detected.
- Remove the Target. The 'YELLOW' LED should not be 'ON'.
 If the LED remains 'ON', carefully turn the Range Adjuster CCW until the LED does not light-up.

IMPORTANT

If, while the conveyor mat is running with no sod on it, the 'YELLOW' LED **remains 'ON'** or 'flickers '**ON-OFF**', **reduce** the sensitivity until the LED remains '**OFF**'.





IMPORTANT⁻

To ensure optimum performance the Sensors External Lens, (facing the target), should be cleaned regularly. Also check the cable connection and sensor body attaching screws for tightness.(Do not exceed 1.3Nm).

Sod End Sensor - Mechanical Type. (PROX Sensor).

Before the leading edge of the sod has reached the Starter Gate the roll '**END**' sequence 'Starts' with the Sensor Flag '**A**' positioned in front of the Sensor '**B**'. See adjustment procedure below.

As the sod passes into the Starter Gate the Sensor Flag 'A' will rotate 'UP' clear of the Sensor 'B'.

When the trailing edge of the sod has passed the Starter Gate the Sensor Flag 'A' will rotate back across the face of the Sensor 'B'.



Do not carry out any adjustment procedure while the engine is running.



Sensor and Sensor Flag Setting.

- Position the Sensor 'B' in the center of the Slot 'C'. Do not fully tighten the locknuts.
- Loosen the Set Screw 'D' in the Sensor Flag boss and position the Sensor Flag half way across the face of the Sensor 'B'. Tighten the Set Screw 'D'.
- Adjust the locknuts on the sensor until the face of the sensor is 2 to 8mm from the sensor flag. Tighten the locknuts.



NOTE: Pages 19, 20 and 21 are used when training operator.

4000 Setting Positions (example: PICK)

1. Go to the "Arm" Screen and press the "Calibrate Positions" button 4.

-	Cur Pr	x: 0 / 0	ARM Arm Step	# 0 / D	Index Co
	-	x	Y	Z	G-Turn
	Postion	0	0	0	0
		Taruet	Pas	mV	PVEDUT
	Rai	0	0	0	0
	Lift	0	0	0	0
	Reach	0	0	0	0
	G-Turn Brachuta	0	0	0	0
ALERA	ITE IS	u		U.	

- 2. Calibration Screen.
 - a. While in this screen the operator can move the arm functions with the Cab 20 Pad Control.
 - Position the arm where you want to save the current position, PICK, i.e. on top of the rolls on the index conveyor.
 - Ensure if changing the Z position the correct roll size is entered. (the machine will take this into calculating the correct position)
 - d. The Up and Down arrow screen buttons move the green selection bar to the desired item to modify. The Left arrow decreases the value and the Right arrow increases the value selected.
 - e. With the arm in its desired location (in this case the PICK position);
 - With the section bar at the Position to select, increase or decrease to scroll until the PICK position is displayed.

4	25	cw J	mater
A	A	Leew	-
	EL .		
L			R

20 Pad Cab Control.

Docition: D//	PSI Limit
NEW ACTUAL SAVED	1800
OND SAVED X: 0 10585 10585 m×100	5 \53
NOSITION Y: 0 1400 1500 in/t00	29.7
Z: 0 1250 950 mXt00	
C-TURN: 0 0 0 degX100	52.0
EW POS,	=
AVE	Max Posido

ii. Now scroll down to the coordinate you wish to change, in this case the Y Position and press the "LOAD ACTUAL POSITION" button 1.

LOAD ACTUAL POSITION		CALIERA	TE POSITIC	DNS		Litt Dow PSI Lim
LORD SAVED POSITION MOVE TO NEW POS,	X: Y: Z: G-TURN:	NEW 10585 1400 950 0	ACTUAL 10585 1400 1250 0	SAVED 10585 1400 950 0	inX100 InX100 InX100 degX100	5 \\S. 5 \\S. 5 \\S. 5 \\S.
SAVE			2 at 5471			Max Positio 17

With the Actual Position loaded under the NEW column, press the "SAVE" button 4 (the NEW value will now be loaded under the SAVED column).



You can also modify the selected "NEW" coordinate using the Left and Right arrow buttons. Refer to the Arm Position Coordinate Chart for the Axis descriptions.

- Iv. To verify the new saved position is correct. Move the arm, manually with the Key Pad, slightly away from its current position. Press the "LOAD SAVED POSITION" button 2. Then press and hold the "MOVE TO NEW POS." button 3. The arm should return to the currently loaded saved position under the NEW column.
- v. Note: When moving to a new position with the screen button use caution because the arm will move directly to the position and will crash into whatever is in its path. So position the arm close to the new target with no obstructions in its path.

This page left blank

Pallet Weight Indicator – Option

The correct truck/trailer weight is necessary when the unit is passing through highway weight checking stations.

The Pallet Weight Indicator system shows the operator the weight of sod on each pallet.

The pallet weight is shown on the cab display screens. The operator can then record the pallet weights.

To initiate the system :

at 'D'.

Press the Pallet Hold Pad 'A' on the console control to enable the Pallet Weight feature.

Note -Will only weigh the pallet when 'HOLD' is 'ON' and the pallet is full.

- The Main Screen will indicate that the Pallet 'HOLD' • Icon 'B' is 'ON'.
- The weight of the Pallet will be shown at 'C' on the Main Screen.



Control Console



Main Screen



Release the Pallet 'HOLD' pad and continue to harvest the the pallets of sod until the total weight of pallets required have been cut.

IMPORTANT

While every effort is made to ensure accurate weight figures some variation may occur. The operator should allow for 5% in the total weight of the trailer load.



Pallet Injector Screen

Pallet Weight Indicator – Option

When the Pallet Weight Indicator Option is installed it requires that Pressure Transducers are fitted as shown below

The Pressure Transducers are wired to the Main Panel as shown.



Pressure Transducers on Mast Cylinder



Lower Transducer



Upper Transducer

SECTION 4

 \bigcirc

Hydraulic Oil – Specification.	4-01
Hydraulic Pumps.	4-01
Oil Tank Filler.	4-01
Oil Tank Level Indicator.	4-01
Oil Cooler.	4-01
In-Line Line Filters.	4-02
Charge Pressure Filter – on Drive System Pump. (P1).	4-02
Arm Spin-On Filter.	4-02
Drive System Torque Hubs – Oil change procedure.	4-03
Drive System Pump – Pressure Check and Adjust.	4-04
Hydraulic Layout.	4-05
Hydraulic Schematic – Main Frame.	4-06
Hydraulic Schematic – Main Conveyor.	4-07
Hydraulic Schematic – Drive System.	4-08
Hydraulic Schematic – Arm.	4-09
6, 7 and 8 Bank PVG Control Valves.	4-10
Decal for Gripper Head PVG Valves.	4-11
Decal for Pallet Dispenser PVG Valves.	4-11
Tank Top Return Connections.	4-11
Rear Torque Hubs. Check bolt torque.	4-12

_____ NOTE _____

Euro Specification Only:	
Gripper Head Hydraulic Schematic. (Sheet 1).	4-13
Gripper Head Hydraulic Schematic. (Sheet 2).	4-14

Oil Filler Cap & Level Indicator – Rear Location.

4-15

Hydraulic System.

The Hydraulic System is filled at the factory with **PETRO-CAN HYDREX XV - All Season Hydraulic Oil**, a premium performance, long life, anti–wear hydraulic fluid.

The Hydraulic Oil Tank contains approximately 120 gallons (imp) of hydraulic oil.

IMPORTANT Use only recommended oils. Failure to do so will result in damage to the hydraulic system If HYDREX XV is not available, some compatible oils are shown in the list opposite.

The Hydraulic Pumps: 'P1'-Drive, 'P2'-Conveyor/Pallet, and 'P3' – Arm, are engine driven.

The Pump '**P1**' supplies oil to the Drive Motors via the Anti- Slip Valves. See Hydraulic Schematics. See P4-08 See P4-04 for pressure check/adjust of Drive Pump.

Pump '**P2**' sends oil to the 8 and 6 Bank Control Valves. See Hydraulic Schematics. See P4-06/07

Pump '**P3**'. Sends oil to the 7-Bank Control Valves for the Arm. See Hydraulics Schematics. See P4-09.

Two sets of In-line Filters a Spin-On Filter for the Arm and a Charge Pressure Filter on Pump '**P1**', ensure the hydraulic oil is kept free of contaminants. See service procedures on pages 4-02.

IMPORTANT

In addition to the oil level 'Sight Gauge' a float will detect low oil level, a warning will 'flash' on the cab display and a 'buzzer' will sound. **Stop operation immediately and investigate for oil leaks.**

Refer to Section six, page 6-13, for oil change schedule.

The Oil Cooler Fan engages automatically when the oil reaches a preset temperature, sensed by a sending unit in the oil tank. Oil temperature is shown on the Cab Display - Controller '**A**'. The Fan reverses periodically to blow debris off the Cooler.

IMPORTANT

To prevent serious damage to the Hydraulic System do not allow water, dirt, or contaminants to enter the system, particularly if working on the hydraulic tank. When working on/repairing hydraulic components thoroughly clean around the area to be worked on. Cap and plug all broken connections.

NOTE

To empty the Hydraulic Oil Tank it is recommended that a suction pump is used to remove the oil through the filler opening. Completely drain the tank by removing the magnetic drain plug.

Compatible hydraulic oils

Conoco Phillips ECOTERRA HV146. This oil is highly recommended

These oils are also recommended.

0 -1	Ambient ter ° F.to 90 ⁰ F. 2 8° C to 32° C.	nperature 0° F [.] to120° F. -6° C. to 49° C.
AMSOIL	HV1 46	HVJ 68
MOBIL/ESSO	UNIVIS N46	UNIVIS N68





See P4-15 - for rear oil tank filler access.



HYDRAULIC SYSTEM _____

Inline Filters.

Inline Filters are located to the rear of the Hydraulic Pumps, and also on the front bulkhead. The filters have a Service Indicator that 'pops-up' when the filters need replacing. It is important that the operator checks the indicator at regular intervals.

The service instructions are shown on the filter. Replace all oil lost during filter change.

IMPORTANT⁻

Keep the Service Indicator area clean so that it is visible to the operator. Dispose of used hydraulic oil properly . *Do not re-use* hydraulic oil.

To access the front Filters remove the bulkhead cover plate.

Charge Pressure Filter.

The Charge Pressure Filter is mounted on the Drive System Pump (P1).

The Filter must be changed after the first 100 hours of operation.

IMPORTANT

It is imperative that the area around the filter is cleaned before changing the filter to prevent any dirt from entering the drive system.

Controller 'A' - Filter Change Indicator.

After the initial filter change, a '**warning**' symbol indicates that the filter pressure is at the point that the filter must be replaced. See screen on P3-05 showing the indicator symbol (No.15).

IMPORTANT Do not delay the filter replacement.

Arm.Spin-On Filter.

Located at rear, to right of mast.

It is important that the Service Indicator is checked regularly.

If the indicator arrow moves into the '**RED**' zone the filter **must be replaced.**

Do not delay the filter replacement.

Refer to the instructions on the filter case for removal and Installation.









HYDRAULIC SYSTEM_

Drive System – Torque Hubs.

IMPORTANT

It is important that the oil in the Torque Hubs is changed after the first 50 hours of operation and then every 1000 hours.

EP150 OIL MUST BE USED

The following procedure is recommended :

Refer to IMPORTANT note at lower right of page.



Machine weights are: 16in.18641lbs (8455kg) . 18in.19141lbs. (8682kg.)

Use a jack, and support stands, with the load capacity to handle these weights.

Surface must be solid and stable, preferably concrete .

Front Wheels.

- Position the Jack at the center the front cross beam and raise the front wheels clear of the ground.
- Position stands at each side under the cross beam. Carefully lower the machine onto the stands.

Rear Wheels.

- Position the Jack under the side beam, in front of the rear wheel. Raise the wheel clear of the ground.
- Position the stand under the side beam. Carefully lower the machine onto the stand. Repeat at opposite side.

To Drain the Oil.

Remove the bolts retaining the Plate (**A**). Reverse the Plate, with the 'top hat' facing inwards, and bolt it back into place. This releases the Hub Brake allowing the wheel to be turned.

NOTE

The oil should be drained after the machine has been driven and the oil in the hubs *is warm.*

- Position the drain plug at the bottom. Loosen the fill plug, to relieve any vacuum. Remove the drain plug. Catch the oil in a suitable container.
- Remove both plugs. Clean any metallic particles from the magnetic faces. Replace the Plugs.
- Turn the wheel to position the fill plug at the top and the level/drain plug at 90 degrees to it. Remove the Level Plug.
- Fill the Hub until clear oil exits the level hole.
- Replace the Level Plug
- Remove and reverse the Retaining Plate (A) to its original position
- Jack up the machine and remove the stands.

The above procedure must be carried out on each Torque Hub at the hours of operation specified .



Front Wheels.



Rear Wheels.



Torque Hub.

IMPORTANT

Refer to page 4-12 for recommended procedure required, at 1000 hrs of operation, to check and re-torque the bolts attaching the rear Torque Hubs to the main frame.

HYDRAULIC SYSTEM ____

Drive System – Pressure test/adjust.

Fig.1

To facilitate easy and safe checking and adjusting of the Drive System Pressure, a Test port is fitted on the Loop Flushing Valve. If a Test Port is not installed on your machine it is recommended that one be obtained from the factory, also the 1000 psi. Gauge, Adaptor, and Hose.

The Test Port replaces a Plug on the Loop Flushing Valve.

To ensure safe and efficient procedures the correct equipment must be used. Failure to do so may result in personal injury and/or equipment damage.

Two persons should carry out this procedure.

One in the operator's seat, a second to attach the equipment and adjust the pressure.

Loop Flushing Valve.

(Located under the inner engine cover). **Fig.2/3**

- Remove the plug in the Valve and fit the Test Port. Remove the Cap '**A**'.
- Attach the Gauge 'B' and Hose to the Test Port 'C'.
- Set the Engine rpm to 1800. With the machine '**stationary**' the gauge reading should be 350/375 psi.
- Engage the Drive '**momentarily**'. The indicated pressure should decrease, to 20/30 psi. lower than the stationary psi.

Pressure Adjustment.

Fig.4

Pressure is adjusted at the Relief Valve 'D' located on the top side of the Drive Pump.

- Loosen the Locknut 'E'.
- Using a 6mm Allen Key turn the Adjuster 'F' CW to increase pressure.
- Turn CCW to decrease pressure.
- Retighten the Locknut 'E'.
- Remove the test equipment. Replace the cap on the Test Port.



Fig.1











HYDRAULIC SYSTEM

Main Components Layout



HYDRAULIC SYSTEM

Hydraulic Layout. Main Frame.




Main Conveyor – Hydraulic Layout.

Hydraulic Schematic. Drive System.



HYDRAULIC SYSTEM

Hydraulic Schematic. Arm.



HYDRAULIC SYSTEM

PVG Control Valves

6-Bank PVG Control Valves.

- 1. Oil Cooler Motor
- 2. Pallet Dispenser Cylinder
- 3. Pallet Paddles Lift Cylinder
- 4. Pallet Inject Motor
- 5. Wall Cylinders
- 6. Mast Cylinder



7-Bank PVG Control Valves.

- 1. Arm Motor.
- 2. Arm Lift Cylinder.
- 3. Arm Reach Cylinder.
- 4. Gripper Head Rotate.
- 5. Multi Grip Cylinder.
- 6. Single Grip Cylinder.
- 7. Squeeze Cylinder.



8-Bank PVG Control Valves.

- 1. Down Pressure Cylinder.
- 2. Main Conveyor Lift Cylinder.
- 3. Depth Cylinder
- 4. Roll Eject Motor.
- 5. Cutter Motor.
- 6. Main Conveyor Motor.(6A Capped)
- 7. Cut-Off Motor.
- 8. Index Conveyor Motor.



Decal - Pallet Dispenser manual controls.

The Pallet Dispenser PVG Control Valves are located behind the left rear wheel.

The operating decal also indicates the control for the oil cooler fan.



To prevent possible serious injuries when using the manual controls on the PVG valves, ensure that all bystanders are well clear of the machine.

Decal - Gripper Head manual controls.

The Gripper Head PVG Valves are located on the left side behind the cab.



Manual operation of Shift Cylinders 2-4, or Squeeze Cylinders 1-5, may result in cylinders to over travel, causing damage to the gripper drive.

Tank Top Return Connections.

- A. Medium Pressure Filter (Arm Valve). Hydraulic Oil Cooler - Return.
- B. Front Bulkhead Filters Arm Filter Return.
- C. Case Drain Arm Pump.
- D. Case Drain Aux. Pump.
- E. From Oil Cooler
- F. Valve Drain Brake Release Motor Min.
- **G**. Valve Drain Brake Release Motor Max.
- H. Anti-Spin Valve Drain Rear.
- I. Anti-Spin Valve Drain Front.







HYDRAULIC SYSTEM _____

Rear Torque Hubs.

IMPORTANT

Every 1000 hours of operation the rear Torque Hubs 5/8 Bolts, six per hub, must be checked and tightened to 200 lbs/ft.

This recommended procedure should be carried out one side at a time, as shown.

To access the rear Torque Hubs:

- Disconnect the Piling Wall Cylinders 'A' and open the piling walls.
- Check the tightness of each Bolt 'B', to 200 lbs/ft.
- To ease access to the bottom two bolts, use a suitable trolley jack to raise the machine.



To prevent possible personal injury while tightening the lower bolts with the machine raised, position a jack-stand under the side beam as indicated.

• Close the piling walls and re-connect the cylinders.

The front wheels and torque hubs are not subject to the same high operating loads as the rear ones so this procedure is not necessary.







Arm Gripper Head Hoses - Euro Specification.

For Euro-Spec machines two valve sections, 8 & 9, are added to the Arm PVG Valve Bank.

The four hoses from the valves 8 & 9, are routed through the 'power-trac' unit 'A,' to bulkhead connections 'B', 'C' 'D' & 'E' on the Arm Carriage.

From the bulkhead the hoses connect to the gripper head.

Refer to schematics sheets 1 and 2.







Sheet 1. Gripper Head Hydraulic Diagram

HYDRAULIC SYSTEM

Arm Gripper Head – Euro Specification. Hydraulic Hoses. Sheet 2.



Sheet 2. Gripper Head Hydraulic Diagram.

Hydraulic Oil Filler Cap and Oil Level Indicator.

The Hydraulic Oil Filler Cap and Oil Level Indicator will be located on the rear face of the oil tank as shown below. The level indicator is located to the lower right of the filler cap. A Flange Cap will be fitted at the previous location of the filler cap Check if this change has been made on this machine.

Page 4-01 in the manual will show the front location of the filler cap and oil level indicator.



SECTION 5

Proximity Sensors. Battery Isolator Switch. Glow Plug Control Box – Location. Starter/Alt. Fuse location on engine block.	5-01 5-01 5-01 5-01
Main Electrical Control Box. Controllers 'B', 'C', 'D' and 'E'. Output Connections	5-02 5-02 5-02
Output Connections – Euro Specification Only.	5-02A
Under Cab Service Panel - Fuses and Relays Glow Plug Control Box – 50A fuse & Relay. Cab Wiring Diagram.	5-03 5-03 5-04
Cab Display. Controller 'A'. Control Console – Underside.	5-05 5-05
Multi-Port Blocks – Cable Connections.	5-06
Multi Port Connector Blocks – Locations.	5-07
Proximity Sensors – Locations.	5-08/5-09/5-10
Drive Pump (P1). Forward/Reverse Solenoids.	5-11
PVG Control Valves – Plug Connections.(6, 7, & 8 Bank).	5-11
Shipping Mode - Disconnecting Conveyor Sensor Cables.	5-12
Service Panel / Cab / Main Electrical Control Box – Inter Connect.	5-13
Electrical Schematics:	
Service Panel. Under Cab Mount.	5-14
Control Console. Overhead Switches; Controller 'A'(Cab Display); Fuel Gauge.	5-15 5-15
E –Stop, ECU Run Circuit. Road, Signal, Work & Field Lights.	5-16 5-16
Main Elec. Panel to Cab Interconnect.	5-17
Control Panel CAN Bus. Control Panel Ground and Power.	5-18 5-18
Camera & Reverse Alarm wiring detail. Steering Column wiring detail.	5-19 5-19

Section 5

The design of the wiring system simplifies the tracing of electrical faults, and repair/replacement of cables.

'YELLOW' cables, from the Electrical Control Box, are connected to Multi-Port Connector Blocks. See page 5-06.

A 'GREEN Lamp on Multi-Port Connector Blocks indicate power from the Main Electrical Control Box. See page 5-05.

A '**YELLOW** Indicator Lamp, at each 'port connection', indicates signal power is '**ON**' in the Cable connecting it to its particular function.

Proximity Sensors.

The Proximity Sensors have Power '**ON**' Indicator Lamps. Indicator Lamps allow the power loss at any Sensor to be quickly traced.

The threaded Connector Plugs are sealed, and designed to be trouble free, but should be checked periodically for tightness, and for moisture or corrosion in the Connectors.



IMPORTANT

- If a problem persists with the operation of the machine, due to electrical faults, it is recommended that you contact your Brouwer Dealer, or the Factory Service Department.
- The diagnosis and/or repair of electrical problems that are beyond the scope of this manual, **must** be done ONLY BY FACTORY TRAINED TECHNICIANS, using the proper diagnostic equipment.

Battery Isolator Switch.



The Battery Isolator Switch *MUST* be 'OFF' before doing any welding procedures on the machine. Failure to follow this instruction will result in serious damage to the Electrical System Components.



IMPORTANT

When the machine is left unattended, or is to be stored for any period of time, the Battery Isolator Switch should be 'OFF' and a lock fitted to prevent unauthorized persons from starting the engine.

Glow Plug 50A. Fuse & Relay Box location.

The Fuse and Relay Box is mounted on the engine cover support. See page 5-03 for inside details.

Power to the box is taken from the Starter/Alt' fuse connection, located on engine block. See below.





Main Electrical Control Box. (Rear of Cab. Left Side).



- 1. Controller 'B'. Arm.
- 2. Controller 'C'. Engine & Conveyor.
- 3. Controller 'D'. Pallet Injector.
- 4. Controller 'E' Output Module
- 5. Fuses. (See inset).

- 6. 12/24V Convertor.
- 7. Remote GSM System.(Option).
- 8. System Power Relay. (Behind GSM Unit).
- 9. Reverse Alarm Relay(Behind GSM Unit Refer to schematic on P5-18.)

Plug Pin Connections: Detail of decal on inside of control box cover.

C1 From Panel / Cab Rev. Alarm Strobe Left Sig. Sw. Left Signal Right Signal Right Sig. S Rev. Lights Brake Lights	C4 ARM Multiport Lift Pos. Reach Pos. Lift Press. Rail Position Shield	C2 Lft. Middle Multiport Right Rear Direction Hyd. Oil Level Spare Conv. DP Sense Shield	C10 Analog S FL PPU FR PPU RL PPU RR PPU Shield	C13 Propel Multiport Brake Release Forward 2 Speed Reverse	C16 Right Rear Valves RL ASV RR ASV Eject Spare	C19 Rail/G-Turn Rail PVE PVE Pwr PVE Pwr Grip Turn PVE	C22 Inj/P.Wall Injector Up Injector Down Piling Wall Close Piling Wall Open	C25 Accumulator Bad Roll Open Bad Roll Close Index REVerse Index ADVance	C28 Euro Grip Grip 1&5 Sense Grip 2&4 Sense Shield
C2 To Panel from Cab Seat Sw. Road/Harv. Mode sw. Brake Sw. Spare E-Stop Cond. Hazard Sw. E-Stop Spare	CS Injector Multiport Push Bar Home Push Bar Away Paddles Up Paddles Down	CB Rt. Middle Multiport Fork Ground Prox Conveyor PPU Index Prox Filter Switch	C11 Conveyor MP Cut Off Prox Head Press, Sense Roll End Conveyor Down Shield	C14 ASV Multiport FLASV FRASV	C17 Grip M Grip Open M Grip Close S Grip Close S Grip Open	C20 SQZ/Forks Squeeze On Squeeze OFF PVE Pwr Forks PVE	C23 Cutoff/head Lift Cut Off PVE PVE Pwr PVE Pwr PVE Pwr Head Lift PVE	C26 Depth/Conv.Lift Depth INCrement Depth DECrement PVE Pwr Conveyor Lift PVE	C29 Euro Grip Mid Grip Open Mid Grip Close PVE Pwr Shift Grip PVE
C3 Cab/Panel Analogue A-Steer Cutter Conveyor Eng. RPM Pedal +12 volts 0 Volts + 5 Volts	<u>C6 Lft. Rear Multiport</u> Load Position Pallet Clear Injector Down Injector Up	CO Analog 12 Axle Position Oil Temp Ski Position Fork Position Shield	<u>C12 Cooling</u> Cooling Fan Fan Reverse Motor Flush	C15 Steer Multiport Steer Left Steer Right Ski Up Ski Down	C18 Reach/Lift Reach PVE PVE Pwr PVE Pwr Lift PVE	C21 Pal. Inj. Paddles Up Paddles Down Push Bar Back Push Bar On	C24 Cutter/Conv Cutter PVE PVE Pwr PVE Pwr Conveyor PVE	C27 E-Stop Estop out Estop in Estop out Estop in Estop out Estop in	C30 Spare

Back of Main Electrical Control Box - Output Connections.



ELECTRICAL SYSTEM Euro-Specification

Main Electrical Control Box

The Euro Specification has additional output connections at the back of the main electrical control box.

These are identified as C28; C29; and C30.

Plugs C28 and C29 are used and the functions are identified in the figure below.



Main Electrical Control Box

Plug Pin Connections

Refer to **C28** and **C29** to identify the plug pin connections.



Under Cab Service Panel.

The Service Panel Tray (Relays and Fuses), is located under the cab, above the cab side step.

To access the Tray, release the Catches on each side and slide it out.

The hinged lid is secured with a soft touch knob. Rubber sealing prevents the entry of water and dust.

Interior details are shown below.

NOTE: Refer to Page 5-14 for schematic details.





Service Panel - Under Cab

 Fuse Block 1: Keep Alive /Ign.Sw.10A. Reverse Lts.& Alarm10A. Road Lts.15A. Field Lts.15A. Work Lts2.15A. Work Lts1.10A. Fuse Block 2: Power Port Ign.15A. Wiper /Radio.15A. ECU Power.20A Tail/Alt.Field.5A. Signals.10A. Starter.15A. 	Relays:13. Work Lts2. 14. Field Lts. 15. Ignition 16. Panel. 17. HVAC		
Relays :3. Panel 'OFF'.4. Reverse Lts.5. Right Signal6. Road Lts7. Starter.8. ECU. Run.9. Panel 'ON'.10. Back-up Alarm.11. Left Signal.12. Work Lts1.	18. Fuse – HVAC. 19. Battery (+). 20. Panel Power. 21. Ground Post. 22. Connector		

Fuse Blocks 1 & 2.

ELECTRICALSYSTEM - Cab Wiring.



System Controller 'A'. Cab Display

If **!!NO CAN BUS!!** is displayed it indicates one of the following :

1.

 Loss of power to Controller No.4 (see P5-02). Check the LED lamp on the Controller. If it is 'ON' the Controller may be faulty.

If the LED lamp is not '**ON**', check the wiring to the controller to restore power.

2.

• Loss of signal from the controller to the display.

If the above checks fail to restore functions, call your Dealer or the factory Service Department.

Control Console. Underside wiring.

- 1. Control Handle.
- 2. Auto-Steer Fine Adjust Potentiometer.
- 3. Cutter Speed Potentiometer.
- 4. Conveyor Speed Potentiometer.
- 5. E-STOP Switch.
- 6. 8 Button Key Pad Connection.
- 7. Engine RPM Control.



Control Console – Underside.



Cab Display.

ELECTRICAL SYSTEM _ Multiport Blocks.

The locations of the Multiport Blocks are show on the opposite page. This page illustrates each cable connection from the Multiport Blocks to the operating function.



MP. C9

J4

Fork Position

J2

Oil Temp

J3

Ski Position

Axle Position

C9

J1











MP. C12

(J4

J2

Fan Rev

Motor Flush

J3

Spare

J1

Cooling Fan

C12

To Main Elec' Contro Box See P5-02







To Main Elec' Control Box See P5-02



To Main Elec' Control Box See P5-02



Do not direct jet of high pressure washer at electrical components.

Keep all electrical connections clean and tight

	- NOTE
ASV	(Anti Spin Valve)
PPU	(Pulse Pick-up)
Press	(Pressure)
Pos.	(Position)
Spare	(Not used)
RL	(Rear Left)
RR	(Rear Right)
FL.	(Front Left)
FR.	(Front Right)

Multi-Port Connector Blocks.

NOTE: Refer to page 5-02 for details of the Multi Ports cable connections at Main Electrical Control Box.



Arm Multiport.



Injector Multiport.



Left Rear Multiport.



Front Three Multiports.



Conveyor Multiport.



Rear Five Multiports

ELECTRICAL SYSTEM Proximity Sensors

IMPORTANT -

To prevent loss of signal from a Sensor it is imperative that a regular check is carried out to ensure that no dirt/debris is allowed to build up on the face of the sensor or the sensor target. If a Proximity Sensor, or the target component, is replaced it must be adjusted, where applicable, to allow a gap between the face of the sensor and the target as indicated below.



1. Cut-Off - Sensor to Target 1/4 in. to 3/8 in.



3. Slab End Sensor. See P3-18 for calibration.



5. Index Conv'.'CLEATS' position Sensor to Target . 1/8 in. to 1/4in



2. Conveyor 'DOWN' - Sensor to Target 1/8 in. to 1/4 in.



4. Roll Flap (Tooth Count) Sensor to Target 1/8 in.max



6. Mast 'Height' Sensor. No adjustment.

ELECTRICAL SYSTEM. Proximity Sensors.



7. Pallet Disp'.'Bottom'. Sensor to Target 1/8in.to1/4in.



8. Pallet Disp'.'Mid.' Sensor to Target 1/8in to 1/4in.



9. Pallet Disp'.'High'. Sensor to Target 1/8in.to1/4in.



10/11.Paddles'Up-Down' Sensor to Target 1/8in. to1/4in.



12. Push Bar 'Away' Sensor to Target 1/4in. to 3/8in.



13. Push Bar 'Home'. Sensor to Target 1/8in. to1/4in.

Proximity Sensors.



14. Ski Angle Sensor. No adjustment.



15. Pallet 'Clear' Sensor (Cover removed). No adjustment



16. Arm Rail Sensor.No adjustment.



17. Forks 'Bottom'. Sensor to Target 1/8in to 1/4in.

IMPORTANT

Check regularly that there is no dirt or debris on the face of the sensors or between the sensors and their targets.

Do not direct high pressure water at any electrical components

Drive Pump (P1). Forward – Reverse Solenoids.

The Displacement Solenoids change the internal operation of the pump to enable Forward and Reverse selection.

Top Solenoid Connector Plug '**A**' (Reverse), goes to **J4** on the front 4-Port Block.(C13). See page 5-02 & 5-07.

Bottom Solenoid Connector Plug '**B**' (Forward) goes to **J2** on the front 4-Port Block.(C13). See page 5-02 & 5-07.



Drive Pump Solenoids.

6-Bank PVG Control Valves.

- 1. Oil Cooler Hyd. Motor.
- 2. Pallet Dispenser Cylinder.
- 3. Paddles Lift Cylinder.
- 4. Pallet Inject Motor.
- 5. Wall Cylinders.
- 6. Mast Cylinder.

7-Bank PVG Valves.

- 1. Arm Motor.
- 2. Arm Lift Cylinder.
- 3. Arm Reach Cylinder.
- 4. Gripper Head Rotate Cylinder.
- 5. Multi Grip Cylinder.
- 6. Single Grip Cylinder.
- 7. Squeeze Cylinder.

8 – Bank PVG Valves.

- 1. Down Pressure Cylinder.
- 2. Main Conveyor Lift Cylinder.
- 3. Depth Cylinder.
- 4. Roll Eject Motor.
- 5. Cutter Motor.
- 6. Main Conveyor Motor.(A-Port Capped).
- 7. Cut-Off Motor.
- 8. Index Conveyor Motor.



6 - Bank PVG Valves.



7-Bank PVG Valves.



^{8 –} Bank PVG Valves.

IMPORTANT

The following procedure must be followed to prevent the loss of function calibration when disconnecting the Sensor Cables on the conveyor for the : Cut-Off; Slab End; Tooth Count; Auto-Steer and Down Pressure.

- Turn the Ignition 'ON'.
- Switch the System Power 'ON'.
- Go to System 'SELECT' Screen. PAD 2.

Select 'SET-UP' on Select Screen.



C

Cab Display – Controller 'A'.



Select Screen





- Disconnect the sensor cables.
- Switch the System Power 'OFF'.
- Turn the ignition 'OFF'.

When the sensor cables are reconnected, and the system is reactivated, it will automatically return to the programmed settings.



Activate Shipping Mode Screen.



Service Panel. Under Cab Mount.



ELECTRICAL SYSTEM

Wiring Schematics.





Wiring Schematics.





	Engine ECU er, Radio Pwr. AC Power AC Power AC Power AC Power AL LS. a Lts. a Lts. b Lts. b Lts. b Lts. b Lts. c Lt. Sw. c Lt. Sw. c Lt. Sw. d Lt. Sw. d Lt. Sw. d Lt. Sw. c Lt. Sw. d Lt.	
		Ma
-	a co	
	3-8 > Console 8 3-7 > Console 8 3-5 > Console 12, 3-5 < Console 12, 3-5 < Console 4 3-3 < Console 4 3-3 < Console 2 3-2 < Console 2 3-1 < Console 1 2-8 Spare 2-6 < 0' Head 2-7 > Console 1 2-8 Spare 2-6 < 0' Head 8w, 2-1 < Console 1 2-8 Spare 2-6 < 1 Head 8w, 2-1 < Console 6 1-7 > K-2-86 1-7 > K-2-86 1-4 > T-6-5 Under 1-8 > T-7-8 1-7 > K-2-86 1-8 > T-6-5 Under 1-8 > T-6-5 Con	
CANBUS 3	Console 5 Volts Console 0 Volts System 12 Volts Pedal Engine RPM Conveyor Speed Cutter Speed Cutter Speed Auto Steer Trim Auto Steer Trim Parad Switch E-Stop Cond Spare P. Brake Switch Reverse Lt.Ctl Right Signal Left Signal Left Signal Left Signal Left Signal Left Signal Left Signal Left Signal	
	Panel Connector 1 Panel Connector 2 Panel Connector 1 Panel Connector 2 Panel Connector 1 Panel Connector 2	
	Joystick Keypad Display Engine Man. Control Box	

Wiring Schematics.

ELECTRICAL SYSTEM Wiring Schematics.





ELECTRICAL SYSTEM Wiring Schematics





SECTION 6.

WARNING Do not operate the machine if any safety guards are damaged or missing. Some safety guards may have been removed for illustration purposes only. Cutter Drive Belt Adjust/Replace. 6-01 Main Conveyor Mat. 6-02 Crown Roller. 6-02 Mat Tension Idler. 6-02 4 inch Roller Drive. 6-02 Conveyor Mat - Splices. 6-03 Conveyor Mat –Metal Clips. 6-03 Conveyor Mat Alignment. 6-04 Index Conveyor Mat. 6-05 Mat Sliders - Replace. 6-06 Mintex Metal Mats. 6-07 Cut-Off Length. 6-08 Cut-Off Blade. 6-08 Cut-Off Springs. 6-08 Pitch Angle Adjust. 6-09 Ground Roller to Cutter Blade Setting. 6-09 Ground Roller Adjust. 6-10 Depth of Cut – Manual Adjust. 6-10 Arm Drive Belt - Replace/Adjust Tension. 6-11

LUBRICATION

Recommended Lubrication Schedule.	6-12
Maintenance Procedures.	6-13
Steer Slewing Ring Lubrication.	6-14/15
Lubrication Points.	6-16 / 6-17 / 6-18
Cutter Drive Belt Adjustment.

When Correctly adjusted there should be ½ inch deflection midway between the drive and driven pulleys. **Do not over tighten the belt,** as this will result in premature belt failure and possible damage to the motor and the eccentric shaft bearings.

To adjust the drive belt tension:

- Remove the side cover to access the drive Belt 'A' and the Motor Sheave 'B'.
- Loosen the Motor Mounting Bolts 'C' and back-off the adjusting bolt Locknut 'D'.
- Turning the Adjusting Bolt 'E' 'OUT' pushes the Motor forward and tightens the Belt. Turning the Adjusting Bolt 'E' 'IN', away from the motor slackens the belt.
- When adjustment is complete, tighten all fasteners and replace the side cover.

Cutter Drive Belt Remove /Replace.

- Proceed as above but turn the Adjusting Bolt 'E' fully inwards, away from the motor.
- Push the Motor back as far as possible to allow the belt to be removed from the drive pulley.
- Remove the Bolts that attach the Side Arm 'F' to the Cutter Blade.
- Remove the Tie Bolt 'G' and push the Side Arm forward to allow the Connecting Rod 'H' to swing down.
- Release the Bearing Lock Collar 'J' and remove the Bearing Retaining Bolts 'K'.
- Slide the bearing '**OUT**', toward the Connecting Rod. The self aligning bearings will allow the Eccentric Shaft to swing down sufficient to allow the belt to be removed from the Cutter Head.

Reverse the procedure to install the new Drive Belt. Adjust the Belt tension as shown above.

 IMPORTANT

 Tighten the Eccentric Shaft Bearings bolts to 300 ft.lbs.

Remove the Cutter Drive Motor.

- Slacken the Drive Belt as shown above.
- Remove the hydraulic fittings from Motor. Note to which 'ports' the hoses connect.
- Remove three bolts 'L' from Taper Bushing.
- Screw the three Bolts 'L' into the three threaded holes 'M'. Tighten the bolts to release the Bushing. Remove the Pulley.
- Remove the motor mounting bolts and lift the Motor from the frame.

Reverse the procedure to install the new motor. Adjust the belt tension as shown above.

IMPORTANT

The Motor Pulley **must be aligned** with the Eccentric Shaft Pulley. Use a Straight Edge '**N**', positioned across the faces of the pulleys as shown.









MAINTENANCE _____

Main Conveyor Mat.

The Rubber Conveyor Mat has proven to work well in a variety of conditions. It is the preferred choice of most sod growers.

See page 6-03 for the installation of a new mat.

The Mat Drive is by Hydraulic Motor '**A**' via Chain and Sprockets '**B**' to Conveyor Drive Shaft '**C**'.

The Mat Drive Sprockets '**D**' run in slots in the mat. The slots have replaceable Metal Clips 'M'. See page6-03 for Clip Replacement procedure.

To prevent premature/excessive wear the mat sprockets must be 'centered' in the mat slots. The 'tracking ' of the mat square to the conveyor frame

The Mat Drive Shaft Alignment Bolts '**E**', on both sides of the conveyor frame, are set at the factory, and should not require adjustment. (See page 6-04).

Crown Roller.

The Crown Roller, at the bottom end of the conveyor, keeps the mat 'tracking' square on the conveyor. The Roller Shaft is aligned in the frame with Taper Wedges ' \mathbf{F} ', located at each Roller Shaft Bearing ' \mathbf{G} '. See the following pages for the correct alignment procedure.

IMPORTANT

The Crown Roller must be set so that the sod guide bracket does not hit against the conveyor mat. Initially position the Roller shaft at the mid-point of adjustment, determined by the backstroke of the cutter blade and with allowance for the thickness of the mat. Also allow for some forward movement of the assembly during final alignment.

Mat Tension Idler.

Tension on the Conveyor mat is maintained by adjustable Tension Idlers 'H'.

Chains on the Idler Arms 'J' are attached to tension springs. Move the chain links to adjust the tension.

IMPORTANT

Do not allow the idler arm to approach an angle of 90 degrees to the frame as it will be pulled over center and mat tension will be lost.

Mat Support. 4 inch Roller Drive.

The Mid-Idler Shaft Sprockets Assembly supports the mat. The Sprockets '**K**' drive the 4 inch Feed Roller '**L**'.









MAINTENANCE

Main Conveyor Mat.

The Conveyor Mat halves are joined together with rubber joiners. This method eliminates the mat ends having to be overlapped and results in a flat mat join. Metal Mat Splices are still used.

When installing a new mat or new mat sliders a mat join kit must be used. The rubber joiner and metal splices cannot be reused. Refer to the parts manual for kit number

Special tools are available for easy removal and Installation of the mat splices. See below.





The Index Conveyor mat is joined with Metal Splices. The mat halves must be joined overlapped as shown.

It is important that the excess portion of the threaded stud Is broken off above the nut

The special tools allow easy removal and installation of the splices. KD90000 for use with hand tool. KD89999 for use with air power.

When installing the new mat use expanding grips 'C' to pull the mat ends together, while securing them with zip ties, until the splices have been fitted.

NOTE: A Special Tool is available for mat installation, as Shown. Part No. S500002



Do not operate the Conveyor until the Stud Ends have been broken off.

Failure to observe this precaution may result in serious injury to the operator, and/or damage to the machine.

Mat Clips.

The Metal Mat Clips will wear and need replacing. Use a chisel or similar tool to open them up for removal.

A Special Tool (Part No. H101724) is available to make installation fast and safe.









Special Tool. S500002.

Mat Clip –Remove/Fit

MAINTENANCE -

Conveyor Mat Installation.

After installing the Conveyor Mat it must be aligned to run 'parallel' in the frame by adjusting the Crown Roller.

Crown Roller Alignment.

CAUTION -

Adjustments **must be done by two people.** One to operate the controls, the second one to make adjustments.

- Loosen the Bearing Bolts 'A' and the Adjusting Wedge Bolts 'B'. Adjust the Wedges 'C', until the Bearing Bolts are positioned in the center of the Adjusting Slots 'D'. (on both sides of the frame). To allow for final adjustment do not fully tighten the fasteners.
- Run the Conveyor at LOW SPEED.
- Observe if the mat tracks to the '**left**' (inner side of the frame), tap the '**right side**' Adjusting Wedge '**down**'.
- If the mat tracks '**right**' (to outer side of the frame), tap the '**left side**' Adjusting Wedge '**down**'.
- Adjust the Wedges 'C', until the Mat runs parallel to the frame.
- Stop the Conveyor.
- Set the Roller Scraper 1/32 in. from the Crown Roller.
- Tighten all fasteners.

Main Conveyor Tracking.

The Conveyor is maintained parallel to the Main Frame by the Conveyor Top Bearings 'M', and also the Tracking Retainer Plate 'E', in the Tracking Guide Assembly 'F', bolted to the Bracket 'G' on the main frame.

This is set-up at the factory and should not need adjusting, except if the Conveyor is removed for service, or if damage occurs.

Conveyor Drive Shaft Bearings.

To install new bearings:

Always replace conveyor shaft bearings **on both sides**. Procedure is similar for each bearing.

- Raise the Cutter Head just clear of the ground.
- Loosen Locknut 'H'. Back-off Bolt 'J' until it is just clear of the Bearing 'M'.
- Back-off the set screw in the Drive Sprocket 'K'. Remove the chain drive sprocket and tooth count sprocket. Do not misplace the Key.
- Remove Bolts 'L' and the Bearing 'M'.
- Install the new bearings, hard against front adjusting bolt 'N', and *just clear* of rear adjuster Bolt 'J'. Tighten the Bearing Bolts 'L'.
- Tighten the Bolts 'J', until they are hard against the Bearings, and tighten the Locknuts 'H'.
- Re-install the Sprockets and Chain.









