

OPERATING, MAINTENANCE, PARTS MANUAL

COMPRESSOR MODELS

XHP1070WCAT (25/300) XHP1170WCAT (25/330)

Code: A



This manual contains important safety information.

Do not destroy this manual.

This manual must be available to the personnel who operate and maintain this machine.



Portable Power P.O. Box 868 - 501 Sanford Ave Mocksville, N.C. 27028 Doosan purchased Bobcat Company from Ingersoll-Rand Company in 2007. Any reference to Ingersoll-Rand Company or use of trademarks, service marks, logos, or other proprietary identifying marks belonging to Ingersoll-Rand Company in this manual is historical or nominative in nature, and is not meant to suggest a current affiliation between Ingersoll-Rand Company and Doosan Company or the products of either.

QUALITY POLICY

We will supply products and services that consistently meet the requirements of our customers and each other.

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.

Foreword

Machine models represented in this manual may be used in various locations worldwide. Machines sold and shipped into European common market countries requires that the machine display the EC Mark and conform to various directives. In such cases, the design specification of this machine has been certified as complying with EC directives. Any modification to any part is absolutely prohibited and would result in the CE certification and marking being rendered invalid. A declaration of that conformity follows:

Declaration of Conformity

WITH EC DIRECTIVE

98/37/EC 89/336/EEC

Ingersoll-Rand Company

P.O. Box 868

501 Sanford Avenue

Mocksville, North Carolina 27028

We

Represented In EC By:

Ingersoll-Rand Company Limited

Swan Lane, Hindley Green

Wigan WN2 4EZ

United Kingdom

Declare that, under our sole responsibility for manufacture and supply, the product(s)

HP1300WCU XP1400WCU P1600WCU XP900WCU NXP1300WCU	VHP825WCU HP935WCU XP1050WCU HP825WCU NHP1500WCU	XHP900WCAT XHP650WCAT XHP750WCAT XHP825WCAT XHP1070CAT	VHP750WCAT VHP850WCAT HP900WCAT XP1000WCAT 10/425	XHP1170WCU XHP1070WCU HP1600WCU HP1300WCU XHP1070WCAT XHP1170WCAT
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To which this declaration relates, is (are) in conformity with the provisions of the above directives using the following principal standards

EN1012-1, EN29001, EN292, EN60204-1 PN8NTC2, EN 50081, EN50082

Issued at Mocksville on 1-1-95

Ric Lunsford

Manager of Quality Control

Issued at Hindley Green on 1-1-95

H. Seddon, Q.A. Manager

Nothing contained in this document is intended to extend any promise, warranty or representation, expressed or implied, regarding the Ingersoll-Rand products described herein. Any such warranties or other terms and conditions of sale of products shall be in accordance with the standard terms and conditions of sale for such products, which are available upon request.

This manual contains instructions and technical data to cover all routine operation and scheduled maintenance tasks by operation and maintenance staff. Major overhauls are outside the scope of this manual and should be referred to an authorized Ingersoll-Rand service department.

All components, accessories, pipes and connectors added to the compressed air system should be:

- of good quality, procured from a reputable manufacturer and, wherever possible, be of a type approved by Ingersoll-Rand.
- clearly rated for a pressure at least equal to the machine maximum allowable working pressure.
- compatible with the compressor lubricant/coolant.
- accompanied with instructions for safe installation, operation and maintenance.

Details of approved equipment are available from Ingersoll-Rand Service departments.

The use of repair parts other than those included within the Ingersoll-Rand approved parts list may create hazardous conditions over which Ingersoll-Rand has no control. Therefore, Ingersoll-Rand cannot be held responsible for equipment in which non-approved repair parts are installed.

Ingersoll-Rand reserves the right to make changes and improvements to products without notice and without incurring any obligation to make such changes or add such improvements to products sold previously.

The intended uses of this machine are outlined below and examples of unapproved usage are also given. However, Ingersoll-Rand cannot anticipate every application or work situation that may arise. **If in doubt, consult supervision.**

This machine has been designed and supplied for above ground operation to be used for compression of normal ambient air containing no additional gases, vapors or particles within the ambient temperature range specified in the general data section of this manual.

This machine should not be used:

- A. For direct or indirect human consumption of the compressed air.
- B. Outside the ambient temperature range specified in the general data section of this manual.
- C. When an actual or foreseeable risk of hazardous levels of flammable gases or vapors exists.
- D. With other than Ingersoll-Rand approved components.
- E. With guards, or controls or switches missing or disabled.
- F. For storage or transportation of materials inside or on the enclosure.

This company accepts no responsibility for errors in translation of this manual from the original English version. You as the customer are expected to provide certain service and maintenance items. Your Ingersoll–Rand dealer can provide all other more detailed service and maintenance items on a special preventive maintenance schedule for each machine. It is very important that the minimum service and maintenance requirements explained in this manual be performed at the required intervals. Exceeding these intervals may reduce the reliability of the machine. The purpose of this manual is to train the operator with functions, operation, and basic service and maintenance requirements of the compressor. During the preparation of this manual, every effort was made to ensure the adequacy and accuracy of the contents.

Before starting the compressor, this manual and instructions should be carefully read to obtain a thorough knowledge of the duties to be performed. Please take pride in the compressor, keep it clean, and in good mechanical condition.

To enable proper maintenance records, Ingersoll-Rand provides a Noise Emission Control Maintenance Log Book (PCD Form 685) with each compressor shipped from the factory. This Log Book contains a recommended schedule and space so that the serviceman can note what service and maintenance was done, by whom, where, and when.

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SECTION 1- SAFETY

SAFETY PRECAUTIONS

General Information

Ensure that the operator reads and understands the decals and consults the manuals before maintenance or operation.

Ensure that the Operation and Maintenance manual, and the manual holder if equipped, are not removed permanently from the machine.

Ensure that maintenance personnel are adequately trained, competent and have read the manuals.

Make sure that all protective covers are in place and that the canopy/doors are closed during operation.

The specification of this machine is such that the machine is not suitable for use in flammable gas risk areas. If such an application is required then all local regulations, codes of practice and site rules must be observed. To ensure that the machine can operate in a safe and reliable manner, additional equipment such as gas detection, exhaust spark arrestors, and intake (shut-off) valves may be required, dependent on local regulations or the degree of risk involved.

Air discharged from this machine may contain carbon monoxide or other contaminants which will cause serious injury or death. Do not breathe this air.

Compressed air can be dangerous if incorrectly handled. Before doing any work on the unit, ensure that all pressure is vented from the system and that the machine cannot be started accidentally.

Ensure that the machine is operating at the rated pressure and that the rated pressure is known to all relevant personnel.

All air pressure equipment installed in or connected to the machine must have safe working pressure ratings of at least the machine safety valve rating.

If more than one compressor is connected to one common downstream plant, effective check valves and isolation valves must be fitted and controlled by work procedures, so that one machine cannot accidentally be pressurized or over pressurized by another. Compressed air must not be used for a feed to any form of breathing apparatus or mask.

The discharged air contains a very small percentage of compressor lubricating oil and care should be taken to ensure that downstream equipment is compatible.

If the discharged air is to be ultimately released into a confined space, adequate ventilation must be provided.

When using compressed air, always use appropriate personal protective equipment.

All pressure containing parts, especially flexible hoses and their couplings, must be regularly inspected, be free from defects and be replaced according to the Manual instructions.

Avoid bodily contact with compressed air.

Never operate unit without first observing all safety warnings and carefully reading the operation and maintenance manual shipped from the factory with this machine.

Never operate the engine of this machine inside a building without adequate ventilation. Avoid breathing exhaust fumes when working on or near the machine. Do not alter or modify this machine.

A battery contains sulfuric acid and can give off gases which are corrosive and potentially explosive. Avoid contact with skin, eyes and clothing. In case of contact, flush area immediately with water.

Exercise extreme caution when using booster battery. To jump battery, connect ends of one booster cable to the positive (+) terminal of each battery. Connect one end of other cable to the negative (-) terminal of the booster battery and other end to a ground connection away from dead battery (to avoid a spark occurring near any explosive gases that may be present). After starting unit, always disconnect cables in reverse order.

This machine may include such materials as oil, diesel fuel, antifreeze, brake fluid, oil/air filters and batteries which may require proper disposal when performing maintenance and service tasks. Contact local authorities for proper disposal of these materials.

High Pressure Air can cause serious injury or death. Relieve pressure before removing filler plugs/caps, fittings or covers.

Air pressure can remain trapped in air supply line which can result in serious injury or death. Always carefully vent air supply line at tool or vent valve before performing any service.

This machine produces loud noise with the doors open or service valve vented. Extended exposure to loud noise can cause hearing loss. Always wear hearing protection when doors are open or service valve is vented.

Never inspect or service unit without first disconnecting battery cable(s) to prevent accidental starting.

Do not remove the pressure cap from a HOT radiator. Allow radiator to cool down before removing pressure cap.

Do not use petroleum products (solvents or fuels) under high pressure as this can penetrate the skin and result in serious illness. wear eye protection while cleaning unit with compressed air to prevent debris from injuring eye(s).

Disconnected air hoses whip and can cause serious injury or death. Always attach a safety flow restrictor to each hose at the source of supply or branch line in accordance with OSHA Regulation 29CFR Section 1926.302(b).

Hot pressurized fluid can cause serious burns. Do not open radiator while hot.

Rotating fan blade can cause serious injury. Do not operate without guard in place.

Use care to avoid contacting hot surfaces (engine exhaust manifold and piping, air receiver and air discharge piping, etc.).

Ether is an extremely volatile, highly flammable gas. USE SPARINGLY! Do NOT use ETHER if unit has GLOW Plug starting aid. Engine damage will result.

Never allow the unit to sit stopped with pressure in the receiver–separator system. As a precaution, open the manual blowdown valve.

Never operate unit with guards, covers or screens removed. Keep hands, hair, clothing, tools, blow gun tips, etc. well away from moving parts.

Make sure wheels, tires and tow bar connectors are in safe operating condition and tow bar is properly connected before towing.

Whenever the machine is stopped, air will flow back into the compressor system from devices or systems downstream of the machine unless the service valve is closed. Install a check valve at the machine service valve to prevent reverse flow in the event of an unexpected shutdown when the service valve is open.

Hazardous Substance Precaution

The following substances are used in the manufacture of this machine and may be hazardous to health if used incorrectly.

Precaution: Avoid ingestion, skin contact and breathing fumes for the following substances: Antifreeze, Compressor Oil, Engine Lubricating Oil, Preservative Grease, Rust Preventative, Diesel Fuel and Battery Electrolyte.

The following substances may be produced during the operation of this machine and may be hazardous to health:

Avoid build-up of Engine Exhaust Fumes in confined spaces.

Avoid breathing Exhaust Fumes.

Avoid breathing Brake Lining Dust during maintenance.

SAFETY LABELS

Look for these signs on machines shipped to international markets outside North America, which point out potential hazards to the safety of you and others. Read and understand thoroughly. Heed warnings and follow instructions. If you do not understand, inform you supervisor.



Corrosion risk



Hot Surface



Lifting point



WARNING: Electrical shock risk.



Parking Brake



No open flame



Diesel Fuel. No open flame.



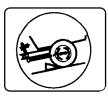
Do not operate the machine without guard being fitted.



Lifting point



WARNING - Flammable liquid.



When parking use prop stand, handbrake and wheel chocks.



Air/gas flow or Air discharge.



WARNING - Hot and harmful exhaust gas.



Tie down point



Do not breathe the compressed air from this machine.



Read the Operation and Maintenance manual before operation or maintenance of this machine is undertaken.



WARNING - Maintain correct tire pressure. (Refer to the *GENERAL INFORMATION* section of this manual).



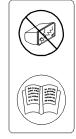
WARNING: Consult the operation and maintenance manual before performing any maintenance.



Rough Service Designation Wet Location Operation



Do not stack



Replace any cracked protective shield.



Do not use fork lift truck from this side





Do not operate with the doors or enclosure open.



On (power).

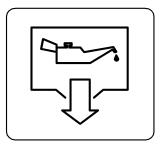


Off (power).



Emergency stop.

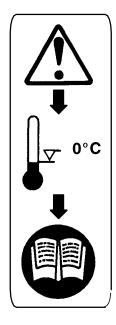
WARNING - Before connecting the tow bar or when preparing to tow, consult the operation and maintenance manual.



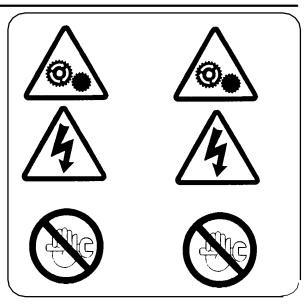
Oil Drain



Do not exceed the speed limit.



WARNING - For operating temperature below 0°C, consult the operation and maintenance manual.



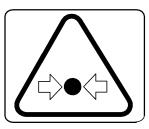
WARNING - Do not undertake any maintenance on this machine until the electrical supply is disconnected and the air pressure is totally relieved.



Read the Operation and Maintenance manual before operation or maintenance of this machine is undertaken



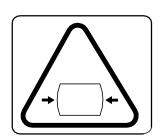
Do not remove the Operating and Maintenance manual and manual holder from this machine.



Pressurized vessel.



Use fork lift truck from this side only.



Pressurized component or system.

Look for these signs on machines shipped to markets in North America, which point out potential hazards to the safety of you and others. Read and understand thoroughly. Heed warnings and follow instructions. If you do not understand, inform you supervisor.



Indicates the presence of a hazard which WILL cause serious injury, death or property damage, if ignored.



Indicates the presence of a hazard which CAN cause serious injury, death or property damage, if ignored.



Indicates the presence of a hazard which WILL or can cause injury or property damage, if ignored.

(Yellow Background)



Indicates important set-up, operating or maintenance information.

(Blue Background)











↑ WARNING

Improper operation of this equipment. Can cause serious injury or death.

Read Operator's Manual supplied with this machine before operation or servicing.

Modification or alteration of this machine. Can cause serious injury or death.

Do not alter or modify this machine without the express written consent of the manufacturer.



MARNING

Rotating fan blade. Can cause serious injury.







△ WARNING

Door under pressure.
Can cause serious injury.

Use both hands to open door when machine is running.





CAUTION

DO NOT WELD.
ELECTRONIC DAMAGE
WILL OCCUR.

This engine is equipped with an electronic engine controller and other electronic components.



MWARNING

Collapsing jackstand.
Can cause serious injury.

Insert locking pin completely



Excessive towing speed. Can cause serious injury or death.

Do NOT exceed 65 mph (105 km/hr.)





△ WARNING

Falling off machine.

Can cause serious injury or death.



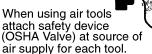
Access lifting bail from inside machine.



△ WARNING

Disconnected air hoses whip.

Can cause serious injury or death.







MARNING

Combustible gas.

Can cause serious burns, blindness or death.

Keep sparks and open flames away from batteries.



CAUTION

DO NOT USE ETHER.

ENGINE DAMAGE WILL OCCUR.

This engine is equipped with an electric heater starting aid.



MARNING

High pressure air. Can cause serious injury or death.

Relieve pressure before removing filler plugs/caps, fittings or covers.





USE DIESEL FUEL ONLY



NOTICE

COOLANT FILL INSTRUCTIONS Adding:

Remove radiator cap. Top off at radiator. Use same anti-freeze mixture as in radiator.

Replacing:

With system cool, remove radiator cap. Drain coolant and close drain. At radiator, refill system. Replace radiator cap. Run for 30 minutes. Stop and allow to cool. At radiator, add coolant as necessary to reach "Cold" level.

FREE SAFETY DECALS!

To promote communication of Safety Warnings on products manufactured by the Portable Compressor Division in Mocksville, N.C., Safety Decals are available **free** of charge. Safety decals are identified by the decal heading: **DANGER, WARNING or CAUTION.**

Decal part numbers are on the bottom of each decal and are also listed in the compressor's parts manual. Submit orders for Safety Decals to the Mocksville Parts Service Department. The no charge order should contain only Safety Decals. Help promote product safety! Assure that decals are present on the machines. Replace decals that are not readable.

SECTION 2 - Warranty

Ingersoll-Rand, through its distributor, warrants that each item of equipment manufactured by it and delivered hereunder to the initial user will be free of defects in material and workmanship for a period of three (3) months from initial operation or six (6) months from the date of shipment to the initial user, whichever occurs first.

With respect to the following types of equipment, the warranty period enumerated below will apply in lieu of the foregoing warranty period.

- A. **Aftercoolers** The earlier of nine (9) months from date of shipment to or six (6) months from start up by initial user.
- B. Portable Compressors, Portable Generator Sets (GENSET) 8KW, 11KW, 20KVA thru 575KVA, Portable Light Towers and Air Dryers The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user.
 - **3.5KW thru 7.0KW and 10KW** The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user, whichever occurs first. Ingersoll–Rand will provide a new part or repaired part, at it's election, in place of any part which is found to be defective in material or workmanship during the period described above. Labor cost to replace the part is the responsibility of the user.
- C. **Portable Compressor Air Ends -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service by the initial user. For Air Ends, the warranty against defects will include replacement of the complete Air End, provided the original Air End is returned assembled and unopened.
- C.1 Portable Compressor Airend Limited Optional Warranty The earlier of sixty (60) months from shipment to or the accumulation of 10,000 hours of service. The optional warranty is limited to defects in rotors, housings, bearings and gears and provided all the following conditions are met:
 - 1. The original air end is returned assembled and unopened.
 - 2. Continued use of genuine Ingersoll-Rand parts, fluids, oil and filters.
 - 3. Maintenance is performed at prescribed intervals.

Oil-Free airends are fee-based and may require a maintenance agreement. Formal enrollment is required.

- D. **Genset Generators 8KW, 11KW, 20KVA thru 575KVA -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service by the initial user.
 - **3.5KW thru 7.0KW and 10KW** The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service.
- E. **Portable Light Tower Generators** The earlier of twelve (12) months from shipment to or the accumulation of 2,000 hours of service by the initial user. Light Source model only, the earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service.
- F. **Ingersoll-Rand Engines -** The earlier of twenty-four (24) months from shipment to or the accumulation of 4,000 hours of service.

- G. Ingersoll-Rand Platinum Drive Train Warranty (Optional) Platinum drive train pertains to the Ingersoll-Rand Engine and Airend combination. The earlier of sixty (60) months from shipment to, or the accumulation of 10,000 hours of service. The starter, alternator, fuel injection system and all electrical components are excluded from the extended warranty. The airend seal and drive coupling are included in the warranty (airend drive belts are not included). The optional warranty is automatically available when meeting the following conditions:
 - 1. The original airend is returned assembled and unopened.
 - 2. Continued use of genuine Ingersoll-Rand parts, fluids, oil and filters.
 - 3. Maintenance is performed at prescribed intervals.

It is the obligation of the user to provide verification that these conditions have been satisfied when submitting warranty claims.

F. Spare Parts—Six (6) months from date of shipment.

Ingersoll–Rand will provide a new part or repaired part, at its election, in place of any part which is found upon its inspection to be defective in material and workmanship during the period prescribed above. Such part will be repaired or replaced without charge to the initial user during normal working hours at the place of business of an Ingersoll–Rand distributor authorized to sell the type of equipment involved or other establishment authorized by Ingersoll–Rand. User must present proof of purchase at the time of exercising warranty.

The above warrantees do not apply to failures occurring as a result of abuse; misuse, negligent repairs, corrosion, erosion and normal wear and tear, alterations or modifications made to the product without express written consent of Ingersoll–Rand; or failure to follow the recommended operating practices and maintenance procedures as provided in the product's operating and maintenance publications.

Accessories or equipment furnished by Ingersoll-Rand, but manufactured by others, including, but not limited to, engines, tires, batteries, engine electrical equipment, hydraulic transmissions, carriers, shall carry whatever warranty the manufacturers have conveyed to Ingersoll-Rand and which can be passed on to the initial user.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, (EXCEPT THAT OF TITLE), AND THERE ARE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

GENERAL WARRANTY INFORMATION

GENERAL WARRANTY	Extended Coverage			
Portable Compressor	Package	1 year/2000 hrs		
	Airend	2 yrs/4000 hrs	5 yrs/10,000 hrs	
			Limited warranty, major components (refer to operator's manual).	
Portable Genset 8kW, 11KW, 20KVA thru 575KVA	Package	1 yr/2000 hrs	None	
	Generator	2 yrs/4000 hrs	None	
Portable Genset 3.5KW thru 7.0KW and 10KW	Package	1 yr/2000 hrs (parts only)	None	
	Generator	1 yrs/2000 hrs (parts only)	None	
	•		•	
Light Tower	Package	1 yr/2000 hrs		
	Generator	1 yr/2000 hrs	2 years/4000 hours, for Lightsource introduced 8/16/99.	

ENGINES				
CATERPILLAR	Months	Hours	Extended Coverage	
	12	unlimited	Available at dealer	
CUMMINS	24	2000	Major components 3 yrs/10,000 hrs Available at dealer	
JOHN DEERE (in compressors)	24	2000	5 yrs/5000 hrs using OEM fluids and filters with \$250 deductible	
(in generators as of 1/1/01)	24	2000	2 yrs/4000 hrs using IR fluids and filters	
DEUTZ	24	2000	Available at dealer	
INGERSOLL-RAND	24	4000	5 yrs/10,000 hrs when using genuine Ingersoll- Rand fluids and parts. Refer to operator's manu- al.	
KUBOTA (North America only)	24	2000	Major components 36 mo/3000 hrs (parts only)	
(Western Europe & Oceania)	24	2000	None	
(Central & South America, Asia, Middle East & Africa)	12	1000	None	
MITSUBISHI	24	2000	2 yrs/4000 hrs using IR fluids & filters	
VOLVO	24	2000	2 yrs/4000 hrs using ir fluids & filters	
HONDA	12	unlimited	None	
VANGUARD	24	unlimited	None	

PARTS				
	Months	Hours	Coverage	
Ingersoll-Rand	6	No Limit	Parts Only	

AIREND EXCHANGE				
	Months	Hours	Extended Coverage	
Airend	12	2000 hours	2 yrs/4000 hrs - available from IR.	

Note: Actual warranty times may change. Consult the manufacturer's warranty policy as shipped with each new

product.

WARRANTY REGISTRATION

Complete Machine Registration

<u>Machines shipped to locations within the United States</u> do not require a warranty registration unless the machine status changes (i.e. change of ownership).

<u>Machines shipped outside the United States</u> require notification be made to initiate the machine warranty.



Fill out the Warranty Registration Form in this section, keep a copy for your records and mail form to:

Ingersoll-Rand Company
Portable Compressor Division
P.O. Box 868
Mocksville, North Carolina 27028

Attn: Warranty Department

Note: Completion of this form validates the warranty.

Selling Distributor	Servicing Distributor	r WARR	NTY REGISTRATION
Name	Name		r/User Name
Address	Address	Addres	ss
City	City	City	
County	_	County	у
State	State	State	
Zip Code	Zip Code	Zip Co	 ode
Telephone		Teleph	
	Complete the Applic Owner/User Type of Busines		
Construction-Heavy (highway, excavation, etc.	Asphalt Contracto	tor	Other Mining
Construction-Light (carpentry, plumbing, mason, etc.)	Government , pools, (municipal, state county, etc.)	te, Quarry	☐ Shallow Oil & Gas
Rental (rental center, rental flee	et, etc.) Building Contrac	ctor	Utility Company (gas, electric, water, etc.)
☐ Industrial (plant use)	Other specify	Exploration	☐ Utility Contractor
Model	Unit S/N	Engine S/N	Date Delivered
Unit-Hours	Airend S/N	Truck S/N	Truck Engine S/N
The Purchaser has been maintenance, general operations.	RVICING DISTRIBUTOR/USER instructed and/or has read the peration and safety precautions. ion of liability has been reviewed	e manual and understands s.	s proper preventative

- In the event that this unit is to be used within a nuclear facility, the owner/user shall notify Ingersoll-Rand of such
 use so that Ingersoll-Rand may arrange for appropriate nuclear liability protection from the owner-licensee of the
 facility.
- 4. Ingersoll-Rand reserves the right to make design changes or modifications of Ingersoll-Rand products at anytime without incurring any obligation to make similar changes or modifications on previously sold units.