MAINTENANCE _____

Index Conveyor Mat.

The Index Conveyor Mat has Metal Splices joining the mat and Metal Clips in the sprocket holes.. Refer to P6-03 for service instructions.

The Mat '**A**' is tensioned with a Sprocket Shaft '**B**' that is attached to the Pivot Arms '**D**'.

The Pivot Arms 'D' must be adjusted equally with the Links 'C' to ensure that the Sprocket Shaft is level with the conveyor frame.

The correct position of the Roll Cleats 'E' relative to the Main Conveyor 'F' ensures that the sod rolls drop onto the Index Conveyor **between the Roll Cleats.**

The position of the Roll Cleats is determined by the position of the Sensor Flag 'G' relative to the Sensor 'H'.

IMPORTANT

When adjusting the Sensor Flag start with it 'centered' on the face of the Sensor, then proceed to rotate it in **small** increments until the correct Roll Cleat position is obtained.

To adjust the Conveyor Cleats position:

NOTE: CW & CCW as viewed from arrow 'I'

- Loosen the clamp bolt 'J' in the Sensor Flag boss.
- Rotate the Sensor Flag 'G' 'clockwise' to move the cleats 'forward'.
- Rotate the Sensor Flag 'G' 'counter clockwise' to move the cleats 'rearwards'.
- Tighten the clamp bolt 'J'.

IMPORTANT

When adjusting the Sensor Flag, the gap between the Sensor Flag and the face of the Sensor '**H**' must be set at **1/8in to 1/4in.**

To replace any worn or damaged Roll Cleats remove the Clamp Bar ' \mathbf{K} '.









Conveyor Mat Sliders.

Service life of Conveyor Sliders varies depending on the soil conditions.

Inspect them for excessive wear, particularly under the Roll-up Tray, when replacing the Mat and at major service.

The Sliders '**A**,' fit onto 'T-Section' Rails and are fastened at the lower end with Flat Head S.S. Screws '**B**' and Locknuts. Excessive wear will be evident when the frame rails show through the Sliders.

Wear thickness, 3/8 inch, is less than the overall thickness.

Remove/Replace Upper Slides.

- Locate a join in the Mat and position it at the midpoint of the Conveyor Frame.
- Remove the Idler Tension Springs, see page 6-02.
- Remove the Mat Splices and Rubber Joiner 'C'.

See page 6-03 reference replacement kit.

- Pull the Mat clear of the top Drive Sprockets and off the bottom front Crown Roller.
- Remove the Screws and Locknuts fastening the Sliders to the frame rails, and pull the Sliders up and off the Rails. It may be easier and quicker to cut badly worn Sliders off the Rails. Clean up the rails for easier fitting of the new sliders.
- Feed the Slider onto the rail, from the top. 'Knock' it down the rail until the bottom fasteners can be fitted.

Always replace the Sliders as a set.

Lower Sliders.

To replace the Lower Mat Sliders 'D' :

- Remove the Locknuts 'E', and lift the Sliders off the rails
- Remove 'T-Bolts' 'F', from the Sliders and fit them into the new Sliders, and bolt them into place.

Roll-up Conveyor Bump Stops.

The Roll-up Conveyor is a Mintex Metal Mat. See page 6-07 for details on the Mintex Mats.

- Roll-up Conveyor Bump Stops '**G**', are attached on both sides of the Frame.
- Replace badly worn or damaged Bump Stops.









MAINTENANCE — Mintex Metal Mats. Roll-Up and Roll Eject.

Roll-Up Mat 'A'. and Eject Mat 'B'.

Replace complete Mats as there are no replacement parts. To ensure a long service life, it is important that the Mat Drive and Driven Shafts, are parallel to each other and set 'square' in the Frame.

The links, at the outer edge of the Mat must point 'opposite' to the direction of mat travel.

Mat Drive Sprockets.

- The Sprockets are keyed to the shaft and locked with Set Screws.
- The teeth of the Drive Sprockets 'C' must contact the Mat Connectors 'D'.
- Sprocket Teeth **must be centered** in the Mat openings. If the Teeth contact the side face of the Links it will result in excessive and premature wear to the Sprockets and the Mat, and early failure of the Mat.

Idler Sprockets.

The Idler Sprockets also are keyed and locked with Set Screws. They are positioned one inch closer to the center of the mat than the Drive Sprockets.

If the Sprocket Teeth show excessive wear, it is recommended that the Roll-Up Frame Assembly be removed for complete overhaul.

To replace the Roll-Up Mat 'A'.

- Loosen the Bearing Bolts 'E', (both sides). Push the bearings 'forward' to slacken the mat.
- Locate the Removable Mat Connector 'D', remove the two Jam Nuts 'F.' Pull the Connector out and remove the mat from the Frame.
- Install the new Mat in reverse order.
- Tighten the Mat by pushing the Bearings back in the Slots in the frame. To ensure that the shaft is square in the frame, measure that the bearings are in the slots 'equally' on both sides of the frame,

IMPORTANT

To prevent premature and excessive wear **do not over tension the Mats.** They should be just 'snug tight'.

To replace the Roll Eject Mat 'B'.

- Loosen the Drive Shaft Bearing Bolts 'G'. (Both Sides).
- Push the shaft 'down' in the slots, to slacken the mat.
- Remove the Locknuts 'F', Mat Connector 'D' and remove the Mat.
- Install the new Mat. Push the Bearings 'up' in the slots 'equally' on both sides, to tension the Mat, and tighten the Bearing Bolts.









Cut Length of Sod

The Cut-Off Sensor and the programmed 'cut length', determine the length of cut. Maximum cut length of sod is 80 inches. This can be adjusted, to suit sod conditions, to a minimum of 60 inches.

- IMPORTANT -

If the Cut-off Sensor is remove / replaced it must be adjusted to allow 1/4in.to 3/8 in. clearance to the face of the Cut-off Cam Sensor Arm.

See Section 2 for length of cut adjustment.

Cut-Off Blade.

It is essential that the Cut-Off Blade '**A**', is kept 'sharp'. As the blade wears, and also when it is sharpened, its depth will be reduced.

To compensate for loss of blade depth, holes in the Blade Holder ' ${f B}$ ', allow for adjustment.

The 'bungee' Tensioner 'C', attached to a hook on the Blade Holder, positions the blade vertically but allows it to pivot forward when cutting.

Check that the edge of the Cut-Off Blade Mount does not hit the sod on the 'down' stroke, as this will damage the sod and cause problems when the sod is laid.

NOTE

A 'serrated' blade is available for use in soft soil, or excessive thatch. This blade will give a cleaner more positive cut in these conditions.

Cut-Off Springs.

The Cut-Off Springs 'D', are adjustable. If the spring tension needs to changed , to suit sod conditions , adjust **each spring equally**, using Adjusters 'E'.

Adjust the 'bungee' Tensioner 'C', using Adjuster 'F', the same amount as on the cut-off springs.

The Cut-Off Blade depth should only be deep enough to give a clean cut, whatever thickness of sod is being cut









ADJUSTMENTS

Pitch Angle.

Pitch Angle is the angle that the Cutter Blade makes relative to the ground. It is set at the factory for 'average' turf conditions. Adjustment is provided to improve cutting performance, in soft or in hard soils.

In soft conditions the Pitch Angle should put the Cutter Blade almost parallel to the ground.

In harder soils the Pitch Angle should be increased to maintain the correct cutting angle and to prevent the Cutter Blade from coming out of the ground.

NOTE

The set-up of the Cutter Blade to the Conveyor Mat and the Ground Roller is important.

An 'extreme' Pitch Angle may require the Ground Roller to be adjusted, to maintain the recommended clearance between the Roller and the Cutter Blade.

Refer to the Ground Roller Adjustment below.

Pitch Angle Setting.

- Loosen the Lock-bolts 'A', in the Adjuster Bracket 'B'
- Remove the Locator Bolts 'C'.
- To set the Pitch Angle for 'Hard' Soil : Pull the Adjuster Bracket 'FORWARD' to 'increase' the Cutter Blade Angle.
- To set the Pitch Angle for 'soft' Soil : Push the Adjuster Bracket 'REARWARDS' to 'decrease' the Cutter Blade angle.

IMPORTANT

The original Depth Adjustment Holes in the Adjuster Bracket **must be used** when replacing the Locator Bolts.

- Re-fit and tighten the Locator Bolts 'C'.
- Retighten the Lock-bolts 'A'.

Ground Roller to Cutter Blade Setting.

The Ground Roller compresses the turf ahead of the Cutter Blade.

For average conditions the Roller to Cutter Blade setting is 1 ½ inches. This is measured, with the Cutter Blade at its '**full forward**' stroke position, from the center-line of the Ground Roller to the Cutter Blade.

Adjustment is made for various soils to maintain a quality cut.

For example:

• Peat/Muck Soils – Adjust to less than 1½ inches.

• Stoney Ground – Adjust to 2 to 2 ¼ inches. See page 6-10 for adjustment procedure.







ADJUSTMENTS

Ground Roller Adjustment.

To adjust the clearance between the Ground Roller and the Cutting Blade :

- Loosen the four Locknuts 'A', sufficient to allow the Roller Bracket 'B', to 'slide' freely.
- Turn the Adjusting Bolts 'C', 'clockwise' to reduce the Roller to Blade clearance.
- Turn the Adjusting Bolt 'C' 'counterclockwise' to increase the Roller to Blade clearance.
- To ensure that the Roller Bracket is 'square' to the Frame, turn the Adjusting Bolts 'evenly' on both sides of the frame. Check that the 'notches' 'D', in the Roller Bracket and those in the Frame are aligned equally, on both sides.
- Fully tighten the Locknuts.
- To prevent dirt build-up on the Roller, adjust the Roller Scraper, to 1/32 in. clear of the Roller.

Pivoting Front Roller.

The Front Roller '**J**' pivots in bearing '**K**'. The 'polygon' bearing does not require lubrication. Lubricate the Roller Support Bearings. See page 6-12.

Depth of Cut.

During operation the Depth of Cut is controlled on the Cab Control Handle. See Page 2-02. Further adjustment can be made manually. The machine is set-up at the factory with a Depth of Cut setting for 'average' conditions.

If manual adjustment is required to the depth of cut :

- Loosen the Rear Adjustment Bolts 'E'.
- Remove the Front Locator-bolts 'F'.
- To 'decrease' the Depth of Cut, lift the Adjustment Frame 'G', 'UP', and fit the Front Locator-bolts into the 'lower' hole in the Adjustment Frame 'G'.
- To '**increase**' the Depth of Cut, lower the Adjustment Frame, and fit the Front Locator-bolts into the '**upper**' hole in the Adjustment Frame.
- Remove the Rear Adjustment Bolts 'E', and fit them into the same, 'upper' or 'lower', hole in the Adjustment Frame 'G', as the front Locator Bolts.

IMPORTANT

Do not attempt to install the front Locator-bolts in the **lower set of holes** in the Cutter Head Frame and the **top hole** in the Adjustment Frame, as the Adjustment Frame will foul against the Cutter Head Frame









ADJUSTMENTS

Depth of Cut.

A Depth of Cut indicator is fitted on the depth cylinder.

This gives the operator a quick visual indication of the depth of cut setting ,and if turf conditions change, to make the necessary adjustment.

Remove Arm Drive Belt.

Front Clamp.

- To slacken the belt, back-off the Locknut '**A**' and also the adjuster nut inside the Arm Housing.
- Loosen the Socket Hd. Bolts 'B'.
- Remove the Socket Hd. Bolts 'C' and slide the belt
- sideways 'D' out of the Clamp.
- Pull the loose end of the belt off the drive motor and through the Arm Mount.

Rear Clamp

- Loosen the Socket Hd. Bolts 'E'.
- Remove the Socket Hd. Bolts 'F' and slide the Belt sideways 'G 'out of the Clamp.

Install a new belt in the reverse order.

IMPORTANT

To ensure that the drive belt is tensioned correctly the following procedure must be carried out. It is important that the belt is not set too tight as this will result in premature belt failure.

Checking Arm Drive Belt Tension.

Using a suitable tension gauge :

- Attach a strap around the Drive Belt.
- Hook the gauge in the strap and pull upwards.
- The gauge reading should reach 25lbs. before the belt shows *any deflection*.

If available a compression gauge can also be used.









LUBRICATION

Recommended Lubrication Schedule.

It is important that the Recommended Service Schedule is followed. Regular service and cleaning will maintain the machine in good working condition, prolong its working life and reduce repair costs. Refer to the illustrations on following pages.

Every12 hours of operation.

Apply light oil to the chains that drive :

- Main Conveyor.
- Index Conveyor.
- Roll-Up Mat.
- Roll Eject Mat.
- Pallet Lift.
- Four Inch Roller.
- Pallet Push Bar Chains.
- Mast Forks Lift Chains.

IMPORTANT

Do not apply penetrating 0il,e.g WD 40, to any plastic bushings, such as IGUS. Particularly in: Gripper Guide Blocks and the Index Conveyor Slide Blocks



Do not use grease to lubricate chains. It accumulates dirt and results in premature chain wear.

Weekly.

Apply oil to the Pallet Injector Shafts, Linkages and Pivots.

Every 80 hours of operation :

Apply grease gun to all bearings:

- Cut-Off Cam.
- Connecting Rods.
- Cut-Off Blade Shaft.
- Ground Roller and Front Roller.
- Crown Roller.
- Main Conveyor Drive Shaft and Conveyor Sprocket Support Shaft.
- Four Inch Roller Shaft, Sprocket Drive Shaft, and Pivot Arm.
- Mat Idler Roller Shaft and Idler Arm Pivot.
- Roll-Up Mat Drive and Idler Shafts.
- Eject Mat Drive and Idler Shafts
- Pallet Lift Rollers.
- Gripper Pivots.
- Arm Carriage Slide Bearings
- Index Conveyor Front Idler Shaft and Rear Drive Shaft.
- Index Conveyor Mat Tension Idler Shaft.
- Pallet Injector Pivot Bearings.

IMPORTANT

Steering Pivot Slewing Ring.

Refer to the following pages for details on lubricating procedure for the Slewing Ring. To ensure a long operating life on the Slewing Ring it is important to adhere to the lubricating instructions. Also note the **caution** concerning pressure washing in the vicinity of the upper grease seal.

MAINTENANCE.

Maintenance Procedures.	DAILY	After first 25 hours	Every 50 hours	Every 100 hours	
ENGINE. Important: Refer to the engine manufacturers manual for full maintenance/service instructions.					
Check/Top-off Engine Oil Level.	Х	1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 - 1970 -			
Check/Top-off Engine Coolant Level.	Х				
Check for Water/Oil Leaks.	x	Refer to the Engine Manufacturers Manual for: Air Cleaner Pre-cleaner; Air Cleaner Element, Engine Oil and Oil Filter change. Battery maintenance.			
Clean Air Intake Screen.	X				
Clean Radiator Cooling Fins.	х				
Check and top-off Battery.			x		
HYDRAULIC SYSTEM.					
Check for Oil Leaks.	X				
Check Oil Level and top off as required.				x	
Change Hydraulic Oil.	After the first 1000 hours of operation. Then every 2000 hours.				
In-Line Filters & Arm Spin-off Filter.	See pa	See page 4-02 for service information.			
Charge Pressure Filter. (On Drive Pump - P1) .	See page 4-02 for service information				
DRIVE SYSTEM. IMPORTANT Change the Oil in the Torque Hubs after the first 50 hours of operation. Then every 1000 hours or annually, whichever occurs first. EP 150 OIL MUST BE USED. See page 4-03 for procedure					
HARVESTER					
Check all Fasteners and Fittings.		X		x	
Check and oil, Chains and Sprockets.	х				
Check Tire Pressures : Front -35 psi. Rear - 48 psi.	}x				
Check/Sharpen/Replace-Cutter Blades.	x			-	
Check/Adjust /Replace-Cutter Drive Belt.	x				
Check Main and Index Conveyor Belts.	x		<i>P</i>		
Check Conveyor Slides.	x				
Check Lug Nut Torque: Rear – 240 lbs/ft. Front – 240 lbs/ft.	x	X			

STORAGE: Clean the machine. Maintain Tire Pressures. Turn Battery Isolator Switch '**OFF**'. Maintain Battery Charge. Grease Hydraulic Cylinder Rods.

LUBRICATION -

Steer Slewing Ring.

IMPORTANT

It is important that the Slewing Ring is lubricated following the recommended instructions.

Failure to follow these instruction may cause the breakdown of the bearing raceway, resulting in expensive repair costs.

Apply the pressure gun to both grease fittings '**A**' located on the inside face of the Slewing Ring.



LUBRICANTS.

Suitable lubricants for the raceway system are shown below.

Depending on operating temperatures, grease with base oils up to ISO VG1500 can be used to improve the lubricating film in slewing rings which are driven with very high loads and at very low speeds – (swiveling operation).

If these conditions occur, contact **INA** Engineering Service.

Raceway Lubricant.

Manufacturer.

Aralub HLP2.	Aral.
Energrease LS-EP2.	BP.
Gilssando EP2.	DEA.
EPEX EP2.	ELF.
BEACON EP2.	ESSO.
Centoplex GLP 402.	Kluber.
Mobilux EP2.	Mobil.
Alvania EP2.	Shell.
Retinax LX2. (INA Designation ;SM03).	Shell
	1

See following page for more important information on Slewing Ring lubrication.

Slewing Ring.

Initial Grease Lubrication.

INA Slewing Rings are supplied with an initial grease lubrication of a high quality lithium complex soap base grease KPN2N-25 (DIN 51825).

The free space in the raceway system in the bearing is filled with grease. A grease with an operating temperature range of -13deg.F to +302deg.F(- 25deg.C to +150 deg. C), is suitable.

Re-lubrication Interval.

Re-lubrication intervals are dependant on :

- Operating conditions.
- Environmental issues such as contamination, water etc.
- The design of the Slewing Ring.

The re-lubrication interval can only be precisely determined by carrying out tests under operating conditions. If comparable results are not available, the guide values shown below can be used.

Values shown are based on the following conditions:

- Operating temperature 158deg.F (70deg.C).
- Circumferential speed 0,5m/s.
- Low to medium loading.

Recommended re-lubrication period.

Heavy contamination, operating in field conditions. Harvesters, Cranes, Diggers. Excavators.	100 to 200 hours.
Excavators.	hours.

The raceway system of a slewing ring should always be re-lubricated in the following instances :

- After each cleaning eg. spraying with water, steam etc.
- Before and after long stationary periods, such as inactive winter months, if high levels of moisture occur.

Grease 'operating life' for the raceway system.

If re-lubrication is not possible, the operating life is a decisive factor.

Experience of a large number of applications shows that guide values for the grease operating life can be taken as twice that of the guide value for the re-lubrication interval.

At operating temperatures over 158deg. F (70deg.C), both the re-lubrication interval and the grease operating life are reduced.

In order to ensure operational safety, the grease operating life should not exceed 3 years.

IMPORTANT

When using a pressure washer do not allow the water jet to be pointed at the Slewing Ring Seals. The high pressure water will force dust, dirt and contaminants past the seals and into the raceway. This will result in premature failure of the bearings in the raceway system.

Raceway System.

Re-lubrication procedure.

Contaminants such as dirt, dust, spray water and cont aminants are forced out by the re-lubrication procedure.

- It is preferred that the same lubrication as used for the initial operation should be used for re-lubrication.
- Re-lubrication should always be carried out while the slewing ring is warm from operation.
- Clean the lubricating grease fittings.
- Press grease into the lubricating grease fittings in turn, until a collar of fresh grease forms all the way around both of the seals (turn one bearing ring slowly during this process).
- The used grease must be able to flow out unhindered.
- Ensure that all feed ducts are full of lubricant before returning the slewing ring to operation.

LUBRICATION











and a state of the







LUBRICATION

















LUBRICATION_













SECTION 7

Auto-Steer Set-Up.

Set-Up and Operation	7-01
Hydraulic Schematic	7-02
Electrical Schematic.	7-03
Steer Cylinder - replace/set-up.	7-04

AUTO-STEER

Auto-Steer Operation.

When the machine is ready to commence harvesting, it is important that the Auto-Steer set-up is carried out as shown in the following instructions.

The operator must read the operating instructions in Sections 2 and 3, before using the Auto-Steer.

Cutting the Starting Strip.

The starting strip of turf must be cut '**manually steering**', this creates the turf 'edge' for the Guide Shoe to follow.

• Start the engine and Switch System Power '**ON**' with Switch '**A**'. Prepare to start the harvesting procedure as shown on page 3-07.

Using *manual steering* proceed to cut the starting strip. The starting strip *must be cut straight*, to ensure satisfactory operation of the Auto-Steer.

When the starting strip has been cut :

- Position the harvester parallel to the start strip, with the Cutter Side Blade aligned with the 'cut edge' of the turf.
- Activate the Auto-Steer to '**ON**' with Pad '**B**', on the Control Handle.

NOTE

If the Guide Shoe lowers on the 'un-cut' turf, when the Auto-Steer is activated, turn the Auto-Steer '**OFF**'. The re-set cylinder will move the Guide Shoe 'off ' the un-cut turf, then turn the Auto-Steer back '**ON**'.

Proceed to cut the second strip:

- Lower the Cutter Head with Pad 'C'.
- Continue cutting the second strip, using the 'Fine Adjust' Control 'D to trim any waste, or leave a strip of turf if required.









AUTO-STEER



AUTO-STEER



AUTO-STEER _____

Steer Cylinder.

If the Steer Cylinder is replaced it is important that the following procedure is followed.

- Prior to installation: With the Cylinder fully retracted the Rod and Head Ends should be adjusted to 29 in.(737mm) center to center.
- At this Point tighten only the Head End Lock-nut.

The Rod End lock-nut 'E' is tightened after the sensor alignment procedure as shown below.



SET SCREW

LINE

IMPORTANT

If the Sensor is replaced or moved from cylinder to cylinder it is imperative that the indicator line on the Sensor is positioned 180 deg. from the cylinder, as shown. The Set Screw allows the removal of or adjustment of the Sensor.

- Ensure that the 'notch' 'G' in the cylinder rod is aligned with the Cylinder Sensor 'C'.
- Turn the Rod End 'D' to position the Lock-bolt 'F' 180 degrees opposite to the Cylinder Sensor 'C'. Tighten lock-bolt 'F' until it is hard against the flat portion of the Cylinder Rod 'B'. Tighten the Lock-nut 'E'..
- Tighten the Locknut 'E'.

This prevents the possible rotation of the cylinder rod if the lock-nut 'E' loosens, causing misalignment of the sensors and loss of auto-steer calibration.

Steering angle - Stop Bolts adjustment.

- Turn the Stop Bolts 'A'&'B' fully 'IN'.
- Retract the Steer Cylinder, (left lock), until it 'bottoms out'.
- Turn the Stop Bolt 'A' out until it is against the Frame, at 'C'
 Extend the cylinder '*slightly*' so that the bolt is 1/8in. away from the frame, and tighten it hard against the frame. Tighten the lock-nut.
- Repeat the procedure with Stop Bolt 'B' and with the cylinder fully extended. (Right lock).





LINE MUST BE 180 DEG FROM CYL

SECTION 8

Controls	8-01
Air Conditioning Filter Service.	8-01
Windshield Washer Fluid Container.	8-01
Engine and Air conditioning Coolers.	8-02

Radio Owners Manual.

CAB MAINTENANCE

Cab Controls.

- 1. Hazard Lights. 2. Road Lights.
- 3. Field Lights. 4. Work Lights.
- 5. A/C Controls. 6. Rear View Screen
- 7. Cab O/Head Light. 8. W/Shield Washer/Wiper.
- 9. Radio.(See following Insert for Owner's Manual).
- 10. Switch Panel. (See page 2-01).



Cab Air Conditioner Filter.

Remove the Air Cleaner Cover to access the Filter. Unscrew the retainer nut and remove the filter. Thoroughly clean the filter, or fit a new one if needed When fitting the cover ensure that the rubber seal is intact and correctly seated.

Windshield Washer.

The Washer Fluid Container is located as shown.

Always use a quality washer fluid that is suitable for the temperature zone in which the machine will be operating.



CAB MAINTENANCE

Engine, Aftercooler and Air Conditioner Coolers.

Check regularly and remove any dust or debris from the coolers that will affect their efficiency.

See section 9 – Engine Operation and Service Manual for Radiator/Cooler maintenance procedure.







HEAVY DUTY

JHD1635BT

AM/FM/RBDS/WB/USB/AUX-IN/BT/Sirius XM Ready Heavy Duty Radio

Installation and Operation Manual





CONTENTS

INTRODUCTION

System Features

Features of Jensen JHD1635BTmobile audio system include:

- Full Dot Matrix LCD
- AM/FM US/EURO Tuner with 30 Presets (12AM, 18FM)
- RBDS (Radio Broadcast Data Service) with PTY Search
- Sirius XM Radio Ready
- USB Playback of MP3 and WMA files (Front USB or Rear USB)
 - Weatherband Tuner with SAME Technology
- Mute
- Bluetooth (Supports A2DP, AVRCP and HFP)
- Pre-set Equalizer 5 settings (User, Flat, Pop, Classical, Rock)
- Electronic Bass, Treble, Balance and Fader Controls
- Output Power 45W x 4
- Clock 12/24 Hour Selectable
- Public Announcement (PA) Feature with Optional Microphone
 - IR Wireless Remote Control Ready (sold separately)
 - 2-Channel Pre-amp Line Level Outputs
- 2- Wire Power with Non-Volatile Memory and Clock/Time support
 - Auxiliary Audio Input (Front 3.5mm Stereo Jack, Rear RCA)
- Wired Remote Control Ready(JHDHBC Sold Separately)

Content List

- Jensen Heavy Duty Radio
 - Hardware Kit
- Installation Manual
- Quick Reference Guide





SAFETY INFORMATION

When Driving

Keep the volume level low enough to be aware of the road and traffic conditions.

When Washing Your Vehicle

Do not expose the product to water of excessive moisture. Moisture can cause electrical shorts, fire or other damage.

When Parked

Parking in direct sunlight can produce very high temperatures inside your vehicle. Give the interior a chance to cool down before starting playback.

Use the Proper Power Supply

This product is designed to operate with a 12 volt DC negative ground battery system.

WARNING:

- TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK, DO NOT EXPOSE THIS EQUIPMENT TO RAIN OR MOISTURE.
- TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK AND ANNOYING INTERFERENCE, USE ONLY THE RECOMMENDED ACCESSORIES.

INSTALLATION

many cases, a special installation kit will be required to mount the radio to the dashboard. See the dealer where the radio was purchased for kit availability. Always check the kit application This unit is designed for installation in vehicle cabs with an existing 1-DIN radio opening. In before purchasing to make sure the kit works with your vehicle.

Before you Begin

- Disconnect Battery
- Before you begin, always disconnect the battery negative terminal. Remove Transport Screws d.

Important Notes

- Before final installation, test the wiring connections to make sure the unit is connected properly and the system works.
 - Use only the parts included with the unit to ensure proper installation. The use of unauthorized parts can cause malfunctions.
- Consult with your nearest dealer if installation requires the drilling of holes or other modifications to your vehicle.

۲.

- Install the unit where it does not interfere with driving and cannot injure passengers during a sudden or emergency stop.
 - If the installation angle exceeds 30° from horizontal, the unit might not give optimum performance.
- Avoid installing the unit where it will be subjected to high temperatures from direct sunlight, hot air, or from a heater, or subject to excessive dust, dirt or vibration.

DIN Front Mount

Dashboard

- disengage it. The removal keys are Slide the mounting sleeve off of the removed. If it is locked into position, depicted in "Removing the Unit" on use the removal keys (supplied) to chassis if it has not already been page 3.
- carefully cut or files as necessary until Check the dashboard opening size by sliding the mounting sleeve into it. If the opening is not large enough, the sleeve easily slides into the ц сі

opening. Do not force the sleeve into the opening or cause it to bend or bow. Check that there will be sufficient space behind the dashboard for the radio chassis.

Locate the series of bend tabs along the top, bottom and sides of the mounting sleeve. With the sleeve fully inserted into the dashboard opening, bend as many of the tabs outward as necessary to firmly secure the sleeve to the dashboard. ы.

Place the radio in front of the dashboard opening so the wiring can be brought through the mounting sleeve.

4

- Follow the wiring diagram carefully and make certain all connections are secure and insulated with crimp connectors or electrical tape to ensure proper operation. After completing the <u>ى</u> ы.
- wiring until the problem is accessory switch must be off and proceed with final turn the accessory switch into the mounting sleeve mounting of the chassis. Carefully slide the radio wiring connections, turn corrected. Once proper on). If the unit does not operation is achieved, the unit on to confirm operate, recheck all operation (vehicle



right-side-up until it is fully seated and the spring clips lock it into place. making sure it is

- CAUTION: The perforated rear support strap or rear rubber mounting bushing must damage to the radio or the mounting surface and void the manufacturer's warranty. Attach one end of the perforated support strap (supplied) to the screw stud on the rear of above or below the radio using the screw and plain washer provided. Bend the strap, as the chassis using the hex nut provided. Fasten the other end of the dashboard either necessary, to position it. Some vehicle installations provide cavity for rear support. In be used in the installation of the radio. Installation without either may result in these applications, place the rubber bushing over the screw stud and insert. ö
- Test radio operation by referring to the operating instructions for the unit. **Removing the Unit**

<u></u>б

Bend Tabs

- To

IIIII

182

Screw Stud

remove the plastic end caps, insert the removal keys are inserted at an angle, To remove the radio after installation, removal keys straight back until they they will not lock properly to release click, and then pull the radio out. If the unit.

Reconnect Battery

When wiring is complete, reconnect the battery negative terminal.





WIRING



DETAIL A SHOWN FROM PIN VIEW

NO CONNECTION	B8
+12V ACC SWITCHED	B7
NO CONNECTION	B6
GROUND	B5
NO CONNECTION	B4
NO CONNECTION	B3
NO CONNECTION	B2
NO CONNECTION	B1
RIGHT REAR SPEAKER (-)	A8
RIGHT FRONT SPEAKER (-)	A7
LEFT FRONT SPEAKER (-)	A6
LEFT REAR SPEAKER (-)	A5
LEFT REAR SPEAKER (+)	A4
LEFT FRONT SPEAKER (+)	A3
RIGHT FRONT SPEAKER (+)	A2
RIGHT REAR SPEAKER (+)	A1
DESCRIPTION	PIN NO.

WARNING! Do not connect the +12VDC ACC switched wire to the battery. This wire MUST be connected to the Accessory/Ignition wire or a +12 volts switched power source.



JHD1635BT

A	≿
	D
S	ζ
	E
	T

BASIC OPERATION



Power On/Off/Radio

Press the rotary encoder **POWER** button (1) to turn the unit on or *press and hold* to turn off. The unit will resume at the last mode selected (Tuner, Auxiliary, etc.).



Volume Control

To increase the volume, turn the rotary encoder (1) to the right. To decrease the volume, turn the rotary encoder to the left. While adjusting the volume, the LCD displays a bar graph and numerical representation of the level.



The maximum volume setting is 40.

Mute

Press the **MUTE** button (22) to mute the audio output. Press **MUTE** again to restore the audio output to the previous level.

Mode

Press the **MODE** button (4) to select a different mode of operation, as indicated on the display panel. Available modes include the following: Tuner (AM/FM) > SXM (SiriusXM) > iPod/USB > Auxiliary > BT Audio. Tuner is the default source when a prior source is no longer available.

NOTE: iPod, USB or SiriusXM (SXM) mode will be skipped if the device is not installed.

NOTE: SiriusXM (SXM) mode will be skipped when the Region menu option is set to "EURO".

Reset

The reset button should be activated for the following reasons:

- Initial installation of the unit when all wiring is completed
 - Function buttons do not operate
 - Error symbol on the display

Use a ball point pen or thin metal object to press the RESET button (21). This may be necessary should the unit display an error code.

Audio Menu

Press the **POWER/AUDIO** button (1) to access the audio menu. You can navigate through the audio menu items by pressing the **POWER/AUDIO** button repeatedly. Once the desired menu item appears on the display, adjust that option by turning the rotary encoder (1) within 5 seconds. The unit will automatically exit the audio menu after five seconds of inactivity. The following menu items can be adjusted.

Bass Level

Use the rotary encoder (1) to adjust the Bass level range from "-6" to "+6".

Treble Level

Use the rotary encoder (1) to adjust the Treble level range from "-6" to "+6".

Balance

Adjusting Balance controls the relative level between the left and right speakers in each pair. Use the rotary encoder (1) to adjust the Balance between the left and right speakers from "Left 12" to "Right 12".

Fader

Adjusting Fade controls the relative level between the front and rear speaker pairs. Use the rotary encoder (1) to adjust the Fader between the rear and front speakers from "Rear 12" to "Front 12".



- Press and hold the PTY/CAT/MENU button (2) for more than 2 seconds to enter the system menu. The first menu item, "Key Beep", will appear on the display.
- Ņ Press the TUNE/SEEK |<</ >>| (18, 19) button repeatedly to navigate the system menu.
- Press the **INFO/ENTER** button (16) to select the desired item.
- Press the INFO/ENTER button again to adjust the selected menu item

The following items can be adjusted:

- Key Beep (On / Off): Turn the audible beep On/Off (heard when functions/buttons are selected).
- LCD Backlight (1-10): Adjust LCD brightness
- LCD Contrast (1-10): Adjust LCD contrast.
- Button Backlight (1-10): Adjust Button brightness
- Tuning Region (USA / EURO): Set frequency spacing for various regions.
- Power-Off Clock (Off, 1-10): Brightness setting of clock when powered off
- Clock Format (12Hour / 24Hour): Select 12 or 24 hour display mode.
- Set Clock (HH : MM):
- Press the INFO/ENTER button (16) to view the clock set screen
- Press the INFO/ENTER button to move to the next digit.
- Press the TUNE/SEEK |<</ >>| (18, 19) buttons to adjust the selected digit
- Alarm Time
- Alarm (On/Off)
- Alarm Set Time (HH:MM
- Preset-Only Tuning (On / Off)
- Sirius XM Settings Menu (only appears when Sirius XM tuner is connected and in Sirius XM mode)
- Clock Autoset (On/Off): Sets clock based on SXM data
- Time Zone1 (Atlantic / Eastern / Central / Mountain / Pacific / Alaska)
- Daylight Saving Time (Yes/No)
- Set Lock Code: _
- Locked Channels: List of Channels (Locked / Unlocked)
- SXi Firmware Version
- Weather Alert Configuration
- Min Alert Level (All / None / Warnings / Watches)
- Auto-On Enable (Yes/No): Select "Enabled" to turn on the radio when NOAA alerts
- are issued. This function only works when the +12V switched is on Alert Volume (Select Volume Level 0-40)
- Clear SAME Codes <ENTER>
- SAME Code 1: _
- SAME Code 2: _
- SAME Code 3: _
- SAME Code 4: _
- SAME Code 5:
- SAME Code 6:

- SAME Code 7:
- Battery Alarm (On/Off)
- Battery Auto-Off (On/Off)
- Bluetooth Setup
- BT: (On/Off)
- BT HFP Volume: (Select Volume Level 0-40) Hands-free call volume
- BT Device List <Enter>: View a list of devices paired with the unit
- Lock
- Connect / Disconnect
- Delete
- BT Pair <Enter to enable>
- BT Auto Answer: (On/Off)
- Reset System Defaults <ENTER>: Press the INFO/ENTER button (16) to return the unit to factory default set up values.

Equalizer

curves: USER > FLAT > POP > CLASSICAL > ROCK Press the EQ/LOUD button (11) to choose one of the following pre-defined bass and treble



Loudness

characteristics of human hearing Press and hold the EQ/LOUD button (11) to toggle loudness on/off. When listening to music at low volumes, this feature will boost the bass and treble ranges to compensate for the

Auxiliary Input

To access an auxiliary device

- Connect the portable audio player to the 1/8" AUX IN on the front panel (13)
- Press the MODE button (4) to select "Auxiliary" mode.
- ω Press MODE again to cancel "Auxiliary" mode and go to the next mode

PA Operation

- Connect PA Microphone (JMICHFP) with a 4-PIN connector to the 4-PIN socket on the rear of the unit.
- "ON" The unit will automatically switch to PA mode when the mic switch is pushed
- The PA output level can be adjusted using the rotary volume encoder (1).
- With radio power off, the radio will wake up when PA mic button is pressed to make an and PA is active. Radio will return to the off state when the PA mic is released. announcement. Please note that it will take a few seconds before the radio "wakes up'
Liquid Crystal Display (LCD)

The current frequency and activated functions are shown on the LCD panel (20).

NOTE: LCD panels may take longer to respond when subjected to cold temperatures for an extended period of time. In addition, the visibility of the characters on the LCD may decrease slightly. The LCD display will return to normal when the temperature increases to a normal range.

Setting the Clock

To set the clock to display the current time, turn the vehicle ignition on and turn the radio on. Enter the system menu and adjust the clock by selecting the "Set Clock" menu item.

- Press the INFO/ENTER button (16) to view the clock set screen.
- Press the TUNE/SEEK |<< / >>| (18, 19) buttons to adjust the selected digit.

Press the INFO/ENTER button to move to the next digit.When no adjustment is made for five seconds, the time will become set and normal operation will resume.

Scroll

When the information is too long to be displayed on the LCD, press the **DISP/SCROLL** button (12) to view the entire title. The information will scroll twice and then return to abbreviated text.



TUNER OPERATION



Select a Band

Press the **BAND/WB** button (15) to change between three FM bands and two AM bands. Press and hold the **BAND/WB** button to access the Weather band (WB).

Manual Tuning

Press the **TUNE/SEEK [<<** or **>>]** buttons (18, 19) to seek stations up/down step by step.

Auto Seek Tuning

Press and hold the **TUNE/SEEK** [<< or >>] buttons (18, 19) to automatically seek the next or previous strong station.

NOTE: Seek tuning is not available for weather band channels. Use the up or down tuning buttons to manually select any of the seven available weather band channels.

ω

Preset Stations

Six numbered preset buttons store and recall stations for each band.

Store a Station

Select a band (if needed), then select a station. Press and hold a preset button (5-10) for two seconds. The preset number will appear on the LCD.

Recall a Station

Select a band (if needed). Press a preset button (5-10) to select the corresponding stored station.

NOTE: Preset buttons are pre-assigned frequencies in weather band mode.

Automatically Store / Preset Scan (AS/PS)

Automatically Store

Select an AM or FM band. Press and hold the **AS/PS** button (14) for more than 2 seconds to automatically select 18 strong stations (12 for AM). "Storing Presets" appears on the screen and the new stations replace any stations already stored.

Preset Scan

Select a band. Press **AS/PS** (14) to scan stations stored in the current band. The unit will pause for 5 seconds at each preset station. Press **AS/PS** again to stop scanning when the desired station is reached.

RBDS Operation

This unit is equipped to display RBDS (Radio Broadcast Data Service) information when broadcast by the radio station.

NOTE: Radio stations broadcasting RBDS may not be available in your listening area.

In FM radio mode, press the **PTY/CAT/MENU** button (2) to list the following Program Type (PTY) options: ANY / News / Information / Sports / Talk / Rock / Classic Rock / Adult Hits / Soft Rock / Top 40 / Country / Oldies / Soft / Nostalgia / Jazz / Classical / Rhythm and Blues / Soft Rhythm & Blues / Foreign Language / Religious Music / Religious Talk / Personality / Public / College / Weather / Emergency Test / EMERGENCY!

To search for stations in a PTY category:

- Press the **PTY/CAT/MENU** button (2) to view the current PTY category.
- Press the TUNE/SEEK <- or >> buttons to move through the list of available categories and select the program type you wish to search.
- After selecting the desired PTY, press the **INFO/ENTER** button (16) to search the band for broadcasts of this type. "PTY Search" is displayed while the tuner is searching.

NOTE: Performing a PTY search on "ANY" will Seek Tune and stop on any station broadcasting RBDS, regardless of the program type.

Weather Band Operation

What is the NOAA Weather Radio/Weatheradio Canada?

Service (NWS) network. The U.S. network has more than 530 stations covering the 50 states as broadcasting frequencies used. A similar system is available in Canada under the Weatheradio well as the adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands and the U.S. Pacific broadcasts local weather emergency information 24 hours a day via the National Weather Territories. Each local area has its own transmitting station and there are a total of seven VOAA (National Oceanic and Atmospheric Administration) is a nationwide system that Canada service administered by Environment Canada.

Tuning to Weatherband

Press and hold the **BAND/WB** button (15) to access the Weatherband. The indication "WB" will WB-2", "WB-3", "WB-4", "WB-5", "WB-6" or "WB-7". The seven frequencies are shown in the appear on the display panel, along with the current number and channel indication: "WB-1", following table:

	nei loico
Frequency (MHz)	Preset
162.400	2
162.425	7
162.450	2
162.475	£
162.500	9
162.525	-
162.550	Ļ

WR Frequencies

frequency cannot be accessed using a preset button. The frequency can only be reached using The above table also shows which preset button will access the frequency. Note that one the tuning controls.

Use the TUNE/SEEK |<< or >>| buttons (18, 19) or the preset buttons to tune to each of the seven channels until you find the weatherband station broadcasting in your area.

How many stations can I expect to receive?

Since the broadcasts are local weather and information, the transmission power is usually very unless you are on the edge of two or more broadcast signals. The most you will receive will be low (much less than standard AM or FM stations) so you will usually receive only one station two or three, and that is rare.

Is it possible I won't receive any stations?

signal or none at all. Also, similar to AM and FM signals, weatherband signals are subject to Depending on where you are located, there is a possibility you will receive only a very weak

surrounding conditions, weather, obstructions of the signal by hills or mountains, etc.

NOAA Weather Alert

NOAA warning tone (1050 Hz) is received/detected. If no additional warning tone is received for 60 seconds, the unit will switch back to the last known function mode. See "System Menu" on The Weather Alert function adds an additional level of user safety by automatically switching from any of the available function modes to weather band for a minimum of 60 seconds if a page 6 to learn how to turn the WB Alert feature on.

SAME Decoding and Filtering

Geographical Area code and has the form PSSCCC where "P" represents a portion of the county, the system setting menu with up to seven Geographical Area codes to limit the automatic tuning county, province, or major metropolitan area within the state. This unit can be configured through SAME data contains information about the geographic region affected by the alert, the type of 'SS" is a two-digit state, territory, or offshore marine area identifier and "CCC" identifies the alert, and its effective time. The geographic region included in the SAME data is called the Specific Area Message Encoding (SAME) data is also broadcast prior to alert broadcasts. or power on functions described above.

SAME data also includes the type of alert being broadcast. This unit can be configured through the System Setting Menu to limit the automatic tuning or power on functions based on the type of alert.

subdivision. The next two digits identify the state or territory, and the last three identify the county. FIPS code or Federal Information Processing System code is a six digit code that identifies the The FIPS code for your area can be found by calling the NWS toll free number or visiting the SAME is activated by programming a 6 digit code - called a FIPS code - into your radio. The states and counties (or parishes) in the United States. The first digit identifies the county web site.

The phone number is 1-888-NWS-SAME (1-888-697-7263). Upon calling, an automated system will prompt you to enter your state and county. When you confirm the information, the system will provide your six digit FIPS code.

The web site is: www.nws.noaa.gov/nwr/indexnw.htm. Upon selecting your state from the chart, you will see a listing of all the counties in that state. For each county there is a listing of the SAME# (FIPS code), the location of the transmitter, the WB frequency, the call sign, the transmitter power and miscellaneous remarks.