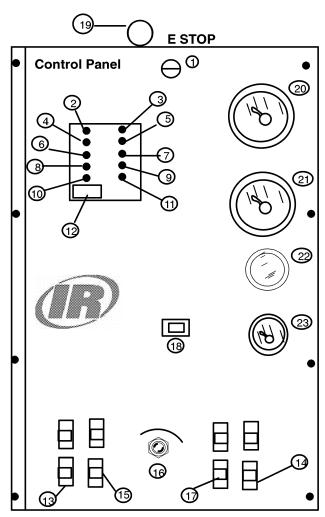
	Attention: Warranty I	r Department	
	Ingersoll-Rand Comp Portable Compressor P.O. Box 868 Mocksville, North Car	noisivia ro	
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SECTION 3 - GENERAL DATA

UNIT MODELS		XHP1070	1170V	VCAT
Air Delivery - cfm (litres/sec	9)	1070 (505)	1170 (553)
COMPRESSOR				
Rated Operating Pressure -	- psi (kPa)		150-350	(1034-2412)
ENGINE (Diesel)				
Manufacturer Model Rated Horsepower at 1800 Electrical System Full Load Speed - rpm	rpm	475		C15 525 24 VDC
No Load Speed - rpm				
FLUID CAPACITIES - U.S. Compressor Lubricant	Gallons (litres)			
Engine Lube (including filter				, ,
Engine Coolant (Radiator)				15.2 (57.5)
Fuel Tank (Clean DIESEL fo	uel)			230 (870)
UNITS MEASUREMENTS/ Feet (Meters)	WEIGHTS HS	SRG	. Wagon RG	LRG
Overall Length Overall Height Overall Width Gross Weight - pounds (kg	8.3 7.5	33 (2.54) 5 (2.29)	. 8.33 (2.54)	7.25 (2.21) 7.5 (2.29)
RUNNING GEAR				
Tire Size	21	5/75R17.5H	. 215/75R17.5H	NA
Towing Speed (Maximum) r	nph 65		. 20	NA
Inflation Pressure		5 psig	. 125 psig	NA
EXPENDABLE SERVICE F	PARTS			
Part Number	Description		nere Used	Quantity
36860336				
36762250	•			
36864361	•		•	
36864379		-	-	
35362235	. •			
35362268	_			
22090534	-			
22090526	•	•		
22090542	Filter Cup, Fuel		. C15	1

CAUTION: Any departure from the specifications may make this equipment unsafe.

SECTION 4 - OPERATING INSTRUCTIONS



OPERATING CONTROLS AND INSTRUMENTS

The operating controls and instruments are arranged on the control panel as shown above. A description of each panel device is as follows:

- 1. **Panel Light:** Illuminates PHE instrument and control panel controlled by Switch 14.
- High Compressor Temp: Fault indicator lamp. Indicates shutdown due to high compressor temperature.
- 3. **Low Radiator Coolant Level:** Alarm indicator lamp. Indicates engine coolant needs service.
- Low Engine Oil Pressure: Fault indicator lamp. Indicates shutdown due to low engine oil pressure.
- Restricted Air Filter: Alarm indicator lamp. Indicates engine/compressor air inlet filters need service.

- High Engine Coolant Temp: Fault indicator lamp. Indicates shutdown due to high engine water temperature.
- 7. **Restricted IQ Air Filters:** Fault indicator lamp. Indicates shutdown due to high Pon IQ air filters (if equipped).
- 8. **Low Fuel Level:** Fault indicator lamp. Indicates shutdown due to low fuel level. Lamp blinks at low fuel warning.
- Compressor Malfunction: Fault indicator lamp. Indicates shutdown due to compressor system fault. Refer to Fault Code List.
- Low Battery Voltage: Alarm indicator lamp. Indicates battery or charging system requires service.
- Engine Malfunction: Engine Fault code.
 Refer to service card or engine manual for codes and service requirements.
- Malfunction Code (4 Digit): Compressor or engine fault. Refer to manual for list of codes and service requirements.
- Ether Inject: Injects a measured shot of ether for aid in cold weather starting of engine. Caution: Use Sparingly.
- 14. **Panel Light Switch**: Controls panel lamp # 1.
- 15. **Service Air Switch:** Momentary contact switch. Allows engine to warm up at low compressor pressure.
- Main Power Control Switch: ON/OFF Start Switch.
- 17. **Heaters:** ON/OFF Power Switch for regulation and IQ heaters. Prevents freeze up in cold weather.
- 18. **Hourmeter:** Indicates machine operating hours.
- 19. **E-STOP**: Emergency Stop Push Button (ESA units only). Push to stop, turn to release.
- 20. Discharge Air Pressure Gage: Indicates pressure in receiver tank, normally from 0 psi(kPa) to the rated pressure of the machine.
- 21. **Engine Tachometer:** Indicates engine speed in RPM from 0 when stopped to full speed.
- 22. **Systems Gage:** Engine Water Temp
 Compressor Oil Temp
 Engine Oil Pressure
 Battery Voltage
- 23. **Fuel Level Gage:** Indicate fuel level in tank.

WARNING

Do not climb on top of unit.

LIFTING UNIT

Central Lifting Bail

 Hoist/crane per machines gross weight (see general data)

BEFORE TOWING

Ensure that the tires, wheels and running gear are in good condition and secure.

Wagon Style Running Gear

- Do not tow this unit in exess of 20 mph (32km/hr).
- Use a tow vehicle whose towing capacity is greater than the gross weight of this unit. (see general data).
- Machine is not designed to be Highway Towable.
- Set parking brake or chock wheels before disconnecting from towing vehicle.
- Optional Parking Brake located beside towbar on front of unit, if equipped.
- Push lever down to apply brake.

High Speed Running Gear

- Use jack to raise or lower lunette eye.
- Use tow vehicle whose towing capacity is greater than the gross weight of this unit (see general data).
- Do not tow this unit in excess of 65 mph.
- Place wheel chocks under tires before disconnecting from towing vehicle.
- When raising or lowering lunette eye, always stand to one side.

Wheel Chock - HSRG

- Located inside of front towbar
- Secure unit with chocks before disconnecting drawbar from tow vehicle.

SETTING UP (ALL UNITS)

Place the unit in an open, well-ventilated area. Position as level as possible. The design of these units permits a maximum 10 degree limit on out-of-level operation.

When the unit is to be operated out-of-level it is important: (1) to keep the engine crankcase oil level near the high level mark (with the unit level), and (2) to have the compressor oil level gauge show no more than mid-scale (with the unit running at full load). Do not overfill either the engine crankcase or the compressor lubricating oil system.

- Chock wheels or set parking brake.
- Optional Parking Brake located beside towbar on front of unit, if equipped.
- Push lever down to apply brake.

This unit is equipped with on-board fuel tanks with a total capacity of 230 gallons which provides 10 hours of full load operation.

COMPRESSOR MOUNTING

Portable compressors, which are modified to remove the running gear and mount the machine direct to trailers, truck beds or frames, etc. may experience failure of the enclosure, frame, and/or other components. It is necssary to isolate the compressor package from the carrier base with a flexible mounting system. Such a system must also prevent detachment of the package from the carrier base in the event the isolators fail. Contact Ingersoll-Rand representative for flexible mounting kits.

Warranty does not cover failures attributable to mounting of the compressor package to the carrier base unless it is an Ingersoll-Rand provided system.

WARNING

Do not connect the air discharge on this unit onto a common header with any other unit of any description, or any other source of compressed air, without first making sure a check-valve is used between the header and the unit. If this unit is connected in parallel with another unit of higher discharge pressure and capacity, a safety hazard could occur in a back-flow condition.

WARNING

Unrestricted air flow from a hose will result in a whipping motion of the hose which can cause serious injury or death. A safety device must be attached to the hose at the source of supply to reduce pressure in case of hose failure or other sudden pressure release. Reference: OSHA regulation 29 CFR Section 1926.302 (b).

Air hose restraining cable installation:

Secure hose restraining cable at each end to prevent accidental hose whipping. At the machine-side of the air hose, install and secure one end of the hose restraining cable on the 3" nipple on the inlet side of the 3" service valve. Install the other end of the hose restraining cable over the main hose connector.

Install suitable 3" air hose between service valve on unit and point of air use. The air hose must be rated for outdoor use and for pressurized air service. Minimum rating is 250°F (121°C) and 200 psig (HP) or 425 psig (XHP).

BEFORE STARTING

Open manual blowdown valve to ensure the separator has been vented of all pressure. Close the valve before starting.

Inspect the complete installation including remote fuel lines (if any) and air hose routing and connections.

Check battery for proper connections and condition.

WARNING

Combustible gas can cause severe burns, blindness or death. Keep sparks and open flame away from battery.

- Check the compressor lubricating oil level. The proper oil level is labeled on the compressor sump sight glass.
- Check engine oil level. The proper level is labeled on the engine dipstick. Add oil when required. Do not overfill.
- To jump-start, connect the positive booster/charger cable to the 24VDC positive (+) terminal of the battery. Then connect the negative booster/charger cable to the engine block...Not to the negative (-) terminal of the weak battery. After starting, disconnect the negative (-) cable from engine block; then from the booster battery/charger. Disconnect positive (+) cable from both batteries.

WARNING

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can result in a loss of coolant and possible severe personal injury.

WARNING

Hot pressurized fluid can cause serious burns. Do not open radiator while hot.

Check coolant to assure coolant level is at minimum level when the unit is cold.

Check engine coolant level by removing the radiator top cap and looking for coolant in the filler neck of the radiator. Add coolant as required. Insure that radiator cap is installed properly and tightened.

Note: This machine will not allow engine starting if engine coolant is low.

NOTICE: If the appropriate mixture of antifreeze is not used during freezing temperatures, failure to drain the engine may cause costly engine damage. Never use water only as corrosion inhibitors are required in engine coolant fluid.

CAUTION

No smoking, sparks, or open flame near fuel.

Check the fuel level. Add only CLEAN DIESEL fuel for maximum service from the engine. Refer to the Engine Operator's Section for fuel specifications.

NOTICE

To minimize condensation (water) in the fuel tank, it is recommended to fill the tank at the end of each day.

WARNING

This machine produces loud noise with doors open. Extended exposure to loud noise can cause hearing loss. Wear hearing protection when doors or valve(s) are open.

- Close the side doors to maintain a cooling air path and to avoid recirculation of hot air. This will maximize the life of the engine and compressor and protect the hearing of surrounding personnel.
- Make sure no one is IN or ON the compressor unit.

STARTING -

NOTICE

This unit is equipped with a battery disconnect switch which removes power from the machine controller for long term storage. The switch is located on the side of the engine near the battery. This switch must be turned ON to provide power to the control panel for starting this unit.

Close the air service valve to isolate the compressor from the compressed air tool until the engine is warmed up.

- Turn the keyswitch to the "ON" position (first position). All diagnostic lamps and the LED display will light for two (2) seconds. Then all lamps should go off except for ALTERNATOR NOT CHARGING and LOW ENGINE OIL PRESSURE.
- 2. In freezing weather (below 32°F/0°C), flip HEATERS switch "ON" and wait sixty (60 seconds). This applies heat to the control system components for easier starting. Leave this switch "ON" while operating at these temperatures.
- 3. When the keyswitch is turned to "START" the engine starter will be engaged. Do not operate the engine starter motor for more than ten (10) seconds without allowing at least one minute cooling time between start attempts.

CAUTION

Ether is an extremely volatile, high flammable gas. Use Sparingly! If too much is injected, the uncontrolled explosion may result in costly damage to the engine.

- In cold weather, as required, press the ETHER INJECT button <u>once or twice only</u> while the engine is cranking. This injects a measured amount of ETHER to the engine.
- Following a successful start, the engine will accelerate to idle speed of 1200 RPM for warm-up. Compressor discharge pressure will be maintained at 60 psi during warm-up.
- 6. Press the LOAD button. The engine will increase speed up to 1800 rpm until the pressure reaches the desired set point.

After the engine has warmed up, open the service air valve to supply air to the compressed air tool.

NORMAL OPERATION

The Operator may observe and monitor operating parameters using the gages on the panel. In the event the machine controller detects a parameter outside normal operating limits, the unit will shutdown.

In the event the machine controller detects a parameter at a dangerously high or low level, the machine will be automatically be stopped with the cause of the SHUTDOWN shown on the diagnostic lights.

Delivered air volume at set point pressure is accomplished by two methods:

- 1). The compressor is loaded (inlet valve fully open or modulated partially open), or unloaded (inlet valve fully closed).
- 2) Engine speed varies between 1200 RPM and 1800 RPM while compressor is loaded to match the required volume flow.

Operation - Loaded

Assume engine has been started and is running in the unload state at 1200 RPM. If there is air demand (pressure falls below the load point pressure), compressor will load at 1200 RPM by opening the inlet valve.

As air demand rises and falls, engine speed is controlled between 1200 RPM and 1800 RPM to match the required flow while maintaining rated pressure.

Operation - Unloaded

If there is no air demand at 1200 RPM (Pressure rises above the unload point pressure), the compressor will unload by closing the inlet valve. The unit then runs at 1200 RPM unloaded with no air delivery. If air demand increases (pressure falls to below the load point pressure), the compressor reloads to meet the required air demand.

STOPPING

- Close air service valve(s).
- Allow the unit to run at "no load" for 3 to 5 minutes to reduce the engine temperatures.
- Turn the keyswitch to the "OFF" position.

NOTICE

Once the engine stops, the automatic blowdown valve will continue to relieve all pressure from the check valve to discharge valve piping.

NOTICE

Failure to allow turbo cool down prior to stopping can cause turbocharger damage.

WARNING

Even after pressure is relieved from the piping system, any air supply line from the compressor to a tool or machine could remain under pressure and cause serious personal injury or death. After the compressor stops, carefully open a valve at any tool or machine to exhaust the pressure in any line prior to removal or servicing.

CAUTION

Never allow the unit to sit stopped with pressure in the receiver-separator system. As a precaution, open the service valve.

IQ System

The optional IQ System is a complete, self-contained system which provides cooler, cleaner air than from a standard portable compressor. The system utilizes an integral aftercooler, high-efficiency filtration, and a patented condensate disposal system to provide the cool, clean air. The condensate disposal system injects all liquid condensed from the moisture separator and filters into the engine exhaust system where it is vaporized by heat. This eliminates the need for collecting the condensate, and the added cost of disposing of the condensate, which is often regulated by local, state, and/or federal regulations.

A low ambient feature of the IQ System automatically adjusts movable louvers to control airflow through the aftercooler, ensuring that the compressed air temperature always remains above freezing temperatures (typically 45°F) at any ambient temperature down to -20°F. This prevents the need for 120V AC heat tracing systems, or any manual adjustment to prevent freezing of the compressed air system. All drain points for the condensate handling system are heated with 24VDC heat tracing, which is integral to the compressor control orifice heater system.

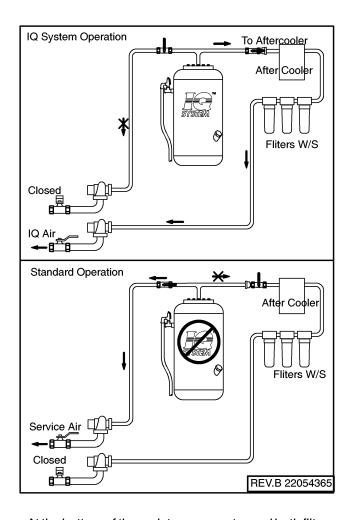
Theory of Operation

The compressed air exits the separator tank through the top cover piping, and can then travel along one of two paths, selectable via manual valving.

One path allows Standard Operation, which bypasses the IQ System, and delivers air quality equivalent to a standard oil-flooded portable compressor.

If the IQ System is enabled by proper setting of the selector valve, the compressed air first enters the aftercooler.

The aftercooler is cooled by the incoming compressor package air, which is controlled by movable louvers mounted on the aftercooler. At most conditions, the louvers are fully open, and maximum aftercooling is available. The compressed air and condensate (water with a small amount of compressor lubricant) exits the aftercooler and enters the moisture separator, where most of the condensate is removed. The compressed air then flows through two stages of filtration, where the aerosol water and oil is removed down to approximately 0.01 ppm, and all particulates are removed down to 0.01 micron.



At the bottom of the moisture separator and both filters are strainers and constant-bleed orifices, which are sized to allow the maximum flow of condensate while minimizing compressed air loss.

The condensate lines are then piped together, and the condensate is injected at a single point into the engine exhaust piping. The compressed air then travels through the minimum pressure valve, and out through the service air valve. The air pressure gauge on the instrument panel indicates the pressure inside the separator tank. A service air pressure gauge is located inside the front door of the compressor on the filter support.

If the IQ System is bypassed (Standard Operation selected), the delivered air pressure will be approximately equal to the separator tank pressure. If the IQ System operation is selected, the delivered air pressure will be slightly less, depending on the restriction of the filters.

CAUTION

The compressor regulation system is adjusted to maintain regulated pressure at the separator tank. DO NOT adjust regulation to provide full regulation pressure at the service valve when the IQ System is enabled. This will result in operation at excessive horsepower levels, causing overheating, reduced engine life, and reduced airend life.

Low Ambient Option Operation

When the ambient temperature falls to the point that the aftercooler outlet temperature is approaching 45°F, the Temperature Control Unit (TCU), mounted on the rear of the control panel, will automatically adjust the louvers to control the cooling airflow through the aftercooler.

In the event that the unit is operating under abnormal conditions (i.e., an enclosure door open) which would cause excessive cooling of the aftercooler, a temperature sensor in the aftercooler outlet header will signal the TCU to further close the louvers if the compressed air temperature falls to approximately 36°F or lower.

There are no user selectable or serviceable components in the TCU. Contact Ingersoll-Rand Service if any abnormal operation of the freeze protection control system occurs.

MAINTENANCE

Daily Maintenance:

Verify, during full-load (maximum compressed air delivery) that the IQ System filter restriction indicators do not show excessive restriction. Restriction indicators for the filters are mounted inside the control panel, and will shut down the compressor if restriction exceeds recommended values.

CAUTION

Excessively restricted filter elements may cause an increase in the amount of aerosol water and oil carryover, which could result in damage to downstream equipment. Normal service intervals should not be exceeded.

Weekly Maintenance:

- Remove Y-strainer screens at the bottom of the moisture separator and both filters and clean out any residue.
- Verify that the orifices below the Y-strainers are not clogged.
- Verify that the piping from the orifice purge points to the exhaust system is not clogged.

CAUTION

Blockage of the Y-strainers, orifices, or piping can result in flooding of the vessels with condensate. If flooding occurs, excessive condensate may enter the air stream and could result in damage to downstream equipment.

Yearly Maintenance:

The normal maintenance interval on the primary and secondary IQ System filters is one year, or earlier if pressure drop becomes excessive. Restriction indicators for the filters are mounted on the filter support inside the front door, and will shut down the compressor if restriction exceeds recommended values.

CAUTION

Excessively restricted filter elements may cause an increase in the amount of aerosol water and oil carryover, which could result in damage to downstream equipment. Normal service intervals should not be exceeded.

Filter Replacement

- With engine stopped, ensure pressure is relieved from air system.
- Remove all wires and hoses connected to drains on bottom of each filter housing. Inspect fittings and hoses for any blockage. Clean if necessary.
- Using a chain wrench or similar tool, loosen the housing. The housing should be removed by hand after loosening, taking care to prevent the housing from falling to the floor panel.

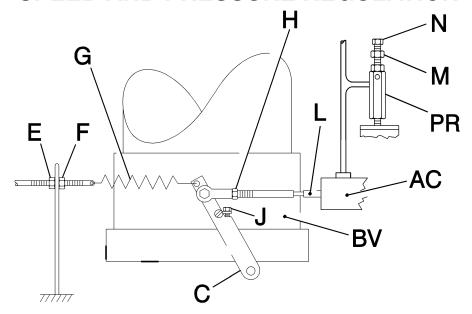
• Lower the housing to floor panel and lean it against the airend. Remove and replace the filter element, being careful not to damage outer wrap.

Verify the part number of new element vs. old element, as the two IQ filters are of different media.

• Put a small amount of petroleum jelly or other non-synthetic grease on the element o-ring to aid installation into the filter head.

- Replace housing making sure to not overtighten.
- Repeat the above procedure on the remaining filter element.
- Reconnect all wires and hoses to drains on bottom of each filter housing.

SPEED AND PRESSURE REGULATION



Adjustment Instructions

The operating pressure of this unit was set at the factory to the maximum rating (at full speed). See General Data. However, this pressure may be reset down to 150 psi (1050 kPa).

Normally, regulation requires no adjusting; but if proper adjustment is lost, proceed as follows:

- 1. **WITH UNIT STOPPED**, loosen nut (E) to relax spring (G).
- Loosen nut (H). Turn rod (L) in Air Cylinder (AC) until approximately 3/4 inch (20 mm) between nut (H) and flats on rod (L).
- 3. Turn rod (L) One round into rod end bearing. Tighten nut (H). Rotate butterfly shaft/lever (C), open and close, several times to assure that linkage is not binding.
- 4. With air cylinder rod (L) fully extended, take slack out of spring (G) by moving nuts (E) and (F). Tighten nuts.

- 5. Start unit and allow to warm up for 3 to 5 minutes.
- 6. Push "Service Air" button on control panel.
- 7. With service air valve closed, adjust pressure regulator (PR) to rated pressure (350 psi) plus 10 psi (70 kPa) as follows:
- 8. Loosen locknut (M) counterclockwise;. Turn adjustment cap (N) clockwise to increase pressure, counterclockwise to decrease pressure.
- 9. Open service air valve and observe full load engine speed (*). Adjust regulator to give rated operating pressure (*). Tighten locknut (M).
- Close and slowly open service air valve. If engine speed surges, increase tension on spring
 (G) by moving nuts (E) and (F).
- 11. To regulate to any pressure between 150 psi (1050 kPa) and maximum rating (350 psi), make adjustments at the pressure regulator.

SECTION 5 - MAINTENANCE

GENERAL

In addition to periodic inspections, many of the components in these units require periodic servicing to provide maximum output and performance. Servicing may consist of pre-operation and post-operation procedures to be performed by the operating or maintenance personnel. The primary function of preventive maintenance is to prevent failure, and consequently, the need for repair. Preventive maintenance is the easiest and the least expensive type of maintenance. Maintaining your unit and keeping it clean at all times will facilitate servicing.

CONTAINMENT BASE

This unit uses a containment base large enough to hold the fluid contents of the engine oil, coolant, fuel or compressor oil systems.

Drain plugs are located at strategic positions in this base to drain accumulated fluids and also to allow access to system drain plugs in the fuel tanks and compressor oil resevoir for flushing.

A central drain system is provided for normal service of engine, fuel, or compressor system.

The containment base should be drained and flushed monthly or following any fluid discharge into the base.

SCHEDULED MAINTENANCE

The maintenance schedule is based on normal operation of the unit. This page can be reproduced and used as a checklist by the service personnel. In the event unusual environmental operating conditions exist, the schedule should be adjusted accordingly.

COMPRESSOR OIL LEVEL

The oil level is most consistent when the unit is running unloaded and should be checked at this time. The oil level should be between the high/low indicators on the sight glass located on the side of the receiver tank.

COMPRESSOR OIL

This machine was factory filled with Ingersoll-Rand Fluid.

By continued use of Ingersoll-Rand compressor fluids and filters, optional warranty will be extended for the base airend (rotors, housings, gears and bearings) when substantiated with proof of conformance to recommended maintenance intervals and purchase of OEM Ingersoll-Rand filters and fluids.

Optional Warranty - The earlier of 60 months from shipment to, or the accumulation of 10,000 hours of service by the initial user. The optional warranty is limited to defects in major components (rotors, housings and bearings), and is automatically available to the original user when he meets the following two conditions:

- 1. Submissions of proof that Ingersoll-Rand fluid, filters and separators have been used. Refer to the Operation and Parts manual for the correct fluids, filters and separator elements required.
- 2. Submission of proof that maintenance intervals have been followed.

WARRANTY	TIME	*BARE AIREND	**AIREND COMPONENTS
STANDARD	2 yrs/4000 hrs	100% parts and labor	100% parts and labor
OPTIONAL	5 yrs/10,000 hrs	100%	0%

Bare Airend – Pertains to major airend parts (rotors, housings, and bearings).

Airend Components - Pertains to auxiliary attachments to the bare airend (drive coupling, seals, pumps, valves, tubes, hoses, fittings and filter housing).

The compressor oil must be replaced every 1000 hours of operation or six (6) months, whichever comes first.

Refer to the fluids and lubricants chart for ambient temperature ranges and specifications, in the lubrication section of this manual.

Refer to the fluids and lubricants chart for ambient temperature ranges and specifications in the lubrication section of this manual.

AIR CLEANER

This unit is equipped with an AIR FILTERS RESTRICTED lamp on the instrument panel.

When this message is viewed, both the engine and airend filters should be replaced.

Also, each week, squeeze the rubber valve (precleaner dirt dump) on each air cleaner housing to ensure that they are not clogged.

NOTICE: Holes or cracks downstream of the air cleaner housing will cause the restriction indicators to be ineffective.

To service the air cleaners on all units proceed as follows:

- Loosen outer wing nut and remove with outer element. Inspect red window on special inner wing nut to find small dot. If dot is not visible, remove cotter pin and special wing nut and inner (safety) element.
- Inspect air cleaner housing for any condition that might cause a leak and correct as necessary.

- Wipe inside of air cleaner housing with a clean, damp cloth to remove any dirt accumulation, especially in the area where the element seals against the housing.
- If a new air filter element is to be used check it closely for shipping damage. To reset the signal indicator in the special wing nut, apply suction to the red window.
- Install cleaned or new elements in the reverse order to the above. Tighten wing nuts firmly and replace cotter pin.
- Inspect to ensure that the end cap seals tightly 360 degrees around the air cleaner body.

The air cleaner system (housing and piping) should be inspected every month for any leakage paths or inlet obstructions. Make sure the air cleaner mounting bolts and clamps are tight. Check the air cleaner housing for dents or damage which could lead to a leak. Inspect the air transfer tubing from the air cleaner to the compressor and the engine for holes. Make sure that all clamps and flange joints are tight.

GAUGES

The instruments or gauges are essential for safety, maximum productivity and long service life of the machine. Inspect the gauges prior to start-up. During operation observe the gauges and any lamps for proper functioning. Refer to Operating Controls for the normal readings. Refer to Section B for Wedge Diagnostic Lamp testing.

FUEL TANK

This unit is equipped with dual tanks that can be filled from either side. Using clean fuel in the fuel tanks is important and every precaution should be taken to ensure that only clean fuel is either poured or pumped into the tank. When filling the fuel tank on this unit, by methods other than a pump and hose, use a CLEAN non-metallic funnel.

Every six months the drain plugs should be removed from the tanks so that any sediment or accumulated condensate may be drained. When replacing the drain plugs, make sure they are tightened securely.

BATTERY

Heavy-duty, diesel cranking type batteries were installed at the factory and these should be inspected weekly. Keep the battery posts-to-cable connections clean, tight and lightly coated with a grease. Also the electrolyte level in each cell should cover the top of the plates. If necessary, top-up with clean distilled water.

COMPRESSOR OIL and FUEL COOLERS

The coolers are cooled by means of the fin and tube-type oil cooler. The compressor oil and fuel flow internally through the core sections. Fluid is cooled by the air stream from the cooling fan flowing past the core section. When grease, oil and dirt accumulate on the exterior surfaces of the coolers, their efficiency is impaired.

Each month it is recommended that the coolers be cleaned by directing compressed air which contains a nonflammable safety solvent through the core of the coolers. This should remove the accumulation of grease, oil and dirt from the exterior surfaces of the cooler core so that the entire cooling area can transmit the heat of the fluid to the air stream.

If foreign deposits, such as sludge and lacquer, accumulate in the coolers, high temperature is likely to occur, causing shut down of the unit.

RADIATOR

WARNING

Do not remove the cap from a HOT engine radiator. The sudden release of pressure from a heated cooling system can result in serious personal injury. The engine cooling system is filled at the factory with a 50/50 mixture of water and ethylene glycol. This permanent type antifreeze contains rust inhibitors and provides protection to -35° F (-37°C).

The use of such a mixture is recommended for both summer and winter operation. When using water alone, be sure to add a reputable brand of rust inhibitor to prevent internal corrosion.

It is recommended to test the freezing protection of the coolant every six months or prior to freezing temperatures. Replenish with a fresh mixture every twelve months. A drain for the system is located in the bottom radiator tank.

Each month, inspect the radiator exterior for obstructions (dirt, bugs, etc.). If present, blow water or compressed air containing a nonflammable solvent between the fins in a direction opposite the normal air flow. Should the radiator be clogged internally, standard automotive practices should be followed.

ENGINE CHARGE AIR COOLER

This cooler is a fin and tube-type oil cooler. The engine intake air flows internally through the core section. It is cooled by the air stream from the cooling fan flowing past the core section. When grease, oil and dirt accumulate on the exterior surfaces of the cooler, efficiency is impaired.

Each month it is recommended that the cooler be cleaned by directing compressed air which contains a nonflammable safety solvent through the core of the cooler. This should remove the accumulation of grease, oil and dirt from the exterior surfaces of the cooler core so that the entire cooling area can transmit the heat of the fluid to the air stream.

Ensure that the air connections do not leak. Leaks or loss of cooling will result in low engine power.

HOSES

Each month it is recommended that all of the intake lines to and from the air cleaners, the charge air coolers, the engine cooling system hoses and all of the flexible hoses used for air, oil, and fuel be inspected.

To prevent leaks, regular inspection of these connections for wear or deterioration is a definite "must" if regulator servicing of the air cleaners is not to prove futile.

Premature wear of both the engine and compressor is ASSURED if dust-laden air is permitted to enter the engine or the compressor.

The flexible hoses used in the fuel, oil and air lines on these units are primarily used for their ability to accommodate relative movement between components. It is extremely important they be periodically inspected for wear and deterioration. Clamps are used to prevent hose cover abrasion through vibration. This abrasion may occur when two hose lines cross, or when a hose line rubs against a fixed point; therefore, it is necessary that all clamps be replaced if missing. It is also important the operator does not use the hoses as convenient hand hold or steps. Such use can cause early cover wear and hose failure.

NOTICE

Piping systems operating at less than 150 psi (1050 kPa) may use a special nylon tubing. The associated fittings are also of a special "push-in" design.

Pulling on the tubing will cause the inner sleeve to withdraw and compress, thus tightening the connection. The tubing can be withdrawn only while holding the sleeve against the fitting. The tubing can be removed and replaced numerous times without losing its sealing ability.

To install the nylon tubing, make a mark (with tape or grease pencil) approximately 7/8 inch from the end of the tubing. Insert the tubing into the sleeve and "push-in" past the first resistance to the bottom. The mark should be approximately 1/16 inch from the sleeve, for the 3/8 inch O.D. tubing; 1/8 inch for the 0.25 inch O.D. tubing. This will ensure that the tubing is fully engaged in the sealing mechanism.

COMPRESSOR OIL FILTERS

The compressor lubrication oil systems include spin-on, throw away type oil filters, each with an internal bypass valve. With a clean, new filter element, all of the oil flows through the full element area, from the outside/inside. As each element becomes contaminated with dirt, a pressure differential is created in the filter housing between the oil inlet and outlet ports. As this differential approaches 25 psi (175 kPa), the bypass valve starts to open, thus permitting a small quantity of oil to bypass the filter. As the contaminants continue to build up, more and more of the oil bypasses the filter media itself.

This bypass does not provide any filtration but does allow a maximum flow of compressor lubricating oil to preclude any possible damage from loss of oil. Also the design of the filter prevents any washing-off of any dirt during oil bypassing.

NOTICE

The oil filter must be replaced every 1000 hours of operation.

To service the oil filters it will first be necessary to shut the unit down. Wipe off any external dirt and oil from the exterior of the filter to minimize any contamination from entering the lubrication system. Proceed as follows:

WARNING

High pressure air can cause severe injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system.

- 1. Open the service air valve(s) to ensure that system is relieved of all pressure. Close the valve(s).
- 2. Turn the spin-on filter element counterclockwise to remove it from the filter housing. Inspect the filter element and then discard.

Note: If there is any indication of formation of varnishes, shellacs or lacquers on the oil filter element, it is a warning the compressor lubricating oil has improper characteristics and should be immediately changed.

3. Inspect the oil filter head to be sure the gasket was removed with the oil filter element. Clean the gasket seal area on the oil filter head.

Installing a new oil filter element when the old gasket remains on the oil filter head will cause an oil leak and can cause property damage.

- 4. Lubricate the new filter gasket with the same oil being used in the machine.
- 5. Install new filter by turning element clockwise until gasket makes initial contact. Tighten an additional 1/2 to 3/4 turn.
- 6. Start unit and allow to build up to rated pressure. Check for leaks before placing unit back into service.

FASTENERS

Visually check entire unit in regard to bolts, nuts and screws being properly secured. Spot check several capscrews and nuts for proper torque. If any are found loose, a more thorough inspection must be made. Take corrective action.

COMPRESSOR OIL

The lubricating and cooling oil must be replaced every 1000 hours of operation or six (6) months, whichever comes first.

ENGINE COOLING FAN DRIVE

The heat exchanger or cooling fan is driven by a single belt arrangement from the engine. Inspect the cooling fan belt weekly. These belts should be maintained at the proper tension by the auto tension system on the engine.

EXTERIOR FINISH CARE

This unit was painted and heat cured at the factory with a high quality, thermoset polyester powder coating. The following care will ensure the longest possible life from this finish.

- If necessary to remove dust, pollen, etc. from housing, wash with water and soap or dish washing liquid detergent. Do not scrub with a rough cloth, pad, etc.
- 2. If grease removal is needed, a fast evaporating alcohol or chlorinated solvent can be used. Note: This may cause some dulling of the paint finish.
- If the paint has faded or chalked, the use of a commercial grade, non-abrasive car wax may partially restore the color and gloss.

Field Repair of Texture Paint

1. The sheet metal should be washed and clean of foreign material and then thoroughly dried.

- 2. Clean and remove all grease and wax from the area to be painted using Duponts 3900S Cleaner prior to sanding.
- 3. Use 320 grit sanding paper to repair any scratches or defects necessary.
- 4. Scuff sand the entire area to be painted with a red scotch brite pad.
- 5. Wipe the area clean using Duponts 3900S.
- 6. Blow and tack the area to be painted.
- 7. Apply a smooth coat of Duponts 1854S Tuffcoat Primer to all bare metal areas and allow to dry.
- Apply 2 medium wet coats of Duponts 222S Adhesion Promoter over the entire area to be painted, with a 5 minute flash in between coats.
- 9. To apply the texture coat, use Duponts 1854S Tuffcoat Primer. The proper technique to do this is to spray the Tuffcoat Primer using a pressure pot and use about 2-5 pounds of air pressure. This will allow the primer to splatter causing the textured look. Note: you must be careful not to put too much primer on at one time, this will effect the amount of texture that you are trying to achieve. Allow the texture coat to flash for 20 minutes or until dry to touch.
- 10. Apply any of Duponts Topcoat Finishes such as Imron™ or Centari™ according to the label instructions.

Note: To re-topcoat the textured surfaces when sheet metal repairs are not necessary, follow steps 1, 2, 4, 5, 6, 8 and 10.

CAUTION

- Any unauthorized modification or failure to maintain this equipment may make it unsafe and out of factory warranty.
- If performing more than visual inspections, disconnect battery cables and open manual blowdown valve.
- Use extreme care to avoid contacting hot surfaces (engine exhaust manifold and piping, air receiver and air discharge piping, etc.).
- Never operate this machine with any guards removed.
- Inch and metric hardware was used in the design and assembly of this unit. Consult the parts manual for clarification of usage.

Notice: Disregard any maintenance pertaining to components not provided on your machine.

NOTICE

Drain the frame after power-washing/cleaning or heavy rains.

MAINTENANCE SCHEDULE

These time periods should be reduced if operating in extreme conditions (very hot, cold, dusty or wet).

		Daily	Weekly	Monthly	3 MOS.	6 MOS.	12 MOS.
LARGE UNITS			•		500 hours	1000 hours	2000 hours
**Hydraulic Oil Level			С			R	
Compressor Oil Level		С					
Engine Oil Level		С					
**Radiator Coolant Level		С					
Gauges/Lamps		С					
Air Cleaner Service Indicators		С					
Fuel Tank (fill at end of day)		С				DRAIN	
**Fuel/Water Separator	DRAIN	С					
Air Cleaner Precleaner Dumps			С				
Fan/Alternator Belts			С				
Battery Connections/Electrolyte			С				
**Tire Pressure and Surface			С				
**Wheel Lug Nuts				С			
Hoses (oil, air, intake, etc.)				С			
Automatic Shutdown System	Test			С			
Air Cleaner System	Visual			С			
Compressor Oil Cooler	Exterior			С	CLEAN		
**Engine Radiator	Exterior			С	CLEAN		
Fasteners, Guards					С		
Air Cleaner Elements					WI		
** Fuel/Water Separator Element						R	
*Compressor Oil Filter Element						R	
*Compressor Oil						R	
**Wheels (bearings, seals, etc)						С	С
Engine Coolant	Test					С	R
Shutdown Switch Settings	Test						С
Scavenge Orifice & related parts							CLEAN
Oil Separator Element							R
**Lights (running, brake, & turn)		СВТ					
**Pintle Eye Bolts		СВТ					
Engine (oil changes, oil & fuel filters, etc)					R		

^{**}Disregard if not appropriate for this particular machine.

R=replace, **C**=check (adjust if necessary), **WI**=OR when indicated, **CBT** = check before towing.

Refer to specific sections of the operator's manual for more information.

SECTION 6 - LUBRICATION

GENERAL INFORMATION

Lubrication is an essential part of preventive maintenance, affecting to a great extent the useful life of the unit. Different lubricants are needed and some components in the unit require more frequent lubrication than others. Therefore, it is important that the instructions regarding types of lubricants and the frequency of their application be explicitly followed. Periodic lubrication of the moving parts reduces to a minimum the possibility of mechanical failures.

The Preventive Maintenance Schedule shows those items requiring regular service and the interval in which they should be performed. A regular service program should be developed to include all items and fluids. These intervals are based on average operating conditions. In the event of extremely severe (hot, cold, dusty or wet) operating conditions, more frequent lubrication than specified may be necessary. Details concerning lubrication of the running gear are in Maintenance Section.

All filters and filter elements for air and compressor lubricant must be obtained through Ingersoll-Rand to assure the proper size and filtration for the compressor.

COMPRESSOR OIL CHANGE

These units are normally furnished with an initial supply of oil sufficient to allow operation of the unit for approximately 6 months or 1000 hours, whichever comes first. If a unit has been completely drained of all oil, it must be refilled with new oil before it is placed in operation. Refer to specifications in Lubrication Table.

NOTICE

Some oil types are incompatible when mixed and result in the formation of varnishes, shellacs, or lacquers which may be insoluble. Such deposits can cause serious troubles including clogging of the filters. Where possible, do NOT mix oils of different types and avoid mixing different brands. A type or brand change is best made at the time of a complete oil drain and refill.

If the unit has been operated for the time/ hours mentioned above, it should be completely drained of oil. If the unit has been operated under adverse conditions, or after long periods in storage, an earlier change period may be necessary as oil deteriorates with time as well as by operating conditions.



High pressure air can cause severe injury or death from hot oil and flying parts. Always relieve pressure before removing caps, plugs, covers or other parts from pressurized air system. Ensure the following conditions are met:

- Discharge air pressure gauge reads zero (0).
- No air discharging from an "open" manual blow-down valve.

An oil change is good insurance against the accumulation of dirt, sludge, or oxidized oil products.

Completely drain the reservoir, piping, and cooler. If the oil is drained immediately after the unit has been run for some time, most of the sediment will be in suspension and, therefore, will drain more readily. However, the fluid will be hot and care must be taken to avoid contact with the skin or eyes.

After the unit has been completely drained of all old fluid, close the drain valve, install new oil filter elements. Add oil in the specified quantity at the filler plug. Tighten the filler plug and run the machine to circulate the oil. Check the oil level. DO NOT OVERFILL.

NOTICE

Ingersoll-Rand provides compressor oil specifically formulated for Portable Compressors and requires the use of these fluids in order to obtain extended limited airend warranty.

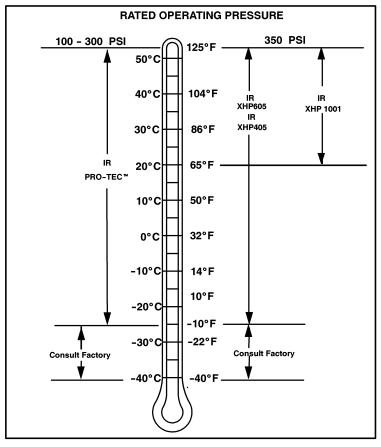
Portable Compressor Fluid Chart

Refer to these charts for correct compressor fluid required. Note that the selection of fluid is dependent on the design operating pressure of the machine and the ambient temperature expected to be encountered before the next oil change.

Note: Fluids listed as "preferred" are required for extended warranty.

Compressor oil carryover (oil consumption) may be greater with the use of alternative fluids.

Design Operating Pressure	Ambient Temperature	Specification
100 psi to 300 psi	-10°F to 125°F (-23°C to 52°C)	Preferred: IR Pro-Tec™
		Alternate: ISO Viscosity Grade 46 with rust and oxidation inhibitors, de- signed for air compres-
350 psi	(-23°C to 52°C) -10°F to 125°F	sor service. Preferred: IR XHP 605 Alter- MatxHP405
		ISO Viscosity Grade 68 Group 3 or 5 with rust and oxidation inhibitors designed for air com- pressor service.
	65°F to 125°F (-18°C to 52°C)	Preferred: XHP605 IR XHP1001



Preferred Ingersoll-Rand Fluids - Use of these fluids with original I-R filters can extend airend warranty. Refer to operator's manual warranty section for details or contact your I-R representative.

Ingersoll-Rand Preferred Fluids	1 gal. (3.8 Litre)	5 gal. (19.0 Litre)	55 gal. (208.2Litre)	220 gal. (836 litre)
Preferred:				
IR Pro-Tec™	36899698	36899706	36899714	36899722
IR XHP605	-	22252076	22252050	22252068
IR XHP1001	-	35612738	35300516	-
XHP405	-	22252126	22252100	22252118

SECTION 7 - Trouble Shooting

INTRODUCTION

Trouble shooting for a portable air compressor is an organized study of a particular problem or series of problems and a planned method of procedure for investigation and correction. The trouble shooting chart that follows includes some of the problems that an operator may encounter during the operation of a portable compressor.

The chart does not attempt to list all of the troubles that may occur, nor does it attempt to give all of the answers for correction of the problems. The chart does give those problems that are most apt to occur. To use the trouble shooting chart:

- A. Find the "complaint" depicted as a bold heading.
- B. Follow down that column to find the potential cause or causes. The causes are listed in order (1,2,3 etc.) to suggest an order to follow in trouble shooting.

ACTION PLAN

A. Think Before Acting

Study the problem thoroughly and ask yourself these questions:

- (1) What were the warning signals that preceded the trouble?
- (2) Has a similar trouble occurred before?
- (3) What previous maintenance work has been done?
- (4) If the compressor will still operate, is it safe to continue operating it to make further checks?

B. Do The Simplest Things First

Most troubles are simple and easily corrected. For example, most complaints are "low capacity" which may be caused by too low an engine speed or "compressor over- heats" which may be caused by low oil level.

Always check the easiest and most obvious things first; following this simple rule will save time and trouble.

Note: For trouble shooting electrical problems, refer to the Wiring Diagram Schematic found in Parts List Section.

C. Double Check Before Disassembly

The source of most compressor troubles can be traced not to one component alone, but to the relationship of one component with another. Too often, a compressor can be partially disassembled in search of the cause of a certain trouble and all evidence is destroyed during disassembly. Check again to be sure an easy solution to the problem has not been overlooked.

D. Find And Correct Basic Cause

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so the same failure will not be repeated. A complaint of "premature breakdown" may be corrected by repairing any improper wiring connections, but something caused the defective wiring. The cause may be excessive vibration.

General Information

The WEDGE controller records and displays diagnostic fault codes for the compressor system and the electronic engine. These codes are displayed on the 4-digit LED display on the machine control panel. Two of the ten LED diagnostic lamps on the control panel are used with fault codes display. One lamp is designated "Engine Fault" and the other "Compressor Fault". When the engine fault lamp is on, all codes displayed are engine faults. When the compressor fault lamp is on, all codes displayed are compressor or package related faults.

A list of compressor and engine faults is attached with the placards inside the machine control panel and provided in this section. The table of Alert/Sutdown conditions in this section also lists the compressor fault codes and a list of the engine fault codes is provided. The engine diagnostic fault codes can also be read with the manufacturer's service tool. A service tool connector is mounted on the engine. This connector provides a connection to the J1939 CAN network. For advanced engine troubleshooting, it is recommended that the manufacturer's service tools be used with accompanying service literature.

Flash codes are used to represent diagnostic codes in the electronic system in order to alert the operator that a problem exists. The flash codes are a two digit number.

Flash codes can represent more than one diagnostic code. Diagnostic codes may be viewed using ET, the engine manufacturer's service tool.

A list of compressor and engine Flash Code and Event Codes is attached with the placards inside the machine control panel and provided in this section. The Table of Alert/Shutdown conditions in this section also lists the compressor fault codes and a list of the engine fault codes is provided.

FLASH CODE	DIAGNOSTIC FLASH CODES DESCRIPTION
NA	Ether Start Relay open/short to +batt
13	Ether Start Relay short to ground
21	5 Volt Sensor DC Power Supply short to +batt
	5 Volt Sensor DC Power Supply short to ground
	Digital Sensor Supply short to +batt
	Digital Sensor Supply short to ground
24	Engine Oil Pressure open/short to +batt
	Engine Oil Pressure short to ground
25	Turbo Outlet Pressure above normal
	Turbo Outlet Pressure open/short to +batt
	Turbo Outlet Pressure short to ground
26	Atmospheric Pressure open/short to +batt
	Atmospheric Pressure short to ground
27	Engine Coolant Temperature open/short to +batt
	Engine Coolant Temperature short to ground
28	Throttle Position calibration required
32	Throttle Position signal abnormal
34	Speed/Timing Sensor Loss of Signal
	Speed/Timing Sensor Mechanical Failure
	Loss of Secondary Engine Speed Signal
	Secondary Engine Speed Sensor Mechanical Failure
37	Fuel Pressure open/short to +batt
	Fuel Pressure short to ground
38	Intake Manifold Air Temp open/short to +batt
	Intake Manifold Air Temp short to ground

FLASH CODE	DIAGNOSTIC FLASH CODES DESCRIPTION
42	Engine timing calibration required
51	System Voltage intermittent/erratic
53	Electronic Control Module Error
56	Personality Module mismatch
	Check Programmable Parameters
58	J1939 Data Link communications
72	Injector Cylinder #1 fault
	Injector Cylinder #2 fault
73	Injector Cylinder #3 fault
	Injector Cylinder #4 fault
74	Injector Cylinder #5 fault
	Injector Cylinder #6 fault

GENERAL INFORMATION

Event codes refer to engine operating conditions such as low oil pressure or high coolant temperature. Logged events usually indicate a mechanical problem instead of an electronic system problem.

EVENT CODE DESCRIPTION
Engine Overspeed Shutdown
Fuel Filter Restriction Derate
Fuel Filter restriction Shutdown
High Engine Coolant Temperature Derate
High Engine Coolant Temperature Shutdown
High Engine Coolant Temperature Warning
High Inlet Air Temperature Derate
High Inlet Air Temperature Warning
Low Engine Oil Pressure Derate
Low Engine Oil Pressure Shutdown
High Fuel Temperature Derate
High Fuel Temperature Shutdown
High Fuel Temperature Warning
Low Engine Coolant Level Derate
Low Engine Coolant Level Shutdown
Low Engine Coolant Level Warning
Fuel Filter Restriction Warning
High Fuel Pressure
Low Engine Oil Pressure Warning
Engine Overspeed Warning

ALERT/SHUTDOWN CONDITIONS VERSION SOFTWARE V1.01	Al	LERT	SHUTDOWN			
	CODE	LIGHT	CODE	LIGHT	DELAY (sec)	
Low Engine Speed (RPM <800)			1	CPRSR Malf.	30	
High Engine Speed (RPM >1900)			2	CPRSR Malf.	30	
Engine Crank Time Exceeded			3	CPRSR Malf.	0	
Low Fuel Level		Fuel Level (blinks)	4	Fuel Level (steady)	0	
High Discharge Temp. (RT2>247 deg. F)			30	CPRSR Malf., High Comp Temp.	3	
Low AE Oil Pressure (HP1600 only)			31	CPRSR Malf.	3	
Disch. Temp (RT2) Sensor Fault			32	CPRSR Malf.	10	
High Separator Tank Temp (RT1>247 deg.F)			50	CPRSR Malf., High Comp Temp	3	
Machine ID Not Valid			51	CPRSR Malf.	0	
IQ Filter Restriction			52	CPRSR Malf IQ Filt. Rest	0	
Sep. Tank Temp (RT1) Sensor Fault			53	CPRSR Malf.	10	
Sep. Tank Pressure (RT1) Sensor Fault	33	CPRSR Malf.				
Reg. System Pressure PT2) Sensor Fault	54	CPRSR Malf.				
Air Filter Restriction		Soiled Filter				
Low Battery Voltage		Battery Charging Condition				
Serial Comm. Problem	70	CPRSR Malf.				