NOTE: Because broadcast areas overlap you may want to set more than one S.A.M.E. location. If you live near the border between counties, you may want to receive alerts from more than one tower.

default code has been programmed at the factory - 000000 - to respond to all messages within Your radio is capable of being programmed with up to 7 different FIPS location codes. The your area.



USB OPERATION



Digital File Playback

If the user connects a USB mass storage device, the radio automatically powers on, if necessary, and switches to digital file playback mode. Changing modes or turning off the radio pauses playback. Playback shall resume exactly where paused when returning to digital file playback mode.

Inserting a USB Device

The front USB connector (17) and the rear USB connector work separately. The front USB connector is located at the bottom right of the front panel, behind a protective rubber cover. Pull gently to lower the rubber cover and reveal the USB slot. The rear USB connector is located at the back of the module. Insert a USB device at the front or rear USB connector to switch to USB mode and begin playback automatically. Only the current device can be charged.

When both front and rear USB connectors are connected to USB devices, press **MODE** (4) to select either front USB or rear USB to playback. If the non-playing device is pulled off, the playing device will continue the playback without any impact.

If the USB device is playing music with front USB connector, and then insert another device into the rear USB connector, the device connected via rear USB will begin music playback and the device connected via front USB will stop. Vice versa.

Controlling File Playback

Selecting Tracks

Press the **TUNE/SEEK** >>| (19) or **TUNE/SEEK** |<< button (18) to advance to the next track/ file. The selected track number will appear on the display. *Press and hold* the **TUNE/SEEK** >>| or |<< button to fast forward or fast reverse. Playback begins when the button is released. *Play/Pause Playback*

> Press the **MUTE/>**|| button (22) to suspend playback. "Pause" is displayed on the screen. Press the **MUTE/>**|| button again to resume play.

Previewing Tracks

Press the **2/INT** button (6) to play the first 10 seconds of each track in the current folder sequentially. Press **2/INT** again to stop Intro Scan and resume normal play at the current track. **Repeat Play**

- Press the 1/RPT button (8) during disc play to repeat the current track.
- Press 1/RPT again to stop repeat play.

Random Play

- Press the **3/RDM** button (5) during playback to play all tracks in the current folder in random, shuffled order.
- Press 3/RDM again to stop random play

Folder Navigation (MP3 Only)

- Press the PTY/CAT/MENU button (2) to view a list of all songs in the current folder.
- Press the >>| / UP (19) and |<< / DN (18) buttons to navigate the list.
- Press the **INFO/ENTER** button (16) to play the highlighted song or view files in the selected folder. Continue pressing INFO/ENTER until the desired file is selected.
- Press the **PTY/CAT/MENU** button again to navigate up through the file structure.
- The unit will automatically exit the folder navigation menu after 5 seconds of inactivity.

MP3 Specifications

Notes on MP3 Playback

- Any directory that does not include an MP3 file is skipped
- Maximum number of folders: 512 (including skipped directories)
- Maximum number of folder levels: 12
- Maximum number of MP3 files: 999
- Maximum number of characters for MP3 file name and folder name: 32
- Maximum number of Characters of ID3 Tag:
- ID3 Tag version 1.0: 32
- ID3 Tag version 2.x: 32

File Playing Order

Files will be continually played sequentially within the current folder. To play songs in another folder, press the **PTY/CAT/MENU** button (2) twice to move up a folder level. Press the **>>/ UP** and **I<</ DN** buttons to navigate the list and then press the **INFO/ENTER** button (16) to access the selected song or folder.

SIRIUSXMTM RADIO OPERATION



NOTE: Only SiriusXMTM brings you more of what you love to listen to, all in one place. Get comedy and entertainment. Welcome to the world of satellite radio. A SiriusXM Vehicle over 140 channels, including commercial-free music plus the best sports, news, talk, Tuner and Subscription are required. For more information, visit www.siriusxm.com.

(Requires optional SIRIUSXM tuner) **Accessing SIRIUSXM Mode**

Press the MODE button (4) to change the mode to SiriusXM mode

Accessing your SiriusXM ID

TUNE/SEEK |<< (18) button to tune to channel "000". The screen will display "Radio ID" with the ID displayed in the middle of the LCD screen. The SiriusXM radio ID is 8 characters long and The SiriusXM ID is required for activation. To display your SiriusXM radio ID, use the does not include the letters I, O, S, or F.

Selecting a Band

In SiriusXM mode, press the BAND/WB button (15) to access the SiriusXM user-preset channel groups in the following order: SXM1, SXM2, SXM3.

Category Tuning

- Press the **PTY/CAT/MENU** button (2) to access Category mode.
- While in category mode, press 5/CAT- OR 6/CAT+ buttons (9, 10) to choose a category. сi
- The current channel number within the chosen category will always be the default first Press the **TUNE/SEEK** |<</ >>| buttons (18, 19) to navigate channels in that category. channel tuned.) ς.
- Press the INFO/ENTER button (16) to select the desired channel. 4

Channel Up/Down Tuning

Press the TUNE/SEEK |</ >>| buttons to search for a channel. Press and hold the **TUNE/SEEK** buttons to fast search.

Direct Tuning Mode

- Press and hold the INFO/ENTER button to enter direct tuning mode. ..
- Press TUNE/SEEK |</ >>| buttons to change the first of three digits for the desired channel in the direct entry screen. ä
- Press the INFO/ENTER button to confirm the entered digit and move to the second digit field.
 - Press TUNE/SEEK |<< / >>| buttons to select the second digit. 4.

ъ.

ć.

- Press the INFO/ENTER button to confirm the entered digit and move to the third digit field. Press TUNE/SEEK |<< / >>| buttons to select the third digit.
 - Press the INFO/ENTER button to confirm the three digit channel and tune to the selected channel. <u>م</u> .

Storing Preset Channels

The preset buttons (5-10) can be used to store 6 channels, allowing convenient access to your favorite channels.

Programming Channels

- Select the channel you want to store in memory. ..
- Press and hold a preset button (5-10) until the corresponding preset button number appears. с.
- Repeat steps 1 and 2 to program additional channels. *с*і

Preset Recall

Press one of the six preset buttons (5-10) to directly select a preset channel stored in the current band.

Preset Scan

Press AS/PS button (14) to scan stations stored in all three user-preset channel groups (SXM1 SXM2 and SXM3). The unit will pause for 10 seconds at each preset station.

Preset Tuning

18 preset stations in sequential order. Access preset tuning mode through the system menu. In Preset Tuning Mode, you can use the TUNE/SEEK |</ >>| buttons to access all Set Preset-Only Tuning to "ON."

Alternate Display Mode

Press the DISP/SCROLL button (12) to change the display information between single and dual While in category tuning list mode, press the DISP/SCROLL button in sequence to change the Press and hold the DISP/SCROLL button to scroll the Artist/Song Title information. line text display. In dual line mode, both artist and title are available for viewing. display information from Channel Name, Artist, and Song Title.

Satellite Signal Strength

The display will indicate satellite reception strength as shown below.

Excellent	Good	Weak	No Signal	Signal Strength
$ \triangleleft$	∀. I	\mathbb{P}	YX	Strength Display

Reset SiriusXM Channel Lock Code

default "0000". Resetting the lock code will not affect the locked channels list. If you forget your Parental Control lock code, use the following directions to reset the code to the

- <u>-</u> In SiriusXM mode, tune to Channel 0
- Ņ Set volume to 0.
- ω Press and hold the rotary encoder (1) to power off the unit.
- 4 With power off, press and hold the volume knob until the system version info is displayed on the screen
- ი თ Press the Preset 3 (5) button, screen will return to the clock
- Press the rotary encoder to power on the unit
- 7 The lock code has now been reset to "0000"

Channel Lock

Access Channel Lock through the System Menu under the "SiriusXM Satellite Radio" menu. See

"System Menu" on page 6.

- Select "Set Lock Code" and press the INFO/ENTER button (16)
- Ņ Enter the default lock code of "0000". To set the lock code:
- a Press the TUNE/SEEK |<< / >>| (18, 19) buttons to enter the first digit of the default
- Press the INFO/ENTER button to move to the next digit.
- <u></u> Repeat above steps to enter all 4 digits of the default code.
- Press the TUNE/SEEK |<</ >>| buttons to enter the first digit of the new code.
- Press the INFO/ENTER button to move to the next digit.
- Repeat above steps to enter all 4 digits.
- ω After setting a new four digit code, you can lock channels by entering the "Locked Repeat above steps to confirm the new code.
- Channels" menu.
- 4 Upon entering the Locked Channels list, you will be prompted to enter your four digit code.
- Press the TUNE/SEEK |<< / >>| buttons to enter the first digit.
- Press the INFO/ENTER button to move to the next digit.
- σı After entering the code, you can navigate the list using the TUNE/SEEK |<< / >>| buttons Repeat above steps to enter all 4 digits.
- <u>о</u> Press the INFO/ENTER button to Lock (indicated by a \bigoplus icon) or Unlock \bigoplus the selected channel to highlight the channels.



Advisory Messages Reported by the SiriusXM Vehicle Tuner

On-Screen Display	Advisory Message	Cause	Explanation/Solution
Check Antenna	Check Antenna	The radio has detected a fault with the SiriusXM antenna. The antenna cable is either disconnected or damaged.	 Verify that the antenna cable is connected to the SiriusXM Connect Vehicle Tuner. Inspect the antenna cable for damage and kinks. Replace the antenna if the cable is damaged.
Check Tuner	Check Tuner	 The radio is having difficulty communicating with the SiriusXM Connect Vehicle Tuner. The tuner may be disconnected or damaged. 	 Verify that the SiriusXM Connect Vehicle Tuner cable is securely connected to the radio SiriusXM mating connector/ cable. If the problem persists, disconnect and reconnect the tuner and then contact your dealer.
No signal	No signal	The SiriusXM Connect Vehicle Tuner is having difficulty receiving the SiriusXM satellite signal.	 Verify that your vehicle is outdoors with a clear view of the southern sky. Verify that the SiriusXM magnetic mount antenna is mounted on a metal surface on the outside the vehicle. Move the SiriusXM antenna away from any obstructions. Inspect the antenna cable for damage and kinks. Replace the antenna if the cable is damaged. If the problem persists, disconnect and reconnect the tuner and then contact your dealer.
Scrolling "Subscription Updated" – press any key to continue"	Subscription Updated	The radio has detected a change in your SiriusXM subscription status.	 Press any key to clear the message. No further action is required. Questions about your subscription in the United States please visit www.siriusxm.com/activatenow or call SiriusXM Listener Care at 1-866-635-2349 Questions about your subscription in Canada, please visit www.siriusxm.ca/activatexm or call XM Listener Care at 1-877-438-9677
Chan Unavailable	Channel Not Available	The channel that you have requested is not a valid SiriusXM channel or the channel that you were listening to is no longer available. You may also see this message briefly when first connecting a new SiriusXM Connect Vehicle tuner. Visit www.siriusxm.com for more information about the SiriusXM channel lineup.	Visit www.siriusxm.com/channellineup for more information about the SiriusXM channel lineup.
Ch Unsubscribed	Channel Not Subscribed	The channel that you have requested is not included in your SiriusXM subscription package or the channel that you were listening to is no longer included in your SiriusXM subscription package.	 Questions about your subscription in the United States please visit www.siriusxm.com/activatenow or call SiriusXM Listener Care at 1-866-635-2349. Questions about your subscription in Canada please visit www.siriusxm.ca/activatexm or call XM Listener Care at 1-877-438-9677.



HEAVY DUTY	

On-Screen Display	Advisory Message	Cause	Explanation/Solution
Chan Locked	Channel Locked	The channel that you have requested is Locked by the radio	See the section on Parental Control, page 12 for more information
		Parental Control feature.	on the Parental Control feature and how to access locked channels.
Enter Code:	Enter Lock Code	User prompted to enter the lock/unlock code.	Enter the four digit code to unlock the channel
Wrong Code	Invalid Lock Code	The unlock code entered by the user is incorrect	 Input the correct four digit code to unlock the channel.
			 Reset lock code to default following instructions on page 12

iPod[®] OPERATION



This unit is equipped with an iPod ready function that will allow you to control your iPod (if compatible) using the control panel buttons. The following iPod versions are supported:

- iPod Nano 5G, 6G, 7G
 - iPod Classic
- iPhone 4, 4S, 5
- iPod Touch 3G, 4G, 5G

NOTE: Earlier model iPod's are not supported because they do not implement the required control protocol. Also, the iPod shuffle is not supported because it does not utilize the 30-pin Apple iPod Connector. These unsupported iPod models may be connected to the radio using one of the Auxiliary Inputs.

Accessing iPod Mode

Connect a supported iPod or iPhone to the front panel USB (or Rear USB) connector. The iPod icon illuminates in the bottom left corner of the LCD whenever an iPod or iPhone is attached to the USB connector. Music playback begins automatically. To enter iPod mode from any other source, press the **MODE** button (4) until "iPod" appears on the display. If the user connects an iPod containing no songs, the radio will display a message stating "No Songs" in iPod mode.



Turning the iPod On/Off

The iPod power turns on automatically when it is connected to the front panel USB port, as long as the vehicle ignition is turned on. You can turn the iPod off by disconnecting it or by turning the ignition off. When the ignition is off, the iPod will pause and then enter sleep mode after 2 minutes. While the iPod is connected, the power cannot be turned on or off from the iPod itself.

Controlling Playback

Pausing Playback

During playback, press the MUTE/>II button (22) to pause the iPod player. "Pause" will appear on the LCD. Press MUTE/>II again to resume playback.

Repeat Play

During playback, press the **1/RPT** button (8) to repeat the current song. "RPT" will appear on the LCD. Press **1/RPT** again to stop repeat playback.

Random Play

During playback, press the **3/RDM** button (5) to play all songs in the current category in random order. Random play will begin once the current song has finished playing. "RDM" will appear on the LCD. Press **3/RDM** again to stop random playback.

Selecting Tracks

During playback, press the **TUNE/SEEK** |<</ >>| buttons (18, 19) to play the previous or next track in the current category. Press the **TUNE/SEEK** |<< button once to play the song from the start position or press **TUNE/SEEK** |<< twice to play the previous track. Pressing the **TUNE/SEEK** |<< twice to play the previous track. Pressing the **TUNE/SEEK** |<< twice to play the previous track. Pressing the **TUNE/SEEK** |<< twice to play the previous track. Press the **TUNE/SEEK** |<</td>

NOTE: If you press and hold the TUNE/SEEK |<</ >>| button to change the current song to the previous/next song, you will exit fast reverse/forward mode.

Alternate Display Mode

Press the DISP/SCROLL button (12) to change the display information between single and double line text display.

Playlist Search

Press the **PTY/CAT/MENU** button (2) to access Playlist selection mode. While in Category mode, press the **TUNE/SEEK** |<</ >>> buttons to choose file search by Playlist, Artist, Album, Genre, Song, Audiobook or Podcast. Press the **INFO/ENTER** button (16) to select the search mode. Use the **TUNE/SEEK** |<</ >>> buttons to search the available files on the iPod. Press the **INFO/ENTER** button to play the selected song or file.

BLUETOOTH OPERATION

The JHD1635BT includes built-in Bluetooth technology that allows you to connect this head unit to Bluetooth devices for streaming audio playback.

About Bluetooth Technology

Bluetooth is a short-range wireless radio connectivity technology developed as a cable replacement for various electronic devices. Bluetooth operates in 2.4 GHz frequency range and transmits voice and data at speeds up to 2.1 Mbit/s over a range of up to 10 meters.

Bluetooth Menu Options

NOTE: Please note that some BT menu options are only available while the unit is in Bluetooth Audio mode.

Press and hold the **PTY/CAT/MENU** button (2) to enter menu adjustment mode. Press the **SEEK/TUNE** buttons (18, 19) repeatedly to view the Bluetooth Setup Menu options. Press ENTER to choose the highlighted option.

- BT ON/OFF: Press the ENTER button (16) to select "BT ON" or "BT OFF". When "On", the LCD will display the Bluetooth icon (16) (default "BT ON").
- BT HFP Volume: Press the ENTER button repeatedly to adjust the ring volume from 0-40 (default 35/previous setting).
- BT Device List: Press the ENTER button to view a list of previously paired mobile phone device models. Press the SEEK/TUNE buttons (18, 19) to view devices from the list. You cannot delete a device that is actively connected. Press the ENTER button to select the device. Press the SEEK+ or SEEK- button to choose Lock/Unlock, Disconnect or Delete for this device.
- LOCK/UNLOCK: The JHD1635BT can store up to 5 devices for Bluetooth connection. The devices are stored in FIFO (First in First Out) order. To prevent a device from being bumped from the list when more than 5 devices are used, you must lock the device. To lock/Unlock a device, press the ENTER button to display/change the Locked or Unlocked icon.
- DISCONNECT: To disconnect a paired device, press the ENTER button to temporarily remove the Bluetooth link. The link can be re-established through your phone menu by selecting the JHD1635BT for connection.
- DELETE: To delete a device from the list, press the ENTER button. NOTE: Device must be disconnected to be deleted.
- BT Pair: Press the ENTER button to turn BT Pair "On" to put the unit pairing mode to search for and be discovered by Bluetooth devices.
- BT Auto Answer: Press the ENTER button to turn the Auto Answer function "On" or "Off"



Pairing a Bluetooth Device

Before you begin, consult the owner's manual for the Bluetooth device you want to pair with the JHD1635BT.

- . Make sure the device is on and ready to receive a signal from the JHD1635BT. With the JHD1635BT in Bluetooth Audio mode, choose "BT Pair" from the JHD1635BT menu and press the **ENTER** button (16) to begin pairing. The unit is now waiting to connect to a mobile phone device. With the Bluetooth function of the mobile phone device turned on, search for a Bluetooth device.
- 2. When the Bluetooth device has completed its search, the mobile phone will display the Bluetooth device name (JHD1635BT).
- 3. Select JHD1635BT. The Bluetooth icon B will appear on the radio LCD.
- 4. Enter the pairing password (0000), if requested

After connecting successfully, you will be able to listen to music stored on your Bluetooth enabled device through the radio.

BT Audio (A2DP)

The A2DP music is available for Bluetooth enabled phones when the phone is connected. To access Bluetooth mode and play songs stored on your phone, press the **MODE** button (4). While in Bluetooth mode, the Bluetooth Audio icon \mathbb{I} will appear on the LCD.

Selecting Tracks

During playback, press the **SEEK/TUNE** (18, 19) buttons to play the previous or next track. *Pausing Playback* During playback, press the MUTE/>II button (22) to pause the Bluetooth AUDIO player. "BT AUDIO PAUSE" will appear on the LCD. Press MUTE/>II again to resume playback. If you change to another mode, the mobile phone audio will pause. Press the MODE (4) button to return to Bluetooth mode and resume mobile phone audio playback.

NOTE: If a Bluetooth device is disconnected due to the power being turned off or if the device is disconnected inadvertently, the unit will automatically search for the matching Bluetooth device when the power is restored.

Incoming/Outgoing calls

While the mobile device is connected through Bluetooth, the phone number for incoming calls will appear on the LCD. The incoming ring will be output through the unit unless the unit is broadcasting a Weather Band Alert or the PA system is in use.

oroadcasting a vveatner band Alert of the PA system is

Answer Call

If the Bluetooth Auto Answer function is turned "Off", the user must press the "CALL" button (3) to receive and incoming call.

If the BT Auto Answer function is turned "On", the unit will automatically receive the incoming call

after 5 seconds of ringing.

While the microphone (JMICHFP) is connected to the unit, the user can answer incoming calls through the Microphone.

Transfer Call

During the call, *press and hold* the "CALL" button transfer the call between the unit and the mobile device.

End Call

Press the "CALL" button to end a call. The unit will return to the previous mode.

Reject Incoming Call

To reject an incoming call, press and hold the "CALL" button.

CARE AND MAINTENANCE

- Keep the product dry. If it does get wet, wipe it dry immediately. Liquids might contain minerals that can corrode the electronic circuits.
- Keep the product away from dust and dirt, which can cause premature wear of parts.
- Handle the product gently and carefully. Dropping it can damage circuit boards and cases, and can cause the product to work improperly.
- Wipe the product with a dampened cloth occasionally to keep it looking new. Do not use harsh chemicals, cleaning solvents, or strong detergents to clean the product.
- Use and store the product only in normal temperature environments. High temperature can shorten the life of electronic devices, damage batteries, and distort or melt plastic parts.

Ignition

The most common source of noise in reception is the ignition system. This is a result of the radio being placed close to the ignition system (engine). This type of noise can be easily detected because it will vary in intensity of pitch with the speed of the engine.

Usually, the ignition noise can be suppressed considerably by using a radio suppression type high voltage ignition wire and suppressor resistor in the ignition system. (Most vehicles employ this wire and resistor but it may be necessary to check them for correct operation.) Another method of suppression is the use of additional noise suppressors. These can be obtained from most CB radio or electronic supply shops.

Interference

Radio reception in a moving environment is very different from reception in a stationary environment (home). It is very important to understand the difference. AM reception will deteriorate when passing under a bridge or when passing under high voltage lines. Although AM is subject to environmental noise, it has the ability to be received at great distance. This is because broadcasting signals follow the curvature of the earth and are

reflected back by the upper atmosphere.

TROUBLESHOOTING

Symptom	Cause	Solution
No power	The vehicle's accessory	If the power supply is properly
	switch is not on	connected to the vehicle's
		accessory terminal, switch the
		ignition key to "ACC".
	Fuse is blown	Replace the fuse.
No sound	Volume too slow	Adjust volume to audible level.
	Wiring is not properly	Check wiring connections.
	connected	
The operation keys do	Control panel is not	Reinstall control panel.
not work	properly installed	
	Built-in microcomputer is	Press the RESET button.
	not operating properly	
	due to noise	
Cannot tune to radio	Antenna cable is not	Insert the antenna cable firmly.
station, auto-seek does	connected	
not work	Signals are too weak.	Select a station manually.
ERROR-01 on LCD	Database or decoder	Change to another mode.
	error	
ERROR-02 on LCD	No songs on device	Remove device and add songs.
ERROR-03 on LCD	Abnormal current to USB	Change mode or unplug and
	device	reconnect USB device.
ERROR-04 on LCD	iPod/iPhone is not	Unplug and reconnect iPod/iPhone.
	verified	

SPECIFICATIONS

USB

Signal to Noise Ratio
Channel Separation More than 50 dB
Frequency Response
FM Radio
Frequency Coverage (USA)
Frequency Coverage (Europe)
Sensitivity (S/N = 30dB)
Stereo Separation
AM/MW
Frequency Range (USA) 530-1710 kHz
Frequency Range (Europe)
Sensitivity (S/N=20dB)
General
Frequency band(s) (for Bluetooth)
Maximum radio-frequency power transmitted (for Bluetooth)
Operating Voltage DC 12 Volts
Grounding System Negative Ground
Speaker Impedance
Tone Controls:
Bass (at 100 Hz)±10 dB
Treble (at 10 kHz)±10 dB
Power Output
Idle/Standby Current
Current Drain

FCC Notes

WARNING! Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this determined by turning the equipment off and on, the user is encouraged to try to correct the equipment does cause harmful interference to radio or television reception, which can be interference by one or more of the following measures:

Reorient or relocate the receiving antenna. •

- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.



ASA Electronics Corporation

www.asaelectronics.com www.jensenheavyduty.com ©2017 ASA Electronics Corporation v.090217

SECTION 9

Caterpillar Engine. Operation and Maintenance







Operation and Maintenance Manual

C3.6 and C2.8 Industrial Engines

J37 1-UP (Engine) J29 1-UP (Engine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

🛕 WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.

NOTICE

When replacement parts are required for this product Caterpillar recommends using original Caterpillar® replacement parts.

Other parts may not meet certain original equipment specifications.

When replacement parts are installed, the machine owner/user should ensure that the machine remains in compliance with all applicable requirements.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

Table of Contents

Foreword	4
Safety Section	
Safety Messages	6
Safety Messages	10
Additional Messages	13
General Hazard Information	13
Burn Prevention	17
Fire Prevention and Explosion Prevention	19
Crushing Prevention and Cutting Prevention	21
Mounting and Dismounting	21
High Pressure Fuel Lines	21
Before Starting Engine	23
Engine Starting	23
Engine Stopping	24
Electrical System	24
Engine Electronics	25
Product Information Section	
General Information	27
Product Identification Information	38
Operation Section	
Lifting and Storage	40
Features and Controls	43
Engine Diagnostics	57
Engine Starting	59
Engine Operation	63

Aftertreatment Operation	66
Cold Weather Operation	73
Engine Stopping	
Maintenance Section	
Maintenance Recommendations	80
Refill Capacities	83
Maintenance Interval Schedule	91
Warranty Section	
Warranty Information	132
Reference Information Section	
Engine Ratings	133
Customer Service	134
Reference Materials	135
Index Section	
Index	138

Foreword

California Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

WARNING – This product can expose you to chemicals including ethylene glycol, which is known to the State of California to cause birth defects or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Do not ingest this chemical. Wash hands after handling to avoid incidental ingestion.



WARNING – This product can expose you to chemicals including lead and lead

compounds, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to:

www.P65Warnings.ca.gov

Wash hands after handling components that may contain lead.

Literature Information

This manual contains safety, operation instructions, lubrication, and maintenance information. This manual should be stored in or near the engine area in a literature holder or literature storage area. Read, study, and keep it with the literature and engine information.

English is the primary language for all Cat publications. The English used facilitates translation and consistency in electronic media delivery. Some photographs or illustrations in this manual show details or attachments that may be different from your engine. Guards and covers may have been removed for illustrative purposes. Continuing improvement and advancement of product design may have caused changes to your engine which are not included in this manual Whenever a question arises regarding your engine, or this manual, please consult with your Cat dealer for the latest available information.

Safety

This safety section lists basic safety precautions. In addition, this section identifies hazardous, warning situations. Read and understand the basic precautions listed in the safety section before operating or performing lubrication, maintenance, and repair on this product.

Operation

Operating techniques outlined in this manual are basic. They assist with developing the skills and techniques required to operate the engine more efficiently and economically. Skill and techniques develop as the operator gains knowledge of the engine and its capabilities.

The operation section is a reference for operators. Photographs and illustrations guide the operator through procedures of inspecting, starting, operating, and stopping the engine. This section also includes a discussion of electronic diagnostic information.

Maintenance

The maintenance section is a guide to engine care. The illustrated, step-by-step instructions are grouped by fuel consumption, service hours and/or calendar time maintenance intervals. Items in the maintenance schedule are referenced to detailed instructions that follow.

Use fuel consumption or service hours to determine intervals. Calendar intervals shown (daily, annually, etc.) may be used instead of service meter intervals if they provide more convenient schedules and approximate the indicated service meter reading.

Recommended service should be performed at the appropriate intervals as indicated in the Maintenance Interval Schedule. The actual operating environment of the engine also governs the Maintenance Interval Schedule. Therefore, under severe, dusty, wet, or freezing cold operating conditions, more frequent lubrication, and maintenance than is specified in the Maintenance Interval Schedule may be necessary. The maintenance schedule items are organized for a preventive maintenance management program. If the preventive maintenance program is followed, a periodic tune-up is not required. The implementation of a preventive maintenance management program should minimize operating costs through cost avoidances resulting from reductions in unscheduled downtime and failures.

Maintenance Intervals

Perform maintenance on items at multiples of the original requirement. Each level and/or individual items in each level should be shifted ahead or back depending upon your specific maintenance practices, operation, and application. We recommend that the maintenance schedules be reproduced and displayed near the engine as a convenient reminder. We also recommend that a maintenance record be maintained as part of the engine's permanent record.

See the section in the Operation and Maintenance Manual, "Maintenance Records" for information regarding documents that are accepted as proof of maintenance or repair. Your authorized Cat dealer can assist you in adjusting your maintenance schedule to meet the needs of your operating environment.

Overhaul

Major engine overhaul details are not covered in the Operation and Maintenance Manual except for the interval and the maintenance items in that interval. Major repairs are best left to trained personnel or an authorized Cat dealer. Your Cat dealer offers various options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Cat dealer. Consult with your dealer for information regarding these options.

Safety Section

i07853993

Safety Messages

SMCS Code: 1000; 7405

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Ensure that you are familiar with all warning signs.

Ensure that all the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off the engine.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Caterpillar dealer can provide new warning signs.

. Ŧ

C3.6 Industrial Engine



Illustration 1 Typical example (1) Universal Warning label

(2) Hand (High Pressure) Warning label



Illustration 2 Typical example (1) Universal Warning label

Universal Warning

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.



Illustration 3 Typical example g01154807

g06458556

Safety Section Safety Messages

The universal warning labels are located in two positions. One label is on the front over the engine, the other label is on the right side of the engine.

Hand (High Pressure)

\Lambda 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.



5

Illustration 4

Typical example

The hand high-pressure label is on the high-pressure fuel line between pump and manifold, on the right side of the engine.

Ether Warning

🏠 WARNING

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



Illustration 5 Typical example g01154809

g02382677

The ether warning label is installed on the air cleaner close to the intake. The location will depend on the application. In some applications, the ether label will be supplied loose for fitting by the engine installer.

i08067908

Safety Messages

SMCS Code: 1000; 7405

There may be several specific warning signs on your engine. The exact location and a description of the warning signs are reviewed in this section. Ensure that you are familiar with all warning signs.

Ensure that all the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the illustrations are not visible. Use a cloth, water, and soap to clean the warning signs. Do not use solvents, gasoline, or other harsh chemicals. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off the engine.

Replace any warning sign that is damaged or missing. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Your Caterpillar dealer can provide new warning signs.

11 Safety Section Safety Messages

C3.6 Industrial Engine With A Balancer



Illustration 6

Typical example

(1) Universal Warning label

(2) Hand (High Pressure) Warning label

Universal Warning 1

Do not operate or work on this equipment unless you have read and understand the instructions and warnings in the Operation and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in serious injury or death.



Illustration 7 Typical example g01154807

The universal warning labels are located in two positions. One label is on the front over the engine, the other label is on the right side of the engine.

Hand (High Pressure) 2

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 8

Typical example

The hand high-pressure label is on the high-pressure fuel line between pump and manifold, on the right side of the engine.

Ether Warning

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



Illustration 9 Typical example g01154809

g02382677

The ether warning label is installed on the air cleaner close to the intake. The location will depend on the application. In some applications, the ether label will be supplied loose for fitting by the engine installer.

i07672517

Additional Messages

SMCS Code: 1000; 7405

There are several specific messages on this engine. The exact location of the messages and the description of the information are reviewed in this section. Become familiar with all messages.

Make sure that all the messages are legible. Clean the messages or replace the messages if you cannot read the words. Replace the illustrations if the illustrations are not legible. When you clean the messages, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the messages. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the messages. Loose adhesive will allow the messages to fall.

Replace any message that is damaged, or missing. If a message is attached to a part that is replaced, install a message on the replacement part. Any Caterpillar dealer can provide new messages.



Illustration 10

a03422039

Purge notice message

This notice should be located next to the battery disconnect switch.

NOTICE

Do not turn the battery power disconnect switch off until indicator lamp has turned off. If the switch is turned off when the light is illuminated then the DEF system will not purge and DEF could freeze and cause damage to the pump and lines.

i08356131

General Hazard Information

SMCS Code: 1000; 4450; 7405



Illustration 11

g00104545

Attach a "Do Not Operate" warning tag or a similar warning tag to the start switch or to the controls before the engine is serviced or before the engine is repaired. These warning tags (Special Instruction, SEHS7332) are available from your Caterpillar dealer. Attach the warning tags to the engine and to each operator control station. When appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

- Tampering with the engine installation or tampering with the OEM supplied wiring can be dangerous. Personal injury, death and/or engine damage could result.
- Vent the engine exhaust to the outside when the engine is operated in an enclosed area.
- If the engine is not running, do not release the secondary brake or the parking brake systems unless the vehicle is blocked or unless the vehicle is restrained.
- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When working around an engine, the engine must not be in operation. You may only be near a running engine to carry out maintenance procedures that require the engine to be in operation. When work is performed around an engine that is operating, wear protective devices for ears to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.

- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- · Use all cleaning solutions with care.
- · Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- The protective locks or the controls are in the applied position.
- Engage the secondary brakes or parking brakes.
- Block the vehicle or restrain the vehicle before maintenance or repairs are performed.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads to help prevent sparks. If equipped, allow the diesel exhaust fluid to be purged before disconnecting the battery.
- If equipped, disconnect the connectors for the unit injectors that are on the valve cover base. This action will help prevent personal injury from the high voltage to the unit injectors. Do not come in contact with the unit injector terminals while the engine is operating.
- Do not attempt any repairs or any adjustments to the engine while the engine is operating.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.
- For initial start-up of a new engine or for starting an engine that has been serviced, make provisions to stop the engine if an overspeed occurs. The stopping of the engine may be accomplished by shutting off the fuel supply and/ or the air supply to the engine. Ensure that only the fuel supply line is shut off. Ensure that the fuel return line is open.
- Start the engine from the operators station (cab). Never short across the starting motor terminals or the batteries. This action could bypass the engine neutral start system and/or the electrical system could be damaged.

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

Cautiously remove the following parts. To help prevent spraying or splashing of pressurized fluids, hold a rag over the part that is being removed.

- Filler caps
- Grease fittings
- · Pressure taps
- Breathers
- Drain plugs

Use caution when cover plates are removed. Gradually loosen, but do not remove the last two bolts or nuts that are at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose to relieve any spring pressure or other pressure.



Illustration 12

g00702020

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- Caterpillar recommends that you do not stand next to an exposed running engine unless it is necessary when carrying out daily checks or maintenance procedures. When work is performed around an engine that is operating, wear protective devices for ears to help prevent damage to hearing.
- Do not wear loose clothing or jewelry that can snag on controls or on other parts of the engine.
- Ensure that all protective guards and all covers are secured in place on the engine.
- Never put maintenance fluids into glass containers. Glass containers can break.
- · Use all cleaning solutions with care.

Report all necessary repairs.

Unless other instructions are provided, perform the maintenance under the following conditions:

- The engine is stopped. Ensure that the engine cannot be started.
- Disconnect the batteries when maintenance is performed or when the electrical system is serviced. Disconnect the battery ground leads. Tape the leads to help prevent sparks.
- Do not attempt any repairs that are not understood. Use the proper tools. Replace any equipment that is damaged or repair the equipment.

Pressurized Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This action could result in personal injury.

When pressurized air and/or pressurized water is used for cleaning, wear protective clothing, protective shoes, and eye protection. Eye protection includes goggles or a protective face shield.

The maximum air pressure for cleaning purposes must be below 205 kPa (30 psi). The maximum water pressure for cleaning purposes must be below 275 kPa (40 psi).

Fluid Penetration

Pressure can be trapped in the hydraulic circuit long after the engine has been stopped. The pressure can cause hydraulic fluid or items such as pipe plugs to escape rapidly if the pressure is not relieved correctly.

Do not remove any hydraulic components or parts until pressure has been relieved or personal injury may occur. Do not disassemble any hydraulic components or parts until pressure has been relieved or personal injury may occur. Refer to the OEM information for any procedures that are required to relieve the hydraulic pressure.



Illustration 13

a00687600

Always use a board or cardboard when you check for a leak. Leaking fluid that is under pressure can penetrate body tissue. Fluid penetration can cause serious injury and possible death. A pin hole leak can cause severe injury. If fluid is injected into your skin, you must get treatment immediately. Seek treatment from a doctor that is familiar with this type of injury.

Containing Fluid Spillage

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Static Electricity Hazard when **Fueling with Ultra-low Sulfur Diesel** Fuel

The removal of sulfur and other compounds in ultralow sulfur diesel fuel (ULSD fuel) decreases the conductivity of ULSD and increases the ability of ULSD to store static charge. Refineries may have treated the fuel with a static dissipating additive. Many factors can reduce the effectiveness of the additive over time. Static charges can build up in ULSD fuel while the fuel is flowing through fuel delivery systems. Static electricity discharge when combustible vapors are present could result in a fire or explosion. Ensure that the entire system used to refuel your machine (fuel supply tank, transfer pump, transfer hose, nozzle, and others) is properly grounded and bonded. Consult with your fuel or fuel system supplier to ensure that the delivery system complies with fueling standards for proper grounding and bonding.

\Lambda WARNING

Avoid static electricity risk when fueling. Ultralow sulfur diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur contents. Avoid death or serious injury from fire or explosion. Consult with your fuel or fuel system supplier to ensure the delivery system is in compliance with fueling standards for proper grounding and bonding practices.

Inhalation



g00702022

Exhaust

Use caution. Exhaust fumes can be hazardous to health. If you operate the equipment in an enclosed area, adequate ventilation is necessary.

Hexavalent Chromium

Caterpillar equipment and replacement parts comply with applicable regulations and requirements where originally sold. Caterpillar recommends the use of only genuine Caterpillar replacement parts.

Hexavalent chromium has occasionally been detected on exhaust and heat shield systems on Caterpillar engines. Although laboratory testing is the only accurate way to know if hexavalent chromium is, in fact, present, the presence of a yellow deposit in areas of high heat (for example, exhaust system components or exhaust insulation) may be an indication of the presence of hexavalent chromium.

Use caution if you suspect the presence of hexavalent chromium. Avoid skin contact when handling items that you suspect may contain hexavalent chromium, and avoid inhalation of any dust in the suspect area. Inhalation of, or skin contact with, hexavalent chromium dust may be hazardous to your health.

If such yellow deposits are found on the engine, engine component parts, or associated equipment or packages, Caterpillar recommends following local health and safety regulations and guidelines, utilizing good hygiene, and adhering to safe work practices when handling the equipment or parts. Caterpillar also recommends the following:

- Wear appropriate Personal Protective Equipment (PPE)
- Wash your hands and face with soap and water prior to eating, drinking, or smoking, and also during rest room breaks, to prevent ingestion of any vellow powder
- Never use compressed air for cleaning areas suspected of containing hexavalent chromium
- Avoid brushing, grinding, or cutting materials suspected of containing hexavalent chromium
- Obey environmental regulations for the disposal of all materials that may contain or have come into contact with hexavalent chromium
- Stay away from areas that might have hexavalent chromium particles in the air.

Asbestos Information

Cat equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Cat replacement parts. Use the following guidelines when you handle any replacement parts that contain asbestos or when you handle asbestos debris.

Use caution. Avoid inhaling dust that might be generated when you handle components that contain asbestos fibers. Inhaling this dust can be hazardous to your health. The components that may contain asbestos fibers are brake pads, brake bands, lining material, clutch plates, and some gaskets. The asbestos that is used in these components is usually bound in a resin or sealed in some way. Normal handling is not hazardous unless airborne dust that contains asbestos is generated.

If dust that may contain asbestos is present, there are several guidelines that should be followed:

- Never use compressed air for cleaning.
- Avoid brushing materials that contain asbestos.
- Avoid grinding materials that contain asbestos.
- Use a wet method to clean up asbestos materials.
- A vacuum cleaner that is equipped with a high efficiency particulate air filter (HEPA) can also be used.

- Use exhaust ventilation on permanent machining jobs.
- Wear an approved respirator if there is no other way to control the dust.
- Comply with applicable rules and regulations for the work place. In the United States, use Occupational Safety and Health Administration (OSHA) requirements. These OSHA requirements can be found in "29 CFR 1910.1001".
- Obey environmental regulations for the disposal of asbestos.
- Stay away from areas that might have asbestos particles in the air.

Dispose of Waste Properly



a00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of in accordance with local regulations.

Illustration 15

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

Diesel Exhaust Fluid

DEF is an aqueous solution of urea which can release ammonia vapors. Always wear the appropriate Personal Protective Equipment (PPE) that is noted on a material safety data sheet (MSDS) for Diesel Exhaust Fluid (DEF).

- Do not inhale ammonia vapor or mist
- · Do not eat, drink, or smoke in presence of DEF
- Avoid DEF contact with eyes, skin, and clothing
- · Wash thoroughly after handling DEF

Always follow the directions for first aid that are noted on a material safety data sheet (MSDS) for Diesel Exhaust Fluid (DEF).

DEF is not expected to produce significant adverse health effects when the recommended instructions for use are followed.

- Draining DEF must be carried out in a wellventilated area.
- Do not allow the DEF to be spilled onto hot surfaces.

i07277507

Burn Prevention

SMCS Code: 1000; 4450; 7405

Do not touch any part of an operating engine system. The engine, the exhaust, and the engine aftertreatment system can exceed 650° C (1202° F) under normal operating conditions.

Allow the engine system to cool before any maintenance is performed. Relieve all pressure in the air system, hydraulic system, lubrication system, fuel system, and the cooling system before the related items are disconnected.

🛕 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. After the engine has stopped, wait for 10 minutes to allow the fuel pressure to be purged from the highpressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

Allow the pressure to be purged in the air system, in the hydraulic system, in the lubrication system, or in the cooling system before any lines, fittings, or related items are disconnected.

Induction System

Sulfuric Acid Burn Hazard may cause serious personal injury or death.

The exhaust gas cooler may contain a small amount of sulfuric acid. The use of fuel with sulfur levels greater than 15 ppm may increase the amount of sulfuric acid formed. The sulfuric acid may spill from the cooler during service of the engine. The sulfuric acid will burn the eyes, skin and clothing on contact. Always wear the appropriate personal protective equipment (PPE) that is noted on a material safety data sheet (MSDS) for sulfuric acid. Always follow the directions for first aid that are noted on a material safety data sheet (MSDS) for sulfuric acid.

Coolant

When the engine is at operating temperature, the engine coolant is hot. The coolant is also under pressure. The radiator and all lines to the heaters, aftertreatment system or to the engine contain hot coolant.

Any contact with hot coolant or with steam can cause severe burns. Allow cooling system components to cool before the cooling system is drained.

Check the coolant level after the engine has stopped and the engine has been allowed to cool.

Ensure that the filler cap is cool before removing the filler cap. The filler cap must be cool enough to touch with a bare hand. Remove the filler cap slowly to relieve pressure.

Cooling system conditioner contains alkali. Alkali can cause personal injury. Do not allow alkali to contact the skin, the eyes, or the mouth.

Oils

Skin may be irritated following repeated or prolonged exposure to mineral and synthetic base oils. Refer to your suppliers Material Safety Data Sheets for detailed information. Hot oil and lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Appropriate personal protective equipment should be used.

Diesel Fuel

Diesel engines have high-pressure fuel systems and the fuel can reach temperatures of over 100° C (212° F). Ensure that the fuel has cooled before any service or repairs are performed.

Diesel may be irritating to the eyes, respiratory system, and skin. Prolonged exposure to diesel may cause various skin conditions. Appropriate personal protective equipment should be used. Refer to supplier Material safety Data sheets for detailed information.

Batteries

Electrolyte is an acid. Electrolyte can cause personal injury. Do not allow electrolyte to contact the skin or the eyes. Always wear protective glasses for servicing batteries. Wash hands after touching the batteries and connectors. Use of gloves is recommended.

Engine and Aftertreatment System

Do not touch any part of an operating engine or engine aftertreatment system. Allow the engine or the engine aftertreatment system to cool before any maintenance is performed on the engine or the engine aftertreatment system. Relieve all pressure in the appropriate system before any lines, fittings, or related items are disconnected.

Aftertreatment System and Diesel Exhaust Fluid

Diesel Exhaust Fluid (DEF) temperatures can reach 65° to 70°C (149.° to 126°F) during normal engine operation. Stop the engine. Wait for 15 minutes to allow the DEF system to be purged and the DEF to cool before service or repair is performed.

i07676034

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 4450; 7405



Illustration 16

g00704000

All fuels, most lubricants, and some coolant mixtures are flammable.

Flammable fluids that are leaking or spilled onto hot surfaces or onto electrical components can cause a fire. Fire may cause personal injury and property damage.

A flash fire may result if the covers for the engine crankcase are removed within 15 minutes after an emergency shutdown.

Determine whether the engine will be operated in an environment that allows combustible gases to be drawn into the air inlet system. These gases could cause the engine to overspeed. Personal injury, property damage, or engine damage could result.

If the application involves the presence of combustible gases, consult your Caterpillar dealer for additional information about suitable protection devices.

Remove all flammable combustible materials or conductive materials such as fuel, oil, and debris from the engine. Do not allow any flammable combustible materials or conductive materials to accumulate on the engine. Store fuels and lubricants in properly marked containers away from unauthorized persons. Store oily rags and any flammable materials in protective containers. Do not smoke in areas that are used for storing flammable materials.

Do not expose the engine to any flame.

Exhaust shields (if equipped) protect hot exhaust components from oil or fuel spray in a case of a line, a tube, or a seal failure. Exhaust shields must be installed correctly.

Do not weld on lines or tanks that contain flammable fluids. Do not flame cut lines or tanks that contain flammable fluid. Clean any such lines or tanks thoroughly with a nonflammable solvent prior to welding or flame cutting.

Wiring must be kept in good condition. Ensure that all electrical wires are properly routed and securely attached. Check all electrical wires daily. Repair any wires that are loose or frayed before you operate the engine. Clean all electrical connections and tighten all electrical connections.

Eliminate all wiring that is unattached or unnecessary. Do not use any wires or cables that are smaller than the recommended gauge. Do not bypass any fuses and/or circuit breakers.

Arcing or sparking could cause a fire. Secure connections, recommended wiring, and properly maintained battery cables will help to prevent arcing or sparking.

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.

After the engine has stopped, you must wait for 10 minutes 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. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

Ensure that the engine is stopped. Inspect all lines and hoses for wear or for deterioration. Ensure that the hoses are correctly routed. The lines and hoses must have adequate support and secure clamps.

Oil filters and fuel filters must be correctly installed. The filter housings must be tightened to the correct torque. Refer to the Disassembly and Assembly for more information.



Illustration 17

g00704059

Use caution when you are refueling an engine. Do not smoke while you are refueling an engine. Do not refuel an engine near open flames or sparks. Always stop the engine before refueling.

Avoid static electricity risk when fueling. Ultra-low Sulfur Diesel fuel (ULSD fuel) poses a greater static ignition hazard than earlier diesel formulations with a higher sulfur content. Avoid death or serious injury from fire or explosion. Consult your fuel or fuel system supplier to ensure that the delivery system is in compliance with fueling standards for proper grounding and bonding practices.



Illustration 18

g00704135

Gases from a battery can explode. Keep any open flames or sparks away from the top of a battery. Do not smoke in battery charging areas.

Never check the battery charge by placing a metal object across the terminal posts. Use a voltmeter or a hydrometer.

Improper jumper cable connections can cause an explosion that can result in injury. Refer to the Operation Section of this manual for specific instructions.

Do not charge a frozen battery. A frozen battery may cause an explosion.

The batteries must be kept clean. The covers (if equipped) must be kept on the cells. Use the recommended cables, connections, and battery box covers when the engine is operated.

Fire Extinguisher

Make sure that a fire extinguisher is available. Be familiar with the operation of the fire extinguisher. Inspect the fire extinguisher and service the fire extinguisher regularly. Obey the recommendations on the instruction plate.

Ether

Ether is flammable and poisonous.

Do not smoke while you are replacing an ether cylinder.
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.

Lines, Tubes, and Hoses

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

Leaks can cause fires. Consult your Caterpillar dealer for repair or for replacement parts.

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, correct installation will help to prevent vibration, rubbing against other parts, and excessive heat.

i08162291

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 4450; 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 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.

i05768982

21

Mounting and Dismounting

SMCS Code: 1000; 4450; 7405

Do not climb on the engine or the engine aftertreatment system. The engine and aftertreatment system 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.

i07366423

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.



- (1) High-pressure line
- (2) High-pressure line
- (3) High-pressure line

(4) High-pressure line(5) Fuel transfer line that is high pressure(6) High-pressure pump

(7) High-pressure line (8) High-pressure fuel manifold (rail)

q06334696

The high-pressure fuel lines are the fuel lines that are between the high-pressure fuel pump and the highpressure fuel manifold and the fuel lines that are between the fuel manifold and electronic unit injectors. These fuel lines are different from fuel lines on other fuel systems.

The fuel lines are different because of the following items:

- The high-pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.
- The high-pressure fuel lines are formed to shape and then strengthened by a special process.

Do not step on the high-pressure fuel lines. Do not deflect the high-pressure fuel lines. Do not bend or strike the high-pressure fuel lines. Deformation or damage of the high-pressure fuel lines may cause a point of weakness and potential failure. Do not check the high-pressure fuel lines with the engine or the starting motor in operation. After the engine has stopped, you must wait for 10 minutes to allow the fuel pressure to be purged from the highpressure fuel lines before any service or repair is performed on the engine fuel lines. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system.

Do not loosen the high-pressure fuel lines to remove air from the fuel system. This procedure is not required.

Visually inspect the high-pressure fuel lines before the engine is started. This inspection should be each day.

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

• Inspect the high-pressure fuel lines for damage, deformation, a nick, a cut, a crease, or a dent.

- Do not operate the engine with a fuel leak. If there is a leak, do not tighten the connection, to stop the leak. The connection must only be tightened to the recommended torque. Refer to Disassembly and Assembly, "Fuel injection lines - Remove and Fuel injection lines - Install".
- If the high-pressure fuel lines are torqued correctly and the high-pressure fuel lines are leaking, the high-pressure fuel lines must be replaced.
- Ensure that all clips on the high-pressure fuel lines are in place. Do not operate the engine with clips that are damaged, missing, or loose.
- Do not attach any other item to the high-pressure fuel lines.
- Loosened high-pressure fuel lines must be replaced. Also removed high-pressure fuel lines must be replaced. Refer to Disassembly and assembly manual, "Fuel Injection Lines - Install".

i07728672

Before Starting Engine

SMCS Code: 1000

NOTICE

For initial start-up of a new or rebuilt engine, and for start-up of an engine that has been serviced, make provision to shut the engine off should an overspeed occur. This may be accomplished by shutting off the air and/or fuel supply to the engine.

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

Inspect the engine for potential hazards.

Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

If equipped, ensure that the lighting system for the engine is suitable for the conditions. Ensure that all lights work properly, if equipped. All protective guards and all protective covers must be installed if the engine must be started to perform service procedures. To help prevent an accident that is caused by parts in rotation, work around the parts carefully.

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided to help prevent personal injury. The circuits are also provided to help prevent engine damage.

Before starting the engine, ensure that the drive belt is securely in place. The coolant pump is operated by the drive belt.

See the Service Manual for repairs and for adjustments.

i08219601

Engine Starting

SMCS Code: 1000

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 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. Also, check the oil temperature gauge during the heater operation.

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

Note: The engine is equipped with a device for cold starting. If the engine will be operated in very cold conditions, an extra cold starting aid may be required. Normally, the engine will be equipped with the correct type of starting aid for the region of operation.

These engines are equipped with a glow plug starting aid in each individual cylinder that heats the intake air 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.

i02234873

Engine Stopping

SMCS Code: 1000

Stop the engine according to the procedure in the Operation and Maintenance Manual, "Engine Stopping (Operation Section)" in order to avoid overheating of the engine and accelerated wear of the engine components.

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.

Stop the engine if an overspeed condition occurs during the initial start-up of a new engine or an engine that has been overhauled.

To stop an electronically controlled engine, cut the power to the engine and/or shutting off the air supply to the engine.

i08154895

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.

Grounding Practices



Illustration 20

g06296580

Typical example

- (1) Ground to battery
- (2) Ground to starting motor

(3) Starting motor to engine block



a06296637

- Typical example (4) Ground to the battery
- (5) Ground to the engine block
- (6) Primary position for grounding

NOTICE

For C3.6 industrial engines, ensure that a 12 VDC or 24 VDC battery source is used to start the engine. For C2.8 industrial engines, use a 12 VDC battery source to start the engine. Never attempt to start an engine from an external power source such as electric welding equipment, which has a voltage that is unsuitable for engine starting and will damage the electrical system.

Correct grounding for the engine electrical system is necessary for optimum engine performance and reliability. Incorrect grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to the crankshaft bearing journal surfaces and to aluminum components.

Engines that are installed without engine-to-frame ground straps can be damaged by electrical discharge.

To ensure that the engine and the engine electrical systems function correctly, an engine-to-frame ground strap with a direct path to the battery must be used. This path may be provided by way of a direct engine ground to the frame.

The connections for the grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative "-" battery terminal. The wire used must be adequate to handle the full charging current of the alternator.

The power supply connection for the engine electronics should always be from the isolator to the battery. It is the decision of the OEM which polarity the isolator is connected to.

i07925886

Engine Electronics

SMCS Code: 1000; 1900

🏠 WARNING

Tampering with the electronic system installation or the OEM wiring installation can be dangerous and could result in personal injury or death and/ or engine damage.

Electrical Shock Hazard. The electronic unit injectors use DC voltage. The ECM sends this voltage to the electronic unit injectors. Do not come in contact with the harness connector for the electronic unit injectors while the engine is operating. Failure to follow this instruction could result in personal injury or death.

This engine has a comprehensive, programmable Engine Monitoring System. The Electronic Control Module (ECM) has the ability to monitor the engine operating conditions. If any of the engine parameters extend outside an allowable range, the ECM will initiate an immediate action.

The following actions are available for engine monitoring control:

- Warning: A warning light could be illuminated or a sound warning could be activated (horn)
- Derate: The engine power could be reduced by 50 percent
- Shutdown: The engine could be shut down or only operate at low idle

The following monitored engine operating conditions and components can limit engine speed and/or the engine power:

- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Intake Manifold Air Temperature
- Intake Manifold Pressure
- Wastegate Regulator
- Supply Voltage to Sensors
- Fuel Temperature
- Fuel Pressure in Manifold (Rail)
- NOx Reduction System temperature
- Engine Aftertreatment System

The Engine Monitoring package can vary for different engine models and different engine applications. However, the monitoring system and the engine monitoring control will be similar for all engines.

Note: Many of the engine control systems and display modules that are available for Caterpillar engines will work in unison with the Engine Monitoring System. Together, the two controls will provide the engine monitoring function for the specific engine application. Refer to Troubleshooting for more information on the Engine Monitoring System.

Product Information Section

General Information

i07853978

Model View Illustrations

SMCS Code: 1000

The following model views show typical features of the engine. Due to individual applications, your engine may appear different from the illustrations.

C3.6 Industrial Engine Views



Illustration 22

Typical example

- Selective Catalytic Reduction (SCR)
 Diesel Exhaust Fluid (DEF) injector
 Engine harness interface
- (4) Throttle control valve
- (5) NOx Reduction System (NRS) valve
- (6) Air intake from air charge cooler
- (7) Alternator
- (8) Oil gauge (Dipstick)
- (9) Oil filler (lower) (10) Oil filter assembly

g06297496

- (11) Starting motor (12) Oil drain plug
- (13) High-pressure fuel pump
- (14) Diesel Particulate Filter (DPF)



Typical example

(15) Front lifting eye (16) Rear lifting eyes (17) Actuator for turbocharger (18) Turbocharger (19) Air intake from air cleaner

(20) Electronic Control Module (ECM), location for transportation only
(21) Idler for drive belt
(22) Adjuster for drive belt
(23) Coolant pump pulley

(24) Coolant intake(25) Drive belt(26) Coolant outlet(27) Top oil filler

C2.8 Industrial Engine Views



Illustration 24

Typical example

- Diesel Particulate Filter (DPF) and Diesel Oxidation Catalyst (DOC) combined
 Engine harness interface
 NOx Reduction System (NRS) valve

(4) Throttle control valve (5) Alternator (6) Oil filter assembly(7) Oil filler (lower)

(8) Oil gauge (Dipstick)
(9) Oil drain plug
(10) Starting motor
(11) High-pressure fuel pump



Typical example

- (12) Oil filler (upper)
 (13) Front lifting eye
 (14) Rear lifting eyes
 (15) Actuator for turbocharger
 (16) Turbocharger

(17) Air intake from air cleaner(18) Electronic Control Module (ECM), location for transportation only (19) Adjuster for drive belt (20) Coolant pump pulley

(21) Coolant intake (22) Drive belt (23) Coolant outlet

g06481335

5

2 3 4 1 21 6 8 9 13

Loose or Off Engine Components



Illustration 26

Typical example

(1) Primary fuel filter, combined with electric fuel priming pump and Water-In-Fuel (WIF) sensor

12

- (2) If equipped, secondary fuel filter
 (3) Primary fuel filter, combined with manual fuel priming pump and Water-In-Fuel (WIF) sensor
- (4) Coolant diverter valve(5) Diesel Exhaust Fluid (DEF) pump with DEF pump filter
- (6) DEF tank with DEF header installed
- (7) DEF heated lines(8) Link harness
- (9) Electric control module

- (10) Inlet temperature sensor (11) Exhaust assembly

10

- (12) NOx sensors
- (13) Low-pressure fuel line
- g06297651

M0108394-04

i08067930

Model View Illustrations

SMCS Code: 1000

The following model views show typical features of the engine. Due to individual applications, your engine may appear different from the illustrations.

C3.6 Industrial Engine Views For Engines Equipped With A Balancer



Illustration 27

Typical example

- Selective Catalytic Reduction (SCR)
 Diesel Exhaust Fluid (DEF) injector
 Diesel Particulate Filter (DPF)

- (4) NOx Reduction System (NRS) valve

(5) Air intake from air charge cooler (6) Alternator(7) Oil filter assembly (8) Starting motor

(9) Oil drain plug (1 of 2) (10) High-pressure fuel pump (11) Throttle control valve (12) Engine harness interface



Typical example

- (13) Rear lifting eyes
 (14) Actuator for turbocharger
 (15) Turbocharger
 (16) Electronic Control Module (ECM), location for transportation only
 (17) Oil gauge (Dipstick)

- (18) Oil filler
 (19) Oil drain plug (2 of 2)
 (20) Automatic adjuster for drive belt
 (21) Coolant pump pulley
 (22) Coolant intake
 (23) Drive belt

(24) Fan Pulley(25) Coolant outlet(26) Air intake from air cleaner(27) Front lifting eye



Loose or Off Engine Components

Illustration 29

Typical example

- (1) Primary fuel filter, combined with electric fuel priming pump and Water-In-Fuel (WIF) sensor
- (WIF) sensor
 (2) If equipped, secondary fuel filter
 (3) Primary fuel filter, combined with manual fuel priming pump and Water-In-Fuel (WIF) sensor
- (4) Coolant diverter valve(5) Diesel Exhaust Fluid (DEF) pump with **DEF** pump filter
- (6) DEF tank with DEF header installed
 (7) DEF heated lines
 (8) Link harness

- (9) Electric control module

- (10) Inlet temperature sensor (11) Exhaust assembly
- (12) NOx sensors
- (13) Low-pressure fuel line
- g06297651

107853928

Product Description ((Engine and Aftertreatment))

SMCS Code: 1000; 4450; 4491

C3.6 Industrial Engine

The Caterpillar C3.6 industrial engine is a single turbocharged, air to air charge cooled engine. There are two variants of the C3.6 industrial engines. Engines with a power rating of 56 kW (75.1 hp) and below or engines with a power rating of 70 kW (93.9 hp) and above.

The engine aftertreatment system for engines with a power ratings of 56 kW (75.1 hp) and below, is configured as follows:

- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)

The engine aftertreatment system for engines with a power ratings of 70 kW (93.9 hp) and above, is configured as follows:

- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)
- Selective Catalytic Reduction (SCR)

C2.8 Industrial Engine

The Caterpillar C2.8 industrial engine is a single turbocharged engine. The engine may be turbocharged or turbocharged with an air charge cooler.

The engine aftertreatment system is configured as follows:

- Diesel Oxidation Catalyst (DOC)
- Diesel Particulate Filter (DPF)

Engine Specifications

Note: The front end of the engine is opposite the flywheel end of the engine. The left and the right sides of the engine are determined from the flywheel end. The number 1 cylinder is the front cylinder.



Illustration 30

g06297997

Typical example (A) Inlet valves (B) Exhaust valves

Table 1

C3.6 Engine Specifications			
Operating Range (rpm)	800 to 2400 ⁽¹⁾		
Number of Cylinders	4 In-Line		
Bore	98 mm (3.86 inch)		
Stroke	120 mm (4.72 inch)		
Power rating (engines with DOC and DPF)	55.4 kW (74.29 hp)		
Power rating (engines with DOC, DPF, and SCR)	70 to 100 kW (93.87 to 134.1 hp)		
Aspiration	Turbocharged charge cooled		
Compression Ratio	17:1		
Displacement	3.621 L (220.966 cubic inch)		
Firing Order	1-3 -4-2		
Valves per cylinder	4		
Rotation (flywheel end)	Counterclockwise		

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

Table 2

C2.8 Engine Specifications		
Operating Range (rpm)	800 to 2400 (1)	
Number of Cylinders	4 In-Line	
Bore	90 mm (3.54 inch)	
Stroke	110 mm (4.33 inch)	
Power rating	50 kW to 55.4 kW (67.05 hp to 74.29 hp)	

(1	a	ble	2	. co	ont	d)
٠.	-	~ ~ ~	-	, .		~,

Aspiration	Turbocharged and Turbo- charged charge cooled	
Compression Ratio	17:1	
Displacement	2.8 L (170.87 cubic inch)	
Firing Order	1-3 -4-2	
Valves per cylinder	4	
Rotation (flywheel end)	Counterclockwise	

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

Electronic Engine Features

The engine and aftertreatment 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
- NOx reduction system control
- Aftertreatment system control

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

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 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).

Engine Cooling and Lubrication

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

- Belt driven water pump
- Water temperature regulator which regulates the engine coolant temperature
- · Gear-driven gerotor type oil pump
- Oil cooler

The engine lubricating oil is supplied by a gerotor 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.

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. Expected engine life is generally predicted by the average power that is demanded. The average power that is demanded is based on fuel consumption of the engine over time. Reduced hours of operation at full throttle and/or operating at reduced throttle settings result in a lower average power demand. Reduced hours of operation will increase the length of operating time before an engine overhaul is required. For more information, refer to the Operation and Maintenance Manual, "Overhaul Considerations" topic (Maintenance Section).

Aftermarket Products and Caterpillar Engines

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

When auxiliary devices, accessories, or consumables (filters, additives, catalysts), which are made by other manufacturers are used on Caterpillar products, the Caterpillar warranty is not affected simply because of such use.

However, failures that result from the installation or use of other manufacturers devices, accessories, or consumables are NOT Caterpillar defects. Therefore, the defects are NOT covered under the Caterpillar warranty.

Aftertreatment System

The aftertreatment system is approved for use by Caterpillar. To be emissions-compliant, only the approved Caterpillar aftertreatment system must be used on a Caterpillar engine.

Product Identification Information

i07816292

Plate Locations and Film Locations

SMCS Code: 1000; 4450



Illustration 31

g06298126

Typical example

(1) Engine serial number plate location

Serial Number Plate

The engine serial number plate (1) is on the right side of the cylinder block to the rear of the front engine mounting.

Caterpillar dealers need all these numbers to determine the components that were included with the engine. This information permits accurate identification of replacement part numbers.

CATERP	ILLAR®		CAT	
ARRANG	MENT NUMBER		SALES MODEL	
0				0
SERIAL NUMBER				
MADE IN U.K.	ALWAYS GIVE AL	L NUMBERS)	#####	

Illustration 32 Typical example of serial number plate g03047463

i08043623

Emissions Certification Film

SMCS Code: 1000; 7405



Illustration 33 g06522161 Typical location of the engine emission label

The engine emission label is typically installed on the flywheel housing at Position (X). An extra engine emission label may be supplied loose.

107925928

Reference Information

SMCS Code: 1000; 4450

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information in the appropriate space. Make a copy of this list for a record. Keep the information for future reference.

Record for Reference

Engine Model
Engine Serial number
Engine Low Idle rpm
Engine Full Load rpm
In Line Fuel Filter
Primary Fuel Filter
Secondary Fuel Filter Element
Lubrication Oil Filter Element
Auxiliary Oil Filter Element (if equipped)
Total Lubrication System Capacity
Total Cooling System Capacity
Air Cleaner Element
Drive Belt
Clean Emissions Module
Part Number
Serial Number
Diesel Exhaust Fluid (DEF) Pump
Part Number
Serial Number

Operation Section

Lifting and Storage

i08067983

Product Lifting

SMCS Code: 7000; 7002

NOTICE

Always inspect lifting eyebolts and all other lifting equipment for damage before performing any lifting. Never bend the eyebolts and the brackets. Never perform product lifting if components are damaged. Only load the eyebolts and the brackets under tension. Remember that the capacity of an eyebolt is less as the angle between the supporting members and the object becomes less than 90 degrees.

When it is necessary to remove a component at an angle, only use a link bracket that is properly rated for the weight.

Read all the information within product lifting before any lifting is attempted. Ensure that the correct set of lifting eyes for the assembly to be lifted have been selected.

Use a hoist to remove heavy components. Use an adjustable lifting beam to lift the engine. All supporting members (chains and cables) should be parallel to each other. The chains and cables should be perpendicular to the top of the object that is being lifted.

To obtain the correct balance for lifting an application, adjust the chain lengths.

Lifting eyes are designed and installed for the specific engine arrangement. Alterations to the lifting eyes and/or the engine, make the lifting eyes and the lifting fixtures obsolete. If alterations are made, ensure that proper lifting devices are provided.

There are several different designs of lifting eyes. The following sections give examples of lifting eyes on the engine and engine with aftertreatment.

Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

C3.6 Industrial Engine



Illustration 34 Typical example (1) Rear lifting eyes (2) Front lifting eye g06298473

Use all 3 lifting eyes when lifting engine assembly.

Caterpillar recommends that model-specific cradles are used to store and transport engines. Supporting engines on the sump/oil pan is not recommended under any circumstances. This action is for both safety and quality reasons.

C3.6 Industrial Engine Equipped With A Balancer



Illustration 35 Typical example (1) Rear lifting eyes (2) Front lifting eye

Use both lifting eyes when lifting engine assembly.

Caterpillar recommends that model-specific cradles are used to store and transport engines. Supporting engines on the sump/oil pan is not recommended under any circumstances. This action is for both safety and quality reasons.

C2.8 Industrial Engine



Illustration 36

g06458398

Typical example (1) Rear lifting eye (2) Front lifting eye

Use both lifting eyes when lifting engine assembly.

Caterpillar recommends that model-specific cradles are used to store and transport engines. Supporting engines on the sump/oil pan is not recommended under any circumstances. This action is for both safety and quality reasons.

i07676027

Product Storage

SMCS Code: 7002

If the engine will not be started for several weeks, the lubricating oil will drain from the cylinder walls and from the piston rings. Rust can form on the cylinder liner surface. Rust on the cylinder liner surface will cause increased engine wear and a reduction in engine service life. To help prevent excessive engine wear, use the following guidelines:

- Complete all the lubrication recommendations that are listed in the Operation and Maintenance Manual, "Maintenance Interval Schedule".
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. Refer to Operation and Maintenance Manual, "Fluid Recommendations" for more information.

If an engine is out of operation and if use of the engine is not planned, special precautions should be made. If the engine will be stored for more than 1 month, a complete protection procedure is recommended.

Ensure that the outlets on the Clean Emission Module (CEM) are capped. Ensure that the Diesel Exhaust Fluid (DEF) connections are capped.

To prevent damage to the exhaust outlet connection during storage, the weight of the CEM must not act on the exhaust outlet.

For more detailed information on engine storage, refer to Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products".

Your Caterpillar dealer can help in preparing the engine for extended storage periods.

Aftertreatment

The engine must be allowed to perform a DEF purge before the battery disconnect switch is turned off. Allow 2 minutes after the engine has stopped before disconnecting the battery disconnect switch.

The exhaust outlet of the aftertreatment must be capped. To prevent damage to the exhaust outlet connection during storage, the weight of the CEM must not act on the exhaust outlet.

DEF Tank Storage

- Ensure normal engine shutdown, allow the DEF to be purged. Do not disconnect the battery disconnect switch, allow 2 minutes after key off before disconnection.
- 2. Fill the tank with DEF that meets all the requirement defined in ISO 22241-1.
- 3. Ensure that all DEF lines and electrical connection are connected prior to prevent crystal from forming.
- 4. Ensure that the DEF filler cap is correctly installed.

Removal from Storage

DEF has a limited life, refer to table 3 for the time and temperature range. DEF that is outside this range MUST be replaced.

On removal from storage the DEF quality in the tank must be tested with a refractometer. The DEF in the tank must meet the requirements defined in ISO 22241-1 and comply with table 3.

- 1. If necessary, drain the tank and fill with DEF that meets ISO 22241-1.
- Replace the DEF filter. Refer to Operation and Maintenance Manual, "Diesel Exhaust Fluid Filter (Emission Related Component) - Replace" for the correct procedure.
- 3. Ensure that the drive belt is correctly installed. Ensure that all engine coolant and engine oil has the correct specification and grade. Ensure that the coolant and the engine oil are at the correct level. Start the engine. If a fault becomes active turn off the engine, allow 2 minutes for the DEF system to purge, then restart the engine.
- 4. If the fault continues to stay active, refer to Troubleshooting for more information.

Table 3

Temperature	Duration	
10° C (50° F)	36 months	
25° C (77° F)	18 months	
30° C (86° F)	12 months	
35° C (95° F) ⁽¹⁾	6 months	

(1) At 35° C, significant degradation can occur. Check every batch before use.

Features and Controls

i07925952

Alarms and Shutoffs

SMCS Code: 7400

Shutoffs

The shutoffs are electrically operated or mechanically operated. The electrically operated shutoffs are controlled by the ECM.

Shutoffs are set at critical levels for the following items:

- Operating temperature
- Operating pressure
- Operating level
- Operating rpm

The particular shutoff may need to be reset before the engine will start.

NOTICE

Always determine the cause of the engine shutdown. Make necessary repairs before attempting to restart the engine.

Be familiar with the following items:

- · Types and locations of shutoff
- Conditions which cause each shutoff to function
- The resetting procedure that is required to restart the engine

Alarms

The alarms are electrically operated. The operations of the alarms are controlled by the ECM.

The alarm is operated by a sensor or by a switch. When the sensor or the switch is activated, a signal is sent to the ECM. An event code is created by the ECM. The ECM will send a signal to illuminate the lamp.

Your engine may be equipped with the following sensors or switches:

Coolant temperature – The coolant temperature sensor indicates high jacket water coolant temperature.

Intake manifold air temperature – The intake manifold air temperature sensor indicates high intake air temperature.

Intake manifold pressure – The intake manifold pressure sensor checks the rated pressure in the engine manifold.

Fuel rail pressure – The fuel rail pressure sensor measures the high pressure or low pressure in the fuel rail. The ECM will Check the pressure.

Engine oil pressure – The engine oil pressure switch indicates when oil pressure drops below rated system pressure, at a set engine speed.

Engine overspeed – If the engine rpm exceeds the overspeed setting, the alarm will be activated.

Air filter restriction – The switch checks the air filter when the engine is operating.

User-defined switch – This switch can shut down the engine remotely.

Water in fuel switch – This switch checks for water in the primary fuel filter when the engine is operating.

Fuel temperature – The fuel temperature sensor monitors the pressurized fuel in the high-pressure fuel pump.

NRS absolute pressure and NRS delta pressure – A combined pressure sensor across the NRS valve.

Note: The sensing element of the coolant temperature sensor must be submerged in coolant to operate.

Engines may be equipped with alarms to alert the operator when undesirable operating conditions occur.

NOTICE

When an alarm is activated, corrective measures must be taken before the situation becomes an emergency in order to avoid possible engine damage.

If corrective measures are not taken within a reasonable time, engine damage could result. The alarm will continue until the condition is corrected. The alarm may need to be reset.

Note: If installed, the coolant level switch and the oil level switch are indicators. Both switches operate when the application is on level ground and the engine RPM at zero.

Aftertreatment System

- Diesel Oxidation Catalyst _____(DOC)
- Selective Catalyst Reduction _____(SCR)
- Diesel Particulate Filter _____(DPF)

Soot Sensors – The soot sensor monitor the soot level within the DPF.

NOx Sensors – Two NOx sensors monitor the NOx concentration within the exhaust gas before and after the selective catalyst reduction module.

Temperature Sensor – A temperature sensor after the engine exhaust gas exit, after the DOC and before the SCR module monitor the temperatures within the system.

DEF Tank Header Unit – The DEF level sensor monitors the volume of fluid in the tank and signals the ECM if the level drops below a given point.

Testing

Turning the keyswitch to the ON position will check the indicator lights on the control panel. All the indicator lights will be illuminated for 2 seconds after the keyswitch is operated. Replace suspect bulbs immediately.

Refer to Troubleshooting for more information.

i05408886

Battery Disconnect Switch (If Equipped)

SMCS Code: 1411

Allow at least 2 minutes after the engine has stopped before you turn the battery disconnect switch to OFF. Disconnecting the battery power too soon will prevent purging of the Diesel Exhaust Fluid (DEF) lines after the engine is shut down. Also, during the 2 minutes the engine Electronic Control Module (ECM) is active storing information from the engine and aftertreatment sensors.

Not allowing the DEF purge to be performed can damage the DEF system. Not allowing the engine ECM time to store the information from the sensors can damage to emission control system.

Some applications, the engine can be equipped with a wait to disconnect lamp. The wait to disconnect lamp will be illuminated during engine operation and will be extinguished approximately 2 minutes after the engine has stopped.



Illustration 37

Battery disconnect switch label

.....

NOTICE Do not turn off the battery disconnect switch until the indicator lamp has turned off. If the switch is turned off when the indicator lamp is illuminated the Diesel Exhaust Fluid (DEF) system will not purge the DEF. If the DEF does not purge, DEF could freeze and damage the pump and lines.

NOTICE

Never move the battery disconnect switch to the OFF position while the engine is operating. Serious damage to the electrical system could result.

107682710

g03265058

Gauges and Indicators

SMCS Code: 7450

Your engine may not have the same gauges or all the gauges that are described. For more information about the gauge package, see the OEM information.

Gauges provide indications of engine performance. Ensure that the gauges are in good working order. Determine the normal operating range by observing the gauges over a period.

Noticeable changes in gauge readings indicate potential gauge or engine problems. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine and correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance.

Some engine applications are equipped with Indicator Lamps. Indicator lamps can be used as a diagnostic aid. There are two lamps. One lamp has an orange lens and the other lamp has a red lens.

These indicator lamps can be used in two ways:

- The indicator lamps can be used to identify the current operational status of the engine. The indicator lamps can also indicate that the engine has a fault. This system is automatically operated via the ignition switch.
- The indicator lamps can be used to identify active diagnostic codes. This system is activated by pressing the Flash Code button.

Refer to the Troubleshooting Guide, "Indicator Lamps" for further information.

NOTICE

If no oil pressure is indicated, STOP the engine. If maximum coolant temperature is exceeded, STOP the engine. Engine damage can result.



rated rpm.

Engine Oil Pressure – The oil pressure should be greatest after a cold engine is started. The typical engine oil pressure with SAE10W40 is 350 to 450 kPa (50 to 65 psi) at

A lower oil pressure is normal at low idle. If the engine speed and load are stable and the gauge reading changes, perform the following procedure:

- Remove the load.
- 2. Stop the engine.
- Check and maintain the oil level.

Jacket Water Coolant Temperature -Typical temperature range is 82° to 94°C (179.6° to 169.2°F). This temperature range will vary according to engine load and the ambient temperature.

A 100 kPa (14.5 psi) radiator cap must be installed on the cooling system. The maximum temperature for the cooling system is 108° C (226.4° F). This temperature is measured at the outlet for the water temperature regulator. The engine coolant temperature is monitored by the engine sensors and the engine ECM. This programming cannot be altered. Derates can occur if the maximum engine coolant temperature is exceeded.

If the engine is operating above the normal range, reduce the engine load. If high coolant temperatures are a frequent event, perform the following procedures:

- 1. Reduce the load on the engine.
- Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.
- Inspect the cooling system for leaks. If necessary, consult your Caterpillar dealer for assistance.



Tachometer – This gauge indicates engine speed (rpm). When the throttle control lever is moved to the full throttle

position without load, the engine is running at high idle. The engine is running at the full load rpm when the throttle control lever is at the full throttle position with maximum rated load.

NOTICE

To help prevent engine damage, never exceed the high idle rpm. Overspeeding can result in serious damage to the engine. Operation at speeds exceeding high idle rpm should be kept to a minimum.

Ammeter – This gauge indicates the amount of charge or discharge in the battery charging circuit. Operation of the indicator should be to the "+" side of "0" (zero).



Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge operates when the "START/STOP" switch is in the "on" position.



Service Hour Meter – The gauge indicates total operating hours of the engine.

Indicator Lamps

- Shutdown lamp
- Warning lamp
- Low oil pressure lamp
- Wait to start lamp (Glow plug warning lamp)

For information, refer to this manual, "Monitoring System (Table for the Indicator Lamps)" for the sequence of operation of the shutdown lamp and the warning lamp.

The function of the wait to start lamp is automatically controlled at engine start-up.

The function of the low oil pressure lamp is controlled by the engine ECM. If low oil pressure is detected, the lamp will be illuminated. The reason for the illumination of the low-pressure lamp should be investigated immediately.

The glow plug warning lamp will flash to show that the engine is being held at low speed. This function will be performed at engine starting and the duration will depend on ambient temperature and engine temperature.

The lamps will illuminate for 2 seconds to check that the lamps are functioning when the keyswitch is turned to the ON position. If any of the lamps stay illuminated, or a lamp fails to be illuminated the reason should be investigated immediately.

Aftertreatment Lamps and gauges

All applications will require the following lamps and gauges:

- Emission malfunction lamp
- · Action indicator lamp
- Gauge for Diesel Exhaust Fluid (DEF)
- · Low warning lamp for DEF
- Wait to disconnect lamp (optional)

The wait to disconnect lamp will be illuminated during engine operation and will be extinguished approximately 2 minutes after the engine has stopped. Do not disconnect the battery disconnect switch during the period the lamp is illuminated. The diesel exhaust fluid system will be purged during this time. Also, during the 2 minutes the engine electronic control module is active storing information from the engine and aftertreatment sensors.

Note: The wait to disconnect lamp will not be checked at key on.

i07682718

Monitoring System (Engine Indicators and Aftertreatment Indicators)

SMCS Code: 1900; 7400; 7450; 7451

Engine Indicator Lamps

Note: When in operation the amber warning lamp has three states, 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.

Ensure that the engine maintenance is carried out at the correct intervals. A lack of maintenance can result in illumination of the warning lamp. For the correct intervals of maintenance, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule".

Indicator Lamp Table				
Warning Lamp	Shutdown Action Indi- cator Lamp	Lamp State	Description of the Indication	Engine Status
On	On	Lamp Check	When the keyswitch is moved to the ON po- sition, the lamps come on for 2 seconds and the lamps will then go off.	The keyswitch is in the ON position but the en- gine has not yet been cranked.
	If any of the	e indicators will not i If any Indicators sta	lluminate during indicator check, the fault mus y illuminated or flash, the fault must be investig	t be investigated immediately gated immediately.
Off	Off	No Faults	With the engine in operation, there are no active warnings, diagnostic codes, or event codes.	The engine is operating with no detected faults.
On Solid	Off	Warning	Level 1 warning	The engine is operating normally but there is one or more faults with the electronic manage- ment system for the engine.
		Ass	soon as possible the fault should be investigate	ed.
Flashing	Off	Warning	Level 2 warning	The engine continues to be operated, but the level of importance of the warning has increased. Depending on the particular fault and the se- verity the engine may be de-rated. The engine could be damaged if continued to be operated.
			Stop the engine. Investigate the code.	
Flashing	On	Engine Shutdown	Level 3 warning If both the warning lamp and the shutdown lamp are in operation, this issue indicates one of the following conditions. 1. One or more of the shutdown values for the engine protection strategy has been exceeded. 2. A serious active diagnostic code has been detected. If installed, the audible warning will sound. After a short time period, the engine may	The engine is either shutdown or an engine shutdown is imminent. One or more monitored engine parameters have exceeded the limit for an engine shutdown. This pattern of lamps can be caused by the detection of a serious active diagnostic code. Contact your Caterpillar dealer.

Flash Codes

Some applications may support flash codes. A flash code can be viewed by an indicator lamp that when asked will flash in a particular sequence. The indicator lamp used to view the codes is the warning lamp, the lamp can then be referred to as a diagnostic lamp. For more information refer to this Operation and Maintenance Manual, "Diagnostic Lamp".

Aftertreatment System

The aftertreatment indicators should illuminate at key on for 2 seconds to test the system. If any of the indicators do not illuminate, the fault must be investigated immediately. For more information on the illumination of the aftertreatment indicators refer to this Operation and Maintenance Manual, "Selective Catalytic Reduction Warning System".

i08068136

Sensors and Electrical Components

SMCS Code: 1900; 7400

The illustrations within the following sections are typical location of the sensors or electrical components for an industrial engine. Specific engines may appear different due to differences in applications.

- NRS NOx Reduction System
- **DEF** Diesel Exhaust Fluid
- **DOC** Diesel Oxidation Catalyst
- **DPF** Diesel Particulate Filter
- SCR Selective Catalytic Reduction
- **ECM** Electronic Control Module
- NOx Nitrogen Oxides

C3.6 Industrial Engines



Illustration 38

- Typical example
- Engine 47-pin interface connector
 Inlet throttle valve
 Inlet manifold combined pressure and
- (5) Coolant temperature sensor(6) Alternator(7) Starting motor
 - (8) Camshaft speed/timing sensor
 - (9) Fuel temperature sensor
- (10) Control valve for high-pressure fuel pump
- (11) Temperature sensor post NRS valve

temperature sensor (4) Temperature sensor pre-NRS valve



Typical example

(12) NRS Differential pressure sensor(13) NRS valve(14) Injector 1 and injector 2

(15) Injector 3 and injector 4(16) Actuator for turbocharger(17) Crankshaft speed/timing sensor

(18) Engine oil pressure switch (19) Fuel rail pressure sensor



Typical example

(20) DEF Injector (21) DPF Differential pressure sensor

(22) Temperature sensor controller with 3 probes across aftertreatment (in transport position)

(A) DPF temperature probe(B) DOC temperature probe(C) SCR temperature probe



Industrial engine equipped with a balancer

(23) DPF Differential pressure sensor (24) DEF Injector

(25) Temperature sensor controller connection with 3 probes across aftertreatment

(A) DOC temperature probe(B) DPF temperature probe(C) SCR temperature probe

Off Engine Sensors and Electrical Components



Illustration 42

Typical example

(1) ECM

(2) If equipped, Air intake temperature sensor (Air Cleaner)
(3) Priming pump

(4) Water in fuel switch

(5) Coolant diverter valve
(6) DEF tank level, temperature sensor, and DEF quality sensor

(7) DEF pump(8) NOx sensors(9) DEF heated lines

C2.8 Industrial Engine



Illustration 43

Typical example

- (1) Engine 47-pin interface connector
 (2) Inlet throttle valve
 (3) Temperature sensor pre-NRS valve
 (4) Coolant temperature sensor
 (5) Alternator

- (6) Starting motor
 (7) Camshaft speed/timing sensor
 (8) Fuel temperature sensor
 (9) Control valve for high-pressure fuel pump
- (10) Inlet Manifold Temperature Sensor (11) Inlet Manifold Pressure Sensor

- (12) Temperature sensor post NRS valve



Typical example

(13) NRS Differential pressure sensor (14) NRS valve (15) Injector 1 and injector 2 (Injector 3 and injector 4 not shown)(16) Crankshaft speed/timing sensor (17) Engine oil pressure switch (18) Fuel rail pressure sensor g06481410



Typical example

(19) Temperature sensor controller with 2 probes across aftertreatment (in transport position) (20) Tube assembly for Differential pressure(21) DPF Differential pressure sensor(22) Tube assembly for Differential pressure

(A) DPF temperature probe (B) DOC temperature probe g06481414

C2.8 Off Engine Sensors and Electrical Components



(2) If equipped, Air intake temperature sensor (Air Cleaner)

(3) Priming pump(4) Water in fuel switch
Engine Diagnostics

i01796959

Self-Diagnostics

SMCS Code: 1000; 1900; 1901; 1902

Caterpillar Electronic Engines have the capability to perform a self-diagnostics test. When the system detects an active problem, a diagnostic lamp is activated. Diagnostic codes will be stored in permanent memory in the Electronic Control Module (ECM). The diagnostic codes can be retrieved by using Caterpillar electronic service tools.

Some installations have electronic displays that provide direct readouts of the engine diagnostic codes. Refer to the manual that is provided by the OEM for more information on retrieving engine diagnostic codes.

Active codes represent problems that currently exist. These problems should be investigated first.

Logged codes represent the following items:

- Intermittent problems
- Recorded events
- Performance history

The problems may have been repaired since the logging of the code. These codes do not indicate that a repair is needed. The codes are guides or signals when a situation exists. Codes may be helpful to troubleshoot problems.

When the problems have been corrected, the corresponding logged fault codes should be cleared.

i03554520

Diagnostic Lamp

SMCS Code: 1000; 1900; 1901; 1902; 7451

A diagnostic lamp is used to indicate the existence of an active fault. A fault diagnostic code will remain active until the problem is repaired. The diagnostic code may be retrieved by using the electronic service tool.

i04907245

Diagnostic Flash Code Retrieval

SMCS Code: 1000; 1900; 1901; 1902

Use the following procedure to retrieve the flash codes if the engine is equipped with a "DIAGNOSTIC" lamp:

- 1. Move the keyswitch from the on/off two times within 3 seconds.
- The shutdown warning lamp will flash once.
- 3. A flashing YELLOW lamp indicates a 3-digit diagnostic code for the engine. The sequence of flashes represents the system diagnostic message. Count the first sequence of flashes in order to determine the first digit of the flash code. After a two second pause, the second sequence of flashes will identify the second digit of the flash code. After the second pause, the third sequence of flashes will identify the flash code.
- After the diagnostic codes have been displayed, the shutdown lamp will flash twice and the indicator lamp will start to flash the logged diagnostic codes.
- After the logged diagnostic codes have been displayed, the shutdown lamp will flash three times in order to indication that the code sequences have finished.

Note: If there are no diagnostic codes or logged diagnostic codes, the system will flash the code 551.

i05406659

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 by the ECM can be identified by the electronic service tool. The active codes that have been logged will be cleared when the fault has been rectified or the fault is no longer active. The following logged faults cannot be cleared from the memory of the ECM without using a factory password: Overspeed, low engine oil pressure, high engine coolant temperature, and aftertreatment codes.

i03554534

Engine Operation with Active Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If a diagnostic lamp illuminates during normal engine operation, the system has identified a situation that is not within the specification. Use electronic service tools to check the active diagnostic codes. **Note:** If the customer has selected "DERATE" and if there is a low oil pressure condition, the Electronic Control Module (ECM) will limit the engine power until the problem is corrected. If the oil pressure is within the normal range, the engine may be operated at the rated speed and load. However, maintenance should be performed as soon as possible.