ALERT/SHUTDOWN CONDITIONS Version 1.30	ALERT		SHUTDOWN			
	CODE	LIGHT (Blinks)	CODE	LIGHT (Steady)	DELAY (sec)	Appli- cation
Engine Speed <800 rpm			1	CPRSR Malf.	30	
Engine Speed >1900 rpm			2	CPRSR Malf.	30	
Engine Crank Time Exceeded			3	CPRSR Malf.	0	
Engine Oil Temperature > 252 deg. F	5	CPRSR Malf.				CU
Intake Manifold Temperature > 180 deg. F	6	CPRSR Malf.				
Water in Fuel	8	CPRSR Malf.				CU
Engine Not Responding to Throttle Command	10	CPRSR Malf.				
Low AE Oil Pressure (HP1600 only)			31	CPRSR Malf., High Comp Temp	20	
Disch. Temp (RT2) Sensor Fault			32	CPRSR Malf.	10	
Sep. Tank Pressure (PT1) Sensor Fault	33	CPRSR Malf.				
Sep. Tank Pressure >20 PSI During Startup Attemt (Engine will not crank)			34	CPRSR Malf.	0	
Machine Over Pressure			35	CPRSR Malf.	1	
Safety Valve Open			36	CPRSR Malf.	2	
Sep. Tank Temp > 247 deg. F			50	CPRSR Malf.	3	
Machine ID Not Valid			51	CPRSR Malf.	0	
Sep. Tank Temp (RT1) Sensor Fault			53	CPRSR Malf.	10	
Reg. System Pressure (PT2) Sensor Fault	54	CPRSR Malf.				
Estop Button Pushed	55	CPRSR Malf.	55	CPRSR Malf.	3	
Serial Comm. Problem	70	CPRSR Malf.				
CAN Bus Problem	71	CPRSR Malf.				
Dedicated Lights:						
Low Fuel Level		Fuel Level		Fuel level	3	
Air Filter Restriction		Soiled Filter				
Low Battery Voltage		Battery Charging Condition				
Engine Oil Pressure < 18 PSI		Low Engine Oil Pressure				
Low Coolant Level		Engine Coolant Level			CU	
Engine Coolant Temperature >= 215 deg. F		High Engine Temp.				
Engine Coolant Temperature > = 220 deg F				High Engine Temp.	10	
IQ Filter Restriction				IQ Filt. Rest	3	
High Discharge Temp. (RT2 > 247 deg. F)				High Comp. Temp.	3	
CAN Derived Data =		Application: CU = Cummins only				

VERSION 1.30

Display Number	Parameter	Remarks
2	RPM	Input from VR pickup
3	Engine RPM	Filtered RPM value
4	Reg. Sys. Pressure	PSI
5	Sep. Tank Pressure	PSI
6	Discharge Temperature	Degree F
7	Sep. Tank Temperature	Degree F
8	Target RPM	Commanded Throttle Position
9	Machine Type	*
CAN Derived Data:	•	•
10	Engine Coolant Temp.	Degree F
11	Engine Oil Temp. (Cummins)	Degree F
12	Engine Fuel Pressure (Caterpillar)	PSI
13	Engine Oil Pressure	PSI
14	Intake Manifold Temp.	Degree F
15	RPM	
	Fault Code List	

* Machine Types:

0 = Viking HP CU

1 = Viking XHP CU

2 = EMU LP CAT

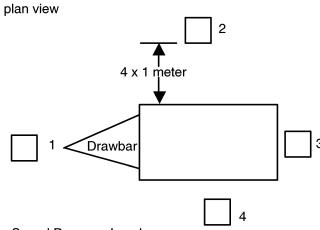
3 = EMU HP CAT

4 = Viking XHP CAT

5 = EMU LP CU

6= EMU HP CU

 $\label{eq:microphone} \mbox{Microphone positions: 1.60 meters above ground level,}$



Sound Pressure Levels

 $dB(A) \text{ re } 2 \times 10^{-5} \text{ N/m } 2$

Position	Level
1	84
2	84
3	84
4	83



TROUBLE SHOOTING CHART

Bold Headings depict the COMPLAINT - Subheadings suggest the CAUSE

Note: Subheadings suggest sequence to follow troubleshooting.

1 <u>Unit Shutdown:</u>

Out of Fuel

Compressor Oil Temp. Too High Engine Water Temp. Too High Engine Oil Pressure Too Low Broken Engine Fan Belt Loose Wire Connection Low Fuel Level Shutdown Defective Sensor

Malfunctioning Relay

Blown Fuse

Engine Malfunctioning
* Airend Malfunctioning

Corrective Action

Add CLEAN diesel Fuel

See Complaint 10

Check coolant level. If necessary, Add.

See Complaint 3 and Complaint 4.

Replace fan belt.

Wiggle wires at switches & connector blocks. Make repairs.

Replace fuel sender. Replace sensor. Replace relay.

Replace fuse.

See Trouble Shooting in Engine Manual.

See Complaint 10.

2. Won't Start/Run:

Low Battery Voltage

Blown Fuse

Malfunctioning Start Switch

Clogged Fuel Filters

Out of Fuel

Compressor Oil Temp. Too High Engine Water Temp. Too High Engine Oil Pressure Too Low Loose Wire Connection Defective Sensor

Malfunctioning Relay Engine Malfunctioning Airend Malfunctioning Check electrolyte level. Check connections.

Replace fuse. Replace switch.

Service filters. See Engine Operator's Manual.

Add CLEAN fuel. See Complaint 10.

Check fluid level. If necessary, Add. See Complaint 3 and Complaint 4. Repair or replace connection.

Replace sensor. Replace relay.

See Trouble Shooting in Engine Manual.

See Complaint 10.

3. High Engine Temperature

Broken Engine Fan Belt

- * Ambient Temp. >115°F
 Dirty Operating Conditions
 Dirty Cooler
- * Out of Level >15 degrees
 Operating Pressure Too High
 Recirculation of Cooling Air
 Loose Wire Connection

Replace fan belt set.

Above spec limit.

Move unit to cleaner environment.

Clean exterior of cooler.

Relocate or reposition uni

Relocate or reposition unit. Reduce pressure to spec.

Close side doors.

Repair or replace.

* : > = greater than, < = less than

4. Low Engine Oil Pressure

Low Oil Level Out of Level >15 degrees Wrong Lube Oil Clogged Oil Filter Element(s) **Engine Malfunctioning** Loose Wire Connection.

5. **Alternator Low Voltage**

Loose or Broken Belts **Loose Wire Connection** Low Battery Voltage

Malfunctioning Alternator

6. **High Compressor Discharge Temperature:**

Airend Malfunctioning

Ambient Temp. > 115°F Out of Level > 15 degrees Low Oil Level Wrong Lube Oil Dirty Cooler **Dirty Operating Conditions** Clogged Oil Filter Elements Loose or Broken Belts Operating Pressure Too High Recirculation Of Cooling Air Malfunctioning Thermostat Malfunctioning Fan Defective Oil Cooler Relief Valve Defective Minimum Pressure Valve Blocked or Restricted Oil Lines

7. **Engine RPM Down:**

Clogged Fuel Filter (primary)

Operating Pressure Too High Dirty Air Filter Wrong Air Filter Element **Engine Malfunctioning** Airend Malfunctioning

Corrective Action

Add oil. Relocate or reposition. See Engine Oil Spec. Change oil. Replace element(s). See Trouble Shooting in Engine Manual. Repair or replace.

Tighten or replace belt set. Repair or replace connection. Check electrolyte level. Add if necessary. Check connectors. Clean & tighten. Recharge battery. Repair or replace alternator.

Corrective Action

Above spec limit. Relocate or reposition unit. Add oil. Look for any leaks. Check spec in this manual. Clean exterior surfaces. Move unit to cleaner environment. Replace elements. Change oil. Tighten or replace belt set. Reduce pressure to spec. Close side doors. Replace belly pan. Replace thermostat in bypass valve. Check fan belt tension. Tighten or replace belt set. Replace valve. Repair or replace valve. Clean by flushing or replace. See Complaint 11, 12

Replace primary filter. Replace final filter. Drain tanks. Add CLEAN fuel.

Reduce pressure to spec limit. Clean or replace elements. Install correct element. See Trouble Shooting in Engine Manual. Refer to Factory.

8. Excessive Vibration:

Rubber Mounts, Loose or Damaged Defective Fan Drive Coupling Defective Engine Malfunctioning Airend Malfunctioning Engine idle speed too low.

Corrective Action

Tighten or replace.
Replace fan.
Replace coupling.
See Trouble Shooting in Engine Manual.
See Complaint 11 and 12.
See Engine Manual.

9. Low CFM:

Dirty Air Filter Incorrect Linkage Adjustment Malfunctioning Inlet Unloader/Butterfly Valve

Wrong Air Filter Element

Clean or replace elements.

Make adjustment per Section 4.

Inspect valve. Make adjustment per Section 4.

Install correct element.

10. Short Air Cleaner Life:

Dirty Operating Conditions Inadequate Element Cleaning Incorrect Stopping Procedure Wrong Air Filter Element

Move unit to cleaner environment. Install new element. Read procedure in this manual. Install proper element.

11. Will Not Unload:

Malfunctioning Inlet Butterfly Valve Ice in Regulation Lines/Orifice Load Solenoid Leak Plugged Vent Leak Inspect valve fit. Re-adjust per Section 4. Apply heat to line(s) and or orifice. Replace load solenoid. Clean and/or replace.

12. Safety Valve Relieves:

Operating Pressure Too High Malfunctioning Inlet Unloader/Butterfly Valve Defective Safety Valve Unit Will Not Unload Fast Enough Reduce pressure to spec limit. Inspect valve fit. Readjust per Section 4. Replace safety valve. Apply heat to lines and/or orifice.

SECTION 8 - ELECTRICAL

WEDGE Controller

The WEDGE controller is the heart of the machine monitor and control system. It provides data collection, alarming and control functions for compressor operations. It is a microcontroller based unit with analog and digital inputs and outputs.

The WEDGE controller is attached to the back of the control panel. The LED annunciators are part of the front panel of the WEDGE. They can be seen through the laminate on the front of the control panel. The WEDGE is attached to the control panel with four #10 size nuts.

The first function of the WEDGE is to scan all analog and digital inputs at a fixed interval. These inputs are scanned every 100 milliseconds. The analog values are then compared against minimum and maximum values and an ALERT or SHUTDOWN is issued, if a value is out of range. The various ALERTS and SHUTDOWNS are listed in section 7 of this manual.

The second function of the WEDGE controller is machine discharge pressure control. The WEDGE monitors the regulation system air pressure and varies the engine throttle to maintain the setpoint pressure. The setpoint pressure is set using the regulator on the separator tank.

The third function of the WEDGE controller is to communicate with the diesel engine via the J1939 CAN network. The WEDGE provides the engine throttle setpoint (software versions 2.0 and greater) to the engine controller via the J1939 CAN Network and retrieves diagnostic information from the engine.

Software versions under 2.0 use the frequency throttle to communicate with the engine. A square wave frequency signal from 150 Hz to 375 Hz is sent from the WEDGE controller to the engine controller. The signal is linear from 150 Hz at engine idle (1200 RPM) to 375 Hz at maximum run speed (1800 RPM). The software version with frequency throttle does not support engine diagnostics.

Figure 8-2 shows the signals between the engine ECM and the WEDGE ECM.

Sensors and Transducers

The electronics system contains sensors and transducers that are used to collect process data from the compressor. The temperature sensors are thermistor devices. A change in temperature causes a resistance change in the thermistor. This resistance change

causes an input voltage change to the WEDGE controller input and is interpreted as a temperature change.

The electronics system also contains pressure transducers to measure process pressure changes. These devices have an output signal of .45 VDC to 4.5 VDC, corresponding to 0 psi and the maximum psi for a selected device. The maximum psi can be 100, 225, or 500 psi. A 5 VDC excitation signal is provided to power the transducers. These are three wire devices: excitation, signal and ground (return) connections.

Controller Outputs:

The WEDGE controller has three different types of outputs: frequency, pulse width modulated (PWM) and 24 VDC digital (ON / OFF). The frequency out is used as a throttle signal for the engine (software versions less than 2.0). The frequency signal is a 50% duty cycle square wave at 24 VDC, and varies from 150 Hz to 375 Hz.

The PWM signal is also used for engine throttle applications. It provides a duty cycle from 10% to 90%, corresponding to 1200 to 1800 RPM engine speeds. Refer to the system diagrams to determine which signal may be used.

The WEDGE controller provides 24 VDC digital outputs to control solenoids, DC heaters, etc. These are 24 VDC ON and 0 VDC OFF. They are current limited and short circuit protected. They may have a voltage level of .5 VDC to 1.4 VDC in the OFF state due to current leakage of the darlington transistors in the output drivers.

Pressure Control

The discharge pressure is controlled by manipulating the engine speed and compressor inlet valve position. The inlet valve position is controlled pneumatically and the engine speed setpoint is determined by the WEDGE controller. The WEDGE measures the pneumatic system regulation pressure and computes an engine speed setpoint. It sends this setpoint to the electronically controlled engine, which controls engine speed to this setpoint.

Electronic Engine

The Viking machine family contains an emissions certified diesel engine. In order to meet the emissions requirements, the engine has an electronic control system.

The control system handles all the monitor, alarm and control functions for the engine. The WEDGE controller communicates with the engine controller over the J1939 CAN network.

The WEDGE controller sends throttle setpoints to the engine (software versions 2.0 and greater) and receives diagnostic and run time data from the engine over the J1939 CAN network. A frequency throttle interface with the engine is used for software versions earlier than 2.0. Figure 8–2 shows the connections between the engine and WEDGE controller.

J1939 Data Link - The CAN network is a single pair shielded cable within the W1 main harness. Figure 8-3 shows a layout of the CAN harness or backbone as it is referred to. The termination resistors (Terminator) are important to prevent reflections on the transmission line and must be in place for the network to function properly. The shield from the cable is connected to the machine frame at the WEDGE controller end. It is very important that this shield be connected and the connection be properly made to the frame.

The engine diagnostics connector is located on the left side of the engine at the engine ECM. This is used to connect the engine manufacturer s service tools to the CAN network. This connector also provides 24 VDC power to these service tools.

There are two other CAN network nodes in the harness. One is for the Autostart option and the other one is for future devices. Figure 8-3 shows these nodes.

Electrical System

The electrical system consists of the wiring harnesses and associated electrical devices such as relays, switches, lights, solenoids and alarm horns.

The electrical system consists of the wiring harnesses and associated electrical devices such as relays, switches, lights, solenoids and alarm horn. There are two wiring harnesses in the Viking family of machines. They are as follows:

54654918 W1 Chassis Main Wiring Harness

22108690 Control Panel Harness w/individual gages.

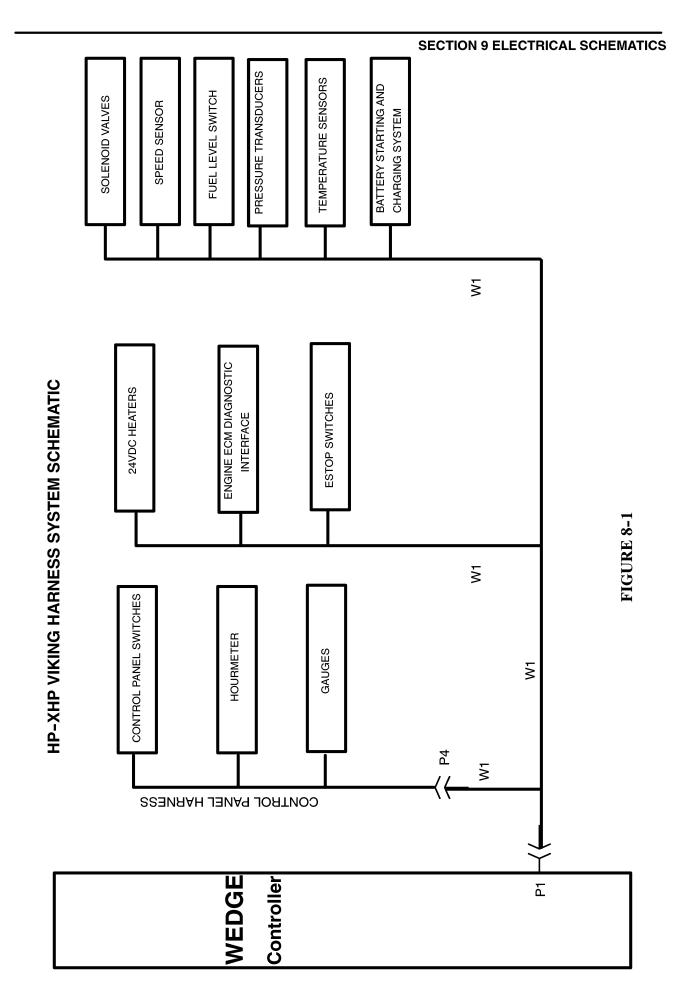
22060594 Control Panel Harness w/ 4 in one gages.

The schematic diagrams show the connections for these harnesses. Figure 8-1 is a system diagram showing harness connection with devices and controllers. The troubleshooting section includes information on how to make harness repairs and information on the connectors used. The control panel harness is purchased with the entire control panel assembly. It is not sold separaterly.

The electrical circuits are protected using ATC style fuses. A fuse should only be replaced with one of the same rating. Replacing a fuse with one of a larger rating could lead to harness damage. If a fault occurs and the circuit does not have the appropriate size fuse, wires could be burned in the harness and damage other circuits.

When battery power is connected to the WEDGE by engaging the main power switch on the unit control panel, it goes thru a start up sequence including a test of all lamps.

All diagnostic lamps and segments of the numeric display should be illuminated simultaneously during the lamp test portion of WEDGE start up.



WEDGE TO ENGINE INTERFACE CATERPILLAR ENGINE

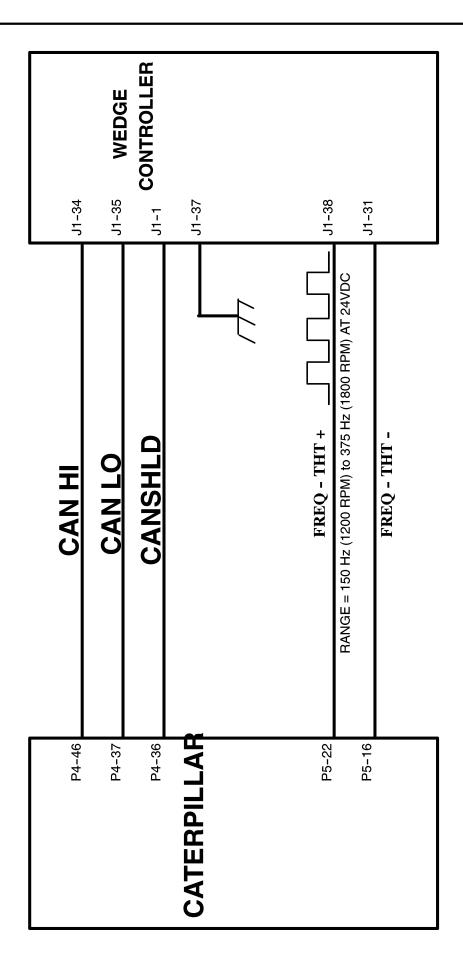


FIGURE 8-2

ENGINE DIAGNOSTICS JACK CONTROLLER WEDGE Ь7 P31 **AUTO START OPTION TERMINATOR** 8 R5 **CAN NODE WITH POWER TERMINATOR R**4 FIGURE 8-3 P15 P6 **ENGINE ECM**

HP-XHP VIKING J1939 CAN COMMUNICATIONS SCHEMATIC

SECTION 10 - PARTS ORDERING

GENERAL

This publication, which contains an illustrated parts breakdown, has been prepared as an aid in locating those parts which may be required in the maintenance of the unit. All of the compressor parts, listed in the parts breakdown, are manufactured with the same precision as the original equipment. For the greatest protection always insist on genuine Ingersoll-Rand Company parts for your compressor.

NOTICE

Ingersoll-Rand Company can bear no responsibility for injury or damages resulting directly from the use of non-approved repair parts.

Ingersoll-Rand Company service facilities and parts are available worldwide. There are Ingersoll- Rand Company Construction Equipment Group Sales Offices and authorized distributors located in the principal cities of the United States. In Canada our customers are serviced by the Canadian Ingersoll-Rand Company, Limited. There are also Ingersoll-Rand International autonomous companies and authorized distributors located in the principal cities throughout the free world.

Special order parts may not be included in this manual. Contact the Mocksville Parts Department with the unit serial number for assistance with these special parts.

DESCRIPTION

The illustrated parts breakdown illustrates and lists the various assemblies, subassemblies and detailed parts which make up this particular machine. This covers the standard models and the more popular options that are available.

A series of illustrations show each part distinctly and in

location relative to the other parts in the assembly. The part number, the description of the part and the quantity of parts required are shown on each illustration or on adjacent page. The quantities specified are the number of parts used per one assembly and are not necessarily the total number of parts used in the machine. Where no quantity is specified the quantity is assumed to be one.

Each description of a part is based upon the "noun first" method, i.e., the identifying noun or item name is always the first part of the description. The noun name is generally followed by a single descriptive modifier. The descriptive modifier may be followed by words or abbreviations such as upper, lower, inner, outer, front, rear, RH, LH, etc. when they are essential.

In referring to the rear, the front or to either side of the unit, always consider the **drawbar end** of the unit as the **front.** Standing at the rear of the unit facing the drawbar (front) will determine the right and left sides.

FASTENERS

Both SAE/inch, ISO/metric hardware have been used in the design and assembly of these units. In the disassembly and reassembly of parts, extreme care must be taken to avoid damaging threads by the use of wrong fasteners. In order to clarify the proper usage and for exact replacement parts, all standard fasteners have been identified by part number, size and description. This will enable a customer to obtain fasteners locally rather than ordering from the factory. These parts are identified in tables that will be found at the rear of the parts illustrations. Any fastener that has not been identified by both part number and size is a specially engineered part that must be ordered by part number to obtain the exact replacement part.

MARKINGS AND DECALS

NOTICE

Do not paint over safety warnings or instructional decals. If safety warning decals become illegible, immediately order replacements from the factory.

Part numbers for original individual decals and their mounting locations are shown within Parts List Section. These are available as long as a particular model is in production.

Afterwards, service sets of exterior decals and current production safety warning decals are available. Contact the Product Support Group at Mocksville for your particular needs and availability.

HOW TO USE PARTS LIST

- Locate the area or system of the compressor in which the desired part is used and find illustration page number.
- Locate the desired part on the illustration by visual identification and make note of part number and description.

HOW TO ORDER

The satisfactory ordering of parts by a purchaser is greatly dependent upon the proper use of all available information. By supplying your nearest sales office, autonomous company or authorized distributor, with complete information, you will enable them to fill your order correctly and to avoid any unnecessary delays.

In order that all avoidable errors may be eliminated, the following instructions are offered as a guide to the purchaser when ordering replacement parts:

- Always specify the model number of the unit as shown on the general data decal attached to the unit.
- b. Always specify the serial number of the unit. THIS IS IMPORTANT. The serial number of the unit will be found stamped on a plate attached to the unit. (The serial number on the unit is also permanently stamped in the metal of the frame side rail.)

- c. Always specify the number of the parts list publication.
- d. Always specify the quantity of parts required.
- e. Always specify the part number, as well as the description of the part, or parts, exactly as it is given on the parts list illustration.

In the event parts are being returned to your nearest sales office, autonomous company or authorized distributor, for inspection or repair, it is important to include the serial number of the unit from which the parts were removed.

TERMS AND CONDITIONS ON PARTS ORDERS

Acceptance: Acceptance of an offer is expressly limited to the exact terms contained herein. If purchaser's order form is used for acceptance of an offer, it is expressly understood and agreed that the terms and conditions of such order form shall not apply unless expressly agreed to by Ingersoll-Rand Company ("Company") in writing. No additional or contrary terms will be binding upon the Company unless expressly agreed to in writing.

Taxes: Any tax or other governmental charge now or hereafter levied upon the production, sale, use or shipment of material and equipment ordered or sold is not included in the Company's price and will be charged to and paid for by the Purchaser.

Shipping dates shall be extended for delays due to acts of God, acts of Purchaser, acts of Government, fires, floods, strikes, riot, war, embargo, transportation shortages, delay or default on the part of the Company's vendors, or any other cause beyond the Company's reasonable control.

Should Purchaser request special shipping instruction, such as exclusive use of shipping facilities, including air freight when common carrier has been quoted and before change order to purchase order can be received by the Company, the additional charges will be honored by the Purchaser.