The active diagnostic code should be investigated. The cause of the problem should be corrected as soon as possible. If the cause of the active diagnostic code is repaired and there is only one active diagnostic code, the diagnostic lamp will turn off.

Operation of the engine and performance of the engine can be limited as a result of the active diagnostic code that is generated. Acceleration rates may be significantly slower. Refer to the Troubleshooting Guide for more information on the relationship between these active diagnostic codes and engine performance.

i01797063

Engine Operation with Intermittent Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If a diagnostic lamp illuminates during normal engine operation and the diagnostic lamp shuts off, an intermittent fault may have occurred. If a fault has occurred, the fault will be logged into the memory of the Electronic Control Module (ECM).

In most cases, it is not necessary to stop the engine because of an intermittent code. However, the operator should retrieve the logged fault codes and the operator should reference the appropriate information in order to identify the nature of the event. The operator should log any observation that could have caused the lamp to light.

- Low power
- · Limits of the engine speed
- Excessive smoke, etc

This information can be useful to help troubleshoot the situation. The information can also be used for future reference. For more information on diagnostic codes, refer to the Troubleshooting Guide for this engine.

Operation Section Engine Starting

Engine Starting

i08171598

Before Starting Engine

SMCS Code: 1000; 1400; 1450

Perform the required daily maintenance and other periodic maintenance before the engine is started. Inspect the engine compartment. This inspection can help prevent major repairs later. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- Ensure that the engine has an adequate fuel supply.
- Ensure that the engine has an adequate diesel exhaust fluid supply
- Open the fuel supply valve (if equipped).
- Drain the water separators.

NOTICE

All valves in the fuel return line must be open and fuel supply lines must be open. Damage to the fuel system can occur if fuel lines are closed with the engine in operation.

If the engine has not been started for several weeks, fuel may have drained from the fuel system. Air may have entered the filter housing. Also, when fuel filters have been changed, some air pockets will be trapped in the engine. In these instances, prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" for more information on priming the fuel system. Also, check that the fuel specification is correct and that the fuel condition is correct. Refer to the Operation and Maintenance Manual, "Fuel Recommendations".

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

- Do not start the engine or move any of the controls if there is a "DO NOT OPERATE" warning tag or similar warning tag attached to the start switch or to the controls.
- · Reset all the shutoffs or alarm components.
- Ensure that any driven equipment has been disengaged. Minimize electrical loads or remove any electrical loads.

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

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

The ability to start the engine will be improved at temperatures below -18 °C (0 °F) from the use of a jacket water heater or extra battery capacity.

The following items provide a means of minimizing starting problems and fuel problems in cold weather: Engine oil pan heaters, jacket water heaters, fuel heaters, and fuel line insulation.

Use the procedure that follows for cold weather starting.

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

1. Disengage any driven equipment.

Note: During key ON, the indicator lamps will be illuminated for 2 seconds to check the lamp operation. If any of the indicator lamps do not illuminate check the bulb. If any indicator lamps stay illuminated or flash, refer to Troubleshooting, "Indicator Lamp Circuit - Test".

- Turn the keyswitch to the RUN position. Leave the keyswitch in the RUN position until the warning light for the glow plugs is extinguished.
- 3. When the warning light for the glow plugs is extinguished, turn the keyswitch to the START position to engage the electric starting motor and crank the engine.

Note: The operating period of the warning light for the glow plugs will change due to the ambient air temperature.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

4. Allow the keyswitch to return to the RUN position after the engine starts.

i08165229

5. Repeat step 2 through step 4 if the engine fails to start.

Note: After starting, the engine may be held at low speed for a duration between 1 and 60 seconds to allow engine systems to stabilize. The duration will depend on ambient temperature, time since last run and other factors. The glow plug warning lamp will flash to indicate that the engine has been held at low speed.

- 6. The engine should not be raced to speed up the warm-up process. Allow the engine to idle for 3 to 5 minutes, or allow the engine to idle until the water temperature indicator begins to rise. When idling after the engine has started in cold weather, increase the engine rpm from low idle to 1200 rpm. This operation will warm up the engine more quickly.
- 7. Operate the engine at low load until all systems reach operating temperature. Check the gauges during the warm-up period.

Following a cold start, white vapor can be seen from the tailpipe. This vapor is normal and caused by condensation leaving the exhaust system after warming up. The white vapor should clear following working of the engine.

i08165241

Starting the Engine

SMCS Code: 1000; 1450

Note: Do not adjust the engine speed control during start-up. The electronic control module (ECM) will control the engine speed during start-up.

Starting the Engine

- 1. Disengage any equipment that is driven by the engine.
- 2. Turn the keyswitch to the RUN position. Leave the keyswitch in the RUN position until the warning light for the glow plugs is extinguished.

Note: If the keyswitch has been left in the RUN position for a long period of time without engaging the electric starting motor, turn the keyswitch from the RUN position to the OFF position and then back to the RUN position to reactivate the glow plug preheat stage.

Note: During the key on, the indicator lamps will be illuminated for 2 seconds to check lamp operation. If any of the lamps do not illuminate, check the bulb. If any indicator lamps stay illuminated or flash, refer to Troubleshooting, "Indicator Lamp Circuit - Test".

3. When the warning light for the glow plugs is extinguished, turn the keyswitch to the START position to engage the electric starting motor and crank the engine.

Note: The operating period of the warning light for the glow plugs will change due to the temperature of the engine.

NOTICE

Do not engage the starting motor when flywheel is turning. Do not start the engine under load.

If the engine fails to start within 30 seconds, release the starter switch or button and wait two minutes to allow the starting motor to cool before attempting to start the engine again.

- 4. Allow the keyswitch to return to the RUN position after the engine starts.
- **5.** Repeat step 2 through step 4 if the engine fails to start.
- 6. After starting, the engine may be held at low speed for a duration between 1 and 60 seconds to allow engine systems to stabilize. The duration will depend on ambient temperature, time since last run and other factors. The glow plug warning light will flash to indicate that the engine is being held at low speed in some applications.

i07926219

Starting with Jump Start Cables

(Do Not Use This Procedure in Hazardous Locations that have Explosive Atmospheres)

SMCS Code: 1000; 1401; 1402; 1900

The connection of battery cables to a battery and the disconnection of battery cables from a battery may cause an explosion which may result in injury or death. The connection and the disconnection of other electrical equipment may also cause an explosion which may result in injury or death. The procedures for the connection and the disconnection of battery cables and other electrical equipment should only be performed in a nonexplosive atmosphere.

🛕 WARNING

Improper jump start cable connections can cause an explosion resulting in personal injury.

Prevent sparks near the batteries. Sparks could cause vapors to explode. Do not allow jump start cable ends to contact each other or the engine.

Note: If possible, first diagnose the reason for the starting failure. Refer to Troubleshooting, "Engine Will Not Crank and Engine Cranks But Will Not Start" for further information. Make any necessary repairs. If the engine will not start only due to the condition of the battery, either charge the battery, or start the engine by using another battery with jump-start cables. The condition of the battery can be rechecked after the engine has been switched OFF.

NOTICE

For C3.6 industrial engines, ensure that a 12 VDC or 24 VDC battery source is used to start the engine. For C2.8 industrial engines, use a 12 VDC battery source to start the engine. Never attempt to start an engine from an external power source such as electric welding equipment, which has a voltage that is unsuitable for engine starting and will damage the electrical system.

NOTICE

Using a battery source with the same voltage as the electric starting motor. Use ONLY equal voltage for jump starting. The use of higher voltage will damage the electrical system.

Do not reverse the battery cables. The alternator can be damaged. Attach ground cable last and remove first.

Turn all electrical accessories OFF before attaching the jump start cables.

Ensure that the main power switch is in the OFF position before attaching the jump start cables to the engine being started.

- 1. Turn the start switch on the stalled engine to the OFF position. Turn off all the engines accessories.
- Connect one positive end of the jump-start cable to the positive cable terminal of the discharged battery. Connect the other positive end of the jump-start cable to the positive cable terminal of the electrical source.

3. Connect one negative end of the jump-start cable to the negative cable terminal of the electrical source. Connect the other negative end of the jump-start cable to the engine block or to the chassis ground. This procedure helps to prevent potential sparks from igniting the combustible gases that are produced by some batteries.

Note: The engine ECM must be powered before the starting motor is operated or damage can occur.

- Start the engine in the normal operating procedure. Refer to this Operation and Maintenance Manual, "Starting the Engine".
- Immediately after the engine is started, disconnect the jump-start cables in reverse order.

After jump starting, the alternator may not be able to recharge fully batteries that are severely discharged. The batteries must be replaced or charged to the proper voltage with a battery charger after the engine is stopped. Many batteries which are considered unusable are still rechargeable. Refer to Operation and Maintenance Manual, "Battery - Replace" and Testing and Adjusting Manual, "Battery - Test".

i08165244

After Starting Engine

SMCS Code: 1000

After starting, the engine may be held at low speed for a duration between 1 and 60 seconds to allow engine systems to stabilize. Holding the engine speed low is controlled by the Electronic Control Module (ECM). The duration will depend on ambient temperature, time since last run and other factors.

Note: In ambient temperatures from 15° to 20°C (59° to 68°F), the warm-up time is approximately 20 to 30 minutes. In temperatures below 15°C (59°F), additional warm-up time may be required. In temperatures greater than 20°C (68° F), warm-up time may be less.

When the engine idles during warm-up, observe the following conditions:

Do not check the high-pressure fuel lines with the engine or the starting motor in operation. If you inspect the engine in operation, always use the correct inspection procedure to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

 Check for any fluid or air leaks at idle rpm and at one-half full rpm (no load on the engine), before operating the engine under load. This check may not be possible in some applications. • Allow the engine to idle for 3 to 5 minutes, or allow the engine to idle until the water temperature indicator begins to rise. Check all gauges during the warm-up period.

Constant speed engines should be allowed to operate at low idle for 3 minutes before used at operational speed. If the low idle option is not available, then operate the engine at operational speed with no load for 2 minutes.

Note: 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.

Engine Operation

i07853963

Engine Operation

SMCS Code: 1000

Correct 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 of the engine.

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). These issues are 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.

Engine Operation and the Aftertreatment System

The exhaust gases and hydrocarbon particles from the engine first pass through Diesel Oxidation Catalyst (DOC). Some of the gasses and matter are oxidized as the gasses pass through the DOC. The gasses then pass through the Diesel Particulate Filter (DPF). The DPF collects the soot and any ash that is produced by the combustion in the engine. During regeneration, the soot is converted into a gas and the ash remains in the DPF. The gasses finally pass through the Selective Catalytic Reduction (SCR). Before the gasses pass through the SCR, Diesel Exhaust Fluid (DEF) is injected into the gas stream.

The DEF is stored in the DEF tank and is pumped to the DEF injector. The DEF injector is controlled by the ECM. The mixtures of DEF and the exhaust gas pass through the SCR reducing the NOx in the exhaust emissions. The DPF may require the exhaust gas temperature to rise to remove the soot. If necessary, the throttle valve is operated to help in rising the exhaust temperature.

The engine software will control the amount of DEF that will be required to keep the exhaust emission compliant.

This design of DPF will not require a service maintenance interval. The DPF 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.

A fault code will be active for any DPF system-related issue. Follow the troubleshooting guide to rectify the issue.

If the DPF loses function, or is tampered with in any way, the check engine lamp, and an amber action (if equipped) will illuminate. A fault code will also annunciate. The lamps and fault code will remain active until the problem is rectified.

NOTICE

The engine and emissions control system shall be operated, used, and maintained in accordance with the instructions provided. Failure to follow the instructions could result in emissions performance that does not meet the requirements applicable to the category of the engine. No deliberate tampering with, or misuse of the engine emissions control system should take place. Prompt action is critical to rectify any incorrect operation, use, or maintenance of the emissions control system.

Carbon Dioxide (CO₂) Emissions Statement

Emissions regulations require that the value of the CO_2 emissions be reported to the end user.

C3.6 Industrial Engine

For engines with a power rating of 56 kW (75.1 hp) and below, 903.75 g/kWh was determined to be the CO_2 value during the EU type approval process. For engines with a power rating of 70 kW (93.9 hp) and above, 733.73 g/kWh was determined to be the CO_2 value during the EU type approval process. This value was recorded in EU type approval certificate. This CO_2 measurement results from testing over a fixed test cycle, under laboratory conditions, with a parent engine representative of the engine family. This value shall not imply or express any guarantee of the performance of a particular engine.

C2.8 Industrial Engine

856.35 g/kWh was determined to be the CO_2 value during the EU type approval process. This value was recorded in EU type approval certificate. This CO_2 measurement results from testing over a fixed test cycle, under laboratory conditions, with a parent engine representative of the engine family. This value shall not imply or express any guarantee of the performance of a particular engine.

i01646335

Engaging the Driven Equipment

SMCS Code: 1000

- 1. Operate the engine at one-half of the rated rpm, when possible.
- 2. Engage the driven equipment without a load on the equipment, when possible.

Interrupted starts put excessive stress on the drive train. Interrupted starts also waste fuel. To get the driven equipment in motion, engage the clutch smoothly with no load on the equipment. This method should produce a start that is smooth and easy. The engine rpm should not increase and the clutch should not slip.

- 3. Ensure that the ranges of the gauges are normal when the engine is operating at one-half of the rated rpm. Ensure that all gauges operate properly.
- Increase the engine rpm to the rated rpm. Always increase the engine rpm to the rated rpm before the load is applied.
- 5. Apply the load. Begin operating the engine at low load. Check the gauges and equipment for proper operation. After normal oil pressure is reached and the temperature gauge begins to move, the engine may be operated at full load. Check the gauges and equipment frequently when the engine is operated under load.

Extended operation at low idle or at reduced load may cause increased oil consumption and carbon buildup in the cylinders. This carbon buildup results in a loss of power and/or poor performance.

104018250

Fuel Conservation Practices

SMCS Code: 1000; 1250

The efficiency of the engine can affect the fuel economy. Caterpillar's design and technology in manufacturing provides maximum fuel efficiency in all applications. Follow the recommended procedures in order to attain optimum performance for the life of the engine.

• Avoid spilling fuel.

Fuel expands when the fuel is warmed up. The fuel may overflow from the fuel tank. Inspect fuel lines for leaks. Repair the fuel lines, as needed.

- Be aware of the properties of the different fuels. Use only the recommended fuels. Refer to the Operations and Maintenance Manual, "Fuel Recommendations" for further information.
- Avoid unnecessary idling.

Shut off the engine rather than idle for long periods of time.

• Observe the service indicator frequently. Keep the air cleaner elements clean.

- Ensure that the turbocharger is operating correctly. For more information refer to this Operation and Maintenance Manual, "Turbocharger Inspect".
- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This fault will consume excess power and excess fuel.

- The belt should be in good condition. Refer to the Systems Operation, Testing and Adjusting, "V -Belt Test" for further information.
- Ensure that all of the connections of the hoses are tight. The connections should not leak.
- Ensure that the driven equipment is in good working order.
- Cold engines consume excess fuel. Utilize heat from the jacket water system and the exhaust system, when possible. Keep cooling system components clean and keep cooling system components in good repair. Never operate the engine without water temperature regulators. All of these items will help maintain operating temperatures.

Aftertreatment Operation

i07682723

Selective Catalytic Reduction Warning System

SMCS Code: 1091-WXX; 7400

The Selective Catalytic Reduction (SCR) system is a system used to reduce Nitrogen Oxide (NOx) emissions from the engine. Diesel Exhaust Fluid (DEF) is pumped from the DEF tank and is sprayed into the exhaust stream. The DEF reacts with the SCR catalyst to reduce NOx and leaves a nitrogen and water vapor.

The engine and emissions control system shall be operated, used, and maintained in accordance with the instructions provided to the end user to maintain the emissions performance of the engine within the requirements applicable to the category of the engine. No deliberate tampering with, or misuse of the engine emissions control system should take place. In particular regarding deactivating, or not maintaining the SCR system.

NOTICE

Stopping the engine immediately after the engine has been working under load can result in overheating of SCR components.

Refer to the Operation and Maintenance Manual, "Engine Stopping" procedure to allow the engine to cool and to prevent excessive temperatures in the turbocharger housing and the DEF injector.

NOTICE

Allow at least 2 minutes after shutting down the engine before you turn the battery disconnect switch to OFF. Disconnecting the battery power too soon will prevent purging of the DEF lines after the engine is shutdown.

Note: For information on DEF, refer to this Operation and Maintenance Manual, "Fluid Recommendations".

Warning Strategy

The Electronic Control Module (ECM) will be enabled with a world-wide warning strategy.

Warning Indicators

The warning indicators consist of a level gauge for the DEF, a low-level lamp for the DEF, an emission malfunction lamp, and the application stop lamp.



Illustration 47

g03069862

(1) DEF gauge (A) Low-level warning lamp

=13

Illustration 48 Emission malfunction lamp g02852336

Warning Levels

The SCR has three levels of warning. The time that the system will stay at each warning level depends on the fault detected and the type of software enabled.

Any warning should be investigated immediately. Contact your Caterpillar dealer if further assistance is required. The system is equipped with an override option. If the override option has been used and the fault still exists, the engine will be locked in de-rate or shutdown mode.

Definitions

- Self-correct Fault condition no longer exists. An active fault code will no longer be active.
- **Notification** Action taken by the system to alert the operator of pending Inducement.
- Inducement Engine derates, vehicle speed limits, or other actions intended to prompt the operator to repair or maintain the emission control system.

Inducement Categories The Inducements are separated into categories. DEF Levels have inducement fault codes separate from the other inducement categories. DEF level inducements are based on the DEF level, the other inducement categories are based on escalating time. The escalating time inducements will always have an associated fault code along with the inducement fault code. The associated fault is the root cause. The escalating time inducement fault code is just an indicator of what level of inducement the engine is in. The escalating time inducement fault code also indicates how much time remains until the next level of inducement. There are three inducement categories that will trigger an escalating time inducement fault code.

Note: The associated codes for each of the escalating time categories can be found in Troubleshooting, SCR Warning System Problem.

- **First Time** When an escalating time inducement fault code becomes active for the first time.
- Repeat occurrence When any escalating time inducement fault code becomes active again within 40 hours of the first occurrence. Engine must run for 40 hours without tripping any escalating time inducement fault before returning back to first occurrence times.
- Safe Harbor Mode (Worldwide) Safe Harbor Mode is a 20 minute engine run time period. Once in level 3 inducement, the operator can perform a key cycle and the engine will enter Safe Harbor Mode. Safe Harbor Mode can only be implemented once. Safe Harbor Mode is not allowed for DEF level inducements with Worldwide configuration.

NOTICE

It is essential to take prompt action to rectify any incorrect operation, use, or maintenance of the emissions SCR control system in accordance with the rectification measures indicated by the warnings listed on the following pages.

World-Wide SCR Warnings

- At Level 1 the emission malfunction lamp will be on solid.
- At Level 2 the emission malfunction lamp will flash.
- At Level 3 the emission malfunction lamp will flash and the stop lamp will activate.
- At Level 3 the engine may shut down, or operate at 1000 Revolutions Per Minute (RPM).

 At Level 3 cycling the keyswitch will give 20 minutes override at full power, before the shutdown or idle is triggered. The emission malfunction lamp will continue to flash.

World-Wide Reduced Performance Setting

Table 5

World-Wide Reduced Performance Setting					
	Catego	ory 1 Fault (Tampering Do	osing Interruption and	Quality)	
-	Normal operation	Level 1	Level 2	Level 3	Override
Inducement Time First Occurrence	None	2.5 Hours	70 minutes	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power
The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered. The override can only be used once					
Inducement Time Repeat Occurrence	None	5 minutes	75 Percent torque	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power
Inducement	None	None	None		
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will be on solid	Emission malfunction lamp will flash
Contact your Caterpilla	ar dealer at level 1 warn	ing, do not let the fault dev	velop.	<u>.</u>	

Table 6

	World-Wide Reduced Performance Setting						
	Category 2 Fault (Non-Tampering Dosing and Interruption)						
-	Normal operation	Level 1	Level 2	Level 3	Override		
Inducement Time First Occurrence	None	10 Hours	10 Hours	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power		
The system must be fa the repeat occurrence The override can only	The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat occurrence inducement time will be triggered. The override can only be used once						
Inducement Time Repeat Occurrence	None	None	2 Hours	50 Percent torque Shut down or idle	Cycling the keyswitch will give 20 minutes of full power		
Inducement	None	None	75 Percent of torque	Until fault neals			
Notification	None	Emission malfunction Iamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will be on solid	Emission malfunction lamp will flash		
Contact your Caterpilla	ar dealer at level 1 warn	ing, do not let the fault dev	velop.		· · · · · · · · · · · · · · · · · · ·		

Table 7

World-Wide Reduced Performance Setting					
Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR)					
-	Normal operation	Level 1	Level 2	Level 3	Override

(continued)

69

(Table 7, contd)					
Inducement Time First Occurrence	None	36 Hours	64 Hours	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power
The system must be f the repeat occurrence The override can only	ault free for 40 hou inducement time be used once	urs before the system will reset to will be triggered.	o zero. If the fault is inte	rmittent, and returns with	nin the 40 hours, then
Inducement Time Repeat Occurrence	None	None	5 Hours	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power
Inducement	None	None	75 Percent of torque		
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will be on solid	Emission malfunction lamp will flash
Contact your Caterpil	lar dealer at level	1 warning, do not let the fault dev	velop.		

World-Wide Reduce Time Setting

Table 8

	World-Wide Reduced Time Setting					
	Catego	ry 1 Fault (Tampering Do	osing Interruption and	Quality)		
-	Normal operation	Level 1	Level 2	Level 3	Override	
Inducement Time First Occurrence	None	2.5 Hours	70 minutes	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power	
The system must be fa the repeat inducement The override can only	The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered. The override can only be used once.					
Inducement Time Repeat Occurrence	None	5 minutes	5 minutes	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes	
Inducement	None	None	None		of full power	
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will activate	Emission malfunction lamp will flash	
Contact your Caterpilla	ar dealer at level 1 warn	ing, do not let the fault dev	velop.	•		

Table 9

World-Wide Reduced Time Setting						
	Categ	ory 2 Fault (Non-Tamp	ering Dosing Interrup	tion)		
-	Normal operation	Level 1	Level 2	Level 3	Override	
Inducement Time First Occurrence	None	5 Hours	5 Hours	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power	
The system must be fault free for 40 hours before the system will reset to zero. If the fault is intermittent, and returns within the 40 hours, then the repeat inducement time will be triggered. The override can only be used once.						
Inducement Time Repeat Occurrence	None	None	1 Hour	50 Percent torque Shut down or idle	Cycling the keyswitch will give 20 minutes of full power	
Inducement	None	None	None	Until fault neals		
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will activate	Emission malfunction lamp will flash	
Contact your Caterpilla	Contact your Caterpillar dealer at level 1 warning, do not let the fault develop.					

Table 10

World-Wide Reduced Time Setting					
Category 3 Fault (Non-Tampering NOx Control Monitoring and Impeded EGR)					
-	Normal operation	Level 1	Level 2	Level 3	Override

(continued)

(Table 10, contd)					
Inducement Time First Occurrence	None	18 Hours	18 Hours	50 Percent torque Shut down or idle Until fault heals	Cycling the keyswitch will give 20 minutes of full power
The system must be fa the repeat inducemen The override can only	ault free for 40 hou t time will be trigge be used once.	rs before the system will reset to red.	o zero. If the fault is inte	rmittent, and returns with	nin the 40 hours, then
Inducement Time Repeat Occurrence	None	None	108 Minutes	50 Percent torque Shut down or idle	Cycling the keyswitch will give 20 minutes of full power
Inducement	None	None	None	Until fault heals	
Notification	None	Emission malfunction lamp will be on solid	Emission malfunction lamp will flash	Emission malfunction lamp will flash The stop lamp will activate	Emission malfunction lamp will flash
Contact your Caterpill	ar dealer at level 1	warning, do not let the fault dev	velop.		

World-Wide DEF Level Warnings

Two options are available but only one option will be enabled.

- The low-level warning lamp will operate when DEF level reaches the trigger point of below 20 percent.
- At Level 1 the low-level warning lamp in the DEF gauge will illuminate and the emission malfunction lamp will be on solid.
- At Level 2 the low-level warning lamp for the DEF is active and the emission malfunction lamp will flash.
- At Level 3 all level 2 warning lamps are active, plus the stop lamp will become active. The engine will shut down or will only operate at 1000 RPM.

Filling the DEF tank will remove the warning from the system.

Table 1'	
----------	--

	World-Wide DEF Level Option 1				
-	Normal operation	Initial indication	Level 1	Level 2	Level 3
Inducement Trigger	Above 19 percent	Below 19 percent	Below 12.5 percent	0 Percent reading	Empty tank
Inducement	None	None	None	Engine may be de- rated by 25 percent torque	The engine may be derated by 50 percent torque. A shutdown or low idle only will be en- forced after 5 minutes.
Notification	None	Low-level lamp illuminated	Low-level lamp illuminated Emission malfunction lamp on solid	Low-level lamp illuminated Emission malfunction lamp flashing	Low-level lamp illuminated Emission malfunction lamp flashing Stop lamp on solid

		World-Wide D	EF Level Option 2		
	Normal operation	Initial indication	Level 1	Level 2	Level 3
Inducement Trigger	Above 19 percent	Below 19 percent	Below 12.5 percent	6 Percent reading	0 Percent reading
Inducement	None	None	None	None	The engine may be derated by 50 percent torque A shutdown or low idle only will be en- forced after 5 minutes.
Notification	None	Low-level lamp illuminated	Low-level lamp illuminated Emission malfunction lamp on solid	Low-level lamp illuminated Emission malfunction lamp flashing	Low-level lamp illuminated Emission malfunction lamp flashing Stop lamp on solid

Table 12

Cold Weather Operation

i08185453

Cold Weather Operation

SMCS Code: 1000; 1250

Caterpillar Diesel Engines can operate effectively in cold weather. During cold weather, the starting and the operation of the diesel engine depends on the following items:

- The type of fuel that is used
- The viscosity of the engine oil
- The operation of the glow plugs
- Optional Cold starting aid
- Battery condition
- Ambient air temperature and altitude
- Parasitic load of the application
- Application hydraulic and transmission oil viscosities

Refer to Special Publication, SEBU5898, "Cold-Weather Recommendations for Caterpillar Machines".

This section will cover the following information:

- Potential problems that are caused by coldweather operation
- Suggested steps which can be taken to minimize starting problems and operating problems when the ambient air temperature is between 0° to-40 °C (32° to 40 °F).

The operation and maintenance of an engine in freezing temperatures is complex. This complexity is because of the following conditions:

- Weather conditions
- Engine applications

Recommendations from your Caterpillar dealer are based on past proven practices. The information that is contained in this section provides guidelines for cold-weather operation.

Hints for Cold-Weather Operation

 After starting the engine, the engine speed will be governed for up to a maximum of 60 seconds.
 After this period, the engine should be operated at low loads until a minimum operating temperature of 80° C (176° F) is achieved.

- Achieving operating temperature will help prevent the intake valves and exhaust valves from sticking.
- The cooling system and the lubrication system for the engine do not lose heat immediately upon shutdown. Therefore an engine can be shut down for a period of time and the retained heat within the engine will allow the engine to start readily.
- Install the correct specification of engine lubricant before the beginning of cold weather. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended viscosity of oil.
- Check all rubber parts (hoses, fan drive belts) weekly.
- Check all electrical wiring and connections for any fraying or damaged insulation.
- Keep all batteries fully charged and warm by ensuring that the engine is allowed to operate at normal operating temperature.
- · Fill the fuel tank at the end of each shift.
- Check the air cleaners and the air intake daily. Check the air intake more often when you operate in snow.
- Ensure that the glow plugs are in working order. Refer to Troubleshooting, "Glow Plug Starting Aid-Test".

Personal injury or property damage can result from alcohol or starting fluids.

Alcohol or starting fluids are highly flammable and toxic and if improperly stored could result in injury or property damage.

🛕 WARNING

Do not use aerosol types of starting aids such as ether. Such use could result in an explosion and personal injury. For jump starting with cables in cold weather, refer to the Operation and Maintenance Manual, "Starting with Jump-Start Cables." for instructions.

Viscosity of the Engine Lubrication Oil

Correct engine oil viscosity is essential. Oil viscosity affects lubrication properties and wear protection that the oil provides for the engine. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended viscosity of oil.

At temperatures below -10° C (14° F) damage to engine components can occur if the engine is allowed to operate at high load and speed immediately after starting.

Recommendations for the Coolant

Provide cooling system protection for the lowest expected outside temperature. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for the recommended coolant mixture.

In cold weather, check the coolant often for the correct glycol concentration to ensure adequate freeze protection.

Engine Block Heaters

Engine block heaters (if equipped) heat the engine jacket water that surrounds the combustion chambers. This heat provides the following functions:

- · Startability is improved.
- Warm up time is reduced.

An electric block heater can be activated once the engine is stopped. A block heater can be 120 V ac 600W or 220 V ac 550W. Consult your Caterpillar dealer for more information.

Idling the Engine

After starting the engine, the engine speed will be governed for a maximum period of 60 seconds. When idling after the engine is started in cold weather, increase the engine rpm from 1000 to 1200 rpm. This idling will warm up the engine more quickly. Maintaining an elevated low idle speed for extended periods will be easier with the installation of a hand throttle. The engine should not be "raced" to speed up the warm-up process. While the engine is idling, the application of a light load (parasitic load) will help in achieving the minimum operating temperature. The minimum operating temperature is 80° C (176° F).

Recommendations for Coolant Warm Up

Warm up an engine that has cooled below normal operating temperatures due to inactivity. This warm -up should be performed before the engine is returned to full operation. During operation in very cold temperature conditions, damage to engine valve mechanisms can result from engine operation for short intervals. This damage can happen if the engine is started and the engine is stopped many times without being operated to warm up completely.

When the engine is operated below normal operating temperatures, fuel and oil are not burned completely in the combustion chamber. This fuel and oil causes soft carbon deposits to form on the valve stems. Generally, the deposits do not cause problems and the deposits are burned off during operation at normal engine operating temperatures.

When starting and stopping an engine many times without being operated to warm up completely, the carbon deposits become thicker. This starting and stopping can cause the following problems:

- · Free operation of the valves is prevented.
- · Valves become stuck.
- · Pushrods may become bent.
- Other damage to valve train components can result.

For these reasons, when the engine is started, the engine must be operated until the coolant temperature is 80° C (176° F) minimum. Carbon deposit on the valve stems will be kept at a minimum. The free operation of the valves and the valve components will be maintained.

The engine must be warmed thoroughly to keep other engine parts in better condition. The service life of the engine will generally be extended. Lubrication will be improved. There will be less acid and less sludge in the oil. This condition will provide longer service life for the engine bearings, the piston rings, and other parts. However, limit unnecessary idle time to 10 minutes to reduce wear and unnecessary fuel consumption.

The Water Temperature Regulator and Insulated Heater Lines

The engine is equipped with a water temperature regulator. When the engine coolant is below the correct operating temperature, jacket water circulates through the engine cylinder block and into the engine cylinder head. The coolant then returns to the cylinder block via an internal passage that bypasses the valve of the coolant temperature regulator. This return ensures that coolant flows around the engine under cold operating conditions. The water temperature regulator begins to open when the engine jacket water has reached the correct minimum operating temperature. As the jacket water coolant temperature rises above the minimum operating temperature, the water temperature regulator opens further allowing more coolant through the radiator to dissipate excess heat.

The progressive opening of the water temperature regulator operates the progressive closing of the bypass passage between the cylinder block and head. This action ensures maximum coolant flow to the radiator to achieve maximum heat dissipation.

Note: Do not restrict the air flow. Restriction of the air flow can damage the fuel system. Caterpillar discourages the use of all air flow restriction devices such as radiator shutters. Restriction of the air flow can result in the following: high exhaust temperatures, power loss, excessive fan usage, and reduction in fuel economy.

A cab heater is beneficial in very cold weather. The feed from the engine and the return lines from the cab should be insulated to reduce heat loss to the outside air.

i07940051

Radiator Restrictions

SMCS Code: 1353; 1396

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

Reducing air flow over components will also affect under hood temperatures. Reducing air flow can increase surface temperatures during an aftertreatment regeneration and could affect component reliability. If an airflow restriction device must be used, the device should have a permanent opening directly in line with the fan hub. The device must have a minimum opening dimension of at least 770 cm² (120 in²).

A centered opening that is directly in line with the fan hub is specified to prevent an interrupted airflow on the fan blades. Interrupted airflow on the fan blades could cause a fan failure.

Caterpillar recommends a warning device for the inlet manifold temperature and/or the installation of an inlet air temperature gauge.

- For turbocharged, air to air charge cooled engines, the warning device for the inlet manifold temperature should be set at 75 °C (167 °F). The inlet manifold air temperature should not exceed 75 °C (167 °F).
- For turbocharged engines, the warning device for the inlet manifold temperature should be set at 180 °C (356 °F). The inlet manifold air temperature should not exceed 180 °C (356 °F).

Temperatures that exceed these limits can cause power loss and potential engine damage.

i05385898

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250; 1280

The following fuels are the grades that are available for Cat engines:

- NO. 1 is ASTM D975 grade 1D S15
- NO. 2 is ASTM D975 grade 2D S15

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 coldweather 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".

i08298402

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250; 1280

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 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 Inline filter, primary fuel filter, and the fuel supply line are the most common components that are affected by cold fuel.

NOTICE

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 correct 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 electric fuel pump.

Note: If so, the temperature of the fuel must not exceed 75° C (167° F) at the electric fuel pump.

For further information on fuel heaters, consult your Caterpillar dealer.

i07677871

Diesel Exhaust Fluid in Cold Weather

SMCS Code: 108K

Due to the freezing point of Diesel Exhaust Fluid (DEF) the aftertreatment system is equipped with electrically heated DEF lines. The system also has a coolant heated element in the DEF tank.

During periods of weather in which DEF can freeze the application should be stood on level ground when not in use. DEF can start to freeze at -11° C (12.2° F).

Note: At certain angles DEF can cover the DEF filler cap. If the DEF freezes, the DEF tank vent could block. A blocked vent in the DEF tank assembly will cause operational difficulties.

For information on DEF refer to this Operation and Maintenance Manual, "Fluid Recommendations".

Engine Stopping

i07693085

Stopping the Engine

SMCS Code: 1000

NOTICE

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

Avoid accelerating the engine prior to shutting down the engine.

Avoiding hot engine shutdowns will maximize turbocharger shaft and bearing life. Also, selective catalytic reduction component life.

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

- Remove the load from the engine. Reduce the engine speed to low idle. Allow the engine to idle for 5 minutes to cool the engine.
- Stop the engine after the cool down period according to the shutoff system on the engine and turn the ignition keyswitch to the OFF position. If necessary, refer to the instructions that are provided by the OEM.

Note: In some applications the engine will continue to operate after the keyswitch is turned to the OFF position. The engine will operate for a short time to allow engine components to cool.

3. Allow at least 2 minutes after the engine has stopped before you turn the battery disconnect switch to OFF. Disconnecting the battery power too soon will prevent purging of the DEF fluid lines after the engine is shut down. Also, during the 2 minutes the engine electronic control module is active, storing information from the engine and aftertreatment sensors.

Delayed Engine Shutdown (if Equipped)

The delayed engine shutdown allows the engine to run for a time after the engine start switch is turned to the OFF position to cool the system components. The engine start switch key may be removed. **Note:** There may be regulations that define the requirements for the operator and/or support personnel to be present when the engine is running.

Leaving the machine unattended when the engine is running may result in personal injury or death. Before leaving the machine operator station, neutralize the travel controls, lower the work tools to the ground and deactivate all work tools, and place the lever for the hydraulic lockout control in the LOCKED position.

Leaving the engine unattended while running may result in property damage in the event of a malfunction.

Note: An authorized dealer can change the maximum run time value up to 30 minutes but the default setting is 10 minutes.

An override can be enabled so that the delayed engine shutdown will not operate. Overriding delayed engine shutdown may reduce engine and system component life. The override is operated by the keyswitch.

At any time during a delayed engine shutdown, the engine start switch may be turned to the ON position. The engine may be placed back into service.

105195199

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.

The OEM may have equipped the application with an emergency stop button. For more information about the emergency stop button, refer to the OEM information.

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

i07486528

After Stopping Engine

SMCS Code: 1000

Note: Before you check the engine oil, do not operate the engine. Wait for at least 30 minutes after the engine has stopped to allow the engine oil to return to the oil pan.

A 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.

- Diesel Exhaust Fluid (DEF) purge, do not disconnect the battery disconnect switch until the DEF purge has been completed. The procedure is automatically controlled and will take approximately 2 minutes.
- After the engine has stopped, you must wait for 10 minutes 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".
- Check the crankcase oil level. Maintain the oil level between the "MIN" mark and the "MAX" mark on the engine oil level gauge.
- If the engine is equipped with a service hour meter, note the reading. Perform the maintenance that is in the Operation and Maintenance Manual, "Maintenance Interval Schedule".
- Fill the fuel tank, to help prevent accumulation of moisture in the fuel. Do not overfill the fuel tank.
- Fill the DEF tank, a low level of DEF in the tank can result in engine de-rate.

NOTICE

Only use antifreeze/coolant mixtures recommended in this Operation and Maintenance Manual, "Refill Capacities and Recommendations" topic or in this Operation and Maintenance Manual, "Fluid Recommendations" topic. Failure to do so can cause engine damage.

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.

Allow the engine to cool. Check the coolant level.

- Check the coolant for correct antifreeze protection and the correct corrosion protection. Add the correct coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Maintenance Section

Maintenance Recommendations

i07819420

System Pressure Release

SMCS Code: 1250; 1300; 1350; 5050

Coolant System

🛕 WARNING

Pressurized system: Hot coolant can cause serious burn. To open cap, stop engine, wait until radiator is cool. Then loosen cap slowly to relieve the pressure.

When the engine is in the AUTOMATIC mode, the engine can start at any moment. To avoid personal injury, always remain clear of the the engine when the engine is in the AUTOMATIC mode.

The engine can have the ability to auto start. Ensure that the power supply is isolated before any service or repair is performed.

To relieve the pressure from the coolant system, turn off the engine. Allow the cooling system pressure cap to cool. Remove the cooling system pressure cap slowly to relieve pressure.

Fuel System

To relieve the pressure from the fuel system, turn off the engine.

High-Pressure Fuel Lines

\Lambda 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.

The high-pressure fuel lines are the fuel lines that are between the high-pressure fuel pump and the highpressure fuel manifold and the fuel lines that are between the fuel manifold and the fuel injectors. The high-pressure fuel lines are different from fuel lines on other fuel systems, the differences are as follows:

- The high-pressure fuel lines are constantly charged with high pressure.
- The internal pressures of the high-pressure fuel lines are higher than other types of fuel system.

Before any service or repair is performed on the engine fuel lines, perform the following tasks:

- 1. Stop the engine.
- 2. Wait for 10 minutes.

Do not loosen the high-pressure fuel lines to remove air from the fuel system.

Engine Oil

To relieve pressure from the lubricating system, turn off the engine.

i07703516

Welding on Engines with Electronic Controls

SMCS Code: 1000

NOTICE

Because the strength of the frame may decrease, some manufacturers do not recommend welding onto a chassis frame or rail. Consult the OEM of the equipment or your Caterpillar dealer regarding welding on a chassis frame or rail.

Correct welding procedures are necessary to avoid damage to the engines ECM, sensors, and associated components. When possible, remove the component from the unit and then weld the component. If removal of the component is not possible, the following procedure must be followed when you weld on a unit equipped with an Electronic Engine. The following procedure is considered to be the safest procedure to weld on a component. This procedure should provide a minimum risk of damage to electronic components.

NOTICE

Do not ground the welder to electrical components such as the ECM or sensors. Improper grounding can cause damage to the drive train bearings, hydraulic components, electrical components, and other components.

Clamp the ground cable from the welder to the component that will be welded. Place the clamp as close as possible to the weld. This will help reduce the possibility of damage. **Note:** Perform the welding in areas that are free from explosive hazards.

- 1. Stop the engine. Turn the switched power to the OFF position.
- **2.** Ensure that the fuel supply to the engine is turned off.
- 3. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
- 4. Disconnect all electronic components from the wiring harnesses. Include the following components:
 - Electronic components for the driven
 equipment
 - ECM
 - Sensors
 - · Electric operated fuel pump
 - Electronically controlled valves
 - Relays
 - Aftertreatment ID module

NOTICE

Do not use electrical components (ECM or ECM sensors) or electronic component grounding points for grounding the welder.



Illustration 49

g06392357

81

Use the example above. The current flow from the welder to the ground clamp of the welder will not damage any associated components.

(1) Engine

- (2) Welding electrode
- (3) Keyswitch in the OFF position
- (4) Battery disconnect switch in the open position
- (5) Disconnected battery cables
- (6) Battery (7) Electrical/Electronic component
- (8) The component that is being welded
- (9) Current path of the welder
- (10) Ground clamp for the welder
- 5. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld to reduce the possibility of welding current damage to the following components. Bearings, hydraulic components, electrical components, and ground straps.

Note: If electrical/electronic components are used as a ground for the welder, or electrical/electronic components are located between the welder ground and the weld, current flow from the welder could severely damage the component.

- 6. Protect the wiring harness from welding debris and spatter.
- 7. Use standard welding practices to weld the materials.

i04807435

Severe Service Application

SMCS Code: 1000

An engine which operates outside of normal conditions is operating in a severe service application.

An engine that operates in a severe service application may need more frequent maintenance intervals in order to maximize the following conditions:

- Reliability
- Service life

The number of individual applications cause the impossibility of identifying all of the factors which may contribute to severe service operation. Consult your Caterpillar dealer for the unique maintenance that may be necessary for your engine.

An application is a severe service application if any of the following conditions apply:

Severe Environmental Factors

- · Frequent operation in dirty air
- Frequent operation at an altitude which is above 1525 m (5000 ft)
- Frequent operation in ambient temperatures which are above 32° C (90° F)
- Frequent operation in ambient temperatures which are below 0° C (32° F)

Severe Operating Conditions

- Frequent operation with inlet air which has a corrosive content
- Operation with inlet air which has a combustible content
- Operation which is outside of the intended application
- Operation with a plugged fuel filter
- Extended operation at low idle (more than 20% of hours)
- Frequent cold starts at temperatures below 0° C (32° F)
- Frequent dry starts (starting after more than 72 hours of shutdown)

- Frequent hot shutdowns (shutting down the engine without the minimum of 2 minutes to 5 minutes of cool down time)
- · Operation above the engine rated speed
- Operation below the peak torque speed
- Operating with fuel which does not meet the standards for distillate diesel fuel as stated in Special Publication, SEBU6250, "Caterpillar Machine Fluids Recommendations" "Distillate Diesel Fuel"
- Operating with a blend of distillate fuel which contains more than 20 percent biodiesel

Improper Maintenance Procedures (Maintenance Procedures Which May Contribute to a Severe Service Application)

- Inadequate maintenance of fuel storage tanks from causes such as excessive water, sediment, and microorganism growth.
- Extending maintenance intervals beyond the recommended intervals
- Using fluids which are not recommended in Special Publication, SEBU6250, "Caterpillar Machine Fluids Recommendations"
- Extending maintenance intervals for changing the engine oil and engine coolant without S·O·S validation
- Extending maintenance intervals for changing air filters, oil filters, and fuel filters
- · Failure to use a water separator
- Using filters which are not recommended by Special Publication, PEWJ0074, "2008 Cat Filter and Fluid Application Guide"
- Storing the engine for more than 3 months but less than 1 yr (For information about engine storage, refer to Special Publication, SEHS9031, "Storage Procedure for Caterpillar Products")

Refill Capacities

i08068174

g06511838

Refill Capacities

SMCS Code: 1000; 1348; 1395; 7560

Lubrication System for Engines Equipped With a Standard Oil Pan



Illustration 50 Typical example (1) Standard Oil Pan

OEM – Original Equipment Manufacturer

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require extra oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Maintenance Section" for more information on Lubricant Specifications.

Table 13

C3.6 Industrial Engine Refill Capacities			
Compartment or System	Capacity		
Crankcase Oil Sump(1)	8 to 10.6 L (2.11360 to 2.80052 US gal)		

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require extra oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. The design of the oil pan can change the oil capacity of the oil pan. Table 14

C2.8 Industrial Engine Refill Capacities		
Compartment or System	Capacity	
Crankcase Oil Sump(1)	7.5 to 8.8 L (1.98150 to 2.32496 US gal)	

(1) These values are the approximate capacities for the crankcase oil sump which includes the standard factory installed oil filters. Engines with auxiliary oil filters will require extra oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. The design of the oil pan can change the oil capacity of the oil pan.

Lubrication System for Engines Equipped With a Balancer Oil Pan



Illustration 51 Typical example

(2) Oil Pan with a balancer

OEM – Original Equipment Manufacturer

The refill capacities for the engine crankcase reflect the approximate capacity of the crankcase or sump plus standard oil filters. Auxiliary oil filter systems will require extra oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Maintenance Section" for more information on Lubricant Specifications.

Note: During engine oil changes both sides of the engine oil pan must be drained of lubricant.

q06511850

Table 15

C3.6 Industrial Engine With a Balancer Oil Pan Refill Capacities		
Compartment or System	Capacity	
Crankcase Oil Sump (1)	8.5 to 10 L (2.246 to 2.642 US gal)	

Cooling System

Refer to the OEM specifications for the External System capacity. This capacity information will be needed to determine the amount of coolant/ antifreeze that is required for the Total Cooling System.

Table 16

C3.6 Industrial Engine Refill Capacities		
Compartment or System	Capacity	
Engine Only	4.3 L (1.136 US gal)	
External System Per OEM ⁽¹⁾		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

Table 17

C2.8 Industrial Engine Refill Capacities		
Compartment or System	Capacity	
Engine Only	3.9 L (1.03038 US gal)	
External System Per OEM(1)		

(1) The External System includes a radiator or an expansion tank with the following components: heat exchanger and piping. Refer to the OEM specifications. Enter the value for the capacity of the External System in this row.

DEF System

DEF – Diesel Exhaust Fluid

Table 18

DEF Tank Capacity

(continued)

19 L (5 US gal)(1)

(Table 18, contd) (1) OEM tank size shape, and capacities could be different.

i07676428

Fluid Recommendations

SMCS Code: 1280; 1348; 1395; 7560

Engine Lubrication Oil

NOTICE

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

- EMA_____Engine Manufacturers Association
- API_____American Petroleum Institute
- SAE____Society Of Automotive Engineers Inc.
- DEO-ULS _____Diesel Engine Oil-Ultra Low Sulfur

Cat DEO-ULS

Cat DEO-ULS is developed and tested to provide superior protection and life for your Caterpillar engines.

- Better Detergents
- Advanced Additive Package
- Enhanced Dispersants
- Improved Protection from Thermal breakdown and Oxidation Breakdown

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

- · Cat DEO-ULS (SAE 10W-30)
- Cat DEO-ULS (SAE 15W-40)

Cat DEO-ULS Multigrade oil is available in various viscosity grades that include SAE 10W-30 and SAE 15W-40. To choose the correct viscosity grade for the ambient temperature, see illustration 52. Multigrade oils provide the correct viscosity for a broad range of operating temperatures. Multigrade oils are also effective in maintaining low oil consumption and low levels of piston deposits.

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

Note: Cat DEO-ULS in SAE 15W-40 passes the following proprietary tests: sticking of the piston ring, oil control tests, wear tests, and soot tests. Proprietary tests help ensure that Caterpillar multigrade oil provides superior performance in Caterpillar Diesel Engines. In addition, Cat DEO-ULS Multigrade oil exceeds many of the performance requirements of other manufacturers of diesel engines. Therefore, this oil is an excellent choice for many mixed fleets. True high-performance oil is produced with a combination of the following factors: industry standard tests, proprietary tests, field tests, and prior experience with similar formulations. The design and the development of Caterpillar lubricants that are both high performance and high quality are based on these factors.

Commercial Oils

Note: Non-Caterpillar commercial oils are second choice oils.

NOTICE

Caterpillar require the use of the following specification of engine oil. Failure to use the appropriate specification of engine oil will reduce the life of your engine. Failure to use the correct specification of engine will also reduce the life and the effectiveness of your aftertreatment system.

Table 19

API Classifications for the Industrial Engine

Oil Specification

ECF-3 CK-4

AECA E9

NOTICE

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

Note: API FA-4 oil is designed for use in selected onhighway applications and is NOT designed to support off-road applications, including Caterpillar Engines. DO NOT use API FA-4 oil for Caterpillar engines.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information that relates to lubrication for your engine.

Lubricant Viscosity Recommendations

The proper SAE viscosity grade of oil is determined by the minimum ambient temperature during cold engine start-up, and the maximum ambient temperature during engine operation. Refer to illustration 52 (minimum temperature) to determine the required oil viscosity for starting a cold engine.

Refer to illustration 52 (maximum temperature) to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Note: Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

If ambient temperature conditions at engine start-up require the use of multigrade SAE 0W oil, SAE 0W-40 viscosity grade is preferred.



Illustration 52

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

q03329687

S·O·S Oil Analysis

Caterpillar has developed a tool for maintenance management that evaluates oil degradation and the tool also detects the early signs of wear on internal components. The Caterpillar tool for oil analysis is called $S \cdot O \cdot S$ Oil Analysis and the tool is part of the $S \cdot O \cdot S$ Services program. $S \cdot O \cdot S$ Oil Analysis divides oil analysis into three categories:

- Wear Analysis
- · Oil condition
- Extra tests

The wear analysis monitors metal particles, some oil additives, and some contaminants.

Oil condition uses infrared (IR) analysis to evaluate the chemistry of the oil. Infrared analysis is also used to detect certain types of contamination.

Extra tests are used to measure contamination levels from water, fuel, or coolant. Oil viscosity and corrosion protection can be evaluated, as needed.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" or contact your local Cat dealer for additional information concerning the $S \cdot O \cdot S$ Oil Analysis program.

Lubricating Grease

Caterpillar provides a range of moderate greases to high performance greases to service the entire line of Caterpillar products that operate throughout the wide variety of climates. You will always be able to find a grease that will meet your machines requirements for a certain application. Caterpillar grease products often exceed Caterpillar specifications.

Before selecting a grease products for any application, the performance requirements must be determined. Consult the grease recommendations that are made by the OEM for the equipment when the equipment is operated in the expected conditions. Then, consult with your Cat dealer for a list of greases and the following related characteristics.

- · Performance specifications
- · Available sizes of containers
- Part numbers

Always choose a grease that meets the recommendations that are specified by the equipment manufacturer for the application, or choose a grease that exceeds the recommendations that are specified by the equipment manufacturer for the application.

Always choose a grease that meets the requirements of the most demanding application. A product that barely meets the minimum performance requirements will shorten the life of the part. Use the grease that yields the least total operating cost. Base this cost on an analysis that includes the costs of the parts, the labor, the downtime, and the cost of the grease that is used.

Some greases are not chemically compatible. Consult your supplier to determine if two or more greases are compatible.

Purge the grease from a joint at the following times:

• Switching from one grease to another grease

· Switching from one supplier to another supplier

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

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

Fuel

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for the Caterpillar Specification for distillate fuel and for additional information that relates to fuel for your engine.

Ultra low Sulfur Diesel (ULSD)

Your Caterpillar Diesel Engine must use ultra low sulfur diesel fuel. This fuel complies with the emissions regulations that are prescribed by the European Union and the Environmental Protection Agency of the United States.

Engines that are manufactured by Caterpillar are certified with the fuel that is prescribed by the United States Environmental Protection Agency. Engines that are manufactured by Caterpillar are certified with the fuel that is prescribed by the European Certification. Caterpillar does not certify diesel engines on any other fuel.

Note: The owner and the operator of the engine has the responsibility of using the fuel that is prescribed by the United States Environmental Protection Agency and other appropriate regulatory agencies.

Fuel tank inlet labels are installed to ensure that the correct fuels are used. Illustration 53 is an example of one of the labels designs that will be installed.



Illustration 53 Typical example g02157153

Fuel Additives

Many types of fuel additives are available. Caterpillar does not generally recommend the use of fuel additives.

In special circumstances, Caterpillar recognizes the need for fuel additives. Use caution if using fuel additives. The additive may not be compatible with the fuel. Some additives may precipitate. This action causes deposits in the fuel system. The deposits may cause seizure. Some additives may be corrosive and some additives may be harmful to the elastomers in the fuel system.

Some additives may damage emission control systems. Some additives may cause the amount of sulfur in the fuel to be greater than 15 ppm.

Contact your fuel supplier for those circumstances when fuel additives are required. Your fuel supplier can recommend the best additives for your application and for the proper level of treatment.

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

Diesel Exhaust Fluid

General Information

Diesel Exhaust Fluid (DEF) is a liquid that is injected into the exhaust system of engines equipped with Selective Catalytic Reduction (SCR) systems. SCR reduces emissions of nitrogen oxides (NOx) in diesel engine exhaust.

In engines equipped with SCR emissions reduction system, DEF is injected in controlled amounts into the engine exhaust stream. At the elevated exhaust temperature, urea in DEF is converted to ammonia. The ammonia chemically reacts with NOx in diesel exhaust in the presence of the SCR catalyst. The reaction converts NOx into nitrogen (N2) and water (H2O).

DEF is known by many brands including AdBlue or API certification.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for more information.

DEF Recommendations

For use in Caterpillar engines, DEF must meet all the requirements defined by "ISO 22241-1" Requirements.

Caterpillar recommends the use of DEF available through the Cat parts ordering system for use in Caterpillar engines equipped with SCR systems. Refer to Table 20 for part number information:

Table	20
-------	----

Cat Part Number	Container Size
350-8733	2.5 gal bottle
350-8734	1000-L totes

In North America, commercial DEF that is API approved and meets all the requirements defined in "ISO 22241-1" may be used in Cat engines that are equipped with SCR systems.

Outside of North America, commercial DEF that meets all requirements defined in "ISO 22241-1" may be used in Cat engines that are equipped with SCR systems.

The supplier should provide documentation to prove that the DEF is compliant with the requirements of "ISO 22241-1".

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

NOTICE

Do not use agriculture grade urea solutions. Do not use any fluids that do not meet "ISO 22241-1" Requirements in SCR emissions reduction systems. Use of these fluids can result in numerous problems including damage to SCR equipment and a reduction in NOx conversion efficiency.

DEF is a solution of solid urea that is dissolved in demineralized water to produce a final concentration of 32.5% urea. DEF concentration of 32.5% is optimal for use in SCR systems. DEF solution of 32.5% urea has the lowest attainable freeze point of -11.5° C (11.3° F). DEF concentrations that are higher or lower than 32.5% have higher freeze points. DEF dosing systems and "ISO 22241-1" specifications are designed for a solution that is approximately 32.5%.

Caterpillar offers a refractometer, Cat part number 360-0774, that can be used to measure DEF concentration. Follow the instructions provided with the instrument. Appropriate commercial portable refractometers can be used to determine urea concentration. Follow the instructions from the manufacturer.

DEF Guidelines

DEF solution is typically colorless and clear. Changes to color or clarity are indicators of quality issues. Quality of DEF can degrade when stored and handled inappropriately or if DEF is not protected from contamination. Details are provided below.

If quality issues are suspected, testing of DEF should focus on urea percentage, alkalinity as NH3 and biuret content. DEF that does not pass all these tests or that is no longer clear should not be used.

Materials compatibility

DEF is corrosive. Due to the corrosion caused, DEF must be stored in tanks constructed of approved materials. Recommended storage materials:

Stainless Steels:

- 304 (S30400)
- 304L (S30403)
- 316 (S31600)
- 316L (S31603)

Alloys and metals:

- Chromium Nickel (CrNi)
- Chromium Nickel Molybdenum (CrNiMo)
- Titanium

Non-metallic materials:

- Polyethylene
- Polypropylene
- Polyisobutylene
- Teflon (PFA)
- Polyfluoroethylene (PFE)
- Polyvinylidene fluoride (PVDF)
- Polytetrafluoroethylene (PTFE)

Materials NOT compatible with DEF solutions include Aluminum, Magnesium, Zinc, Nickel coatings, Silver, and Carbon steel and Solders containing any of the above. Unexpected reactions may occur if DEF solutions come in contact with any non-compatible material or unknown materials.

Bulk storage

Follow all local regulations covering bulk storage tanks. Follow proper tank construction guidelines. Tank volume typically should be 110% of planned capacity. Appropriately vent indoor tanks. Plan for control of overflow of the tank. Heat tanks that dispense DEF in cold climates. DEF will start to freeze at -9° C (15.8° F).

Bulk tank breathers should be fitted with filtration to keep airborne debris from entering the tank. Desiccant breathers should not be used because water will be absorbed, which potentially can alter DEF concentration.

Handling

Follow all local regulations covering transport and handling. DEF transport temperature is recommended to be -5° C (23° F) to 25° C (77° F). All transfer equipment and intermediate containers should be used exclusively for DEF. Containers should not be reused for any other fluids. Ensure that transfer equipment is made from DEF-compatible materials. Recommended material for hoses and other non-metallic transfer equipment includes:

- Nitrile Rubber (NBR)
- Fluoroelastomer (FKM)
- Ethylene Propylene Diene Monomer (EPDM)

The condition of hoses and other nonmetallic items that are used with DEF should be monitored for signs of degradation. DEF leaks are easily recognizable by white urea crystals that accumulate at the site of the leak. Solid urea can be corrosive to galvanized or unalloyed steel, aluminum, copper, and brass. Leaks should be repaired immediately to avoid damage to surrounding hardware.

Cleanliness

Contaminants can degrade the quality and life of DEF. Filtering DEF is recommended when dispensed into the DEF tank. Filters should be compatible with DEF and should be used exclusively with DEF. Check with the filter supplier to confirm compatibility with DEF before using. Mesh-type filters using compatible metals, such as stainless steel, are recommended. Paper (cellulose) media and some synthetic filter media are not recommended because of degradation during use.

Care should be taken when dispensing DEF. Spills should be cleaned immediately. Machine or engine surfaces should be wiped clean and rinsed with water. Caution should be used when dispensing DEF near an engine that has recently been running. Spilling DEF onto hot components will cause harmful vapors.

Stability

DEF fluid is stable when stored and handled properly. The quality of DEF rapidly degrades when stored at high temperatures. The ideal storage temperature for DEF is between -9° C (15.8° F) and 25° C (77° F). DEF that is stored above 35° C (95° F) for longer than 1 month must be tested before use. Testing should evaluate Urea Percentage, Alkalinity as NH3 and Biuret content.

The length of storage of DEF is listed in the following table:

Table 21

Storage Temperature	Expected DEF Life	
Below 25° C (77° F)	18 months	
25° C (77° F) to 30° C (86° F)	12 months	
30° C (86° F) to 35° C (95° F)	6 months	
Above 35° C (95° F)	test quality before use	

Refer to "ISO 22241" document series for more information about DEF quality control.

Note: Dispose of all fluids according to applicable regulations and mandates.

Filling Tank

The DEF tank filler cap is colored blue. A special nozzle size is required to fill a DEF tank. Ensure that the DEF tank is on level ground before the tank is filled.

Spillage

Care should be taken when dispensing DEF. Spills should be cleaned immediately. All surfaces should be wiped clean and rinsed with water.

DEF that has been split will crystallize when the water within the liquid evaporates. Split DEF will attack paint and metal. If DEF is split, wash the area with water.

Caution should be used when dispensing DEF near an engine that has recently been running. Spilling DEF onto hot components may cause the release of ammonia vapors. Do not breathe ammonia vapors. Do not clean up any spills with bleach.

Coolant

The following two coolants are recommended for use in Caterpillar diesel engines:

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 D6210" or "ASTM D4985" specifications

NOTICE

The Caterpillar industrial engine must be operated with a 1:1 or 50 percent 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.

NOTICE

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

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

Caterpillar recommends a 1:1 or 50 percent 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 D6210" or "ASTM D4985" 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.

NOTICE

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

Use only Cat ELC Extender with Cat ELC.

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

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

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

Table 22

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 Cool- ant/Antifreeze that meets "ASTM D6210"	3000 Service Hours or Two Years	
Commercial Heavy-Duty Cool- ant/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 now.

- (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 23

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

Odor analysis

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual to find the maintenance interval for collecting the coolant samples.

S·O·S Coolant Analysis (Level 2)

A coolant analysis (Level 2) is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside cooling system.

The $S \cdot O \cdot S$ Coolant Analysis has the following features:

- Full coolant analysis (Level 1)
- Identification of the source of metal corrosion and of contaminants
- · Water hardness
- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling

The results are reported, and appropriate recommendations are made.

Refer to the Maintenance Interval Schedule in this Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 2) - Obtain" for the maintenance interval for collecting the coolant samples.

Testing the engine coolant is important to ensure that the engine is protected from internal cavitation and from corrosion. The analysis also tests the ability of the coolant to protect the engine from boiling and from freezing. The S \cdot O \cdot S Coolant Analysis can be done at your Caterpillar dealer. Caterpillar S \cdot O \cdot S Coolant Analysis is the best way to monitor the condition of your coolant and your cooling system. S \cdot O \cdot S Coolant Analysis is a program that is based on periodic samples.

Refer to Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for additional information. i08356181

Maintenance Interval Schedule

SMCS Code: 1000; 4450; 7500

S/N: J371-Up

When Required

"Battery - Replace"	93
"Battery or Battery Cable - Disconnect"	94
" DEF Filler Screen (Emission Related Componen Clean"	t) - 104
" Diesel Exhaust Fluid (Emission Related Component) - Fill"	105
" Diesel Exhaust Fluid Tank - Flush"	108
" Engine - Clean"	110
" Engine Air Cleaner Element - Replace"	110
" Engine Oil Sample - Obtain"	114
" Fuel System - Prime"	118

Daily

" Coolant Level - Check"	101
" Driven Equipment - Check"	110
" Engine Air Cleaner Service Indicator - Inspect"	111
" Engine Air Precleaner - Check/Clean"	112
" Engine Oil Level - Check"	112

Every Week

" Hoses and	Clamps -	Inspect/Replace"		. 125
-------------	----------	------------------	--	-------

Every 50 Service Hours

"Fuel Tank Water and Sediment - Drain" 1	24	4
--	----	---

Every 250 Service Hours

" Coolant Sample (Level 1) - Obtain"	•••	102
" Engine Oil Sample - Obtain"		114

Every 500 Service Hours or 1 Year

"Battery Electrolyte Level - Check"	94
" Cooling System Supplemental Coolant Additive (SCA) - Test/Add" 1	03

" Engine Air Cleaner Element - Replace"	110
" Engine Oil and Filter - Change"	114
" Fuel System Primary Filter (Water Separator) Element - Replace"	119
" Fuel System Secondary Filter - Replace"	123

Every 1000 Service Hours

" E	Belt - Inspect [*]	95
" E	Belt Tensioner - Check"	96
" V	Vater Pump - Inspect"	131

Every 2000 Service Hours

" Aftercooler Core - Inspect" 9	3
" Alternator - Inspect"	3
" Engine Mounts - Inspect"	2
" Starting Motor - Inspect"	9

Every Year

	" (Coolant	Sample	(Level 2)	- Obtain"		102
--	-----	---------	--------	-----------	-----------	--	-----

Every 3000 Service Hours

'Alternator and Fan Belts - Re	eplace" 93
--------------------------------	------------

Every 3000 Service Hours or 3 Years

" Coolant	(DEAC) - Change"	• •													96	
-----------	-------	-------------	-----	--	--	--	--	--	--	--	--	--	--	--	--	----	--

Every 4000 Service Hours

"Aftercooler Core - Clean/Test"		93
---------------------------------	--	----

Every 4500 Service Hours

|--|

Every 6000 Service Hours

Every 6000 Service Hours or 3 Years

Coolant Extender (ELC) - Add"	100
--------------------	-------------	-----

Every 10 000 Service Hours

Every 12 000 Service Hours or 6 Years

" Coolant	(ELC) - Change"	99
-----------	-----------------	----

Overhaul

Overhaul Considerations	is"	126
-------------------------	------------	-----
Maintenance Section Aftercooler Core - Clean/Test

i01807350

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

SMCS Code: 1064-081; 1064-070

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.

i02322295

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.

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.

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.

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.

i02680137

Alternator and Fan Belts -Replace

SMCS Code: 1357-510

Refer to Disassembly and Assembly Manual, " Alternator Belt - Remove and Install".

105425759

Battery - Replace

SMCS Code: 1401-510

Batteries give off combustible gases which can explode. A spark can cause the combustible gases to ignite. This can result in severe personal injury or death.

Ensure proper ventilation for batteries that are in an enclosure. Follow the proper procedures in order to help prevent electrical arcs and/or sparks near batteries. Do not smoke when batteries are serviced.

🛕 WARNING

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

1. Switch the engine to the OFF position. Remove all electrical loads.

Note: After the engine has stopped, allow 2 minutes in order for the diesel exhaust fluid lines to be purged before disconnecting the power.

- 2. Turn off any battery chargers. Disconnect any battery chargers.
- **3.** Ensure that the battery disconnect switch is in the OFF position.
- 4. Disconnect the NEGATIVE "-" cable from the NEGATIVE "-" battery terminal.
- 5. Disconnect the POSITIVE "+" cable from the POSITIVE "+" battery terminal.

Note: Always recycle a battery. Never discard a battery. Dispose of used batteries to an appropriate recycling facility.

- 6. Remove the used battery.
- 7. Install the new battery.

Note: Before the cables are connected, ensure that the battery disconnect switch is in the OFF position.

- 8. Connect the POSITIVE "+" cable to the POSITIVE "+" battery terminal.
- 9. Connect the NEGATIVE "-" cable to the NEGATIVE "-" battery terminal.
- **10.** Turn the battery disconnect switch to the ON position.

i02724529

Battery Electrolyte Level - Check

SMCS Code: 1401-535-FLV

When the engine is not run for long periods of time or when the engine is run for short periods, the batteries may not fully recharge. Ensure a full charge in order to help prevent the battery from freezing. If batteries are properly charged, ammeter reading should be very near zero, when the engine is in operation.

A WARNING

All lead-acid batteries contain sulfuric acid which can burn the skin and clothing. Always wear a face shield and protective clothing when working on or near batteries.

1. Remove the filler caps. Maintain the electrolyte level to the "FULL" mark on the battery.

If the addition of water is necessary, use distilled water. If distilled water is not available use clean water that is low in minerals. Do not use artificially softened water.

- 2. Check the condition of the electrolyte with the 245-5829 Coolant Battery Tester Refractometer.
- 3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- Use a solution of 0.1 kg (0.2 lb) baking soda and 1 L (1 qt) of clean water.
- · Use a solution of ammonium hydroxide.

Thoroughly rinse the battery case with clean water.

Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to not fit properly. Coat the clamps and the terminals with 5N-5561 Silicone Lubricant, petroleum jelly or MPGM.

i05424317

Battery or Battery Cable - Disconnect

SMCS Code: 1401; 1402-029

The battery cables or the batteries should not be removed with the battery cover in place. The battery cover should be removed before any servicing is attempted.

Removing the battery cables or the batteries with the cover in place may cause a battery explosion resulting in personal injury.

Maintenance Section Belt - Inspect

1. Turn the start switch to the OFF position. Turn the ignition switch (if equipped) to the OFF position and remove the key and all electrical loads.

Note: After the engine has stopped, allow 2 minutes in order for the diesel exhaust fluid lines to be purged before disconnecting the power.

- Disconnect the negative battery terminal. Ensure that the cable cannot contact the terminal. When four 12 V batteries are involved, 2 negative connections must be disconnected.
- 3. Remove the positive connection.
- 4. Clean all disconnected connection and battery terminals.
- 5. Use a fine grade of sandpaper to clean the terminals and the cable clamps. Clean the items until the surfaces are bright or shiny. DO NOT remove material excessively. Excessive removal of material can cause the clamps to fit incorrectly. Coat the clamps and the terminals with a suitable silicone lubricant or petroleum jelly.
- 6. Tape the cable connections in order to help prevent accidental starting.
- 7. Proceed with necessary system repairs.
- In order to connect the battery, connect the positive connection before the negative connector.

Belt - Inspect

SMCS Code: 1357-040; 1357; 1397; 1397-040



Illustration 54 Typical example g06301080

To maximize the engine performance, inspect the belt (1) for wear and for cracking. Replace the belt if the belt is worn or damaged.

 Inspect the belt for cracks, splits, glazing, grease, displacement of the cord and evidence of fluid contamination.

The belt must be replaced if the following conditions are present.

- The belt has a crack in more than one rib.
- More than one section of the belt is displaced in one rib of a maximum length of 50.8 mm (2 inch).

To replace the belt, refer to Disassembly and Assembly, "Alternator Belt - Remove and Install". If necessary, replace the belt tensioner. Refer to Disassembly and Assembly, "Alternator Belt -Remove and Install" for the correct procedure.

95

i07380538

i07382084

Belt Tensioner - Check

SMCS Code: 1358-535



Illustration 55 Typical example

- 1. Remove the belt. Refer to Disassembly and Assembly. "Alternator Belt Remove and Install".
- 2. Ensure that the belt tensioner (2) is securely installed. Visually inspect the belt tensioner for damage. Check that the pulley on the tensioner rotates freely and that the bearing is not loose.
- 3. Some engines have an idler pulley (2). Ensure that the idler pulley is securely installed. Visually inspect the idler pulley for damage. Ensure that the idler pulley can rotate freely and that the bearing is not loose.



Illustration 56

Typical example

(A) Tensioner stop

(3) Tensioner body stop

(B) Tensioner stop

- 4. Ensure that the tensioner has full movement of travel from stop (A) the other stop (B). Using a constant force the tensioner should move smoothly between the tensioner stop and the tensioner body stop.
- 5. If necessary, replace damaged components.

Install the belt. Refer to Disassembly and Assembly, "Alternator Belt - Remove and Install".

i07817018

g06302436

Coolant (DEAC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- · The engine overheats frequently.
- · Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

NOTICE

Use of commercially available cooling system cleaners may cause damage to cooling system components. Use only cooling system cleaners that are approved for Caterpillar engines.

NOTICE

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

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This inspection is a good opportunity to replace the water pump, the water temperature regulator, and the hoses, if necessary.

Drain

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.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

Note: Refer to Operation and Maintenance Manual, "General Hazard Information" for information on containing a fluid spillage.



Illustration 57

g06302798

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

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 to remove any debris.
- 2. Install connection hose. Clean the drain plugs. Install the drain plugs and tighten securely.

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.

 Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pt) 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 85° C (185° 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 to relieve any pressure. Remove the cooling system filler cap. Remove the connection hose or remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Install the connection hose.
- 6. The drain plug O rings on the engine block must be replaced. Clean the drain plugs and install new O ring seal. Install the drain plugs and tighten securely.

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 to remove any debris.
- 2. Clean the drain plugs. Install the drain plugs and tighten securely.

NO	ΤI	С	E

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.

- Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pt) 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.
- Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 85° C (185° 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 to relieve any pressure. Remove the cooling system filler cap. Open the drain valve (if equipped) or remove the cooling system drain plug. Allow the water to drain. Flush the cooling system with clean water.
- 6. The drain plug O rings on the engine block must be replaced. Clean the drain plugs and install new O ring seal. Install the drain plugs and tighten securely.

Fill

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.

- Fill the cooling system with the coolant/antifreeze. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on cooling system specifications. Install the cooling system filler cap.
- 2. Start and run the engine at low idle. Increase the engine rpm to high idle. Operate the engine to open the engine thermostat. This operation will allow any air in the system to be purged. Decrease the engine speed to low idle. Stop the engine.
- **3.** Maintain the coolant level at the maximum mark that is correct for your application.

- 4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, perform a pressure test. A 9S-8140 Pressurizing Pump is used to perform the pressure test. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap. If the cooling system filler cap does not retain the correct pressure, install a new cooling system filler cap.
- 5. Start the engine. Inspect the cooling system for leaks and for the correct operating temperature.

i07817031

Coolant (ELC) - Change

SMCS Code: 1350-070; 1395-044

Clean the cooling system and flush the cooling system before the recommended maintenance interval if the following conditions exist:

- The engine overheats frequently.
- Foaming is observed.
- The oil has entered the cooling system and the coolant is contaminated.
- The fuel has entered the cooling system and the coolant is contaminated.

Note: When the cooling system is cleaned, only clean water is needed when the ELC is drained and replaced.

Note: Use non-foaming detergent to clean oil or fuel contamination.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. Replace the water pump, the water temperature regulator, and the hoses, if necessary.

NOTICE

Service or repair of the engine cooling system must be performed on level ground. The engine must be level to check the coolant level. The engine must be level to avoid the risk of introducing an air lock into the coolant system.

Drain

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.

1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.



Illustration 58

g06302798

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

Allow the coolant to drain.

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.

For information regarding the disposal and the recycling of used coolant, consult your Caterpillar dealer or consult Dealer Service Tools.

Flush

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

 Install the connection hose. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

				NO	TICE				
Do	not	fill	the	cooling	system	faster	than	5	L
(1.3)	US	gal)	per r	ninute to	avoid air	locks.			

Cooling system air locks may result in engine damage.

- **3.** Fill the cooling system with clean water. Install the cooling system filler cap.
- **4.** Start and run the engine at low idle until the temperature reaches 50° to 70°C (122° to 158°F).
- 5. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap. Remove the cooling system drain plugs. Allow the water to drain. Flush the cooling system with clean water. Install the connection hose. Clean the drain plugs. Install the drain plugs. Refer to Torque Specifications, SENR3130 for more information on the correct torques.

Fill

				NO	TICE				
Do	not	fill	the	cooling	system	faster	than	5	L
(1.3	US	gal)	per r	ninute to	avoid air	locks.			

Cooling system air locks may result in engine damage.

- Fill the cooling system with Extended Life Coolant (ELC). Refer to Operation and Maintenance Manual, "Fluid Recommendations" for more information on cooling system specifications. Install the cooling system filler cap.
- 2. Start and run the engine at low idle. Increase the engine rpm to high idle. Operate the engine to open the engine thermostat. An open thermostat will allow any air in the system to be purged. Decrease the engine speed to low idle. Stop the engine.
- **3.** Maintain the coolant level at the maximum mark that is correct for your application.

- 4. Clean the cooling system filler cap. Inspect the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is damaged, discard the old cooling system filler cap and install a new cooling system filler cap. If the gasket that is on the cooling system filler cap. If the gasket that is on the cooling system filler cap is not damaged, use a 9S-8140 Pressurizing Pump to pressure test the cooling system filler cap. The correct pressure for the cooling system filler cap is stamped on the face of the cooling system filler cap is not retain the correct pressure, install a new cooling system filler cap.
- **5.** Start the engine. Inspect the cooling system for leaks and for proper operating temperature.

i04913503

Coolant Extender (ELC) - Add

SMCS Code: 1352-544-NL

Cat ELC (Extended Life Coolant) does not require the frequent additions of any supplemental cooling additives which are associated with the present conventional coolants. The Cat ELC Extender only needs adding once.

NOTICE

Use only Cat Extended Life Coolant (ELC) Extender with Cat ELC.

Do NOT use conventional supplemental coolant additive (SCA) with Cat ELC. Mixing Cat ELC with conventional coolants and/or conventional SCA reduces the Cat ELC service life.

Check the cooling system only when the engine is stopped and cool.

Personal injury can result from hot coolant, steam and alkali.

At operating temperature, engine coolant is hot and under pressure. The radiator and all lines to heaters or the engine contain hot coolant or steam. Any contact can cause severe burns.

Remove cooling system pressure cap slowly to relieve pressure only when engine is stopped and cooling system pressure cap is cool enough to touch with your bare hand.

Do not attempt to tighten hose connections when the coolant is hot, the hose can come off causing burns.

Cooling System Coolant Additive contains alkali. Avoid contact with skin and eyes.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

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 procedure will allow you to check accurately the coolant level. This procedure will also help in avoiding the risk of introducing an air lock into the coolant system.

- Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
- 2. If necessary, drain enough coolant from the cooling system in order to add the Cat ELC Extender.
- 3. Add Cat ELC Extender according to the requirements for your engines cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities and Recommendations" article for more information.
- 4. Clean the cooling system filler cap. Inspect the gaskets on the cooling system filler cap. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.

i05682210

Coolant Level - Check

SMCS Code: 1395-082

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.

Check the coolant level when the engine is stopped and cool.

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 procedure will allow you to check accurately the coolant level. This procedure will also help in avoiding the risk of introducing an air lock into the coolant system.

- 1. Remove the cooling system filler cap slowly in order to relieve pressure.
- 2. Maintain the coolant level at the maximum mark that is correct for your application. If the engine is equipped with a sight glass, maintain the coolant level to the correct level in the sight glass.



Illustration 59

Typical filler cap gaskets

 Clean the cooling system filler cap and check the condition of the filler cap gaskets. Replace the cooling system filler cap if the filler cap gaskets are damaged. Reinstall the cooling system filler cap.

g02590196

4. Inspect the cooling system for leaks.

Note: The Diesel Exhaust Fluid (DEF) tank requires coolant flow around the tank. The Coolant Diverter Valve (CDV) will turn the flow on or off. If the coolant system has been filled with the CDV in the closed position, coolant level will drop because of the opening of the CDV. The coolant flow will be diverted when the ambient temperature is approximately -5° C (23° F).

i04913603

Coolant Sample (Level 1) - Obtain

SMCS Code: 1350-008; 1395-554; 1395-008; 7542

Note: Obtaining a Coolant Sample (Level 1) is optional if the cooling system is filled with Cat ELC (Extended Life Coolant). Cooling systems filled with Cat ELC should have a Coolant Sample (Level 2) that is obtained at the recommended interval as stated in the maintenance interval schedule.

Note: Obtain a Coolant Sample (Level 1) if the cooling system is filled with any other coolant instead of Cat ELC including the following coolants:

- Commercial long life coolants that meet the Caterpillar Engine Coolant Specification -1 (Caterpillar EC-1)
- Cat DEAC (Diesel Engine Antifreeze/Coolant)
- Commercial heavy-duty coolant/antifreeze
- Table 24

Recommended Interval			
Type of Coolant	Level 1	Level 2	
Cat DEAC			
Conventional heavy duty-coolant	E		
Commercial coolant that meets the re- quirements of the Caterpillar EC-1 standard	Every 250 service hours	Every year ⁽¹⁾	
Cat ELC or conven- tional EC-1 coolant	Optional	Every year ⁽¹⁾	

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

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

Note: Level 1 results may indicate a need for Level 2 Analysis.

Obtain the sample of the coolant as close as possible to the recommended sampling interval. In order to receive the full effect of $S \cdot O \cdot S$ analysis, establish a consistent trend of data. In order to establish a pertinent history of data, perform consistent samplings that are evenly spaced. Supplies for collecting samples can be obtained from your Caterpillar dealer.

Use the following guidelines for proper sampling of the coolant:

- Complete the information on the label for the sampling bottle before you begin to take the samples.
- Keep the unused sampling bottles stored in plastic bags.
- Obtain coolant samples directly from the coolant sample port. You should not obtain the samples from any other location.
- Keep the lids on empty sampling bottles until you are ready to collect the sample.
- Place the sample in the mailing tube immediately after obtaining the sample in order to avoid contamination.
- · Never collect samples from expansion bottles.
- · Never collect samples from the drain for a system.

Submit the sample for Level 1 analysis.

For additional information about coolant analysis, see this Operation and Maintenance Manual, "Refill Capacities and Recommendations" or consult your Caterpillar dealer.

104913805

Coolant Sample (Level 2) - Obtain

SMCS Code: 1350-008; 1395-554; 1395-008; 7542

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Cat Dealer Service Tool Catalog" or refer to Special Publication, PECJ0003, "Cat Shop Supplies and Tools Catalog" for tools and supplies suitable to collect and contain fluids on Cat products.

Dispose of all fluids according to local regulations and mandates.

Refer to Operation and Maintenance Manual, "Cooling System Coolant Sample (Level 1) - Obtain" for the guidelines for proper sampling of the coolant.

Submit the sample for Level 2 analysis.

For additional information about coolant analysis, see Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engines Fluids Recommendations" or consult your Caterpillar dealer.

i03644817

Cooling System Supplemental Coolant Additive (SCA) - Test/ Add

SMCS Code: 1352-045; 1395-081

Cooling system coolant additive contains alkali. To help prevent personal injury, avoid contact with the skin and the eyes. Do not drink cooling system coolant additive.

Note: Test the concentration of the Supplemental Coolant Additive (SCA) or test the SCA concentration as part of an $S \cdot O \cdot S$ Coolant Analysis.

Test for SCA Concentration

Coolant and SCA

NOTICE

Do not exceed the recommended six percent supplemental coolant additive concentration.

Use the 8T-5296 Coolant Conditioner Test Kit or use the 4C-9301 Coolant Conditioner Test Kit in order to check the concentration of the SCA. Refer to this Operation and Maintenance Manual, "Refill Capacities and Recommendations" for more information.

Water and SCA

NOTICE

Do not exceed the recommended eight percent supplemental coolant additive concentration.

Test the concentration of the SCA with the 8T - 5296 Coolant Conditioner Test Kit. Refer to the Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations" for more information.

S·O·S Coolant Analysis

 $S \cdot O \cdot S$ coolant samples can be analyzed at your Caterpillar dealer. $S \cdot O \cdot S$ Coolant Analysis is a program that is based on periodic samples.

Level 1

Level 1 is a basic analysis of the coolant. The following items are tested:

- 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 $S \cdot O \cdot S$ 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.

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.

 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.

- 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.

i07383194

DEF Filler Screen (Emission Related Component) - Clean

SMCS Code: 108K-070

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



Illustration 60

g03725939

Typical example

- 1. Ensure that the area around cap on the Diesel Exhaust Fluid (DEF) tank is clean. Remove cap (1).
- 2. Using a suitable tool, press the tabs (2) to release the tabs. With the tabs released remove the filler screen (3) from DEF tank neck adapter (4).

- 3. The filler screen can be cleaned in clean water and dried using compressed air. Refer to this Operation and Maintenance Manual, "General Hazard Information" for information on using compressed air.
- **4.** If the filler screen cannot be cleaned or the filler screen is damaged, then the filler screen must be replaced.
- Install filler screen (3) into DEF tank neck adapter (4). Press filler screen into neck adapter and ensure that tabs (2) are located correctly. Install cap (1).

i07383199

DEF Manifold Filters (Emission Related Component) - Replace

SMCS Code: 108K-510



Illustration 61 Typical example

g06302888

- 1. Remove DEF tank manifold. Refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install for more information.
- Remove screw (5) and remove filter (4) and bracket (3) and bracket (2) from assembly (1). Discard old filter.
- **3.** Ensure that new filter (4) is clean and free from damage.
- Place bracket (2) onto assembly (1). Install bracket (3) onto assembly (1).

- Align new filter (4) to assembly suction pipe (1) and install new filter (4). Install screw (5) and tighten to a torque of 2 N·m (16 lb in).
- 6. Install DEF manifold, refer to Disassembly and Assembly, Manifold (DEF Heater) - Remove and Install for more information.

i07383319

Diesel Exhaust Fluid (Emission Related Component) - Fill

SMCS Code: 108K-544



Illustration 62 Typical example g06303219

Ensure that the correct specification Diesel Exhaust Fluid (DEF) is used. Ensure the cleanliness of the DEF, refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information.

Care should be taken when dispensing DEF. Spills should be cleaned immediately. All surfaces should be wiped clean and rinsed with water.

DEF that has been spilt will crystallize when the water within the liquid evaporates. Spilt DEF will attack paint and metal. If DEF is spilt, wash the area with water.

Caution should be used when dispensing DEF near an engine that has recently been running. Spilling DEF onto hot components may cause the release of ammonia vapors. Do not breathe ammonia vapors. Do not clean up any spills with bleach. Ensure that the DEF tank is full before starting work.

- Before filling the DEF tank, ensure that the DEF lines have been purged. Purging of the DEF lines will take place, after the engine has stopped. Only after the DEF lines have purged, should the DEF tank be filled. For more information on the time taken for purging the DEF lines, refer to this Operation and Maintenance Manual, "Battery Disconnect Switch".
- 2. Ensure that the DEF cap (1) and the surrounding area are clean and free from dirt. Ensure that all equipment use in filling the tank is clean and free from dirt.
- 3. Remove the DEF cap from the tank.
- 4. Fill the tank with the required amount of DEF. Ensure that dirt is not introduced into the tank during filling. Do not over fill the tank. The DEF will require room for expansion.

Note: Always fill the DEF tank on level ground. Cold weather can affect DEF, refer to this Operation and Maintenance Manual, "Diesel Exhaust Fluid in cold Weather" for more information.

5. The opening on the DEF tank (2) is a special diameter. Ensure that the correct nozzle is used when filling the DEF tank.

Note: At key on the DEF level gauge will show the last known DEF level and will transition to the new DEF level value.

6. Install the DEF cap. Check visually the DEF tank for leakage.

107383609

Diesel Exhaust Fluid Filter (Emission Related Component) - Replace

SMCS Code: 108K-510

🔥 WARNING

Personal injury can result from improper handling of chemicals.

Make sure you use all the necessary protective equipment required to do the job.

Make sure that you read and understand all directions and hazards described on the labels and material safety data sheet of any chemical that is used.

Observe all safety precautions recommended by the chemical manufacturer for handling, storage, and disposal of chemicals.

The Diesel Exhaust Fluid (DEF) pump can be located next to the DEF tank. On some application the DEF pump can be installed away from the DEF tank.



Illustration 63 Typical example g06303328

- 1. Ensure that the area around the DEF filter is clean and free from dirt. Use a 27mm Bi-Hex socket to remove filter cap (4).
- 2. Remove the expansion device (3).



g06215916

Illustration 64 Typical example

- **3.** Use supplied tool (5) to remove filter element (2) from DEF pump assembly (1).
- 4. Install new filter element (2) into DEF pump assembly (1).
- Install expansion device (3) into filter element (2). Install filter cap (4) and tighten cap to 20 N⋅m (177 lb in).

i07385681

Diesel Exhaust Fluid Injector (Emission Related Component) - Replace

SMCS Code: 108I-510



Illustration 65 Typical example

dure to remove and install the

For a detailed procedure to remove and install the DEF injector (1), refer to Disassembly and Assembly, DEF Injector and Mounting - Remove and Install.

After installation of the DEF injector, use the electronic service tool to perform the "DEF Dosing System Verification test".