Warranty: The Company warrants that parts manufactured by it will be as specified and will be free from defects in materials and workmanship. The Company's liability under this warranty shall be limited to the repair or replacement of any part which was defective at the time of shipment provided Purchaser notifies the Company of any such defect promptly upon discovery, but in no event later than three (3) months from the date of shipment of such part by the Company. The only exception to the previous statement is the extended warranty as it applies to the special airend exchange program.

Repairs and replacements shall be made by the Company F.O.B. point of shipment. The Company shall not be responsible for costs of transportation, removal or installation.

Warranties applicable to material and equipment supplied by the Company but wholly manufactured by others shall be limited to the warranties extended to the Company by the manufacturer which are able to be conveyed to the Purchaser.

Delivery: Shipping dates are approximate. The Company will use best efforts to ship by the dates specified; however, the Company shall not be liable for any delay or failure in the estimated delivery or shipment of material and equipment or for any damages suffered by reason thereof.

The company makes no other warranty or representation of any kind whatsoever, expressed or implied, except that of title, and all implied warranties, including any warranty of merchantability and fitness for a particular purpose, are hereby disclaimed.

Limitation of Liability:

The remedies of the Purchaser set forth herein are exclusive, and the total liability of the Company with respect to this order whether based on contract, warranty, negligence, indemnity, strict liability or otherwise, shall not exceed the purchase price of the part upon which such liability is based. The Company shall in no event be liable to the Purchaser, any successors in interest or any beneficiary of this order for any conse-

quential, incidental, indirect, special or punitive damages arising out of this order or any breach thereof, or any defect in, or failure of, or malfunction of the parts hereunder, whether based upon loss of use, lost profits or revenue, interest, lost goodwill, work stoppage, impairment of other goods, loss by reason of shutdown or non- operation, increased expenses of operation or claims of customers of Purchaser for service interruption whether or not such loss or damage is based on contract, warranty, negligence, indemnity, strict liability or otherwise.

AIREND EXCHANGE PROGRAM

Your Ingersoll-Rand Company Construction Equipment Group Sales Offices and authorized distributors as well as Ingersoll-Rand International autonomous companies and authorized distributors now

have an airend exchange program to benefit portable compressor users.

On the airend exchange program the exchange price is determined by the age and condition of the airend and may be classified by one of the following categories.

Category "A": The airend must not be over two years old and must have reusable rotor housing(s) and rotor(s).

Category "B": The airend must be between two and five years old and returned with two or more reusable major castings.

Category "C": The airend must be over five years old. Your nearest sales office, autonomous company or authorized distributor must first contact the Parts Service Department at the factory at which your portable air compressor was manufactured for an airend exchange number. The airend must be tagged with this preassigned number and returned to the factory prepaid. The airend must be intact, with no excluded parts, otherwise the exchange agreement may be cancelled. The warranty on an exchange or factory rebuilt airend is 365 days.

Airends being returned to the factory in connection with a WARRANTY CLAIM must be processed through the Customer Service Department. If returned without a Warranty MRR (Material Return Request) Number, no warranty claim will be considered.

ELECTRICAL COMPONENTS

I-R Part Number	Quantity per Mach	Description
54757224	1	IQ Wiring Harness
22102339	1	Coolant Level Switch
36896975	1	Battery Disconnect Switch
54765946	1	0-500 psi Pressure Transducer
36920825	1	0-100 psi Pressure Transducer
36892362	1	24V Sealed Relay
36870665	1	Mag Speed Sensor
36898922	2	Thermistor Temperature Probe
36842300	1	Start/Run Solenoid Valve
36842318	1	Compressor Solenoid Valve
36847838	2	Air Filter Switch
36870608	1	Engine Oil Pressure Sender
36841138	2	Eng & Comp Temp Sender
36850691	1	Startup Compressor
35577873	1	Auxilary Start Relay
54720701	1	Eng Temp Sender Adaptor
36841526	3	Control Heater
54765367	1	Negative Battery Cable
54765375	1	Positive Battery Cable
54765383	1	Positive Jumper Battery Cable
35128982	1	Battery Jumper
35578194	1	Frame Ground Strap
35293075	1	Engine Ground Strap
54688411	1	WEDGE Controller
22101893	1	W1 Chassis Harness
22101919	1	Machine ID Plug
36899599	1	IQ Filter Switch
36899615	1	IQ Filter Switch
54775887	1	IQ Heater Harness
36792083	2	20 AMP ATC Fuse
22071591	2	10 AMP ATC Fuse
	_	

SERVICE TOOLS

Electronic Systems

The following special tools are recommended to perform service procedures in this manual. The tools can be purchased from Ingersoll Rand or equivalent substitutes can be used.

Tool	Tool Description
Fluke 87	Digital Multimeter Used to Measure electrical circuits: volts, ohms amps
54729660	Weather-Pack Terminal Removal Tool Used to repair Packard Electric Weather-Pack Connectors
54729678	Deutsch Terminal Removal Tool (Blue) Used to repair Deutsch connectors
54729686	Deutsch Terminal Removal Tool (Red) Used to repair Deutsch connectors
54729694	Deutsch Terminal Removal Tool (Yellow) Used to repair Deutsch connectors
HDT-48-00	Deutsch Terminal Crimp Tool Used to crimp Deutsch connector terminals
DD	Deutsch Terminal Crimping Tool Used to crimp Deutsch connector terminals
54729710	Electrical Contact Cleaner Used to clean electrical contacts and connectors
54729728	PDA Service Tool Palm Pilot based service tool used to connect to Intellisys (SGP) Controller to load software and extract service information
22073886	Packard Crimp Tool Used to crimp Packard connector terminals
22073878	Thermistor Simulator Plug Used to test thermister circuits
54699616	Deutsch Terminal Removal Tool Used to repair Deutsch connectors
54699657	Deutsch Terminal Removal Tool Used to repair Deutsch connectors
54749643	Packard Metri-Pack Terminal Removal Tool Used to repair Metri-Pack connectors
54749635	Connector Repair Kit Used to make connector repairs

SERVICE TOOLS

Tool No. Tool Description Tool Illustration

Fluke 87	Digital Multimeter Available from electrical and electronic parts distributors.	
54729660	Weather-Pack Terminal Removal Tool	
54699632	Deutsch Terminal Removal Tool (Blue)	
54699640	Deutsch Terminal Removal Tool (Red)	
54699624	Deutsch Terminal Removal Tool (Yellow)	
DT-RT1	Crimp Tool for Deutsch Pins Crimp Available from: Ladd Industries (800-223-1236)	

54729710	Electrical Contact Cleaner	
54729728	PDA Service Tool	
54699616	Deutsch Terminal Removal Tool	
22073886	Packard Crimp Tool	
22073878	Thermistor Simulator	
54749635	Connector Repair Kit	

Metri-Pack Removal Tool	
	I Metri-Pack Removal Tool

INDEX

FRAME ASSEMBLY (FAST TRACK)

FRAME ASSEMBLY (WAGON WHEEL)

RUNNING GEAR ASSEMBLY (FAST TRACK)

RUNNING GEAR ASSEMBLY (WAGON WHEEL)

ENGINE ASSEMBLY

EXHAUST COMPLETE

AIR END COMPLETE

AIR END ASSEMBLY

UNLOADER ASSEMBLY

STARTING AID ASSEMBLY

RADIATOR AND PIPING ASSEMBLY

FUEL TANK ASSEMBLY

AIR INTAKE ASSEMBLY

SEPARATOR TANK ASSEMBLY

AIR END PIPING

AIR PIPING

OIL PIPING

MINIMUM PRESSURE / CHECK VALVE

INSTRUMENT / CONTROL PANEL

BATTERY AND MOUNTING

ENCLOSURE ASSEMBLY

ACOUSTIC ASSEMBLY

WIRING DIAGRAM

PARKING BRAKE ASSEMBLY

SEPARATOR AIR PIPING

AIR CHARGE PIPING

IQ AIR PIPING

IQ COOLER PIPING

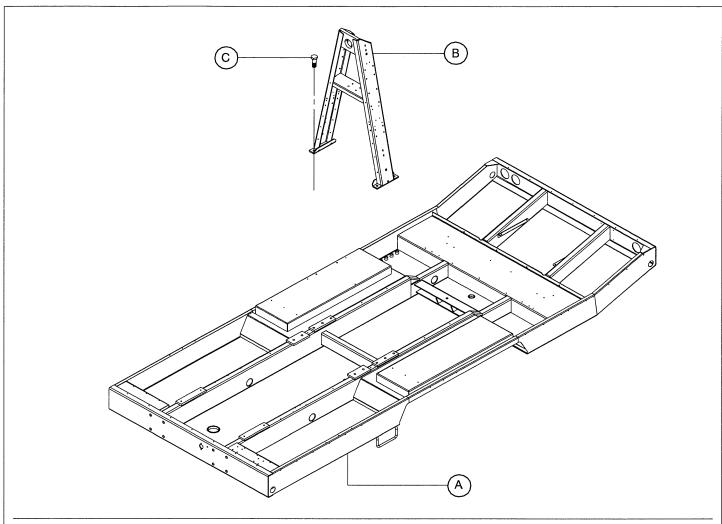
IQ FILTER PIPING

IQ INDICATOR PIPING

CENTRAL DRAIN PIPING

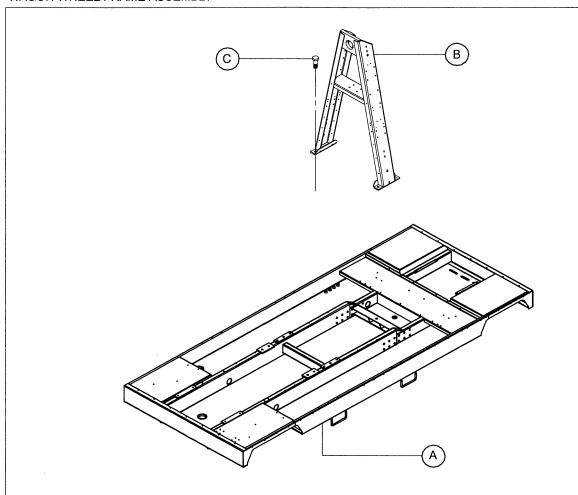
DECAL LOCATION

RECOMENDED SPARE PARTS LIST



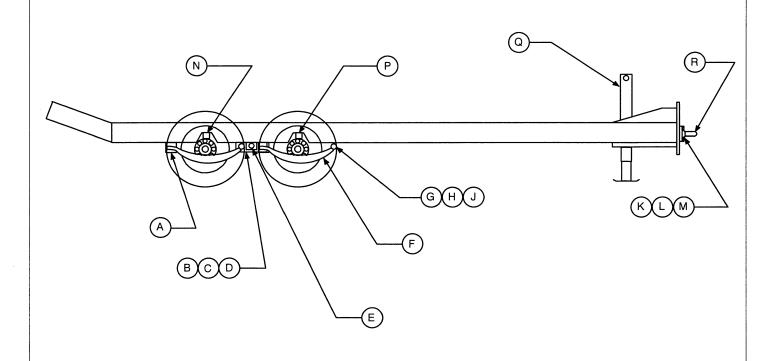
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	54760202	1	FRAME ASSEMBLY				
В	54542543	1	BAIL , LIFTING				
С	96720610	4	SCREW				

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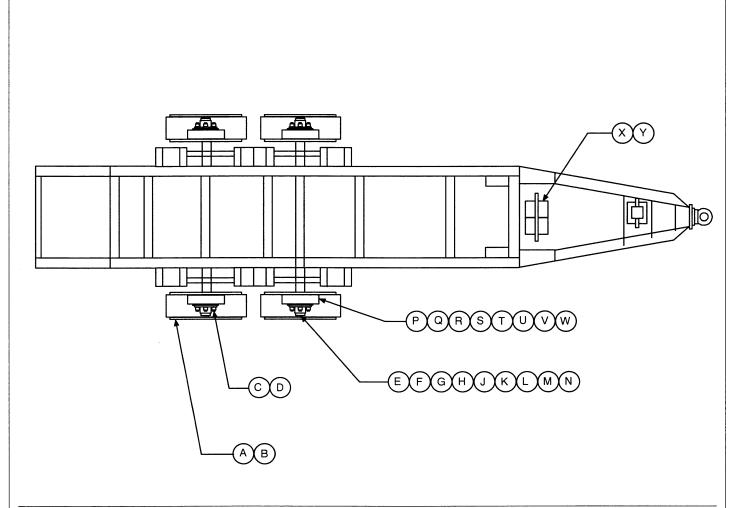
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54501796	1	FRAME ASSEMBLY				
В	54542543	1	BAIL , LIFTING				
С	96720610	4	SCREW				

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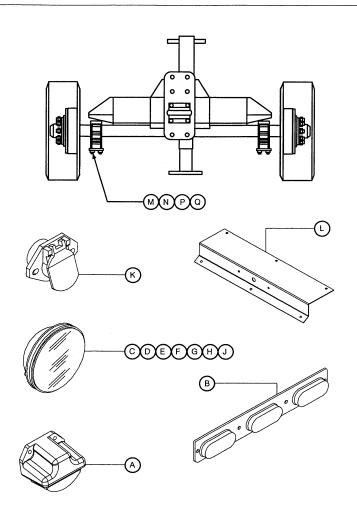


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36880235	2	HANGER , REAR				
В	36880219	2	BAR, EQUALIZER				
С	36880243	2	BOLT, EQUALIZER				
D	36880250	2	LOCKNUT				
E	36880193	2	HANGER, CENTER				
F	36880284	4	SPRING , LEAF				
G	36880201	2	HANGER, FRONT				
Н	36880227	8	BOLT, SHACKLE				
J	35336700	8	LOCKNUT				
K	36880136	4	BOLT				
L	95935011	4	WASHER				
М	95077608	4	LOCKNUT				
N	35144336	8	SCREW				
Р	36880151	4	BUMPER , RUBBER				
Q	36880144	1	JACK , DROPLEG				
R	36880128	1	EYE , PINTLE				

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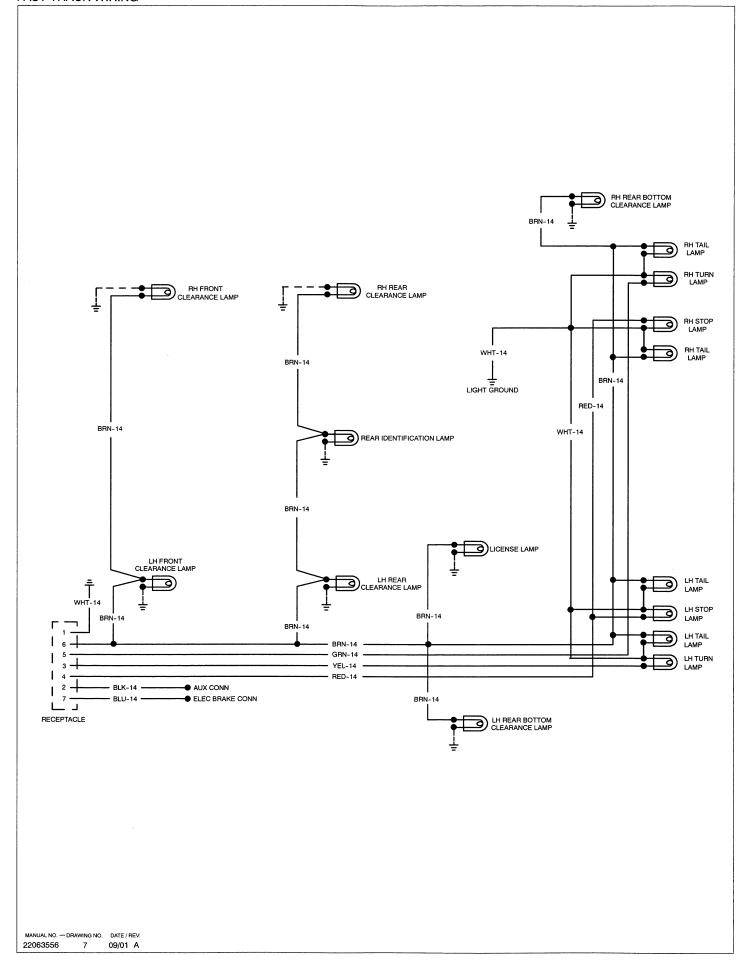


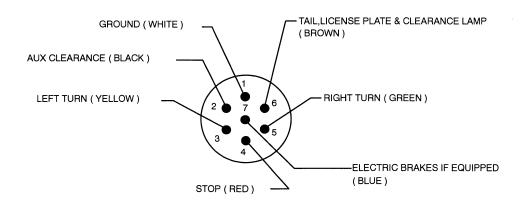
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36877991	4	TIRE				
В	22077515	4	WHEEL				
	36878049	4	CLAMP , PLATE				
С	35272150	8	STUD				
D	22079032	8	NUT				
Ε	36853091	4	NUT				
F	36853109	2	WASHER				
G	36853117	2	WASHER, LOCK				
Н	36851624	1	INNER BEARING CUP				
J	36851616	1	OUTER BEARING CUP				
K	36851608	1	INNER BEARING				
L	36851590	1	OUTER BEARING				
М	36851632	1	SEAL				
N	36776813	8	CAP , DUST				
P	36880268	4	HUB ASSEMBLY				
Q	36880292	2	L.H. ELECTRIC BRAKE				
R	36880300	2	R.H. ELECTRIC BRAKE				
S	36880318	4	SHIELD , BOTTOM DUST				
Т	36880326	4	SHIELD , TOP DUST				
U	36880334	. 7	BOLT				
V	95939955	7	WASHER , LOCK				
W	36880342	7	LOCKNUT				
X	35603190	2	CHOCK, WHEEL				
Υ	35333830	2	STRAP , RUBBER				
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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	36895860	1	LIGHT , LICENSE PLATE				
В	36922144	1	3 LIGHT ASSEMBLY				
С	36788081	2	STOP , TURN AND TAIL LIGHT				
D	36787968	6	GROMMET (USE ON ITEM C & E)				
E	36859320	4	STOP , TURN AND TAIL LIGHT				
F	35367051	4	YELLOW LIGHT				
G	36893642	2	GROMMET (USE ON ITEM F)				
Н	36893634	2	GROMMET (USE ON ITEM F)				
J	35367044	4	RED CLEARANCE LIGHT				
K	36894129	1	7-WAY CONNECTOR				
L	36896306	1	ID BRACKET				
М	36880169	2	PLATE , U-BOLT				
N	36880177	4	U-BOLT				
Р	36880185	8	NUT				
Q	95934741	8	WASHER, LOCK				

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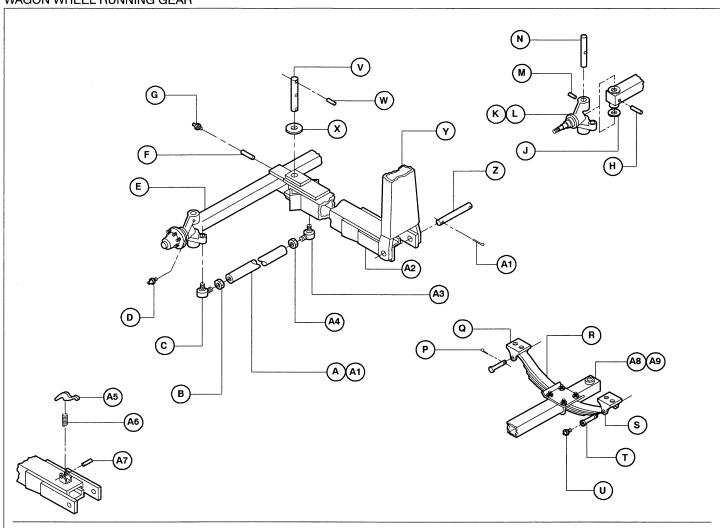




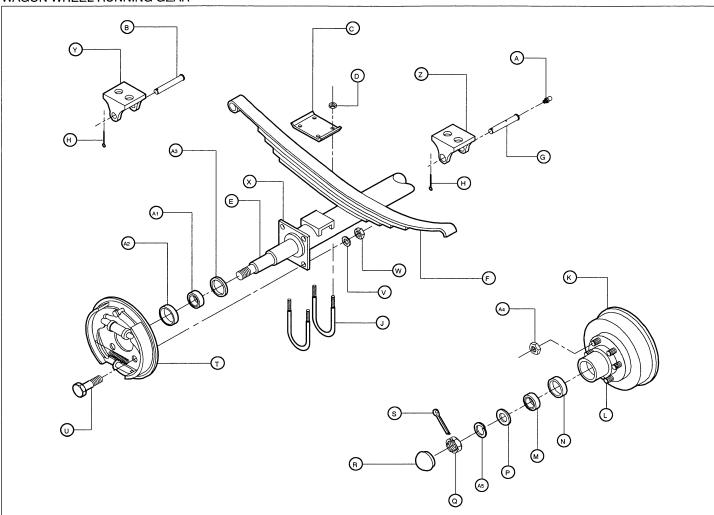
STOP, TAIL & TURN LIGHT OPTION (AS VIEWED FROM REAR OF SOCKET)

				LIST OF MATERIALS					
СКТ	TERMINATION A	TYPE	SIZE	TERMINATION B	TYPE	SIZE	GAUGE	LENGTH	COLOR
1	RECEPTACLE 1	E		GROUND	Α	1/4	14	46	WHT
2	RECEPTACLE 6	E		SPLICE 1	D		14	24	BRN
3	SPLICE 1			LH FRT CLEARANCE	В		14	95	BRN
4	LH FRT CLEAR W/CKT 3B			RH FRT CLEARANCE	В		14	89	BRN
5	SPLICE 1 W/CKT 3A			SPLICE 2	D		14	218	BRN
6	RECEPTACLE 3	E		RH TURN	G		14	342	YEL
7	RECEPTACLE 5	E		LH TURN	G		14	255	GRN
8									
9									
10	RH TURN/TAIL W/CKT 27B			RH REAR CLEAR BOT	В		14	22	BRN
11									
12	SPLICE 2			LH REAR CLEARANCE	В		14	19	BRN
13	LH REAR CLEAR W/CKT 12B			LH REAR TOP CLEAR	В		14	74	BRN
14	LH REAR TOP CLEAR W/CKT 13B			REAR ID W/CKT 15A	В		14	61	BRN
15	R ID W/CKT 14B			RH REAR TOP CLEAR	В		14	56	BRN
16	SPLICE 2 W/CKT 12A			LICENSE LAMP	В		14	31	BRN
17	SPLICE 2 W/CKT 12A			LH TURN/TAIL	G		14	13	BRN
18	RECEPTACLE 4	E		LH STOP LAMP	G		14	261	RED
19	LIGHT GRD W/CKT 24A			LIGHT GROUND			14	36	WHT
20	LEFT STOP LAMP W/CKT 18B			RIGHT STOP LAMP	G		14	99	RED
21	RECEPTACLE 7	E		ELECTRIC BRAKES			14	29	BLU
22	LEFT TURN GRD			LH ST/GRD W/CKT 23A	G		14	30	WHT
23	LEFT STOP GRD			RT ST/GRD W/CKT 24A	G		14	99	WHT
24	RIGHT STOP GRD			RH TURN GRD	G		14	30	WHT
25	LH TURN/TAIL W/CKT 17B			LEFT STOP/TAIL	G		14	30	BRN
26	LH STOP/TAIL W/CKT 25B			RIGHT STOP/TAIL	G		14	99	BRN
27	RH STOP/TAIL W/CKT 26B			RIGHT TURN/TAIL	G		14	30	BRN
28	RECEPTACLE 2	E		AUX	В		14	29	BLK