M0108394-04

g03708638

i07383720

Diesel Exhaust Fluid Tank -Flush

SMCS Code: 108T-046

Required Tools

Table 25

Required Tools			
Tool Part Number Part Description		Part Description	Qty
А	-	Plugs	2

Flushing Procedure

1. Turn the key switch to the OFF position. The key switch must be OFF to allow the DEF pump to purge, ensuring the system is free of pressurized DEF.

Note: Allow the full 2 minutes after turning the key switch to the OFF position before turning the battery disconnect switch to the OFF position. Refer to **Operation and Maintenance Manual, "Battery** Disconnect Switch" for more information.

2. Drain the existing DEF from the DEF tank.

Note: All DEF drained or flushed during this procedure must be disposed of as per local regulations and mandates.

3. Drain the engine coolant to an appropriate level that will allow the coolant lines to be removed from the tank header. Refer to Operation and Maintenance Manual for more information.



Illustration 66

Typical example

- (1) DEF suction line
- (2) Manifold (DEF heater)
- (3) Harness assembly
- (4) DEF backflow line
- (5) Coolant return to the engine (6) Coolant supply to manifold (DEF heater)
- 4. Remove the manifold (DEF heater) from the DEF tank. Refer to Disassembly and Assembly, "Manifold (DEF Heater) - Remove and Install" for the correct procedure.



g06357825

Typical example (2) Manifold (DEF heater)

(7) Filter

- 5. Remove the filter from the manifold (DEF heater). Refer to Disassembly and Assembly, "Manifold (DEF Heater) - Remove and Install" for the correct procedure.
- 6. Flush the DEF suction and backflow connections on the manifold (DEF heater) using distilled water. Install a new filter onto the manifold (DEF heater). Refer to Disassembly and Assembly, "Manifold (DEF Heater) - Remove and Install" for the correct procedure.
- 7. Position the suitable container under the DEF tank drain and flush the DEF tank thoroughly.
- Reinstall the manifold (DEF heater) into the DEF tank. Refer to Disassembly and Assembly, "Manifold (DEF Heater) - Remove and Install" for the correct procedure.



Illustration 68
Typical example
(8) DEF pump
(9) DEF filter cap

g06357828

- Replace the Diesel Exhaust Fluid (DEF) filter. Refer to Operation and Maintenance Manual for the correct procedure.
- 10. Flush the DEF suction and backflow lines into a suitable container using distilled water. The minimum quantity of distilled water that is required is 7.57 L (2 US gal).
- **11.** Reconnect all lines to the DEF pump and to the manifold (DEF heater). Refer to Disassembly and Assembly for the correct procedures.
- 12. Fill the DEF tank to the appropriate level with new DEF. Operation and Maintenance Manual for more information. The new DEF must meet ISO 22241 standards.
- **13.** Start the engine. Refer to Operation and Maintenance Manual for the correct procedure.
- 14. Connect to the electronic service tool.

i02151646

Driven Equipment - Check

SMCS Code: 3279-535

Refer to the OEM specifications for more information on the following maintenance recommendations for the driven equipment:

- Inspection
- Adjustment
- Lubrication
- Other maintenance recommendations

Perform any maintenance for the driven equipment which is recommended by the OEM.

i07819515

Engine - Clean

SMCS Code: 1000-070

🏠 WARNING

Personal injury or death can result from high voltage.

Moisture can create paths of electrical conductivity.

Make sure that the electrical system is OFF. Lock out the starting controls and tag the controls "DO NOT OPERATE".

NOTICE

Accumulated grease and oil on an engine is a fire hazard. Keep the engine clean. Remove debris and fluid spills whenever a significant quantity accumulates on the engine.

Periodic cleaning of the engine is recommended. Steam cleaning the engine will remove accumulated oil and grease. A clean engine provides the following benefits:

- Easy detection of fluid leaks
- Maximum heat transfer characteristics
- Ease of maintenance

Note: Caution must be used to prevent electrical components from being damaged by excessive water when the engine is cleaned. Pressure washers and steam cleaners should not be directed at any electrical connectors or the junction of cables into the rear of the connectors. Avoid electrical components such as the alternator, the starter, and the ECM. Protect the fuel injection pump from fluids to wash the engine.

Ensure that care is taken that the safety labels, emission label, and all other information labels are not removed during engine cleaning.

Aftertreatment

During the engine cleaning process, ensure that water or cleaning fluids cannot enter the aftertreatment system. If cleaning fluids enters the aftertreatment system, damage could occur.

i07272195

Engine Air Cleaner Element -Replace

SMCS Code: 1051-510; 1054-510

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 airborne 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.

Servicing the Air Cleaner Elements

Note: The air filter system may not have been provided by Caterpillar. The procedure that follows is for a typical air filter system. Refer to the OEM information for the correct procedure.

If the air cleaner element becomes plugged, the air can split the material of the air cleaner element. Unfiltered air will drastically accelerate internal engine wear. Refer to the OEM information for the correct air cleaner elements for your application.

- Check the precleaner (if equipped) and the dust bowl daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating in dirty conditions may require more frequent service of the air cleaner element.

• The air cleaner element should be replaced at least one time per year.

Replace the dirty air cleaner elements with clean air cleaner elements. Before installation, the new air cleaner elements should be thoroughly checked for tears and/or holes in the filter material. Inspect the gasket or the seal of the air cleaner element for damage. Maintain a supply of suitable air cleaner elements for replacement purposes.

Air Cleaners

Some application can have dual elements. The dual air cleaner contains a primary air cleaner element and a secondary air cleaner element. Both element must be replaced at the same time.

Do not replace the air cleaner filter elements in a dirty environment, as dirt can enter the air system when the elements are removed.



Illustration 69 Typical example

g06217098

- Ensure that the outer body of the air cleaner to be serviced is clean and free from dirt.
- Inspect the top cover (1) and if necessary remove top cover to clean cover. Ensure that dirt cannot enter the air cleaner system with top cover removed. If necessary, clean top cover and install.

- Remove end cover (4) from air cleaner body (2). If necessary, clean end cover and ensure that the valve (5) is clean and free from dirt. Check the valve (5) for wear or damage, replace if necessary.
- 4. Remove primary air filter element (3) and if equipped, remove the secondary air filter element (Not Shown). Discard all old air filter elements.
- 5. If equipped, install new secondary air filter element (Not Shown) and install new primary air filter element (3).
- 6. Install end cover (4) to air cleaner body (2) and secure end cover. If necessary, reset the air service indicator, refer to this Operation and Maintenance Manual, Engine Air Cleaner Service Indicator - Inspect for more information.

i02335405

Engine Air Cleaner Service Indicator - Inspect

SMCS Code: 7452-040

Some engines may be equipped with a different service indicator.

Some engines are equipped with a differential gauge for inlet air pressure. The differential gauge for inlet air pressure displays the difference in the pressure that is measured before the air cleaner element and the pressure that is measured after the air cleaner element. As the air cleaner element becomes dirty, the pressure differential rises. If your engine is equipped with a different type of service indicator, follow the OEM recommendations in order to service the air cleaner service indicator.

The service indicator may be mounted on the air cleaner element or in a remote location.



Illustration 70 Typical service indicator g00103777

Observe the service indicator. The air cleaner element should be cleaned or the air cleaner element should be replaced when one of the following conditions occur:

- · The yellow diaphragm enters the red zone.
- The red piston locks in the visible position.

Test the Service Indicator

Service indicators are important instruments.

- Check for ease of resetting. The service indicator should reset in less than three pushes.
- Check the movement of the yellow core when the engine is accelerated to the engine rated speed. The yellow core should latch at the greatest vacuum that is attained.

If the service indicator does not reset easily, or if the yellow core does not latch at the greatest vacuum, the service indicator should be replaced. If the new service indicator will not reset, the hole for the service indicator may be restricted.

The service indicator may need to be replaced frequently in environments that are severely dusty.

i07819526

g01453058

Engine Air Precleaner - Check/ Clean

SMCS Code: 1055-535; 1055-070



Illustration 71

Typical engine air precleaner

(1) Wing nut (2) Cover (3) Body

Remove wing nut (1) and cover (2). Check for an accumulation of dirt and debris in body (3). Clean the body, if necessary.

After cleaning the precleaner, install cover (2) and wing nut (1).

Note: When the engine is operated in dusty conditions, more frequent cleaning is required.

Do not tap or strike the air cleaner element.

i02456872

Engine Mounts - Inspect

SMCS Code: 1152; 1152-040

Inspect the engine mounts for deterioration and for proper bolt torque. Engine vibration can be caused by the following conditions:

- Improper mounting of the engine
- · Deterioration of the engine mounts

Any engine mount that shows deterioration should be replaced. Refer to Special Publication, SENR3130, "Torque Specifications" for the recommended torques. Refer to the OEM recommendations for more information.

i08055063

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.



Note: Ensure that the engine is either level or that the engine is in the normal operating position to obtain a true level indication.

NOTICE

Do not overfill the crankcase. Engine damage can result.

Before Operating the Engine



Illustration 72

Typical example of type 2 oil level gauge (dipstick)

(L) Low

(H) High

(A) Crosshatched area

(B) Warning symbol



Illustration 73

g06551003

g06525971

Typical example of type 1 oil level gauge (dipstick) (L) Low

(H) High

 Maintain the oil level between the mark (L) and the mark (H) on the engine oil level gauge (dipstick). Do not fill the crankcase above the (H).

NOTICE

The oil level checked that falls in the crosshatched (Position "A") area between the (H) and below the warning triangle (Position "B") is safe for engine operation.

Operating your engine when the oil level is the in warning triangle area (Position "B") above crosshatched section (Position "A") could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oils lubricating characteristics and could result in the loss of power.

2. Remove the oil filler cap and add oil, if necessary.

3. Clean the oil filler cap. Install the oil filler cap.

4. If necessary, drain a small quantity of oil from the crankcase to reduce the oil level. The oil level needs to be between the mark (L) and the mark (H) before operating the engine. Refer to the "Operation and Maintenance Manual", Engine Oil and Filter – Change, "Drain the Engine Lubricating Oil" for more information.

After Operating the Engine

Note: Before checking the oil level, the engine must have been switched off for a minimum of 30 minutes to allow the oil to drain down to the crankcase.



- 1. Check the oil level and maintain the oil level between the mark (L) and the mark (H) on the engine oil level gauge (dipstick). Do not fill the crankcase above the mark (H).
- 2. If necessary, remove the oil filler cap and add oil.

Note: When the oil level is shown to be at the (L) mark, 1 L (0.3 US gal) of oil added will bring up the oil level within the (L) and (H) marks.

3. Clean the oil filler cap and install the oil filler cap.

If an increase in the oil level is noticed, refer to Troubleshooting, "Oil Contains Fuel".

i08234825

Engine Oil Sample - Obtain

SMCS Code: 1348-554-SM

In addition to a good preventive maintenance program, Caterpillar recommends using $S \cdot O \cdot S$ oil analysis at regularly scheduled intervals. $S \cdot O \cdot S$ oil analysis provides infrared analysis, which is required for determining nitration and oxidation levels.

Obtain the Sample and the Analysis

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Before you take the oil sample, complete the Label, PEEP5031 for identification of the sample. To help obtain the most accurate analysis, provide the following information:

- · Engine model
- Service hours on the engine
- The number of hours that have accumulated since the last oil change
- The amount of oil that has been added since the last oil change

To ensure that the sample is representative of the oil in the crankcase, obtain a warm, mixed oil sample.

To avoid contamination of the oil samples, the tools and the supplies that are used for obtaining oil samples must be clean.

Caterpillar recommends using the sampling valve to obtain oil samples. The quality and the consistency of the samples are better when the sampling valve is used. The location of the sampling valve allows oil that is flowing under pressure to be obtained during normal engine operation.

The 169-8373 Fluid Sampling Bottle is recommended for use with the sampling valve. The fluid sampling bottle includes the parts that are needed for obtaining oil samples. Instructions are also provided.

NOTICE

Always use a designated pump for oil sampling, and use a separate designated pump for coolant sampling. Using the same pump for both types of samples may contaminate the samples that are being drawn. This contaminate may cause a false analysis and an incorrect interpretation that could lead to concerns by both dealers and customers.

If the engine is not equipped with a sampling valve, use the 1U-5718 Vacuum Pump. The pump is designed to accept sampling bottles. Disposable tubing must be attached to the pump for insertion into the sump.

For instructions, see Special Publication, PEGJ0047, "How To Take A Good $S \cdot O \cdot S$ Oil Sample". Consult your Cat dealer for complete information and assistance in establishing an $S \cdot O \cdot S$ program for your engine.

108068432

Engine Oil and Filter - Change

SMCS Code: 1318-510

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

NOTICE

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

Do not drain the engine lubricating oil when the engine is cold. As the engine lubricating oil cools, suspended waste particles settle on the bottom of the oil pan. The waste particles are not removed with draining cold oil. Allow 30 minutes after the engine is stopped, before draining the oil pan. Drain the oil pan with the oil warm. This draining method allows the waste particles that are suspended in the oil to be drained properly.

q06512019

Failure to follow this recommended procedure will cause the waste particles to be recirculated through the engine lubrication system with the new oil.

Oil and Filter Change Intervals

The standard engine oil and filter change period is 500 hours or 1 year. There are several other factors that can alter the standard engine oil and filter change of 500 hours or 1 year.

- If the engine is using engine oil analysis to determine oil and filter change period.
- The engine is working in a severe service environment/Load Factor
- · Infrequent operation of the engine

Refer to this Operation and Maintenance Manual, "Severe Service Application" for more information on reducing the engine oil and filter change period. For severe service applications the recommended oil and filter change period is 250 hours.

If the engine is operated in severe service conditions, Caterpillar recommends the use of engine oil sampling. Refer to this Operation and Maintenance Manual, Engine Oil sample - Obtain for more information.

If the engine is operated infrequently less than 500 hours in a 12-month period, then the engine oil and filter change should be conducted yearly.

Drain the Engine Lubricating Oil From a Standard Oil Pan

Note: Ensure that the vessel that will be used is large enough to collect the waste oil.

After the engine has been run at the normal operating temperature, stop the engine. Use the following method to drain the engine oil pan:



Illustration 76 Typical example of a nonmetallic oil pan.

- 1. Place container below oil drain plug (1). Remove oil drain plug (1) and allow the oil to drain into the container for storage or disposal.
- 2. Remove drain plug seal (2) from the drain plug. Discard the drain plug seal.
- 3. Clean oil drain plug (1) and install new drain plug seal (2). Install oil drain plug (1) into oil pan (3).

Note: The torque given for the oil drain plug is for a nonmetallic oil pan.

 Tighten oil drain plug (1) to a torque of 24 N·m (212 lb in). Remove container below oil drain plug (1) and discard waste oil in accordance with local regulations.

Note: A drain valve may be installed. Tighten the drain valve to a torque of $24 \text{ N} \cdot \text{m}$ (212 lb in).

Draining the Engine Lubricating Oil From an Oil Pan Equipped With a Balancer

Note: Ensure that the vessel that will be used is large enough to collect the waste oil.

After the engine has been run at the normal operating temperature, stop the engine. Use the following method to drain the engine oil pan:



Illustration 77

Typical example of an engine oil pan with a balancer

- 1. Place container below oil drain plug (1) and oil drain plug (5).
- **2.** Remove oil drain plug (1) and oil drain plug (5) from engine oil pan (3) and allow the oil to drain into the container for storage or disposal.
- **3.** Remove drain plug seal (2) and drain plug seal (4). Discard the seals.
- Clean the oil drain plugs and install new drain plug seal (2) and new drain plug seal (4). Install oil drain plug (1) and oil drain plug (5) into oil pan (3).

g06511911

5. Tighten oil drain plug (1) and oil drain plug (5) to a torque of 24 N·m (212 lb in). Remove container below oil drain plug (1) and discard waste oil in accordance with local regulations.

Replace the Oil Filter Element



Illustration 78 Typical example

1. Remove cap (1) from filter body (4). The filter element (3) will be attached to cap (1). Remove filter element (3) from cap (1). Discard old filter element.

- 2. Remove O ring seal (2) from cap (1). Discard O ring seal.
- 3. Ensure that cap and filter body are clean and free from dirt or damage. Inspect new filter element for damage before installing.
- 4. Install new O ring seal (2) onto cap (1). Install new filter element (3) into cap (1). Install new filter element (3) and cap (1) to filter body (4).

5. Tighten cap (1) to a torque of 24 N·m (212 lb in)

Fill the Oil Pan



Illustration 79

Typical example

(1) Top mounted fill cap

(2) Side-mounted filler cap



Illustration 80

q06512039

Typical example of engines equipped with a balancer (3) Oil pan-mounted filler

1. Refer to this Operation and Maintenance Manual, "Fluid Recommendations" for more information on suitable oils.

2. Fill the oil pan with the correct amount of new engine lubricating oil. Refer to this Operation and Maintenance Manual, "Refill Capacities" for more information on refill capacities.

Note: If the oil is filled through the oil filler cap, allow the oil to drain down to the oil pan for a minimum of 30 minutes before starting the engine.

- 3. After installing the oil filler cap, start the engine and run the engine at "LOW IDLE" for 2 minutes. Perform this procedure to ensure that the lubrication system has oil and that the oil filter is filled. Inspect the oil filter for oil leaks.
- **4.** Stop the engine and allow the oil to drain back to the oil pan for a minimum of 30 minutes.
- 5. Remove the engine oil level gauge to check the oil level. Maintain the oil level between "L" and "H" marks on the engine oil level gauge. Do not fill the crankcase above the "H" mark.

Note: For more information on accurate oil level check, refer to this Operation and Maintenance Manual, "Engine Oil Level - Check".

i07669646

Fuel System - Prime

SMCS Code: 1250-548; 1258-548

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.

Ensure that all adjustments and repairs are performed by authorized personnel that have had the correct training.

NOTICE

Do not crank the engine continuously for more than 30 seconds. Allow the starting motor to cool for two minutes before cranking the engine again.

If air enters the fuel system, the air must be purged from the fuel system before the engine can be started. Air can enter the fuel system when the following events occur:

- The fuel tank is empty or the fuel tank has been partially drained.
- · The low-pressure fuel lines are disconnected.
- · A leak exists in the low-pressure fuel system.
- · The fuel filter has been replaced.

Electric Fuel Priming Pump

Use the following procedure to remove air from the fuel system:

- 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 to purge air from the fuel system. This procedure is not required.

After the engine has stopped, you must wait for 10 minutes 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. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system. 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 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".

Mechanical Fuel Priming Pump

Use the following procedure to remove air from the fuel system:

- 1. Ensure that the fuel system is in working order. Check that the fuel supply valve (if equipped) is in the "ON" position.
- 2. Operate the hand priming pump. Count the number of operations of the pump. After approximately 80 depression of the pump stop.

Note: As the fuel system is primed, the pressure will increase within the fuel system and this increase in pressure can be felt during priming.

- 3. The fuel system should now be primed and the engine should be able to start.
- 4. Operate the engine starting motor 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 to purge air from the fuel system. This procedure is not required.

After the engine has stopped, you must wait for 10 minutes 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. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system. 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 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".

i07385499

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.

Fuel System Primary Filter (Water Separator) Element for Electric Fuel Priming Pump

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 to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.



Illustration 81 Typical example g06304505

119

- Install a suitable tube onto drain (2). Open the drain valve (1). Rotate the drain valve fully counterclockwise. Two full turns are required.
- 4. Allow the fuel to drain into the container.
- 5. Remove the tube from the drain (2).
- 6. Remove the wiring harness from connection (3).
- 7. Rotate filter bowl (5) counterclockwise and remove the filter bowl from assembly.

Note: If a strap wrench is required to loosen the filter bowl (5), ensure that the strap is positioned in the middle of the ribbed section. To avoid damage or mechanical failure, do not position the strap around the clear area. Do not apply loads to the clear plastic bowl and the joint of the black plastic section of the lower bowl.



Illustration 82

Typical example

8. Remove the filter element (4). Clean the filter bowl.

Install the New Filter Element



Illustration 83 Typical example g06304524

- 1. After repositioning the self-venting drain up, locate the thread in the new filter element (6) onto the thread (7). Spin on the filter element and tighten the drain valve (2) securely.
- 2. Lubricate the lip (Position (X)) with clean engine oil. Do NOT fill the bowl with fuel before the assembly is installed.

Note: Do not use a tool to install the filter assembly.

- 3. Align the filter bowl (5) to the assembly. Rotate the filter bowl (5) clockwise by hand. Rotate the filter bowl (5) until there is no visible gap between the element and the filter bowl and the assembly.
- 4. Remove the container and dispose of the fuel in a safe place.
- 5. Install the wiring harness to connection (3).

6. The secondary filter element (if equipped) must be replaced at the same time as the primary filter element. Refer to the Operation and Maintenance Manual, "Fuel System Secondary Filter - Replace".

Fuel System Primary Filter (Water Separator) Element for Manual Fuel Priming Pump

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 to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.



Illustration 84 Typical example

g06398147

- 3. Install a suitable tube onto drain (2). Open the drain valve (1). Rotate the drain valve fully counterclockwise. Two full turns are required.
- 4. Allow the fuel to drain into the container.
- 5. Remove the tube from the drain (2).
- 6. Remove the wiring harness from connection (3).
- 7. Rotate filter bowl (5) counterclockwise and remove the filter bowl from assembly.

Note: If a strap wrench is required to loosen the filter bowl (5), ensure that the strap is positioned in the middle of the ribbed section. To avoid damage or mechanical failure, do not position the strap around the clear area. Do not apply loads to the clear plastic bowl and the joint of the black plastic section of the lower bowl.



Illustration 85 Typical example g06398170

121

8. Remove the filter element (4). Clean the filter bowl.

Install the New Filter Element



Illustration 86 Typical example

- 1. After repositioning the self-venting drain up, locate the thread in the new filter element (6) onto the thread (7). Spin on the filter element and tighten the drain valve (2) securely.
- Lubricate the lip (Position (X)) with clean engine oil. Do NOT fill the bowl with fuel before the assembly is installed.

Note: Do not use a tool to install the filter assembly.

- 3. Align the filter bowl (5) to the assembly. Rotate the filter bowl (5) clockwise by hand. Rotate the filter bowl (5) until there is no visible gap between the element and the filter bowl and the assembly.
- **4.** Remove the container and dispose of the fuel in a safe place.
- 5. Install the wiring harness to connection (3).

6. The secondary filter element (if equipped) must be replaced at the same time as the primary filter element. Refer to the Operation and Maintenance Manual, "Fuel System Secondary Filter - Replace".

i07385529

Fuel System Primary Filter/ Water Separator - Drain

SMCS Code: 1260-543; 1263-543

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.

NOTICE

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

NOTICE

The water separator is under suction during normal engine operation. Ensure that the drain valve is tightened securely to help prevent air from entering the fuel system.

Drain Procedure

- 1. Place a suitable container under the water separator to catch any fluid that might spill. Clean up any spilled fluid.
- **2.** Ensure that the outer body of the filter assembly is clean and free from dirt.



Illustration 87 Typical example

- Install a suitable tube onto drain (2). Open the drain valve (1). Rotate the drain valve fully counterclockwise. Two full turns are required.
- 4. Visually check that the fluid will drain. Allow the fluid to drain into the container.
- 5. When fluid free from water comes from the primary fuel filter, tighten the drain valve clockwise by hand only. Remove the tube and remove the container.

i07694301

Fuel System Secondary Filter -Replace

SMCS Code: 1261-510-SE

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.

NOTICE

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

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.

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 fuel filter to catch any fuel that might spill. Clean up any spilled fuel. Clean the outside body of the filter assembly.



Illustration 88

g03088718

- 3. Install a suitable tube onto drain (4). Open the drain valve (3). Rotate the drain valve counterclockwise. Two full turns are required. Loosen vent screw (1).
- **4.** Allow the fuel to drain into the container and remove the tube.
- 5. Tighten the vent screw (1) to a torque of 2.5 N⋅m (22 lb in).
- 6. Remove the filter bowl (2). Rotate the filter assembly counterclockwise to remove the assembly.



Illustration 89

g02546456

7. Rotate the filter element (5) counterclockwise and remove the filter element. Clean the filter bowl.

Install the Element



- Locate the thread (7) in the filter element onto the threads (8). Spin on the element and tighten the drain valve (3) by hand.
- 2. Lubricate the O ring seal (6) with clean engine oil. Do NOT fill the filter bowl (2) with fuel before the filter assembly is installed.

- Do not use a tool to install the filter assembly. Tighten the assembly by hand. Install the filter bowl (2). Turn the filter bowl clockwise until the filter bowl locks into position against the stops.
- 4. Turn the fuel supply valve to the ON position.
- 5. The primary and secondary fuel filters must be replaced at the same time. Refer to the Operation and Maintenance Manual, "Fuel System Primary Filter (Water Separator) Element Replace".
- 6. Prime the fuel system. Refer to the Operation and Maintenance Manual, "Fuel System Prime" for more information.

i02348492

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive wear to the fuel system.

Water can be introduced into the fuel tank when the fuel tank is being filled.

Condensation occurs during the heating and cooling of fuel. The condensation occurs as the fuel passes through the fuel system and the fuel returns to the fuel tank. This causes water to accumulate in fuel tanks. Draining the fuel tank regularly and obtaining fuel from reliable sources can help to eliminate water in the fuel.

Drain the Water and the Sediment

Fuel tanks should contain some provision for draining water and draining sediment from the bottom of the fuel tanks.

Open the drain valve on the bottom of the fuel tank in order to drain the water and the sediment. Close the drain valve.

Check the fuel daily. Allow five minutes after the fuel tank has been filled before draining water and sediment from the fuel tank.

Fill the fuel tank after operating the engine in order to drive out moist air. This will help prevent condensation. Do not fill the tank to the top. The fuel expands as the fuel gets warm. The tank may overflow.

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.

Fuel Storage Tanks

Drain the water and the sediment from the fuel storage tank at the following intervals:

- Weekly
- Service intervals
- Refill of the tank

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

If a bulk storage tank has been refilled or moved recently, allow adequate time for the sediment to settle before filling the engine fuel tank. Internal baffles in the bulk storage tank will also help trap sediment. Filtering fuel that is pumped from the storage tank helps to ensure the quality of the fuel. When possible, water separators should be used.

i07819616

Hoses and Clamps - Inspect/ Replace

SMCS Code: 7554-040; 7554-510

🚯 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.

If you inspect the engine in operation, always use the proper inspection procedure to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information" and Operation and Maintenance Manual, "High Pressure Fuel Lines" for the correct procedures.

Inspect all hoses for leaks that are caused by the following conditions:

- Cracking
- Softness
- Loose clamps

Replace hoses that are cracked or soft. Tighten any loose clamps.

Check for the following conditions:

- End fittings that are damaged or leaking
- Outer covering that is chafed or cut
- · Exposed wire that is used for reinforcement
- · Outer covering that is ballooning locally
- Flexible part of the hose that is kinked or crushed
- Armoring that is embedded in the outer covering

A constant torque hose clamp can be used in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard clamp.

Due to extreme temperature changes, the hose will harden. Hardening of the hoses will cause hose clamps to loosen. This can result in leaks. A constant torque hose clamp will help to prevent loose hose clamps.

Each installation application can be different. The differences depend on the following factors:

- Type of hose
- Type of fitting material
- Anticipated expansion and contraction of the hose
- Anticipated expansion and contraction of the fittings

Replace the Hoses and the Clamps

Refer to the OEM information for further information on removing and replacing fuel hoses (if equipped).

The following text describes a typical method of replacing coolant hoses. Refer to the OEM information for further information on the coolant system and the hoses for the coolant system.

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.

- 1. Stop the engine. Allow the engine to cool.
- 2. Loosen the cooling system filler cap slowly to relieve any pressure. Remove the cooling system filler cap.

Note: Drain the coolant into a suitable, clean container. The coolant can be reused.

- 3. Drain the coolant from the cooling system to a level that is below the hose that is being replaced.
- 4. Remove the hose clamps.
- 5. Disconnect the old hose.
- 6. Replace the old hose with a new hose.
- 7. Install the hose clamps with a torque wrench.

Note: For the correct coolant, see this Operation and Maintenance Manual, "Fluid Recommendations".

- Refill the cooling system. Refer to the OEM information for further information on refilling the cooling system.
- 9. Clean the cooling system filler cap. Inspect the cooling system filler cap's seals. Replace the cooling system filler cap if the seals are damaged. Install the cooling system filler cap.
- **10.** Start the engine. Inspect the cooling system for leaks.

i04224312

Overhaul Considerations

SMCS Code: 7595-043

Reduced hours of operation at full load will result in a lower average power demand. A decreased average power demand should increase both the engine service life and the overhaul interval.

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.

Cylinder Head Assembly, Oil Pump, and Fuel Transfer Pump

These components should be inspected according to the instructions that are found in various Caterpillar reusability publications. The Special Publication, SEBF8029 lists the reusability publications that are needed for inspecting the engine parts.

If the parts comply with the established inspection specifications that are expressed in the reusable parts guideline, the parts should be reused.

Parts that are not within the established inspection specifications should be dealt with in one of the following manners:

- Salvaging
- Repairing
- Replacing

Using out-of-spec parts can result in the following problems:

- Unscheduled downtime
- Costly repairs
- · Damage to other engine parts
- Reduced engine efficiency

Increased fuel consumption

Reduced engine efficiency and increased fuel consumption translates into higher operating costs. Therefore, Caterpillar Inc. recommends repairing outof-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Crankshaft Bearings Crankshaft Seals and Pistons

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings.
- Crankshaft seals
- Piston assembly

Caterpillar Inc. recommends the installation of new parts at each overhaul period.

Inspect these parts while the engine is disassembled for an overhaul.

Inspect the crankshaft for any of the following conditions:

- Deflection
- · Damage to the journals
- · Bearing material that has seized to the journals

Check the journal taper and the profile of the crankshaft journals. If the wear patterns on the rod bearing or the main bearing show a problem, the crankshaft will need to be measured with specialist equipment.

Inspect the camshaft for damage to the journals and to the lobes.

Note: If the camshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the camshaft.

Inspect the following components for signs of wear or for signs of scuffing:

- Camshaft bearings
- Lifters

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core

During an overhaul, Caterpillar Inc. recommends the removal of the oil cooler core. Clean the oil cooler core. Then, pressure test the oil cooler core.

NOTICE Do not use caustic cleaners to clean the core.

Caustic cleaners can attack the internal metals of the core and cause leakage.

Note: Use this cleaning procedure to clean the oil cooler core.

- 1. Remove the oil cooler core.
- Remove any debris from the oil cooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end.
- Flush the oil cooler core internally with cleaner in order to loosen foreign substances. This flushing will also help to remove oil from the oil cooler core.

Note: Caterpillar Inc. recommends the use of Hydrosolv Liquid Cleaners. Table 26 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 26

Hydrosolv Liquid Cleaners			
Part Number	Description	Size	
10-8812		4 L (1 US gallon)	
10-5490	Hydrosolv4165	19 L (5 US gallon)	
8T-7570		208 L (55 US gallon)	
1U-8804		4 L (1 US gallon)	
10-5492	Hydrosolv100	19 L (5 US gallon)	
8T-5571		208 L (55 US gallon)	

- 4. Use steam to clean the oil cooler core. The steam will remove any remaining residue from the cleaner. Flush the fins of the oil cooler core. Remove any other trapped debris.
- 5. Wash the oil cooler core with hot, soapy water. Rinse the oil cooler core thoroughly with clean water.

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.

- **6.** Dry the oil cooler core with compressed air. Direct the air in the reverse direction of the normal flow.
- Inspect the components in order to ensure cleanliness. The oil cooler core should be pressure tested. Repair the oil cooler core, if necessary. Install the oil cooler core.

For more information about cleaning the cores, consult your Caterpillar dealer.

Obtain Coolant Analysis

The concentration of supplemental coolant additive (SCA) should be checked regularly with test kits or with $S \cdot O \cdot S$ Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

For example, considerable deposits are found in the water jacket areas on the external cooling system, but the concentrations of coolant additives were carefully maintained. The coolant probably contained minerals that were deposited on the engine over time.

A coolant analysis can be conducted in order to verify the condition of the water that is being used in the cooling system. A full water analysis can be obtained by consulting your local water utility company or an agricultural agent. Private laboratories are also available for water analysis.

Caterpillar Inc. recommends an $S \cdot O \cdot S$ Coolant Analysis (Level 2).

S·O·S Coolant Analysis (Level 2)

An S \cdot O \cdot S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S \cdot O \cdot S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 1)
- · Visual inspection of properties
- Identification of metal corrosion
- · Identification of contaminants
- Identification of built up impurities (corrosion and scale)
$S \cdot O \cdot S$ Coolant Analysis (Level 2) provides a report of the results of both the analysis and the maintenance recommendations.

For more information about coolant analysis, see your Caterpillar dealer.

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.

i08187031

Turbocharger - Inspect

SMCS Code: 1052-040

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.



Illustration 91

g06304904

Typical example

- 1. Ensure that the turbocharger is clean and free from dirt before removing components for inspection.
- Remove the pipe from the turbocharger exhaust outlet and remove the air intake pipe (1). Visually inspect the piping for the presence of oil. Clean the interior of the pipes to prevent dirt from entering during reassembly.
- 3. Check for obvious heat discoloration of the turbocharger. Check for any loose bolts or any missing bolts. Check for damage to the oil supply line and the oil drain line. Check for cracks in the housing of the turbocharger. Ensure that the compressor wheel can rotate freely.
- Check for the presence of oil. If oil is leaking from the back side of the compressor wheel, there is a possibility of a failed turbocharger oil seal.

The presence of oil may be the result of extended engine operation at low idle. The presence of oil may also be the result of a restriction of the line for the intake air (clogged air filters), which causes the turbocharger to slobber.

5. Install the air intake pipe and the exhaust outlet pipe to the turbocharger housing. Ensure that all clamps are installed correctly and that all clamps are tightened securely. For more information, refer to Systems Operation, Testing, and Adjusting, "Turbocharger - Inspect". i07385593

Walk-Around Inspection

SMCS Code: 1000-040

Inspect the Engine for Leaks and for Loose Connections

A walk-around inspection should only take a few minutes. When the time is taken to perform these checks, costly repairs and accidents can be avoided.

For maximum engine service life, make a thorough inspection of the engine compartment before starting the engine. Look for items such as oil leaks or coolant leaks, loose bolts, worn belts, loose connections, and trash buildup. Make repairs, as needed:

- The guards must be in the correct place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced to reduce the chance of system contamination.

NOTICE

For any type of leak (coolant, lube, or fuel) clean up the fluid. If leaking is observed, find the source and correct the leak. If leaking is suspected, check the fluid levels more often than recommended until the leak is found or fixed, or until the suspicion of a leak is proved to be unwarranted.

NOTICE

Accumulated grease and/or oil on an engine is a fire hazard. Remove the accumulated grease and oil. Refer to this Operation and Maintenance Manual, "Engine - Clean" for more information.

- Ensure that the cooling system hoses are correctly clamped and that the cooling system hoses are tight. Check for leaks. Check the condition of all pipes.
- · Inspect the water pump for coolant leaks.

Excessive coolant leakage may indicate the need to replace the water pump. Remove the water pump. Refer to Disassembly and Assembly, "Water Pump - Remove and Install".

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters, and the rocker cover.
- Inspect the piping for the air intake system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses.

- Ensure that the areas around the rotating parts are clear.
- Inspect the alternator belts and any accessory drive belts for cracks, breaks, or other damage.
- · Inspect the wiring harness for damage.

Belts for multiple groove pulleys must be replaced as matched sets. If only one belt is replaced, the belt will carry more load than the belts that are not replaced. The older belts are stretched. The additional load on the new belt could cause the belt to break.

High-Pressure Fuel Lines

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.

After the engine has stopped, wait 10 minutes to allow the fuel pressure to be purged from the highpressure fuel lines before any service or repair is performed. The 10 minute wait will also allow static charge to dissipate from the low-pressure fuel system. 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 to avoid a fluid penetration hazard. Refer to Operation and Maintenance Manual, "General hazard Information".

Visually inspect the high-pressure fuel lines for damage or signs of fuel leakage. Replace any damaged high-pressure fuel lines or high-pressure fuel lines that have leaked.

Ensure that all clips on the high-pressure fuel lines are in place and that the clips are not loose.

- Inspect the rest of the fuel system for leaks. Look for loose fuel line clamps.
- Drain the water and the sediment from the fuel tank daily.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires. Check for any loose tie-wraps or missing tie-wraps.
- Inspect the ground strap for a good connection and for good condition.

- Disconnect any battery chargers that are not protected against the current drain of the starting motor. Check the condition and the electrolyte level of the batteries, unless the engine is equipped with a maintenance free battery.
- Check the condition of the gauges. Replace any gauges that are cracked. Replace any gauge that cannot be calibrated.

Engine Aftertreatment

Check the condition of the coolant lines, Diesel Exhaust Fluid (DEF) lines, and electrical connections. Check that all clamps, clips, and tiewraps are secure and in good condition. Check that the DEF filler cap is secure and that the cap is clean and free from dirt.

i07385598

Water Pump - Inspect

SMCS Code: 1361-040

A failed water pump may cause severe engine overheating problems that could result in the following conditions:

- · Cracks in the cylinder head
- A piston seizure
- Other potential damage to the engine



Illustration 92

g06304598

Visually inspect the water pump for leaks between water pump pulley (1) and water pump body (2).

The water pump is not a serviceable item. To install a new water pump, refer to Disassembly and Assembly, "Water Pump - Remove" and Disassembly and Assembly, "Water Pump - Install".

Warranty Section

Warranty Information

i06044323

Emissions Warranty Information

SMCS Code: 1000

The certifying engine manufacturer warrants to the ultimate purchaser and each subsequent purchaser that:

- New non-road diesel engines and stationary diesel engines less than 10 liters per cylinder (including Tier 1 and Tier 2 marine engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the United States and Canada, including all parts of their emission control systems ("emission related components"), are:
 - a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed by the United States Environmental Protection Agency (EPA) by way of regulation.
 - b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.
- 2. New non-road diesel engines (including Tier 1 and Tier 2 marine propulsion engines < 37 kW and Tier 1 through Tier 4 marine auxiliary engines < 37 kW, but excluding locomotive and other marine engines) operated and serviced in the state of California, including all parts of their emission control systems ("emission related components"), are:
 - a. Designed, built, and equipped so as to conform, at the time of sale, to all applicable regulations adopted by the California Air Resources Board (ARB).
 - b. Free from defects in materials and workmanship which cause the failure of an emission-related component to be identical in all material respects to the component as described in the engine manufacturer's application for certification for the warranty period.

- 3. New non-road diesel engines installed in construction machines conforming to the South Korean regulations for construction machines manufactured after January 1, 2015, and operated and serviced in South Korea, including all parts of their emission control systems ("emission related components"), are:
 - a. Designed, built, and equipped so as to conform, at the time of sale, with applicable emission standards prescribed in the Enforcement Rule of the Clean Air Conservation Act promulgated by South Korea MOE.
 - b. Free from defects in materials and workmanship in emission-related components that can cause the engine to fail to conform to applicable emission standards for the warranty period.

The aftertreatment system can be expected to function properly for the lifetime of the engine (emissions durability period) subject to prescribed maintenance requirements being followed.

A detailed explanation of the Emission Control Warranty that is applicable to new non-road and stationary diesel engines, including the components covered and the warranty period, is found in a supplemental Special Publication. Consult your authorized Cat dealer to determine if your engine is subject to an Emission Control Warranty and to obtain a copy of the applicable Special Publication.

Reference Information Section

Engine Ratings

i07853902

Engine Rating Conditions

SMCS Code: 1000

It is important to know the use of the engine so that the rating will match the operating profile. The correct rating selection is also important so that the perception of price and value is realized by the customer.

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. The rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm.

Note: For an exact determination of the appropriate rating, follow the OEM specifications or consult your Caterpillar dealer.

The C3.6 industrial engine can have two ratings.

For C3.6 industrial engine with power rating from 56 to 90 kW (75 to 120.7 hp) the rating is C.

For C3.6 industrial engine with power ratings of 95 kW (127.4 hp) and 100 kW (134 hp), the rating is D.

For C2.8 industrial engine, the rating is C.

C – Intermittent service along with maximum power and/or speed are cyclic. The engine at full load should not exceed 50 percent of the duty cycle.

D - For service when the rated power is required for periodic overloads. The maximum horsepower and the rpm of the engine can be utilized continuously for a maximum of 30 uninterrupted minutes. This run is followed by one hour of operation at rating C. The engine should be run at full load. The engine should not exceed 10 percent of the duty cycle.

NOTICE

Operating engines above the rating definitions can result in shorter service life before overhaul.

i04650089

Engine Rating Definitions

SMCS Code: 1000

All engine ratings are in compliance with the following standard ambient air conditions of "ISO14396:2002":

- 100 kPa (29.3 Inches Hg)
- 30 percent relative humidity
- A temperature of 25 °C (77 °F)

The engine ratings are based on the following fuel specifications:

- The Low Heat Value (LHV) of the fuel at 29 °C (84.2 °F) at 42780 kJ/kg (18390 Btu/lb)
- Specific gravity of .833 837 at 15 °C (60 °F)
- The engine ratings are gross output ratings.

Gross Output Ratings – The total output capability of the engine that is equipped with standard accessories.

Standard accessories include the following components:

- Oil pumps
- Fuel pumps
- Water pumps

Subtract the power that is required to drive auxiliary components from the gross output. This process will produce the net power that is available for the external load (flywheel).

Customer Service

i07191578

Customer Assistance

SMCS Code: 1000; 4450

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 Phone: 305-476-6800 Fax: 305-476-6801

Europe, Africa, and Middle East Caterpillar Overseas S.A. 76 Route de Frontenex P.O. Box 6000 CH-1211 Geneva 6 Switzerland Phone: 22-849-4444 Fax: 22-849-4544

Far East Caterpillar Asia Pte. Ltd. 7 Tractor Road Jurong, Singapore 627968 Republic of Singapore Phone: 65-662-8333 Fax: 65-662-8302

China Caterpillar China Ltd. 37/F., The Lee Gardens 33 Hysan Avenue Causeway Bay G.P.O. Box 3069 Hong Kong Phone: 852-2848-0333 Fax: 852-2848-0440 Australia and New Zealand Caterpillar of Australia Ltd. 1 Caterpillar Drive Private Mail Bag 4 Tullamarine, Victoria 3043 Australia Phone: 03-9953-9333 Fax: 03-9335-3366

i03655027

Ordering Replacement Parts

SMCS Code: 4450; 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".
- Part number
- Part name
- Quantity

If there is a question concerning the part number, please provide your dealer with a complete description of the needed item.

Discuss the problem with the dealer. Inform the dealer about the conditions of the problem and the nature of the problem. Inform the dealer about when the problem occurs. This will help the dealer in troubleshooting the problem and solving the problem faster.

Reference Materials

i08160279

Maintenance Records

SMCS Code: 1000; 4450

Caterpillar 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 various other business decisions that are related to engine maintenance.