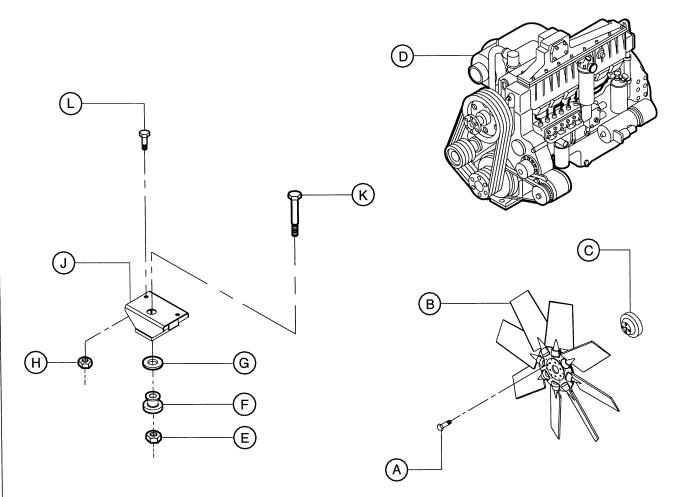
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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION			
Α	36504389	2	ROD , TIE	Х	95934956	2	WASHER			
В	36140730	2	NUT , JAM	Υ	36719557	1	DRAWBAR			
С	35588961	2	BALL JOINT , OUTER	Z	35107168	1	PIN , HINGE			
D	35221894	2	FITTING , LUBE	A1	95201455	2	PIN , COTTER			
Ε	36753259	1	AXLE , FRONT	A2	36753242	1	ARM , CENTER			
F	95717369	1	PIN , ROLL	АЗ	35588953	2	BALLJOINT , INNER			
G	35221894	1	FITTING , LUBE	A4	35140722	2	NUT , JAM			
Н	95338554	2	PIN , ROLL	A 5	36719219	1	LATCH			
J	95239927	4	WASHER	A6	35141167	1	SPRING			
K	36851566	1	L.H. KNUCKLE ASSEMBLY	A7	95098703	2	PIN , ROLL			
L	36851574	1	R.H. KNUCKLE ASSEMBLY	A8	36851376	1	FRONT AXLE ASSEMBLY			
М	95673042	2	PIN , ROLL	A9	36851384	1	REAR AXLE ASSEMBLY			
Ν	35319045	2	PIN , KING	B1	36853042	2	TIE ROD ASSEMBLY			
Р	95018982	2	PIN , COTTER				(INCLUDES A,B,C,A3,A4)			
Q	36719169	2	BRACKET		22077515	4	WHEEL			
R	36719466	2	SPRING		36877991	4	TIRE			
s	36719177	2	BRACKET		36878049	4	RING , CLAMP			
Т	35111590	2	BOLT , SHACKLE							
U	95318556	2	FITTING , LUBE							
V	35588755	1	PIN , CENTER							
W	95717377	2	PIN , ROLL							
	MANUAL NO. — DRAWING NO. DATE / REV: 22063556 9 09/01 A									

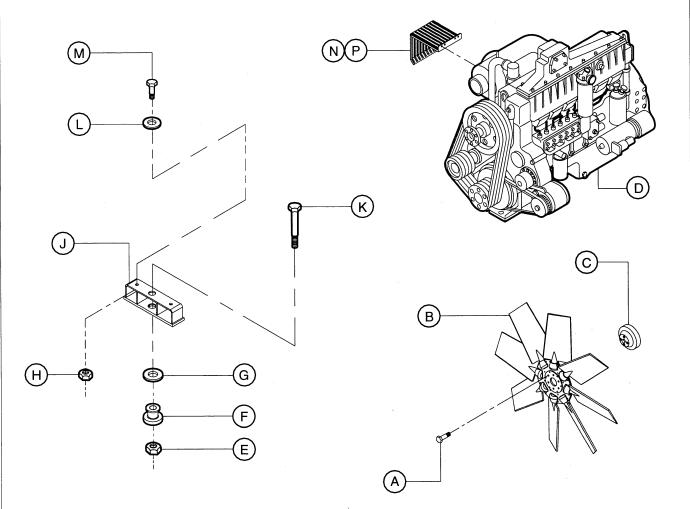


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	95318556	2	FITTING , LUBE	Х	36776839	2	FLANGE , BRAKE MTG
В	35588839	2	RIVET	Υ	36719177	2	BRACKET
С	35589241	2	PLATE , CLAMP	Z	36719169	2	BRACKET
D	35111566	8	NUT	A1	36851608	2	INNER BEARING
E	36851640	1	AXLE , REAR	A2	36851624	2	INNER RACE
F	36719466	2	SPRING	A3	36851632	2	SEAL
G	35111590	2	BOLT , SHACKLE	A4	22079032	8	NUT , CONE
н	95018982	2	PIN , COTTER	A5	36853117	2	WASHER , LOCK
J	35834621	4	U-BOLT				
K	36851665	2	HUB ASSEMBLY (INCLUDES	ITEMS N	l, L, A2)		
L	36764983	8	STUD				
М	36851590	2	OUTTER BEARING				
N	36851616	2	OUTER RACE				
Р	36853109	2	WASHER, FLAT				
Q	36853091	2	NUT				
R	36776813	2	CAP, GREASE				
s	95272902	2	PIN , COTTER				
Т		1	PARKING BRAKE ASSEMBLY				
U	36A2D326Z1	8	BOLT				
V	95934741	8	WASHER, FLAT				
W	95916573	8	NUT				
MANUAL NO 22063556	. — DRAWING NO. DATE / REV: 5 10 09/01 A						



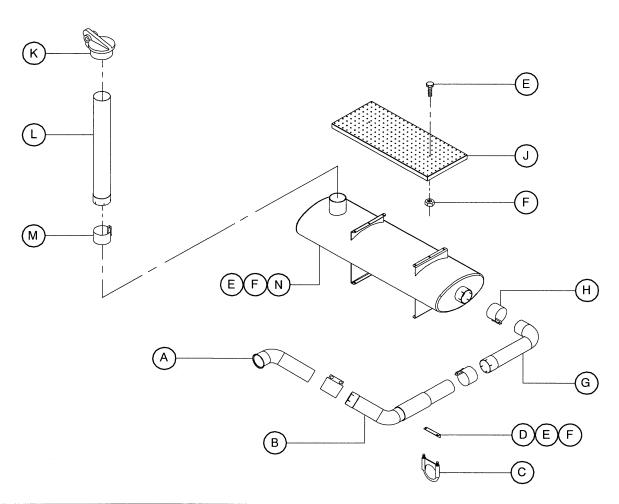
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	95940920	6	SCREW		ı	ENGINE	FILTERS
В	36884047	1	FAN ASSEMBLY				TILI LITO
С	54409339	1	SPACER, FAN	,	20000524	DDIM	IARY FUEL FILTER
D	22213409	1	ENGINE , CAT C15 (1170)	•	22090534 -		
	22079354	1	ENGINE, CAT C15 (1070)	2	22090526 -	SECO	ONDARY FUEL FILTER
Е	35297340	1	NUT	;	35362268 -	WAT	ER FILTER
F	35584556	1	MOUNT, RUBBER	,	35362235 -	OII E	ILTER
G	35273937	1	WASHER	•	33302233	OIL I	ILILI
Н	35145077	2	NUT				
J	54613351	1	BRACKET, ENGINE				
K	96700919	1	SCREW				
L	35144344	2	SCREW				
	22095525	1	TURBO, GUARD				

MANUAL NO.—DRAWING NO. DATE / REV: 22087159 11 08/02 B



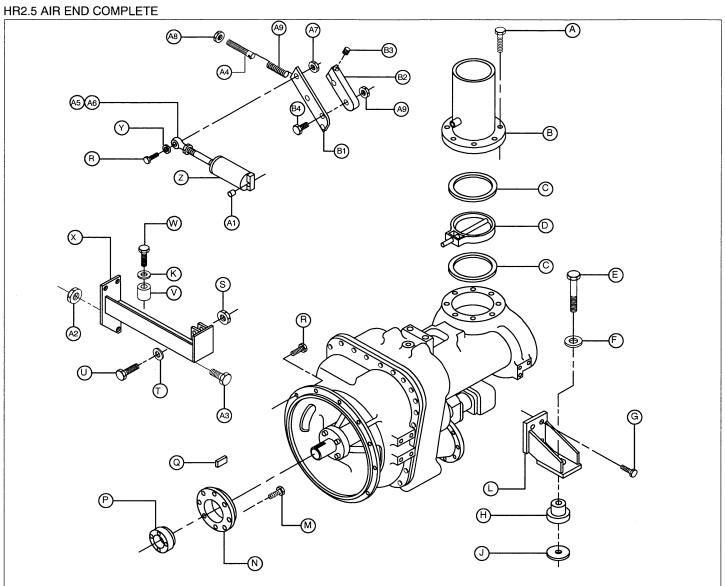
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	95940920	6	SCREW			ENGINE	FILTERS
В	36884047	1	FAN ASSEMBLY				
С	54409339	1	SPACER, FAN		54662036 -	ENG	INE FUEL FILTER
D	54661533	1	ENGINE, QSX-15 CUMMINS		54662036		
Ε	35297340	1	NUT		54662028 -	ENG	INE OIL FILTER
F	35584556	1	MOUNT, RUBBER		54662051 -	ENG	INE WATER SEPARATOR FILTER
G	35273937	1	WASHER				
Н	35297340	2	NUT				
J	54570122	1	BRACKET, ENGINE				
K	96700919	1	SCREW				
L	95935011	2	WASHER				
M	36763670	2	SCREW				
N	54687322	1	GUARD , TURBO				
Р	36879492	2	SCREW				

MANUAL NO.—DRAWING NO. DATE / REV: 22063556 11 08/02 C

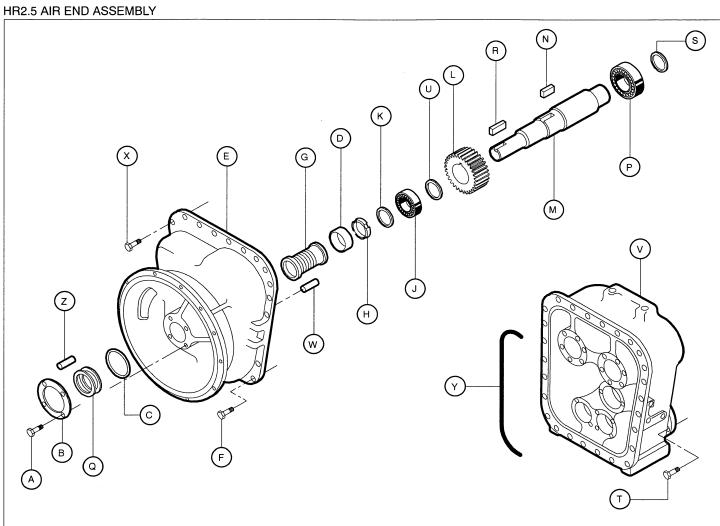


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54603774	1	PIPE , ENGINE TURBO				
В	54616552	1	PIPE , EXHAUST (STANDARD)				
	54738752	1	PIPE , EXHAUST (IQ)				
С	35127653	1	CLAMP				
D	35611235	1	SUPPORT , PIPE				
E	36880995	12	SCREW				
F	36879195	12	NUT				
G	54616560	1	PIPE , EXHAUST				
Н	35307131	3	CLAMP , SEAL				
J	54629589	1	STEP				
K	35851351	1	CAP , RAIN				
L	54629126	1	PIPE , EXHAUST				
М	36799807	1	CLAMP , SEAL				
N	54603204	1	MUFFLER				

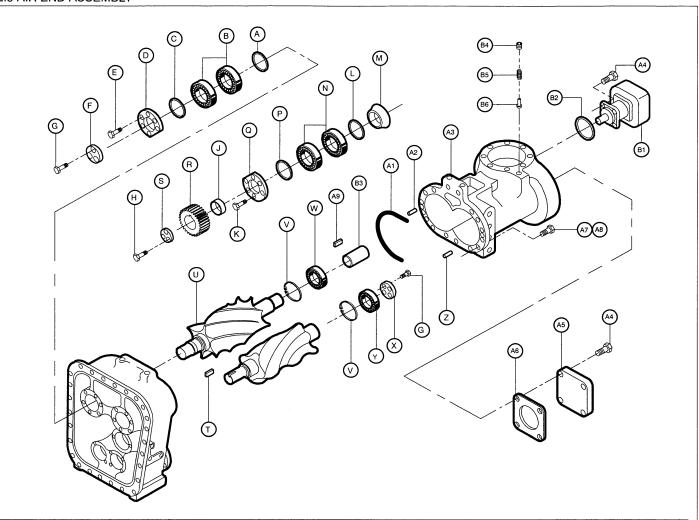
MANUAL NO. — DRAWING NO. DATE / REV: 22063556 12 09/01 A



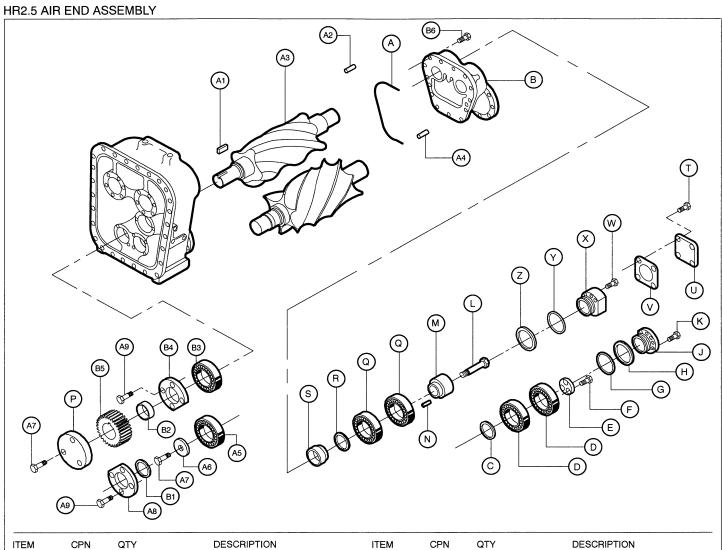
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	35375963	8	SCREW	Υ	95934907	1	WASHER, FLAT
В	36884997	1	FLANGE , INTAKE	Z	35584689	1	CYLINDER , AIR
С	36754059	2	GASKET	A1	35288885	1	BUSHING
D	36884112	1	VALVE, BUTTERFLY	A2	95922894	1	NUT , JAM
E	96700919	2	SCREW	А3	35611680	1	BOLT
F	35273937	2	WASHER, SNUBBER	A4	35605799	1	ROD , ADJUSTER
G	35375385	8	SCREW	A 5	35300532	1	BEARING , ROD END
н	35584556	2	MOUNT, RUBBER	A6	95926028	1	NUT
J	35273937	2	WASHER, SNUBBER	A7	95923330	1	NUT
K	95935011	2	WASHER	A8	35145077	2	NUT
L	54613369	2	BRACKET, MOUNTING	A9	36876258	1	SPRING
M	95941092	8	SCREW	B1	35607910	1	LEVER , REGULATION
N	36783710	1	COUPLING	B2	35264951	1	LEVER , CONTROL
Р	36897916	1	BUSHING	В3	95928917	1	SCREW, SET
Q	36795102	1	KEY	B4	35611680	1	NUT
R	95934626	12	SCREW				
s	95923314	1	NUT				
T	95934998	1	WASHER , FLAT				
υ	35288893	1	PIVOT , LEVER				
V	36898450	1	SPACER				
W	35375963	2	SCREW				
X	36898005	1	BRACKET , AIR CYLINDER				
MANUAL NO. 22063556		E/REV:					



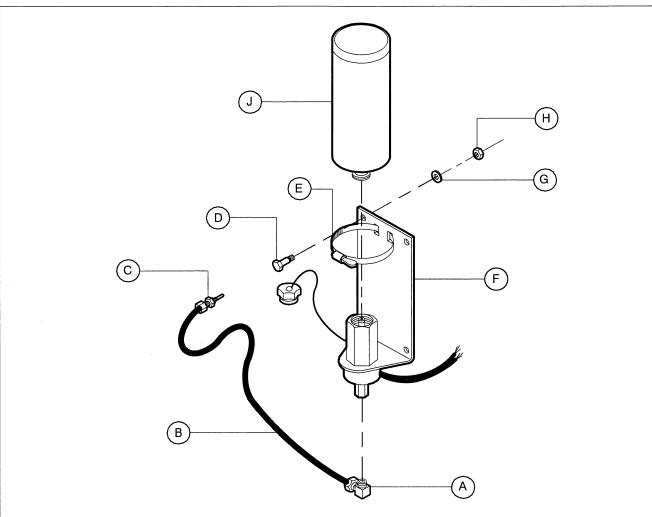
ITEM	CPN	QTY	DESCRIPTION	ľ	TEM	CPN	QTY	DESCRIPTION
Α	96702295	4	BOLT					
В	39577648	1	COVER , OIL SEAL					
С	35355536	1	O-RING					
D	36795128	1	SPACER					
E	36793750	1	CASE, GEAR					
F	96706262		BOLT					
G	39929351	1	SEAL , OIL					
Н	36795169	1	NUT , LOCK					
J	36511640	1	BEARING					
K	36795136	1	SPACER					
L	SEE GEAR	SET CHA	RT .					
М	36792836	1	SHAFT , DRIVE					
N	36795110	1	KEY					
Р	35610203	1	BEARING					
Q	36795151	1	SHIM SET					
R	36795102	1	KEY					
S	35372010	1	SPACER					
Т	35272533	16	SCREW					
U	36795144	1	SPACER	r		γ		
V	36861367	1	HOUSING , MAIN		INPUT		GEAR SET	HR2.5
W	35336122	1	DOWEL	CFM	SPEED		PART NO.	A/E ASSY. NO.
X	35272541		BOLT		SPEED	'	FART NO.	A/E ASSY. NO.
Υ	35355775	1	O-RING	1070	1000		06700070	00047540
Z	95650529	1	PIN, ROLL	1070	1800		36798973	36017549
				1170	1800		54637897	36017556
MANUAL NO 22063556		E/REV: 01 A						



ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	35355833	1	SET , SHIM	A4	96706080	4	SCREW
В	35600105	2	BEARING	A 5	36509388	1	PLATE, COVER
С	35355767	1	SET , SHIM	A6	35275742	1	GASKET
D	35856418	1	PLATE , RETAINING	A7	92398239		SCREW
Ε	96716139	6	SCREW	A8	35295344		SCREW
F	36508414	1	PLATE , RETAINING	A9	95340428	1	KEY
G	35311463	3	SCREW	B1	36861144	1	PUMP , OIL
Н	96712187	3	SCREW	B2	95000410	1	O-RING
J	35355841	1	SPACER	B3	36854701	1	COUPLING
κ	96701487	6	SCREW	B4	36861557	1	PLUG
L	35355825	1	SET , SHIM	B5	36861847	1	SPRING
M	35602457	1	PISTON , THRUST	B6	36861839	1	PISTON
N	35605203	2	BEARING				
Р	35355767	1	SET, SHIM				
Q	36501013	1	PLATE , RETAINER				
R	SEE GEAR	SET CHA	RT ON PREVIOUS PAGE				
S	35355858	1	CLAMP , PLATE				
Т	35355817	1	KEY				
U	36017465	1	SET , ROTOR (1ST STAGE)				
V	95223178	. 1	SNAP RING				
W	35600022	1	BEARING				
Х	35300193	1	CLAMP , PLATE				
Υ	35600030	1	BEARING , ROLLER				
Z	35336122	1	DOWEL				
A1	35355783	1	O-RING				
A2	35336130	1	DOWEL				
АЗ	36861193	1	HOUSING , ROTOR				
MANUAL NO. 22063556		E/REV:					



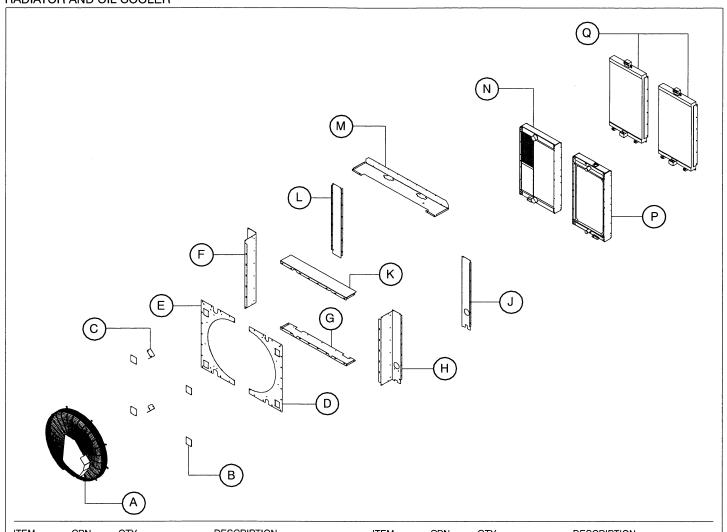
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	35355791	1	O-RING	A4	35336130	1	DOWEL
В	36738128	1	HOUSING , REAR BEARING	A 5	35600014	1	BEARING , ROLLER
С	35355874	1	SET , SHIM	A6	35300201	1	PLATE , CLAMP
D	35600113	2	BEARING , TAPERED ROLLER	A7	35311463	1	SCREW
E	35355957	1	PLATE , CLAMP	A8	35355999	1	PLATE , RETAINING
F	35311463	3	SCREW	A9	35273408	4	BOLT
G	95026290	1	O-RING	B1	35355973	1	SPACER, BEARING
н	35355924	1	SET , SHIM	B2	35355866	1	SPACER
J	35856350	1	COVER, REAR BEARING	B3	35600022	1	BEARING, ROLLER
K	96702295	6	SCREW	B4	35355965	1	PLATE , RETAINING
L	36851277	1	BOLT	B5	SEE GEAR	SET CHA	ART 2 PAGES BACK
М	35864644	1	COUPLING	B6	96712179		SCREW
N	95069522	1	DOWEL				
Р	36847200	1	CLAMP , PLATE				
Q	35600113	2	BEARING , TAPERED ROLLER				
R	35355874	1	SET , SHIM				
s	35355940	1	PISTON , THRUST				
Т	96712179	4	BOLT				
U	36509388	1	PLATE , COVER				
V	35275742	1	GASKET				
w	39125000	6	BOLT				
X	36864676	1	COVER, BEARING				
Y	95026290	1	O-RING				
Z	35355916	1	SET , SHIM				
A1	35355817	1	KEY				
A2	35336122	1	DOWEL				
АЗ	36006732	1	ROTOR SET (2ND STAGE)				
		E/REV:					
22063556	16 09/	01 A					



ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	35103498	1	ELBOW				
В	35132166	1	TUBING (84 INCHES)				
С	35602812	1	ATOMIZER				
D	35322908	4	SCREW				
E	35103506	1	CLAMP				
F	35357961	1	VALVE AND BRACKET ASSEMBLY				
G	95043196	4	WASHER				
Н	92304500	4	NUT				
J	35112911	1	CYLINDER, ETHER				

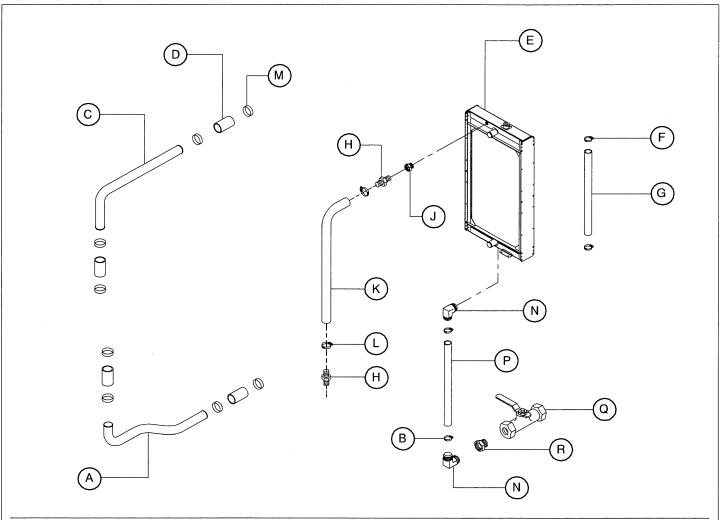
35825595 - OIL TEMPERATURE BY-PASS VALVE ASSEMBLY

MANUAL NO. — DRAWING NO. DATE / REV: 22063556 17 09/01 A



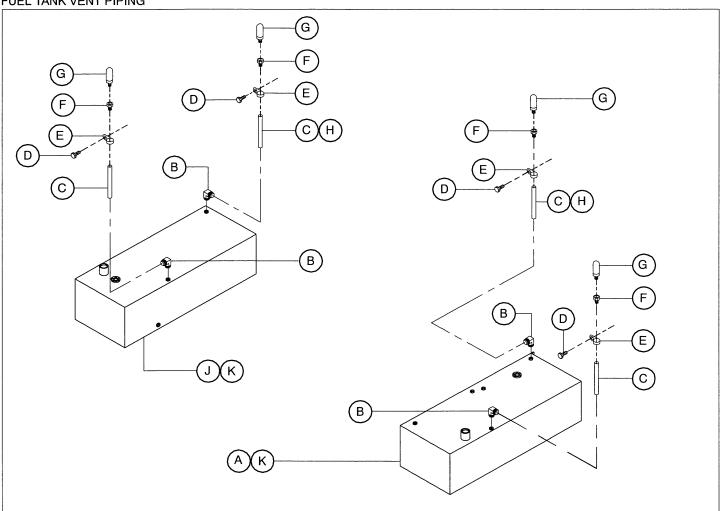
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54501085	1	FAN GUARD ASSEMBLY				
В	54661426	4	PLATE, COVER				
С	54661459	2	BRACKET				
D	54665864	1	ORIFICE , L.H. FAN				
E	54665880	1	ORIFICE, R.H. FAN				
F	54669114	1	SUPPORT , R.H. SHROUD				
G	54669098	1	SUPPORT, BOTTOM SHROUD				
Н	54669122	1	SUPPORT , L.H. SHROUD				
J	54521422	1	SUPPORT , L.H. REAR SHROUD				
K	54669106	1	SUPPORT, TOP SHROUD				
L	54521430	1	SUPPORT , R.H. REAR SHROUD				
М	54521448	1	SUPPORT, TOP REAR SHROUD				
N	54501846	1	COOLER, A/C FUEL				
Р	54501838	1	RADIATOR				
Q	54627161	2	COOLER, OIL				

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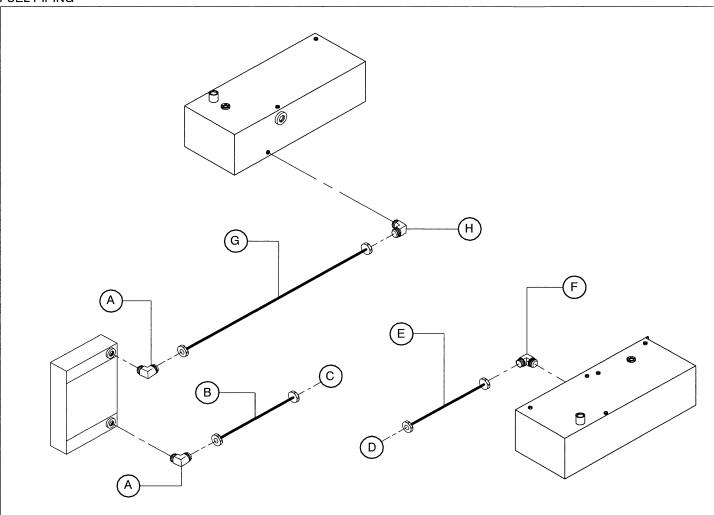
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54637996	1	TUBE , LOWER RADIATOR				
В	95220844	2	CLAMP				
С	54638101	1	TUBE, UPPER RADIATOR				
D	35330570	4	HOSE, CONNECTOR				
E	54501838	1	RADIATOR				
F	95235131	2	CLAMP				
G	35135458	1	HOSE, BY-PASS (55 INCHES)				
Н	35363662	1	FITTING , BARBED				
j	43212216	1	ADAPTER				
K	35285600	1	HOSE, VENT (52 INCHES)				
L	95264776	2	CLAMP				
М	35222017	8	CLAMP				
N	35366665	1	ELBOW				
Р	35326578	1	HOSE , DRAIN (115 INCHES)				
Q	35576115	1	VALVE, BALL				
R	95953949	1	ADAPTER				
	54474572	1	SWITCH, LEVEL				

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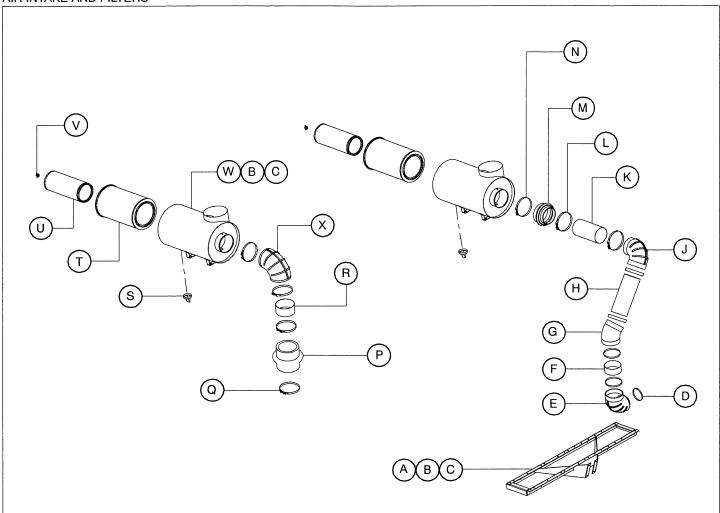
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54594098	1	TANK , R.H. FUEL				
В	35369354	1	ELBOW				
С	35356484	1	TUBING (23 INCHES)				
D	92368687	1	SCREW				
E	35253038	1	CLAMP				
F	35369339	1	REDUCER				
G	35322395	1	BREATHER				
Н	35356484	1	TUBING (40 INCHES HSRG)				
J	54594080	1	TANK , L.H. FUEL				
K	35279025	12	SCREW				

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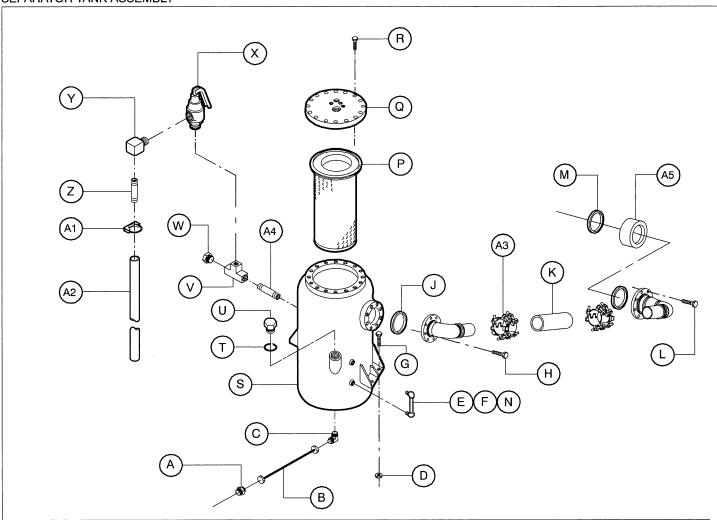


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	35279801	1	ELBOW				
В	35305499	1	HOSE ASSEMBLY				
С	OUT OF FU	EL PUMP	ON ENGINE				
D	INTO FUEL	PUMP ON	N ENGINE				
E	35136548	1	HOSE ASSEMBLY (HSRG)				
	35325083	1	HOSE ASSEMBLY (WAGON WHEEL)				
F	35286756	1	ELBOW				
G	22060156	1	HOSE ASSEMBLY (HSRG)				
	22060149	1	HOSE ASSEMBLY (WAGON WHEEL)				
Н	35309210	1	ELBOW				
	36845014	1	CAP , FUEL TANK				
	54672811	1	SENDER, FUEL LEVEL				

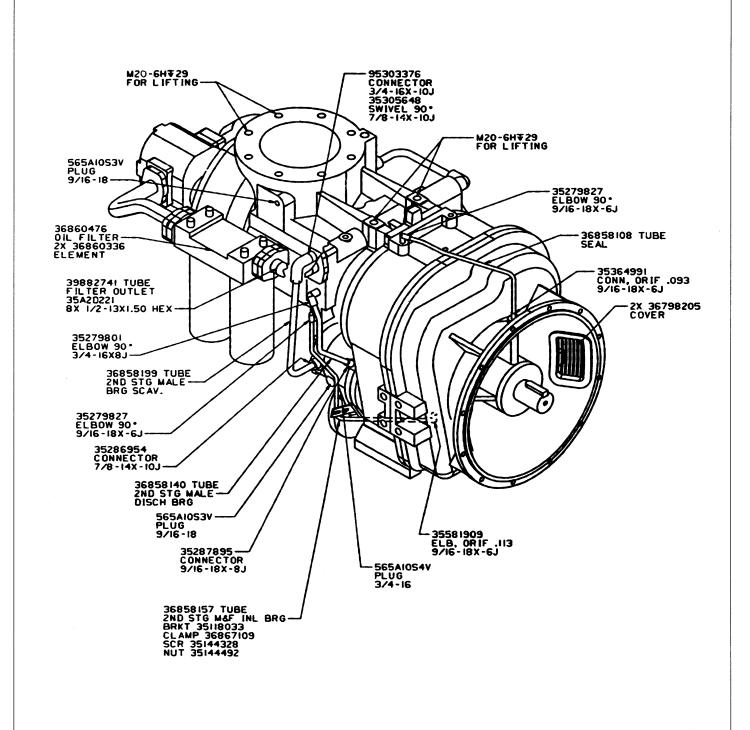
MANUAL NO. — DRAWING NO. DATE / REV: 22063556 21 09/01 A



ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	36879815	1	BRACKET , AIR CLEANER				
В	36880995	12	SCREW				
С	36879195	12	NUT				
D	35161025	1	CLAMP				
E	54599956	1	ELBOW, RUBBER				
F	35112648	1	TUBE				
G	35509074	1	ELBOW , RUBBER				
Н	35123272	1	TUBE				
J	35112630	1	ELBOW , RUBBER				
K	35505866	1	TUBE				
L	35119858	1	CLAMP				
М	35141290	1	HOSE , HUMP				
N	35129071	1	CLAMP				
Р	35120260	1	HOSE , HUMP				
Q	35129071	4	CLAMP				
R	36864726	1	TUBE				
S	36867778	2	EVACUATOR				
Т	36864361	2	ELEMENT , PRIMARY				
U	36864379	2	ELEMENT , SAFETY				
V	35388982	2	NUT , WING				
W	36864346	2	AIR CLEANER ASSEMBLY				
X	35120211	1	ELBOW , RUBBER				
	36847838	2	SWITCH, AIR FILTER				

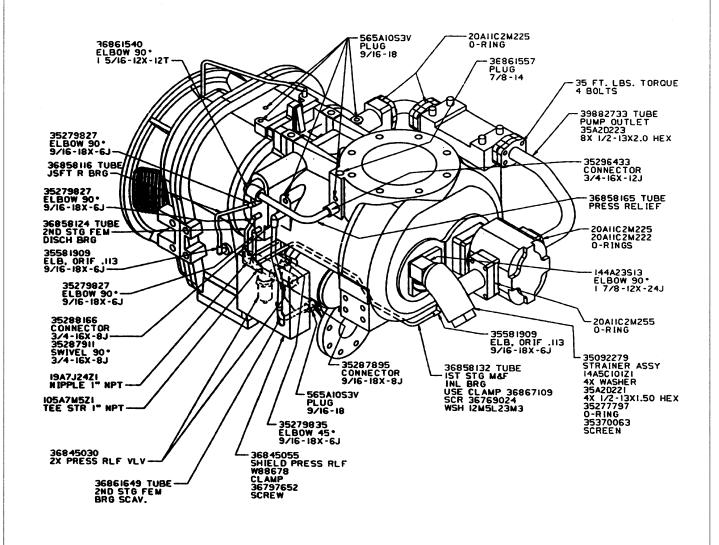


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	95219747	1	CONNECTOR	А3	36883585	2	CLAMP
В	36878254	1	HOSE ASSEMBLY	A4	95928040	1	NIPPLE
С	35294750	1	ELBOW	A 5	36843720	1	VALVE , CHECK
D	36879203	2	NUT		36898922	1	PROBE, TEMPERATURE
E	92121532	1	GLASS, SIGHT				
F	36860468	2	ELBOW				
G	36889608	2	SCREW				
н	95934386	8	SCREW				
J	36786283	1	GASKET				
K	54634829	1	DISCHARGE HOSE ASSEMBLY				
L	35376094	8	SCREW				
М	36762961	1	GASKET				
N	35324649	2	GASKET				
P	43206648	1	ELEMENT, SEPARATOR				
Q	54629159	1	COVER, TANK				
R	95934170	16	SCREW				
S	54629134	1	TANK, SEPARATOR				
Т	35277797	1	O-RING				
U	35802933	1	PLUG , OIL FILL				
V	95953410	, 1	TEE				
W	95953949	1	ADAPTER				
X	35596733	1	VALVE , SAFETY				
Y	95944104	1	ELBOW				
Z	36762821	1	NIPPLE				
A1	35261155	1	CLAMP				
A2	54744156	1	PIPE , SAFETY VALVE				
MANUAL NO. 22063556		E/REV:			*************************		



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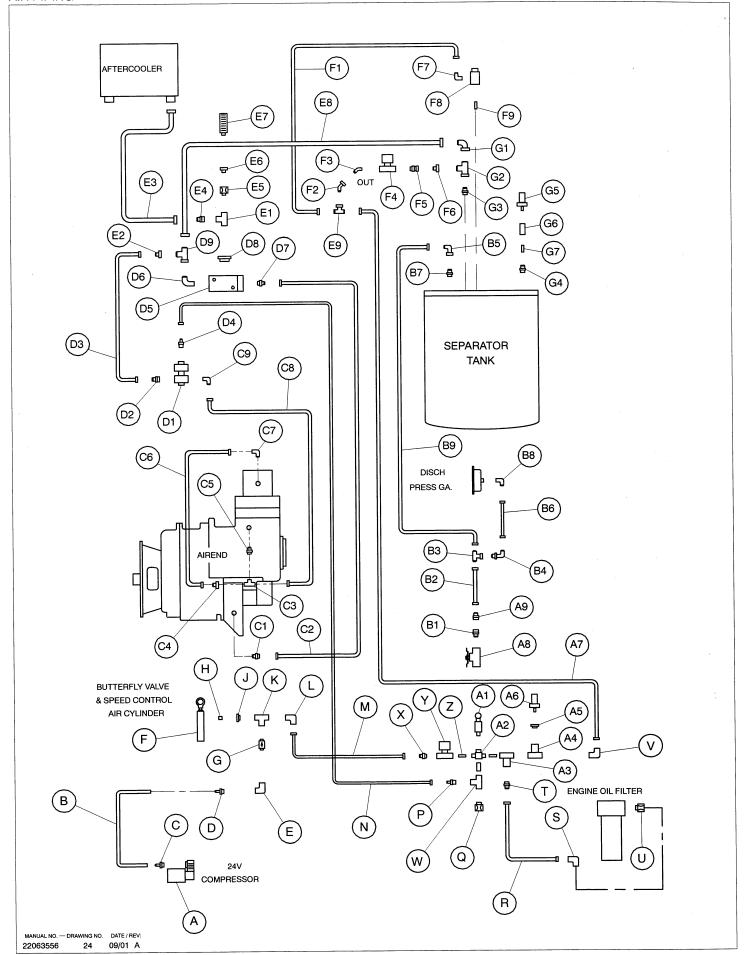
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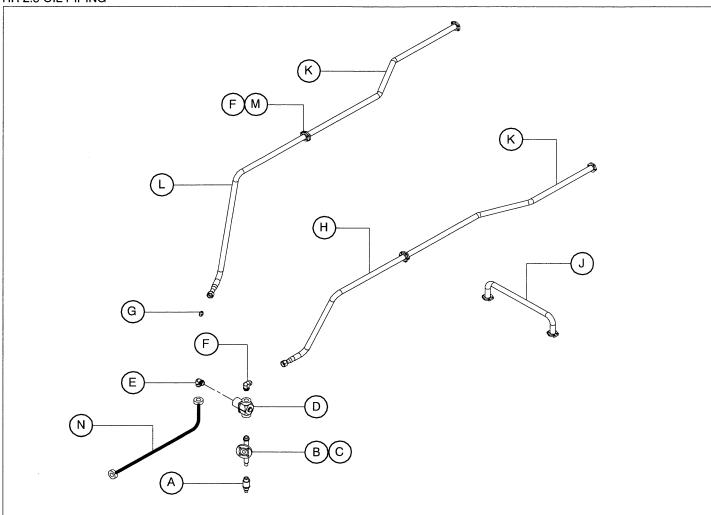
Book 22063556 (11/01)

MANUAL NO. - DRAWING NO. DATE / REV:

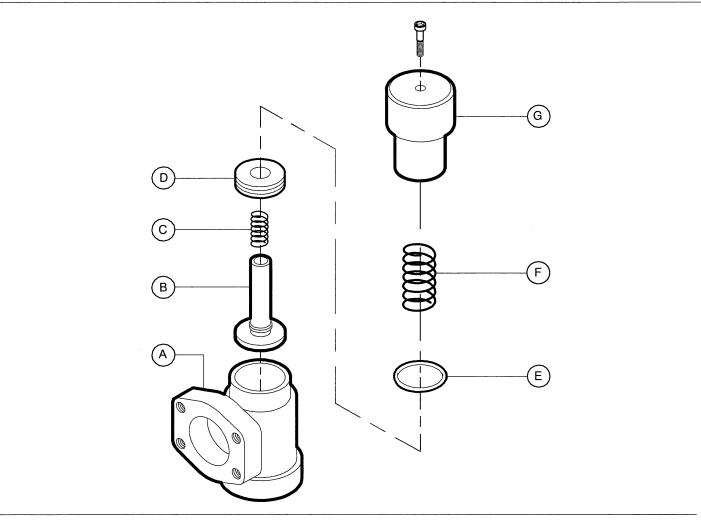
22063556



(A)	36850691	24V COMPRESSOR	(B2)	35282961	HOSE ASSEMBLY	E9)	35283092	TEE
B	35282920	HOSE ASSEMBLY	B3	35283092	TEE	F1	35282946	HOSE ASSEMBLY
©	95287629	ADAPTER	B 4	36852499	FITTING , BULKHEAD	F2	35283100	ELBOW
(D)	35283472	CONNECTOR	B 5	35283068	ELBOW	F3	35294743	ELBOW
E	95954095	ELBOW	B6	35282979	HOSE ASSEMBLY	F4	36842300	VALVE , SOLENOIE
F	35584689	CYLINDER , AIR	B7	35284082	CONNECTOR	(F5)	35368927	CONNECTOR
G	35248145	VALVE , CHECK	(B8)	35280098	ELBOW	F6	35321165	REDUCER
\bigoplus	95953493	NIPPLE	B9	35294701	HOSE ASSEMBLY	F 7	35301126	ELBOW
\bigcirc	95930301	BUSHING	(1)	35283076	CONNECTOR	F8	35315795	VALVE , PRESSUR
K	35321272	TEE	C2	35322592	HOSE ASSEMBLY	F9	95944575	NIPPLE
(L)	35283464	ELBOW	3	95642484	TEE	G1	35301506	ELBOW
M	35282920	HOSE ASSEMBLY	C4	35299734	REDUCER	G 2	35287739	TEE
N	35282912	HOSE ASSEMBLY	<u>C5</u>	35287895	CONNECTOR	G 3	95219747	ADAPTER
P	35283472	CONNECTOR	<u>C6</u>	35310960	HOSE ASSEMBLY	G 4	95930301	BUSHING
<u>@</u>	37081528	ORIFICE (.063)	(7)	35283464	ELBOW	G 5	54765946	TRANSDUCER
R	22042426	HOSE ASSEMBLY	©8)	35295179	HOSE ASSEMBLY	G 6	95010906	COUPLING
S	35279934	ELBOW	(e)	35309210	ELBOW	G 7	95953493	NIPPLE
T	35284082	CONNECTOR	D1	35316405	ANTI-RUMBLE VLV.			
U	54720719	ADAPTER	D2	35286426	CONNECTOR			
\bigcirc	35279934	ELBOW	D3	35252782	HOSE ASSEMBLY			
W	35321272	TEE	D4	35283472	CONNECTOR			
\otimes	35284082	CONNECTOR	D5	35849215	VALVE , AUTO BLOWDO	WN		
\bigcirc	36842318	VALVE , SOLENOID	D6	35294735	ELBOW			
Z	36793776	NIPPLE (3 REQD)	D 7	35290147	CONNECTOR			
(A1)	35325133	VALVE , SAFETY	D8	95944633	BUSHING			
(A2)	35321264	CROSS	D9	35287739	TEE			
A3	35322379	VALVE , BLOWDOWN	E1	35114545	TEE			
(A4	35114545	TEE	E2	35365774	REDUCER			
A5	95930301	BUSHING	E3	35311471	HOSE ASSEMBLY			
A6	36920825	100 PSI TRANSDUCER	E4	35284082	CONNECTOR			
A7	35311471	HOSE ASSEMBLY	E5	35322346	ORIFICE (.156)			
(AB)	35324839	VALVE , BALL	E6	95948501	ADAPTER			1
(A9)	35336139	FITTING , BULKHEAD	E 7	35132299	SILENCER			
B1	35367846	CONNECTOR	(E8)	35376110	HOSE ASSEMBLY			



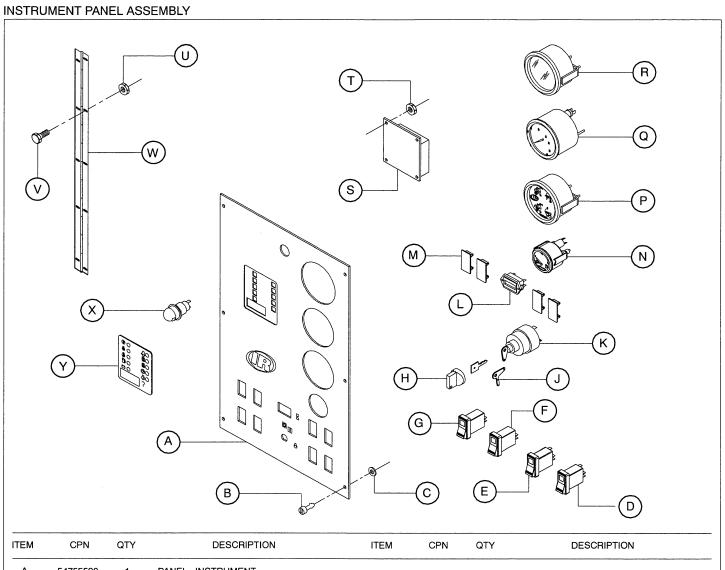
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36885887	1	VALVE , 75 PSI RELIEF				A COLOR
В	36897155	1	MANIFOLD , OIL				
С	36786580	1	GASKET				
D	36897940	1	VALVE , OIL TEMPERATURE BY-PASS				
	39207402	1	150 °F ELEMENT				
E	95431292	1	ELBOW				
F	95357976	4	O-RING				
G	95279329	1	CONNECTOR				
Н	54638382	1	TUBE ASSEMBLY				
J	54628185	1	TUBE ASSEMBLY				
K	54628177	1	TUBE ASSEMBLY				
L	54638374	1	TUBE ASSEMBLY				
М	95920708	8	SCREW				
N	35130863	1	HOSE ASSEMBLY				
		TE / REV:					
2063556	26 09/	01 A					



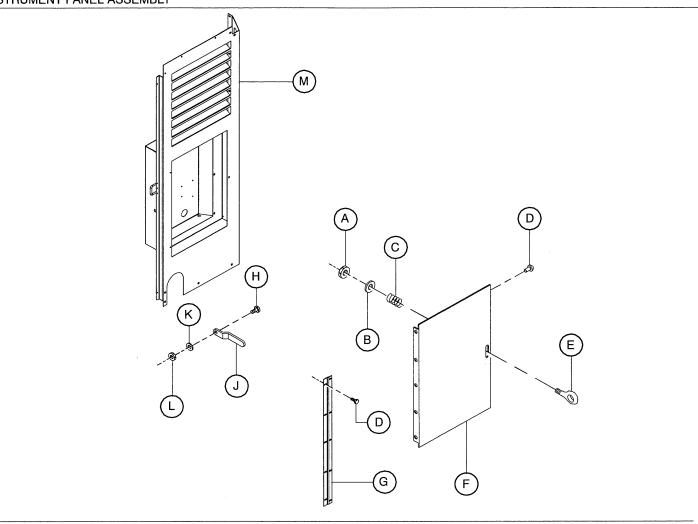
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54699731	1	BODY , CHECK VALVE				
В	54699764	1	CHECK VALVE ASSEMBLY				
С	54699749	1	SPRING, CHECK VALVE				
D	54699772	1	PISTON				
E	54699756	1	O-RING				
F	54699798	1	SPRING , MAIN				
G	54699780	1	CAP				

MINIMUM PRESSURE CHECK VALVE ASSEMBLY 54687504

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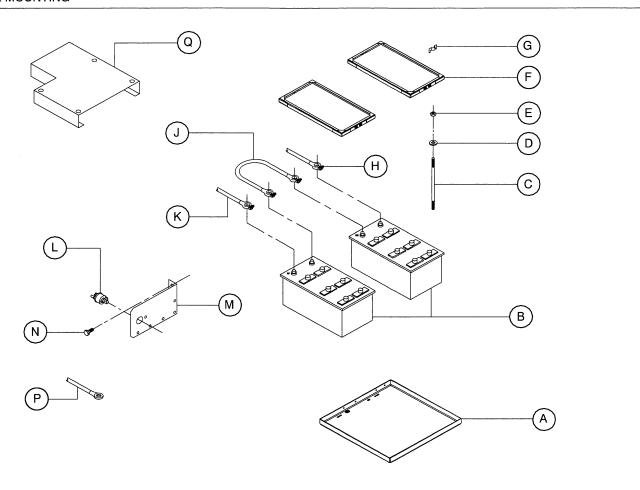