Maintenance records are a key element of a maintenance program that is managed. Accurate maintenance records can help your Cat dealer to fine-tune the recommended maintenance intervals to meet the specific operating situation. These recommendations 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 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 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 repair costs
- Owner receipts
- Maintenance log

i08254037

Maintenance Log

SMCS Code: 1000; 4450

Table 27

Engine Model		Customer Identifier			
Serial Number		Arrangement Number			
Service Hours	Quantity Of Fuel	Service Item		Date	Authorization
			0 E		
				0	
		· · · · · · · · · · · · · · · · · · ·			
ļ					
					
	 				21 C
ļ					
L		2			
L	-				
				1	

i07853896

Reference Material

SMCS Code: 1000; 4450

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Operation and Maintenance Manual, SEBU5898, "Cold-Weather Recommendations"
- Operation and Maintenance Manual, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"

Coolants

- Special Publication, PEHP4036, "Data Sheet -Extended Life Coolant"
- Special Publication, PEHP7057, "Data Sheet -S·O·S Coolant Analysis"
- Special Publication, SEBD0518, "Know Your Cooling System"
- Label, PEEP5027, "Extended Life Coolant/ Antifreeze"

Miscellaneous

- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Service Manual, UENR7548, " C3.6 and C2.8 Industrial Engines"
- Troubleshooting, M0107940, "C3.6 Engines"
- Troubleshooting, M0112481, "C2.8 Engines"
- Systems Operation, Testing, and Adjusting, M0107832, "C3.6 and C2.8 Industrial Engines"
- Specifications, M0107642, " C3.6 Industrial Engines."
- Specifications, M0109805, " C2.8 Industrial Engines."
- Disassembly and Assembly, M0108719, "C3.6 and C2.8 Industrial Engines"
- Specifications, SENR3130, "Torque Specifications"

- Special Publication, PECP9067, "One Safe Source" English language for use in NACD
- Special Publication, SEBF8029, "Index to Guidelines for Reusable Parts and Salvage Operations"
- Special Publication, SEBF8062, "Procedure to Inspect and Clean Air Filters"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Instruction, SEHS7633, "Battery Test Procedure"

Index

A

Additional Messages	13
After Starting Engine	61
After Stopping Engine	78
Aftercooler Core - Clean/Test (Air-To-Air	
Aftercooler)	93
Aftercooler Core - Inspect	93
Aftertreatment Operation	66
Alarms and Shutoffs	43
Alarms	43
Shutoffs	43
Testing	44
Alternator - Inspect	93
Alternator and Fan Belts - Replace	93

В

Battery - Replace	93
Battery Disconnect Switch (If Equipped)	44
Battery Electrolyte Level - Check	94
Battery or Battery Cable - Disconnect	94
Before Starting Engine	23, 59
Belt - Inspect	95
Belt Tensioner - Check	96
Burn Prevention	17
Batteries	18
Coolant	18
Diesel Fuel	18
Engine and Aftertreatment System	18
Induction System	18
Oils	18

С

Cold Weather Operation Hints for Cold-Weather Operation	73 73
Person Pe	74
Recommendations for the Coolant	74
Viscosity of the Engine Lubrication Oil	71
Cold Weather Starting	50
	08
Cooling Systems with Hoovy Donosite or	90
Cooling Systems with Heavy Deposits of	~~
Plugging	98
Drain	97
Fill	98
Flush	97
Coolant (ELC) - Change	99
Drain	99

Fill	100 99
Coolant Extender (ELC) - Add 1	100
Coolant Level - Check 1	101
Coolant Sample (Level 1) - Obtain 1	102
Coolant Sample (Level 2) - Obtain 1	102
Cooling System Supplemental Coolant	
Additive (SCA) - Test/Add 1	103
Add the SCA, If Necessary 1	104
S·O·S Coolant Analysis1	103
Test for SCA Concentration 1	103
Crushing Prevention and Cutting Prevention	21
Customer Assistance 1	134
Outside of the USA and of Canada 1	134
USA and Canada1	134
Customer Service1	134

D

DEF Filler Screen (Emission Related	
Component) - Clean	104
DEF Manifold Filters (Emission Related	
Component) - Replace	105
Diagnostic Flash Code Retrieval	57
Diagnostic Lamp	57
Diesel Exhaust Fluid (Emission Related	
Component) - Fill	105
Diesel Exhaust Fluid Filter (Emission	
Related Component) - Replace	106
Diesel Exhaust Fluid in Cold Weather	76
Diesel Exhaust Fluid Injector (Emission	
Related Component) - Replace	107
Diesel Exhaust Fluid Tank - Flush	108
Flushing Procedure	108
Required Tools	108
Driven Equipment - Check	110

Е

Electrical System	
Grounding Practices	
Emergency Stopping	
Emissions Certification Film	38
Emissions Warranty Information	132
Engaging the Driven Equipment	64
Engine - Clean	
Aftertreatment	110
Engine Air Cleaner Element - Replace	110
Servicing the Air Cleaner Elements	110
-	

Engine Air	Cleaner	Service	Indicator	-
------------	---------	---------	-----------	---

Inspect	111
Test the Service Indicator	112
Engine Air Precleaner - Check/Clean	112
Engine Diagnostics	. 57
Engine Electronics	. 25
Engine Mounts - Inspect	112
Engine Oil and Filter - Change	114
Drain the Engine Lubricating Oil From a	
Standard Oil Pan	115
Draining the Engine Lubricating Oil From a	n
Oil Pan Equipped With a Balancer	115
Fill the Oil Pan	117
Oil and Filter Change Intervals	115
Replace the Oil Filter Element	117
Engine Oil Level - Check	112
After Operating the Engine	113
Before Operating the Engine	113
Engine Oil Sample - Obtain	114
Obtain the Sample and the Analysis	114
Engine Operation	. 63
C2.8 Industrial Engine	. 64
C3.6 Industrial Engine	. 64
Carbon Dioxide (CO ₂) Emissions	
Statement	. 64
Engine Operation and the Aftertreatment	
System	. 63
Engine Operation with Active Diagnostic	
Codes	. 57
Engine Operation with Intermittent	
Diagnostic Codes	. 58
Engine Rating Conditions	133
Engine Rating Definitions	133
Engine Ratings	133
Engine Starting	, 59
Engine Stopping 24	, 78

F

Fault Logging 5	7
Features and Controls 4	3
Fire Prevention and Explosion Prevention 1	9
Ether	0
Fire Extinguisher2	0
Lines, Tubes, and Hoses 2	1
Fluid Recommendations 8	4
Coolant 8	9
Diesel Exhaust Fluid 8	7
Engine Lubrication Oil8	4
Fuel 8	6
Lubricating Grease8	6

S·O·S Coolant Analysis	90
Foreword	4
California Proposition 65 Warning	4
Literature Information	4
Maintenance	4
Maintenance Intervals	5
Operation	4
Overhaul	5
Safety	4
Fuel and the Effect from Cold Weather	75
Fuel Conservation Practices	64
Fuel Related Components in Cold Weather .	76
Fuel Filters	76
Fuel Heaters	76
Fuel Tanks	76
Fuel System - Prime	118
Electric Fuel Priming Pump	118
Mechanical Fuel Priming Pump	118
Fuel System Primary Filter (Water	
Separator) Element - Replace	119
Fuel System Primary Filter (Water Separa	tor)
Element for Electric Fuel Priming Pump.	. 119
Fuel System Primary Filter (Water Separa	tor)
Element for Manual Fuel Priming Pump.	. 121
Fuel System Primary Filter/Water	
Separator - Drain	. 122
Drain Procedure	. 122
Fuel System Secondary Filter - Replace	. 123
Install the Element	. 124
Remove the Element	. 123
Fuel Tank Water and Sediment - Drain	. 124
Drain the Water and the Sediment	. 124
Fuel Storage Tanks	. 125
Fuel Tank	. 124

G

Gauges and Indicators	44
Aftertreatment Lamps and gauges	46
Indicator Lamps	45
General Hazard Information	13
Containing Fluid Spillage	15
Diesel Exhaust Fluid	17
Dispose of Waste Properly	17
Fluid Penetration	15
Inhalation	16
Pressurized Air and Water	15
Static Electricity Hazard when Fueling with	
Ultra-low Sulfur Diesel Fuel	15
General Information	27

Н

High Pressure Fuel Lines	21
Hoses and Clamps - Inspect/Replace	. 125
Replace the Hoses and the Clamps	. 125

•	

Important Safety	Information	
important ourcry		

L

Lifting and Storage	
---------------------	--

Μ

Maintenance Interval Schedule	91
Daily	91
Every 10 000 Service Hours	92
Every 1000 Service Hours	91
Every 12 000 Service Hours or 6 Years	92
Every 2000 Service Hours	91
Every 250 Service Hours	91
Every 3000 Service Hours	91
Every 3000 Service Hours or 3 Years	92
Every 4000 Service Hours	92
Every 4500 Service Hours	92
Every 50 Service Hours	91
Every 500 Service Hours or 1 Year	91
Every 6000 Service Hours	92
Every 6000 Service Hours or 3 Years	92
Every Week	91
Every Year	91
Overhaul	92
When Required	91
Maintenance Log1	36
Maintenance Recommendations	80
Maintenance Records 1	35
Maintenance Section	80
Model View Illustrations	32
C2.8 Industrial Engine Views	29
C3.6 Industrial Engine Views	27
C3.6 Industrial Engine Views For Engines	
Equipped With A Balancer	32
Loose or Off Engine Components	34
Monitoring System (Engine Indicators and	
Aftertreatment Indicators)	46
Engine Indicator Lamps	46
Mounting and Dismounting	21

Ρ

Plate Locations and Film Locations	38
Serial Number Plate	38
Product Description ((Engine and	
Aftertreatment))	35
Aftermarket Products and Caterpillar	
Engines	. 37
Aftertreatment System	37
C2 8 Industrial Engine	35
C3.6 Industrial Engine	
Electronic Engine Features	00 36
Engine Cooling and Lubrication	00
Engine Diagnostics	00 36
Engine Service Life	30 36
Engine Service Life	30 35
Dreduct Identification Information	აე აი
Product Identification Information	00 סס
Product Information Section	21
Product Lifting	40
C2.8 Industrial Engine	41
C3.6 Industrial Engine	40
C3.6 Industrial Engine Equipped With A	
Balancer	41
Product Storage	41
Aftertreatment	42

R

Radiator Restrictions	. 75
Reference Information	. 39
Record for Reference	. 39
Reference Information Section	133
Reference Material	137
Coolants	137
Lubricants	137
Miscellaneous	137
Reference Materials	135
Refill Capacities	83
Cooling System	84
DEF System	84
Lubrication System for Engines Equipped	
With a Balancer Oil Pan	83
Lubrication System for Engines Equipped	
With a Standard Oil Pan	83

0

S

Safety Messages	6, 10
C2.8 Industrial Engine	8
C3.6 Industrial Engine	7
C3.6 Industrial Engine With A Balancer	11
Ether Warning	9, 12
Hand (High Pressure)	9
Hand (High Pressure) 2	12
Universal Warning	8
Universal Warning 1	11
Safety Section	6
Selective Catalytic Reduction Warning	
System	66
Warning Indicators	66
Warning Levels	66
Warning Strategy	66
Self-Diagnostics	57
Sensors and Electrical Components	
C2.8 Industrial Engine	53
C3.6 Industrial Engines	48
Off Engine Sensors and Electrical	
Components	52
Severe Service Application	82
Improper Maintenance Procedures	
(Maintenance Procedures Which May	
Contribute to a Severe Service	
Application)	82
Severe Environmental Factors	82
Severe Operating Conditions	82
Starting Motor - Inspect	. 129
Starting the Engine	60
Starting the Engine	60
Starting with Jump Start Cables (Do Not	
Use This Procedure in Hazardous	
Locations that have Explosive	
Atmospheres)	60
Stopping the Engine	78
Delayed Engine Shutdown (if Equipped)	78
System Pressure Release	80
Coolant System	80
Engine Oil	80
Fuel System	80

Т

Table of Contents	3
Turbocharger - Inspect	129

W

Walk-Around	Inspection		130
-------------	------------	--	-----

High-Pressure Fuel Lines	130
Inspect the Engine for Leaks and for Lo	oose
Connections	130
Warranty Information	132
Warranty Section	132
Water Pump - Inspect	131
Welding on Engines with Electronic	
Controls	80

Product and Dealer Information

Note: For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual.

Delivery Date: _____

Product Information

Model:	
Product Identification Number:	
Engine Serial Number:	
Transmission Serial Number:	
Generator Serial Number:	
Attachment Serial Numbers:	
Attachment Information:	
Customer Equipment Number:	
Dealer Equipment Number	

Dealer Information

Name:		Branch:	
Address:			
Address.			
	Dealer Contact	Phone Number	Hours
Sales: –			
Parts: –			
Service: –			



M0108394 ©2021 Caterpillar All Rights Reserved CAT, CATERPILLAR, LET'S DO THE WORK, their respective logos, "Caterpillar Corporate Yellow", the "Power Edge" and Cat "Modern Hex" trade dress as well as corporate and product identity used herein, are trademarks of Caterpillar and may not be used without permission.

144 January 2021

SECTION 10

Engine Information Center (EIC). User Manual



ENGINEERING TOMORROW

User Manual

Engine Information Center (EIC) DM430E Series Display







Revision history

Table of revisions

Date	Changed	Rev
December 2018	Minor change for print on demand, removed 2 blank pages at end of the manual for required total pages divisive by 4.	0103
December 2018	Added note in regards to keeping ambient light sensor area clean and uncovered for best operation.	0102
December 2018	First edition	0101



Contents

User liability and safety sta	tements	
	OEM responsibility	
	Safety statements	
	Display operation guidelines	
	Machine wiring guidelines	
	Machine welding guidelines	
Overview		
	DM430E Series Display package	6
	DM430E literature references	6
	Technical Information (TI)	6
	Data Sheet (DS)	6
	API Specifications (API)	6
	PLUS+1 [®] GUIDE User Manual	6
	Latest version of technical literature	6
	The Engine Information Center (EIC)	6
	Navigation using soft keys	7
	Initiate and inhibit regeneration	7
	Inhibit Regeneration action	
	Initiate Regeneration action	
	TSC1 RPM setpoint	
Main Manu		
Main Menu		.
	Basic Setup menu	
	Brightness	
	Color Theme	
	lime & Date	
	Language	
	Units	
	Diagnostics menu	
	System Info	
	Fault Log	
	Device List	
	Screen Setup menu	13
	Select Screens	
	Number of Screens	
	System Setup menu	
	Reset Defaults	
	CAN	
	Display	
	PIN Setup	
	Trip Reset	
	·	
Setup to monitor signals		
	Symbols for J1939 parameters	
LED indicators		
	Particulate filter lamp	25
	High exhaust system temperature lamp	25
	Regeneration disabled lamp	25
	Regeneration ababied lamp	23
Installation and mounting		
	Mounting	
	Fastening	27
	Pin assignments	27
ordering information	Madalvarianta	22
	IVIOQEI VARIANTS	
	Model code key	
	Kelated products	





User liability and safety statements

OEM responsibility

The OEM of a machine or vehicle in which Danfoss products are installed has the full responsibility for all consequences that might occur. Danfoss has no responsibility for any consequences, direct or indirect, caused by failures or malfunctions.

- Danfoss has no responsibility for any accidents caused by incorrectly mounted or maintained equipment.
- Danfoss does not assume any responsibility for Danfoss products being incorrectly applied or the system being programmed in a manner that jeopardizes safety.
- All safety critical systems shall include an emergency stop to switch off the main supply voltage for the outputs of the electronic control system. All safety critical components shall be installed in such a way that the main supply voltage can be switched off at any time. The emergency stop must be easily accessible to the operator.

Safety statements

Display operation guidelines

- Disconnect your machine's battery power before connecting power and signal cables to the display.
- Before doing any electrical welding on your machine, disconnect all power and signal cables connected to the display.
- Do not exceed the display power supply voltage ratings. Using higher voltages may damage the display and can create a fire or electrical shock hazard.
- Do not use or store the display where flammable gases or chemicals are present. Using or storing the display where flammable gases or chemicals are present may cause an explosion.
- Software configures the keypad buttons on the display. Do not use these buttons to implement critical safety features. Use separate mechanical switches to implement critical safety features such as emergency stops.
- Design systems that use the display so that a communication error or failure between the display and other units cannot cause a malfunction that might injure people or damage material.
- The protective glass over the display screen will break if hit with a hard or heavy object. Install the display to reduce the possibility of it being hit by hard or heavy objects.
- Storing or operating a display in an environment that exceeds the display specified temperature or humidity rating may damage the display.
- Always clean the display with a soft, damp cloth. Use a mild dishwashing detergent as needed. To avoid scratching and discoloring the display, do not use abrasive pads, scouring powders, or solvents such as alcohol, benzene, or paint thinner.
- Keep ambient light sensor area clean and uncovered for best operation.
- Danfoss graphical displays are not user serviceable. Return the display to the factory in case of failure.



User liability and safety statements

Machine wiring guidelines

A Warning

Unintended movement of the machine or mechanism may cause injury to the technician or bystanders. Improperly protected power input lines against over current conditions may cause damage to the hardware. Properly protect all power input lines against over-current conditions. To protect against unintended movement, secure the machine.

Caution

Unused pins on mating connectors may cause intermittent product performance or premature failure. Plug all pins on mating connectors.

- Protect wires from mechanical abuse, run wires in flexible metal or plastic conduits.
- Use 85° C (185° F) wire with abrasion resistant insulation and 105° C (221° F) wire should be considered near hot surfaces.
- Use a wire size that is appropriate for the module connector.
- Separate high current wires such as solenoids, lights, alternators or fuel pumps from sensor and other noise-sensitive input wires.
- Run wires along the inside of, or close to, metal machine surfaces where possible, this simulates a shield which will minimize the effects of EMI/RFI radiation.
- Do not run wires near sharp metal corners, consider running wires through a grommet when rounding a corner.
- Do not run wires near hot machine members.
- Provide strain relief for all wires.
- Avoid running wires near moving or vibrating components.
- Avoid long, unsupported wire spans.
- Ground electronic modules to a dedicated conductor of sufficient size that is connected to the battery (-).
- Power the sensors and valve drive circuits by their dedicated wired power sources and ground returns.
- Twist sensor lines about one turn every 10 cm (4 in).
- Use wire harness anchors that will allow wires to float with respect to the machine rather than rigid anchors.

Machine welding guidelines

A Warning

High voltage from power and signal cables may cause fire or electrical shock, and cause an explosion if flammable gasses or chemicals are present.

Disconnect all power and signal cables connected to the electronic component before performing any electrical welding on a machine.

The following is recommended when welding on a machine equipped with electronic components:

- Turn the engine off.
- Remove electronic components from the machine before any arc welding.
- Disconnect the negative battery cable from the battery.
- Do not use electrical components to ground the welder.
- Clamp the ground cable for the welder to the component that will be welded as close as possible to the weld.



Overview

DM430E Series Display package

Prior to use, ensure the following are included in the display package:

- DM430E Series Display
- Panel Seal Gasket
- DM430E Series Display Engine Information Center (EIC) User Manual

DM430E literature references

Reference literature

Literature title	Literature type	Literature number
DM430E Series PLUS+1 [®] Mobile Machine Displays	Technical Information	BC00000397
DM430E Series PLUS+1 [®] Mobile Machine Displays	Data Sheet	AI00000332
DM430E Series Display - Engine Information Center (EIC) Software	User Manual	AQ00000253
PLUS+1° GUIDE Software	User Manual	AQ0000026

Technical Information (TI)

A TI is comprehensive information for engineering and service personnel to reference.

Data Sheet (DS)

A DS is summarized information and parameters that are unique to a specific model.

API Specifications (API)

An API is specifications for programming variable settings.

API specifications are the definitive source of information regarding pin characteristics.

PLUS+1° GUIDE User Manual

The Operation Manual (OM) details information regarding the PLUS+1[°] GUIDE tool used in building PLUS +1[°] applications. This OM covers the following broad topics:

- How to use the PLUS+1[®] GUIDE graphical application development tool to create machine applications
- How to configure module input and output parameters
- How to download PLUS+1° GUIDE applications to target PLUS+1° hardware modules
- How to upload and download tuning parameters
- How to use the PLUS+1[®] Service Tool

Latest version of technical literature

Comprehensive technical literature is online at www.danfoss.com

The Engine Information Center (EIC)

The DM430E comes installed with the powerful and flexible Danfoss Engine Information Center (EIC) J1939 engine monitor software application. Use the application to customize the look and feel of your individual engine monitoring needs by creating and controlling analog and digital display information in the screen configurations that work best for your performance requirements.

Navigate through diagnostic information and configuration screens with ease by using the four contextdependent soft keys located at the front of the display. Choose from more than 4500 different monitoring parameter profiles to customize the DM430E.



Overview

Up to four signals can be monitored on each screen. Use the EIC software to configure the DM430E for alarms and alerts.

Navigation using soft keys

The DM430E is controlled by navigation through a set of four soft keys located at the lower front of the display. The keys are context dependent. Soft key selection options are displayed above each key and are dependent on the current navigation location within the engine monitor software program. As a general rule, the far right soft key is the selector button and the far left soft key is the step back one screen key. To optimize full screen use, the on-screen selections are not displayed when not in use. Press any soft key to display current selection options.

Navigation using soft keys



Screen navigation

Navigate Up	Press to move up through menu items or screens
Navigate Down	Press to move down through menu items or screens
Main Menu	Press to go to Main Menu screen
Exit/Back one screen	Press to go back one screen
Select	Press to accept selection
Next Menu	Press to select next digit or screen element
Inhibit Regen	Press to force regeneration of particulate filter
Initiate Regen	Press to inhibit particulate filter regeneration
Increment/decrement	Press to increment or decrement value

Initiate and inhibit regeneration

While EIC DM430E is displaying one of the monitor screens, pressing any soft key will show the available navigation actions in an action menu. There are two separate action menus on this level, the first one to appear contains the following actions (from left to right).

- Next Menu
- Navigate Up
- Navigate Down
- Main Menu

Selecting **Next Menu** will display the second action menu with **Inhibit switch** (Inhibit Regeneration), **Initiate switch** (Initiate Regeneration) and **RPM Set Point**. Pressing it again will show the first set of actions once more. Selecting **Navigate Up** and **Navigate Down** will allow navigation between signal monitoring screens. Selecting **Main Menu** will display the DM430E set up options. If no soft keys are pressed and released for 3 seconds while the action menu is shown, the menu will disappear and the actions are no longer available. Pressing (and releasing) any soft key will activate the first menu once more.



Overview

Inhibit Regeneration action

If the user selects the Inhibit Regeneration action while the action menu is being displayed the same function as described in *Initiate Regeneration action* will be executed, with the following.

- Bit 0 (out of 0-7) in byte 5 (out of 0-7) is set to 1 (true).
- The pop up reads **Inhibit Regen**.
- The acknowledgment lights up the Regeneration Inhibit LED.

Initiate Regeneration action

If the user selects the Initiate Regeneration action while the action menu is being displayed; bit 2 (out of 0-7) in byte 5 (out of 0-7) will be set to 1 (true) in the J1939 message PGN 57344 bound for the engine. This change prompts the message to be transmitted. The bit will stay like this for the duration of the soft key press or for the 3 second countdown to soft key inactivity, whichever occurs first. The bit is then reset to 0 (false).

The soft key press also prompts the display to show a pop up lasting for 3 seconds. This popup simply says **Initiate Regen**. If the display does not receive an acknowledgment from the engine on the change to message PGN 57344 the last half of the pop up will read **No Engine Signal**. This acknowledgment is the command that lights up the Initiate Regeneration LED on the display unit housing.

TSC1 RPM setpoint

The TSC1 message sends the RPM requirement for the engine.



Use the **Main Menu** as the starting point for configuring the DM430E Series Display.

Main Menu screen



Main Menu

Basic Setup	Use to set Brightness, Color Theme, Time & Date, Language, Units	
Diagnostics	Use to view system, fault log and device information	
Screen Setup	Use to select screens, number of screens and parameters (can be PIN protected)	
System Setup	Use to reset defaults and trip information, access CAN information, select display settings, and configure PIN settings	

Basic Setup menu

Use **Basic Setup** to set brightness, color theme, time & date, language, and units for the DM430E Series Display.

Basic Setup screen



Basic Setup menu

Brightness	Use to adjust brightness level of the screen	
Color Theme	Use to set background color of display	
Time & Date	Use to set time, date, and time and date styles	
Language	Use to set the system language, default language is English	
Units	Use to set speed, distance, pressure, volume, mass, temperature and flow settings	



Brightness

Use the minus (-) and plus (+) soft keys to adjust display screen brightness. After 3 seconds of inactivity the screen will go back to basic setup.

Brightness screen



Color Theme

Use to select between 3 options of Light, Dark and Automatic.

Color Theme screen



Time & Date

Use up, down, select, and next soft keys to set time style, time, date style, and date.

Time & Date screen

Time & Date			
Set Time Date Style Set Date			
	•	~	



Language

Use up, down and select soft keys to select program language. Available languages are English, Spanish, French, German, Italian, Swedish and Portuguese.

Language screen



Units

Use up, down, and select soft keys to define units of measurement.

Units of measurement

Speed	kph, mph
Distance	km, miles
Pressure	kPa, bar, psi
Volume	litre, gal, igal
Mass	kg, lbs
Temperature	°C, °F
Flow	lph, gph, igph

Diagnostics menu

Use to obtain system info, fault log entries, and device information.

Diagnostics screen



Diagnostics menu

System Info	Use to display hardware, software, system, and node information for connected devices
Fault Log	Use to view and monitor current and previous fault information
Device List	Use to display list of all currently connected J1939 devices



System Info

The System Info screen contains hardware serial number, software version, node number and ROP version.

System Info screen example



Fault Log

The Fault Log screen contains saved and stored fault information. Select either **Active Faults** or **Previous Faults** to monitor fault activity. Select specific faults to list more information.

Fault Log screen

ſ	Fault L	oa			
	Active Previo	Faults us Fault	s		
	5		-	\checkmark	
-					-
					:

Active faults

Select Active Faults to display all active faults on the CAN network.

Previous faults

Select Previous Faults to display all previously active faults on the CAN network.

Device List

The Device List screen lists J1939 devices and addresses that are currently being monitored on the network.



Screen Setup menu

Use **Screen Setup** to select individual screens for setup, and number of signal screens.



Screen Setup menu

Select Screens	Select screen to set up signal information, screens available are dependent on Number of Screens selection
Number of Screens	Select 1 to 4 screens for information display

Select Screens

Select screen to customize. For screen set up details, see Setup to monitor signals.

Select Screens example



Number of Screens

Select number of screens for display. Choose from 1 to 4 screens. For screen set up details, see *Setup to monitor signals*.

Number of Screens example





System Setup menu

Use System Setup to monitor and control application systems.



System Setup menu

Reset Defaults	Use to reset all system information to the default settings
CAN	Use to customize CAN settings
Display	Use to customize display settings
PIN Setup	Use to customize PIN settings
Trip Reset	Use to reset trip information

Reset Defaults

Select Reset Defaults to reset all EIC settings to original factory default settings.



CAN

Use the CAN settings screen to make the following selections.





CAN settings menu

Fault Popup	Select on/off to enable/disable pop-up messages.
Conversion Method	Select 1, 2 or 3 to determine how to interpret non- standard fault messages. Consult engine manufacturer for correct setting.
Engine Address	Select engine address. Selection range is 0 to 253.
Engine Type	Select from a list of predetermined engine types.
Engine DMs Only	Only accepts fault codes or J1939 DM messages from the engine.
Transmit TSC1	Enable to send the TSC1 (Torque Speed Control 1) message.
JD Interlock	Transmit John Deere Interlock message required for regeneration.

Display



Display Setting

Startup Screen	Select to enable/disable logo display at startup.
Buzzer Output	Select to enable/disable warning buzzer functionality.
Force Return to Gauges	After 5 minutes of inactivity returns to main Gauge.
Demo Mode	Select on/off to enable demonstration mode.

PIN Setup

To reduce the potential for errors, Screen Setup and System Setup menu options can only be accessed after entering a PIN code.

The default code is 1-2-3-4. To change PIN code go to **System Setup** > **PIN Setup** > **Change PIN Code**.

PIN Setup





Trip Reset

Select Yes to reset all trip data.





Setup to monitor signals

The following steps are for screen setup. Steps 1 through 3 are for selecting number of screens and screen types and 4 through 7 are for selecting J1939 monitor controls.

For J1939 parameters available, function and symbols, reference Symbols for J1939 parameters.

1. Navigate to Main Menu > Screen Setup > Number of Screens. Select from one to four screens for signal monitoring.



2. Navigate to Main Menu > Screen Setup > Select Screens and select screen to customize.



3. Select screen type for each of the screens selected. There are four screen variants.



Screen type 1

Type 1 is a two-up screen view with two signal capacity.







Setup to monitor signals

Type 2 is a three-up view with one large signal display capacity and behind it, partially visible, are two small signal display capacities.



Screen type 3

Type 3 is a three-up view with one large and two small signal display capacities.



Screen type 4

Type 4 is a four-up view with four small signal display capacities.



For more screen type customization it is possible to configure the small signal displays by choosing from three styles.

4. After choosing the gauge to modify, press select key, a screen called Modify What? will open.

Within this screen it is possible to modify the signal and advanced parameters. Additionally, for screen type 3 and 4, the gauge type can also be modified.



Setup to monitor signals

Modify What? screen



Modify What?

Signal	Use to define the signal you would like to display.
Advanced Parameters	Use to define gauge icon, range, multiplier and tick settings.
Gauge Type	Use to define gauge appearance.

5. When modifying signal, 3 signal types are available.

Signal Type screen



Signal Type

Standard J1939	Choose from over 4500 signal types.
Custom CAN	Choose a CAN signal.
Hardware	Choose hardware specific signals.

6. When choosing Standard J1939, it is possible to search for available signals. Choose between Text, PGN and SPN search types. Use the left and right arrow soft keys to cycle through the alphabet and enter the signal.

Search for the signal screen




- 7. After making a signal selection, press the right arrow soft key to go to the next selection area.
 - Use left arrow, right arrow, and next soft keys to select signal monitoring screen.
 - Use the right arrow soft key to rotate through the selections in a clockwise rotation.

Examples of screen signal selections



8. Complete screen signal selections then press the back symbol soft key to return to previous menus.

Navigate back for more screen selections or press the back soft key until you reach the Main Screen. *Example of screen setup*





Symbols for J1939 parameters

The following table lists symbols for the J1939 engine and transmission parameters that are available and can be monitored.

Symbols for the J1939 engine and transmission parameters

Symbol	Name/Function	Symbol	Name/Function
	Temperature		Engine coolant temperature
<u>-</u> -∓	Battery charging condition	9 <u>-</u> >;	Engine oil
ſ	Engine		Fuel economy
V	Primary voltage	\bigcirc	Oil; fluid
Q	Transmission	\bigcirc	Transmission
⇒Ö ¢-	Transmission oil pressure		Transmission oil temperature
	Transmission oil temperature		Transmission oil filter
<u>E</u>	Engine intake air filter; engine combustion air filter	\square	Hour meter; elapsed operating hours
)×(Hand accelerator control; hand throttle	[]	Engine failure; engine malfunction
\bigcirc	Engine lubricating oil	$\triangleright \bigodot$	Engine lubricating oil level
₽	Engine lubricating oil pressure	\bigcirc	Engine lubricating oil temperature
	Engine lubricating oil filter		Engine coolant
	Engine coolant level	\$~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Engine coolant pressure
	Engine coolant temperature	Œ	Engine intake; combustion air
ţ,	Engine intake; combustion air pressure	ß	Engine intake; combustion air temperature
(Engine exhaust gas		Engine exhaust gas pressure
	Engine exhaust gas temperature	\bigcirc	Engine start
STOP	Engine stop	, n/min	Engine rotational speed (revolutions per minute)



Symbols for the J1939 engine and transmission parameters (continued)

Symbol	Name/Function	Symbol	Name/Function
	Heat exchanger, coolant fluid radiator; radiator	[])	Fuel system failure; malfunction
⇒∰∻	Fuel pressure	<u>B</u>	Fuel filter
EN.	Fuel temperature	X i	Fuel shut-off
B	Fuel shut-off	0	Transmission failure/malfunction
\bigcirc	Transmission failure/malfunction	\bigcirc	Transmission oil
ÞÖ	Transmission oil level	\mathbf{Q}	Transmission oil level
\bigcirc	Brake system	(\bigcirc)	Brake oil/fluid
	Brake fluid level	(e-c)	Brake system pressure
	Brake system temperature; brake temperature	()	Brake system filter
(!)	Brake system temperature; brake temperature		Brake system, first circuit
(2)	Brake system, second circuit	(ABS)	Anti-lock brake system, failure
\bigcirc	Worn brake linings	Ľ	Hydraulic system
1	Hydraulic system failure/malfunction	<u>اه</u>	Hydraulic oil
Þ <mark>\</mark>	Hydraulic oil level	⇒⊖¢	Hydraulic oil pressure
i.	Hydraulic oil temperature	<u>, 101</u>	Hydraulic oil filter
(!)	Tire failure/malfunction	(\$.\$)	Tire pressure
(!)	Tire failure/malfunction		Liquid cooled oil cooler, oil outlet temperature
	Engine-exhaust-gas coolant temperature		Charge air cooler, coolant inlet temperature
⊳⊟€	Fuel level		Engine coolant filter



Symbol	Name/Function	Symbol	Name/Function
	Engine, electrical preheat (low temperature start aid)	٨	Separator-drive oil
₽	Separator-drive oil pressure		Separator-drive oil filter
	Separator-drive oil temperature		Spray solution tank
⇒∽∽	Spray solution tank pressure	⊳ lan	Spray solution tank level
	Engine air filter pressure	←5 O AUTO	Tractor, front-wheel drive, automatic operation
	Tractor, front-wheel drive, braking	ſ	Road vehicle, engine heating
(Ī)	Road vehicle, engine failure/malfunction	Ē	Road vehicle, electronic diesel control
\bigcirc	Road vehicle, engine start		Road vehicle, engine oil temperature
	Road vehicle, engine oil level	۲ <u>۲</u> ۱::::	Road vehicle, engine oil filter
	Road vehicle, engine coolant level	555	Road vehicle, engine coolant heating
*	Road vehicle, engine coolant fan]]⇒	Road vehicle, engine inlet air filter
- <u>II</u> -3,	Road vehicle, engine emission filter		Road vehicle, engine inlet air preheat
8 £	Transmission converter temperature	<u>.</u>	Transmission converter fluid level
8 !	Transmission converter failure	Het	Axle fluid level
ખ્નાં	Axle failure		Steering fluid level
(<u>F</u>)	Tire temperature	₽₽₽	Road vehicle, fuel temperature
	Road vehicle, fuel filter	±tt €⊟	Fuel heating
₽!	Road vehicle, fuel system failure	Ē.Ē	Battery fluid level
⊑ ⊒!	Battery failure	₽	Engine emission system temperature; diesel particulate filter, regeneration underway

Symbols for the J1939 engine and transmission parameters (continued)



Symbols for the J1939 engine and transmission parameters (continued)

Symbol	Name/Function	Symbol	Name/Function
<3シ	Engine emissions system temperature; diesel particulate filter, regeneration underway		Diesel exhaust fluid (DEF); selective catalyst reduction (SCR) fluid
	Latitude and longitude	n/min	Power take-off (PTO), rotational speed
\bigcirc	Engine system temperature		Differential gear oil temperature



LED indicators

Particulate filter lamp

Stage 1	The right Amber LED indicates the initial need for regeneration.
	The lamp is on solid.
Stage 2	The right Amber LED indicates an urgent regeneration.
	Lamp flashes with 1 Hz.
Stage 3	Same as Stage 2 but check engine lamp will also turn on.

High exhaust system temperature lamp

The left Amber LED indicates the increase of exhaust system temperature due to regeneration.

Regeneration disabled lamp

The left Amber LED indicates that the regeneration disabled switch is active.



Installation and mounting

Mounting

Recommended mounting procedure

mm [in]



Callout	Description	
A	Panel opening for mounting on surface A	
В	Panel opening for mounting on surface B	
1	Panel seal	
2	Panel bracket	
3	Four screws	



Installation and mounting

Fastening



- Use of non-recommended screws can cause damage to housing.
- Excessive screw torque force can cause damage to housing. Maximum torque: 0.9 N m (8 in-lbs).
- Reassembly with self-tapping screws can damage existing threads in housing.
- Oversized panel cutouts can jeopardize product IP rating.
- Ensure the vent is not covered. This excludes the RAM mount option.

Fastening hole depth

mm [in]



Fastening hole depth: 7.5 mm (0.3 in). Standard M4x0.7 screw may be used. **Maximum torque**: 0.9 N m (8 in-lbs).

Pin assignments

12 pin DEUTSCH connector



DEUTSCH DTM06-12SA 12 pin

C1 pin	DM430E-0-x-x-x	DM430E-1-x-x-x	DM430E-2-x-x-x
1	Power ground -	Power ground -	Power ground -
2	Power supply +	Power supply +	Power supply +
3	CAN 0 +	CAN 0 +	CAN 0 +
4	CAN 0 -	CAN 0 -	CAN 0 -
5	AnIn/CAN 0 Shield	AnIn/CAN 0 Shield	AnIn/CAN 0 Shield
6	Digln/AnIn	Digln/AnIn	Digln/AnIn



Installation and mounting

DEUTSCH DTM06-12SA 12 pin (continued)

C1 pin	DM430E-0-x-x-x	DM430E-1-x-x-x	DM430E-2-x-x-x
7	Digln/AnIn	Digln/Anln	Digln/Anln
8	Digln/AnIn	CAN 1+	Sensor power
9	Digln/AnIn	CAN 1-	Secondary power input [*]
10	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)
11	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)	Multifunction input (Digln/Anln/Freq/4-20 mA/Rheostat)
12	Digital out (0.5A sinking)	Digital out (0.5A sinking)	Digital out (0.5A sinking)

* From controller (requires surge protection).

8 pin M12 connector



M12-A 8 pin

C2 pin	Function
1	Device Vbus
2	Device data -
3	Device data +
4	Ground
5	Ground
6	RS232 Rx
7	RS232 Tx
8	NC



Ordering information

Model variants

Part number	Order code	Description
11197958	DM430E-0-0-0	4 Buttons, I/O
11197973	DM430E-1-0-0-0	4 Buttons, 2-CAN
11197977	DM430E-2-0-0-0	4 Buttons, Sensor Power, Secondary Power Input
11197960	DM430E-0-1-0-0	4 Buttons, I/O, USB/RS232
11197974	DM430E-1-1-0-0	4 Buttons, 2-CAN, USB/RS232
11197978	DM430E-2-1-0-0	4 Buttons, Sensor Power, Secondary Power Input, USB/RS232
11197961	DM430E-0-0-1-0	Navigation Buttons, I/O
11197975	DM430E-1-0-1-0	Navigation Buttons, 2-CAN
11197979	DM430E-2-0-1-0	Navigation Buttons, Sensor Power, Secondary Power Input
11197972	DM430E-0-1-1-0	Navigation Buttons, I/O, USB/RS232
11197976	DM430E-1-1-1-0	Navigation Buttons, 2-CAN, USB/RS232
11197980	DM430E-2-1-1-0	Navigation Buttons, Sensor Power, Secondary Power Input, USB/RS232
11197981	DM430E-0-0-0-1	4 Buttons, I/O, EIC Application
11197985	DM430E-1-0-0-1	4 Buttons, 2-CAN, EIC Application
11197989	DM430E-2-0-0-1	4 Buttons, Sensor Power, Secondary Power Input, EIC Application
11197982	DM430E-0-1-0-1	4 Buttons, I/O, USB/RS232, EIC Application
11197986	DM430E-1-1-0-1	4 Buttons, 2-CAN, USB/RS232, EIC Application
11197990	DM430E-2-1-0-1	4 Buttons, Sensor Power, Secondary Power Input, USB/RS232, EIC Application
11197983	DM430E-0-0-1-1	Navigation Buttons, I/O, EIC Application
11197987	DM430E-1-0-1-1	Navigation Buttons, 2-CAN, EIC Application
11197991	DM430E-2-0-1-1	Navigation Buttons, Sensor Power, Secondary Power Input, EIC Application
11197984	DM430E-0-1-1-1	Navigation Buttons, I/O, USB/RS232, EIC Application
11197988	DM430E-1-1-1	Navigation Buttons, 2-CAN, USB/RS232, EIC Application
11197992	DM430E-2-1-1-1	Navigation Buttons, Sensor Power, Secondary Power Input, USB/RS232, EIC Application

Model code

Α	В	C	D	E
DM430E				

Model code key

A—Model name	Description
DM430E	4.3" Color Graphical Display
B—Inputs/Outputs	Description
0	1 CAN Port, 4DIN/AIN, 2 MFIN
1	2 CAN Port, 2DIN/AIN, 2 MFIN
2	1 CAN Port, 2DIN/AIN, 2 MFIN, Sensor Power
C—M12 connector	Description
0	No USB Device, No RS232
1	USB Device, RS232



Ordering information

D—Button Pads	Description
0	4 Buttons, 6 LEDs
1	Navigation buttons, 2 Dual-color LEDs
E—Application key (EIC Application)	Description
0	No Application Key
1	Application Key (EIC Application)

Related products

Connector bag assembly

10100944	DEUTSCH 12-pin Connector Kit (DTM06-12SA)

Connector and cable kit

11130518	Cable, M12 8-Pin to USB Device
11130713	Cable, M12 8-Pin to Lead Wires

Connection tools

10100744	DEUTSCH stamped contacts terminal crimp tool, size 20
10100745	DEUTSCH solid contacts terminal crimp tool

Mounting kit

11198661	Panel mounting kit

Software

11179523 (annual renewal with 11179524 to keep the software updates)	PLUS+1 [*] GUIDE Professional Software (includes 1 year of software updates, a single user license, Service and Diagnostic Tool and Screen Editor)
Online	J1939 CAN EIC Engine Monitor Software*

^t Requires a model with Application Key. See *Model variants* for model codes.







Products we offer:

- DCV directional control valves
- Electric converters
- **Electric machines**
- **Electric motors**
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1[®] controllers
- PLUS+1[®] displays
- PLUS+1[®] joysticks and pedals
- PLUS+1[®] operator interfaces
- PLUS+1[®] sensors
- PLUS+1[®] software
- PLUS+1[®] software services, support and training
- Position controls and sensors
- PVG proportional valves
- Steering components and systems
- Telematics

Danfoss Power Solutions is a global manufacturer and supplier of high-guality hydraulic and electric components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market as well as the marine sector. Building on our extensive applications expertise, we work closely with you to ensure exceptional performance for a broad range of applications. We help you and other customers around the world speed up system development, reduce costs and bring vehicles and vessels to market faster.

Danfoss Power Solutions - your strongest partner in mobile hydraulics and mobile electrification.

Go to www.danfoss.com for further product information.

We offer you expert worldwide support for ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide you with comprehensive global service for all of our components.

Comatrol www.comatrol.com	Local address:
Turolla www.turollaocg.com	
Hydro-Gear www.hydro-gear.com	
Daikin-Sauer-Danfoss www.daikin-sauer-danfoss.com	

Danfoss **Power Solutions (US) Company** 2800 East 13th Street Ames, IA 50010, USA Phone: +1 515 239 6000

Danfoss Power Solutions GmbH & Co. OHG Krokamp 35 D-24539 Neumünster, Germany Phone: +49 4321 871 0

Danfoss **Power Solutions ApS** Nordborgvej 81 DK-6430 Nordborg, Denmark Phone: +45 7488 2222

Danfoss Power Solutions Trading (Shanghai) Co., Ltd. Building #22, No. 1000 Jin Hai Rd Jin Qiao, Pudong New District Shanghai, China 201206 Phone: +86 21 3418 5200

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alterations can be made without subsequent changes being necessary in specifications already agreed All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.