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54755590	1	PANEL , INSTRUMENT				
В	36844124	3	SCREW , QUARTER TURN				
С	35369180	3	RETAINER				
D	22053896	1	SWITCH , LAMPS				
E	22054050	1	SWITCH , HEATER				
F	22054076	1	SWITCH , AFTER WARM-UP				
G	22054068	1	SWITCH, ETHER				
Н	54774104	1	COVER, KEY				
J	22054167	1	KEY, SWITCH				
K	92086719	1	SWITCH, START				
L	54766704	1	METER, HOUR				
М	22054142	4	PLUG , SWITCH				
N	22050991	1	GAUGE , FUEL LEVEL				
Р	22056394	1	GAUGE , 4 IN 1				
Q	36861177	1	TACHOMETER				
R	36841468	1	GAUGE , PRESSURE				
s	54688411	1	MODULE, WEDGE				
Т	95928800	4	NUT				
U	35144492	3	NUT				
V	35365386	3	SCREW				
W	36840908	1	HINGE				
X	36841252	1	LIGHT , PANEL				
Υ	22055800	1	OVERLAY, MODULE				
MANUAL NO. 22063556		E/REV: 01 A					



ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	95923314	1	NUT				
В	95934998	1	WASHER				
С	35327311	1	SPRING				
D	92368687	7	SCREW				
Е	35327303	1	EYEBOLT				
F	36738565	1	DOOR , INSTRUMENT PANEL				
G	36740405	1	HINGE				
Н	35357995	1	STUD				
J	35603349	1	HOLDER, DOOR				
K	95935037	1	WASHER				
L	35273366	1	NUT				
М	22055743	1	PANEL, VERTICAL				

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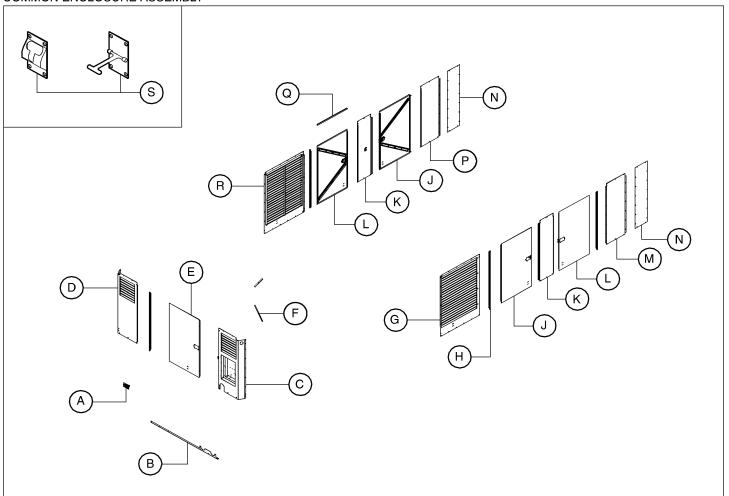


A 36870350 1 TRAY , BATTERY B 35225788 2 BATTERY C 54715479 4 STUD D 95935037 8 WASHER E 95923322 8 NUT F 35562156 2 FRAME G 35108216 4 CLIP H 54765367 1 CABLE , NEGATIVE J 35128982 1 CABLE , JUMPER K 54765375 1 CABLE , POSITIVE L 36896975 1 SWITCH , MASTER CUT-OFF M 54737400 1 BRACKET , SWITCH N 35279025 2 SCREW P 54765383 1 CABLE , MASTER SWITCH Q 54706825 1 COVER , BATTERY 35578194 1 GROUND STRAP FROM STARTER	TEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
C 54715479 4 STUD D 95935037 8 WASHER E 95923322 8 NUT F 35562156 2 FRAME G 35108216 4 CLIP H 54765367 1 CABLE, NEGATIVE J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 GROUND STRAP FROM STARTER	Α	36870350	1	TRAY , BATTERY				******
D 95935037 8 WASHER E 95923322 8 NUT F 35562156 2 FRAME G 35108216 4 CLIP H 54765367 1 CABLE, NEGATIVE J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 COVER, BATTERY 35578194 1 GROUND STRAP FROM STARTER	В	35225788	2	BATTERY				
E 95923322 8 NUT F 35562156 2 FRAME G 35108216 4 CLIP H 54765367 1 CABLE, NEGATIVE J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 GROUND STRAP FROM STARTER	С	54715479	4	STUD				
F 35562156 2 FRAME G 35108216 4 CLIP H 54765367 1 CABLE, NEGATIVE J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 GROUND STRAP FROM STARTER	D	95935037	8	WASHER				
G 35108216 4 CLIP H 54765367 1 CABLE, NEGATIVE J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 GROUND STRAP FROM STARTER	E	95923322	8	NUT				
H 54765367 1 CABLE , NEGATIVE J 35128982 1 CABLE , JUMPER K 54765375 1 CABLE , POSITIVE L 36896975 1 SWITCH , MASTER CUT-OFF M 54737400 1 BRACKET , SWITCH N 35279025 2 SCREW P 54765383 1 CABLE , MASTER SWITCH Q 54706825 1 COVER , BATTERY 35578194 1 GROUND STRAP FROM STARTER	F	35562156	2	FRAME				
J 35128982 1 CABLE, JUMPER K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 COVER, BATTERY 35578194 1 GROUND STRAP FROM STARTER	G	35108216	4	CLIP				
K 54765375 1 CABLE, POSITIVE L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 COVER, BATTERY 35578194 1 GROUND STRAP FROM STARTER	Н	54765367	1	CABLE , NEGATIVE				
L 36896975 1 SWITCH, MASTER CUT-OFF M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 COVER, BATTERY 35578194 1 GROUND STRAP FROM STARTER	J	35128982	1	CABLE , JUMPER				
M 54737400 1 BRACKET, SWITCH N 35279025 2 SCREW P 54765383 1 CABLE, MASTER SWITCH Q 54706825 1 COVER, BATTERY 35578194 1 GROUND STRAP FROM STARTER	K	54765375	1	CABLE , POSITIVE				
N 35279025 2 SCREW P 54765383 1 CABLE , MASTER SWITCH Q 54706825 1 COVER , BATTERY 35578194 1 GROUND STRAP FROM STARTER	L	36896975	1	SWITCH, MASTER CUT-OFF				
P 54765383 1 CABLE , MASTER SWITCH Q 54706825 1 COVER , BATTERY 35578194 1 GROUND STRAP FROM STARTER	М	54737400	1	BRACKET, SWITCH				
Q 54706825 1 COVER , BATTERY 35578194 1 GROUND STRAP FROM STARTER	N	35279025	2					
35578194 1 GROUND STRAP FROM STARTER	Р	54765383	1	CABLE , MASTER SWITCH				
	Q	54706825	1	COVER, BATTERY				
		35578194	1	GROUND STRAP FROM STARTER				
35293075 1 GROUND STRAP TO RH OF ENGINE		35293075	1	GROUND STRAP TO RH OF ENGINE				

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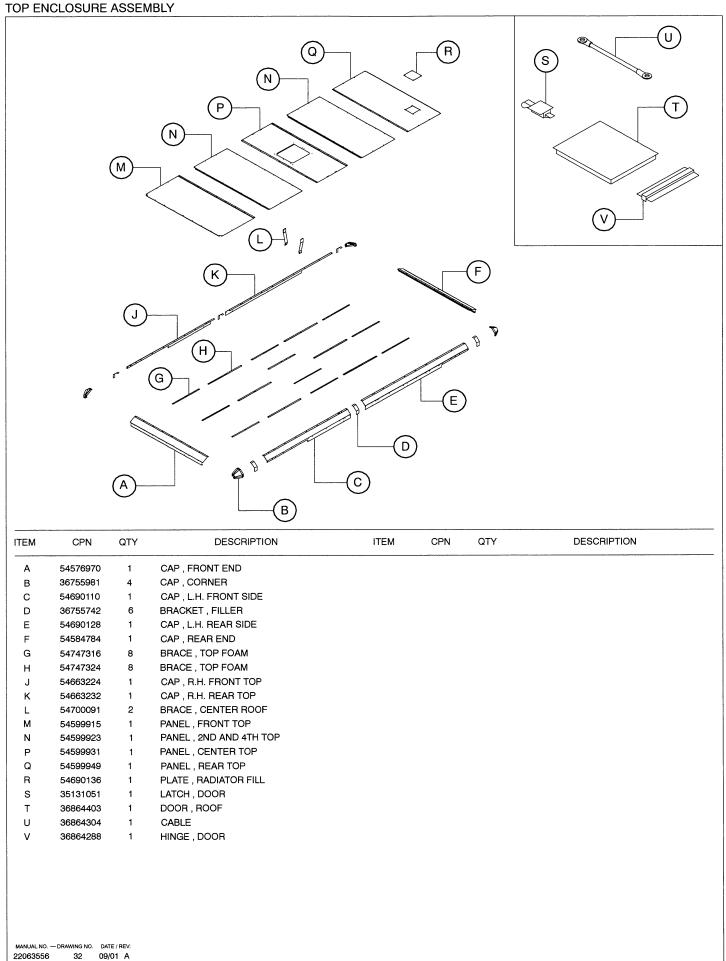
COMMON ENCLOSURE ASSEMBLY

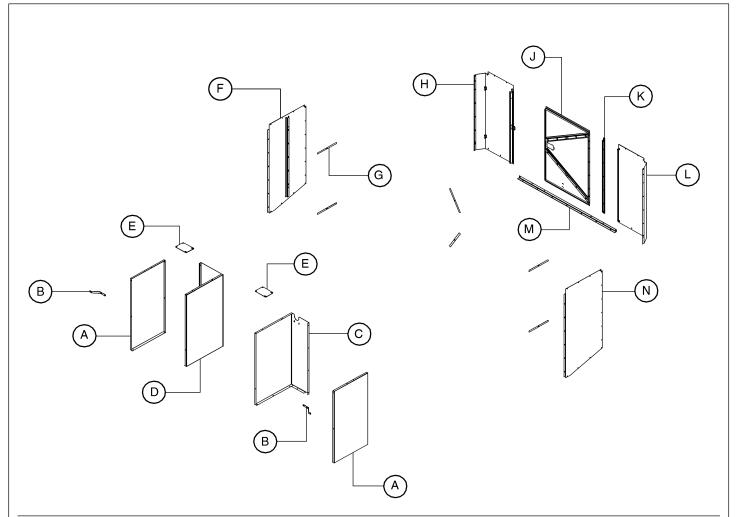


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36793602	5	LATCH , DOOR SLAM				
В	54576871	1	BRACE , FRONT PANEL				
С	22055743	1	PANEL , L.H. FRONT				
	54744479	1	PANEL , L.H. FRONT (IQ UNITS)				
D	22055750	1	PANEL, R.H. FRONT				
E	36863363	1	DOOR, FRONT				
F	54718184	6	BRACE, FRONT				
G	54587944	1	GRILLE , L.H. FRONT SIDE				
Н	36863413	5	HINGE				
J	36863660	1	DOOR, SIDE				
к	54587969	1	PANEL, CENTER				
L	36863652	1	DOOR, SIDE				
М	54587977	1	PANEL , L.H. REAR SIDE				
N	54663240	1	PANEL , REAR SIDE				
Р	54587985	1	PANEL , R.H. REAR SIDE				
Q	36863371	5	ANGLE, DOOR DRIP				
R	54587951	1	GRILLE, R.H. FRONT SIDE				
s	36849925	5	LATCH, DOOR				

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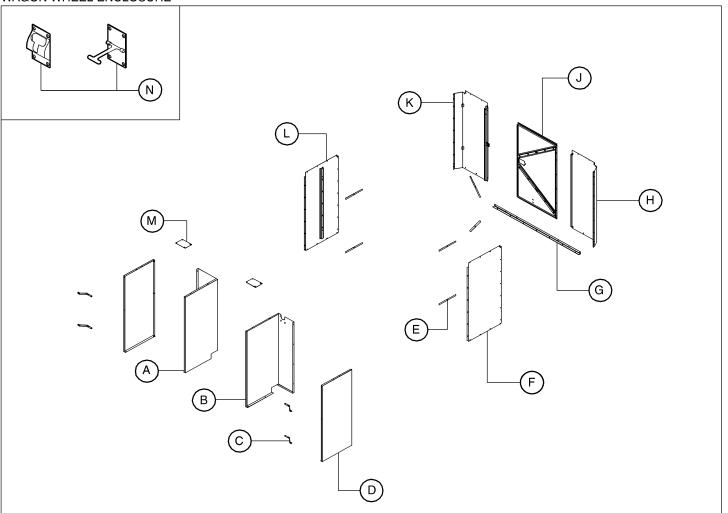


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	54640982	1	BAFFLE , L.H. OUTSIDE		NOTE: AL	I OTHER ENG	CLOSURE PARTS ARE SHOWN
В	54641022	1	STRIP , SUPPORT				
С	54640966	1	BAFFLE , L.H. INSIDE		,	ON COMMON E	ENCLOSURE DRAWING.
	22055479	1	BAFFLE , L.H. INSIDE (IQ UNITS)				
D	54640974	1	BAFFLE , R.H. INSIDE				
	22055487	1	BAFFLE , R.H. INSIDE (IQ UNITS)				
E	54641006	1	PLATE , TIE				
F	54672761	1	PANEL , R.H. REAR				
G	54718184	6	STRIP , FOAM RETENTION				
Н	54663299	1	PANEL, R.H. REAR CORNER				
J	54672779	1	DOOR , REAR				
	36793602	1	LATCH , DOOR SLAM				
K	54692744	1	HINGE				
L	54663281	1	PANEL , L.H. REAR CORNER				
М	54576921	1	STRIP , PANEL SUPPORT				
N	54672753	1	PANEL , L.H. REAR SIDE				

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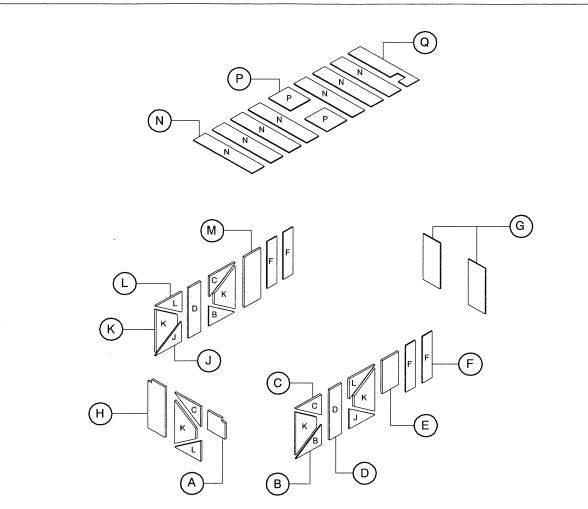
WAGON WHEEL ENCLOSURE



ITEM	CPN	QTY	DESCRIPTION	
Α	54688239	1	BAFFLE , R.H.	NOTE: ALL OTHER ENCLOSURE PARTS ARE SHOWN
	22055503	1	BAFFLE , R.H. (IQ UNITS)	
В	54688221	1	BAFFLE , L.H.	ON COMMON ENCLOSURE DRAWING.
	22055495	1	BAFFLE , L.H. (IQ UNITS)	
С	54641022	4	SUPPORT , BAFFLE	
D	54688247	2	BAFFLE , OUTSIDE	
E	54718184	6	STRAP, FOAM	
F	54663265	1	PANEL , L.H. REAR SIDE	
G	54576921	1	ANGLE , REAR MOUNTING	
Н	54576954	1	PANEL , L.H. REAR	
J	36863363	1	DOOR, REAR	
	36793602	1	LATCH, SLAM	
	36863413	1	HINGE	
K	54576962	1	PANEL , R.H. REAR	
L	54663273	1	PANEL , R.H. SIDE	
M	54641006	2	PLATE , TIE	
N	36849925	1	HOLDER, DOOR	

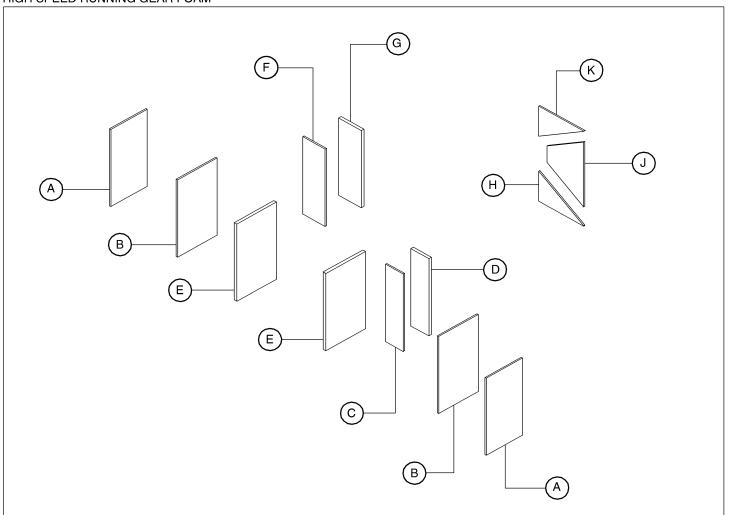
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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54721204	1	FOAM , L.H. FRONT TOP				
В	54719703	2	FOAM, DOOR				
С	54719711	3	FOAM, DOOR				
D	54719646	2	FOAM , CENTER PANEL				
Ε	54719695	1	FOAM , L.H. SIDE				
F	54759519	4	FOAM , R.H. / L.H. REAR SIDE				
G	54759527	2	FOAM, REAR				
Н	54721675	1	FOAM , R.H. FRONT				
J	54720065	2	FOAM, DOOR				
K	54719661	5	FOAM, CENTER DOOR				
L	54720057	3	FOAM, DOOR				
М	54719653	1	FOAM , R.H. REAR SIDE				
N	54699046	7	FOAM, TOP				
Р	54699087	2	FOAM , CENTER TOP				
Q	54710041	1	FOAM, REAR TOP				

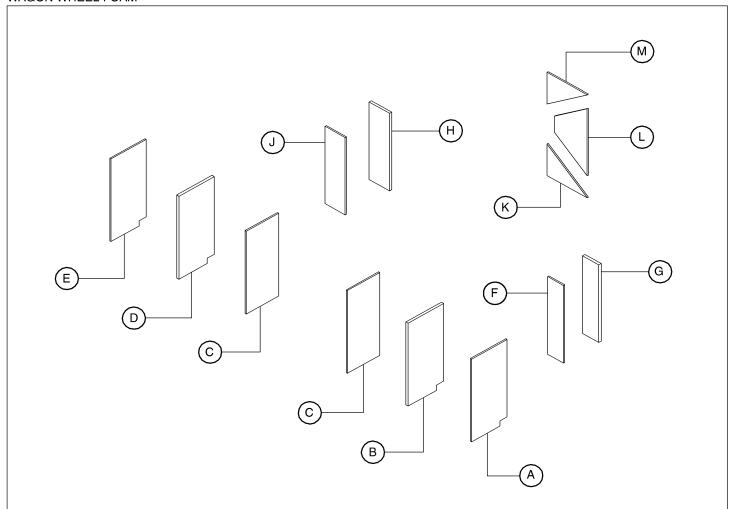
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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54675848	1	FOAM , SPLITTER BAFFLE				
В	54675830	1	FOAM , SPLITTER BAFFLE				
С	54675822	1	FOAM , L.H. BAFFLE				
D	54675806	1	FOAM , L.H. BAFFLE				
E	54675814	1	FOAM , L.H.				
F	54685334	1	FOAM, R.H.				
G	54685326	1	FOAM, R.H.				
Н	54759550	1	FOAM , BOTTOM DOOR				
J	54759543	1	FOAM , CENTER DOOR				
K	54759535	1	FOAM , TOP DOOR				
	22087514	1	FOAM , R.H. FRONT VERTICAL CORNER	R (IQ UNITS)			

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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION			
Α	54691134	1	FOAM , L.H. SPLITTER BAFFLE							
В	54691175	1	FOAM , L.H. SPLITTER BAFFLE	OAM , L.H. SPLITTER BAFFLE						
С	54691118	1	FOAM , SPLITTER BAFFLE							
D	54691191	1	FOAM , R.H. SPLITTER BAFFLE							
Е	54691159	1	FOAM , R.H. SPLITTER BAFFLE	FOAM , R.H. SPLITTER BAFFLE						
F	54691126	1	FOAM , L.H. BAFFLE							
G	54691167	1	FOAM , L.H. BAFFLE							
Н	54691183	1	FOAM, R.H. BAFFLE							
J	54691142	1	FOAM, R.H. BAFFLE							
K	54670459	1	FOAM, BOTTOM DOOR							
L	54760442	1	FOAM, MIDDLE DOOR							
М	54760434	1	FOAM, TOP DOOR							
	22087514	1	FOAM , R.H. FRONT VERTICAL CORNER (IC	UNITS)						

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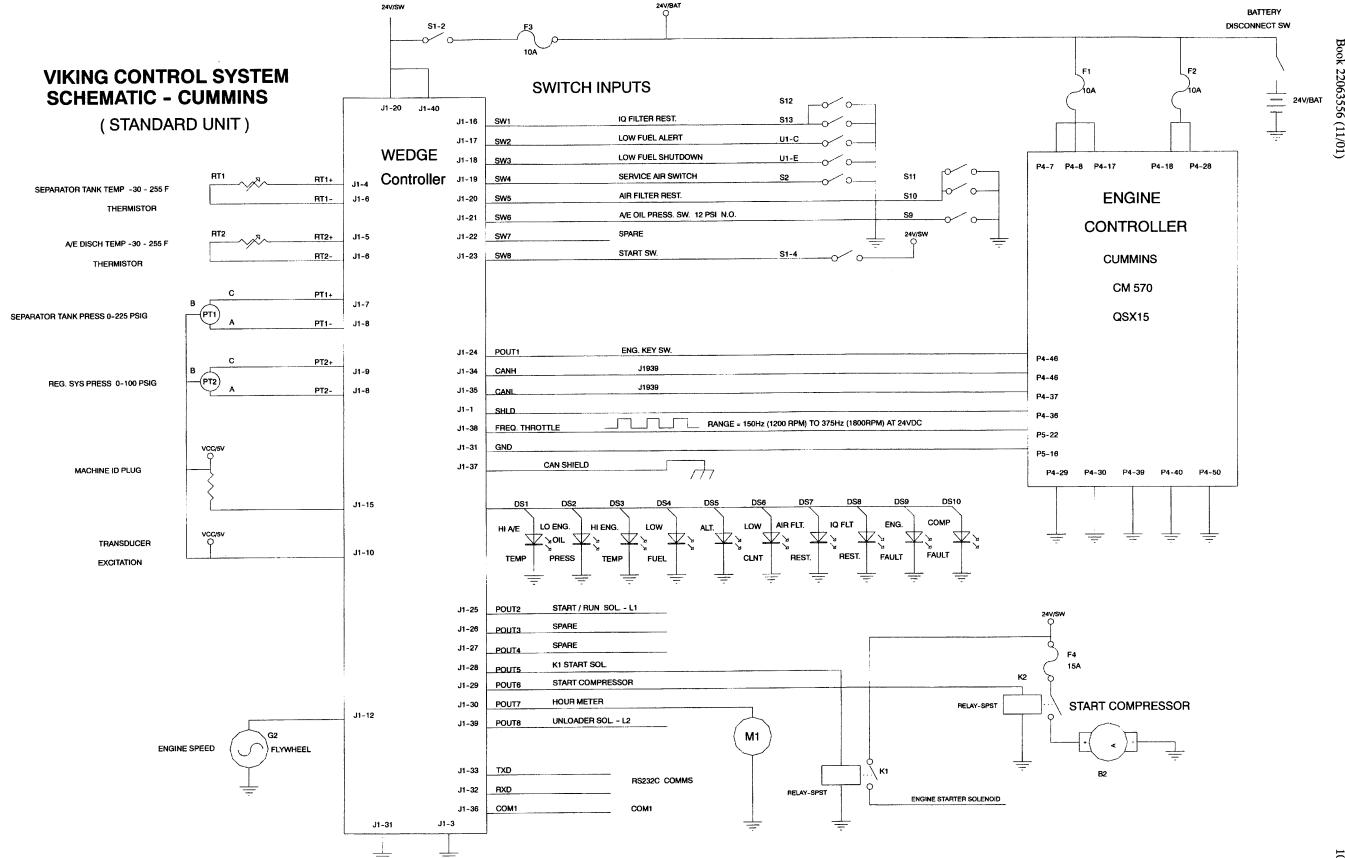
VIKING ELECTRICAL COMPONENTS

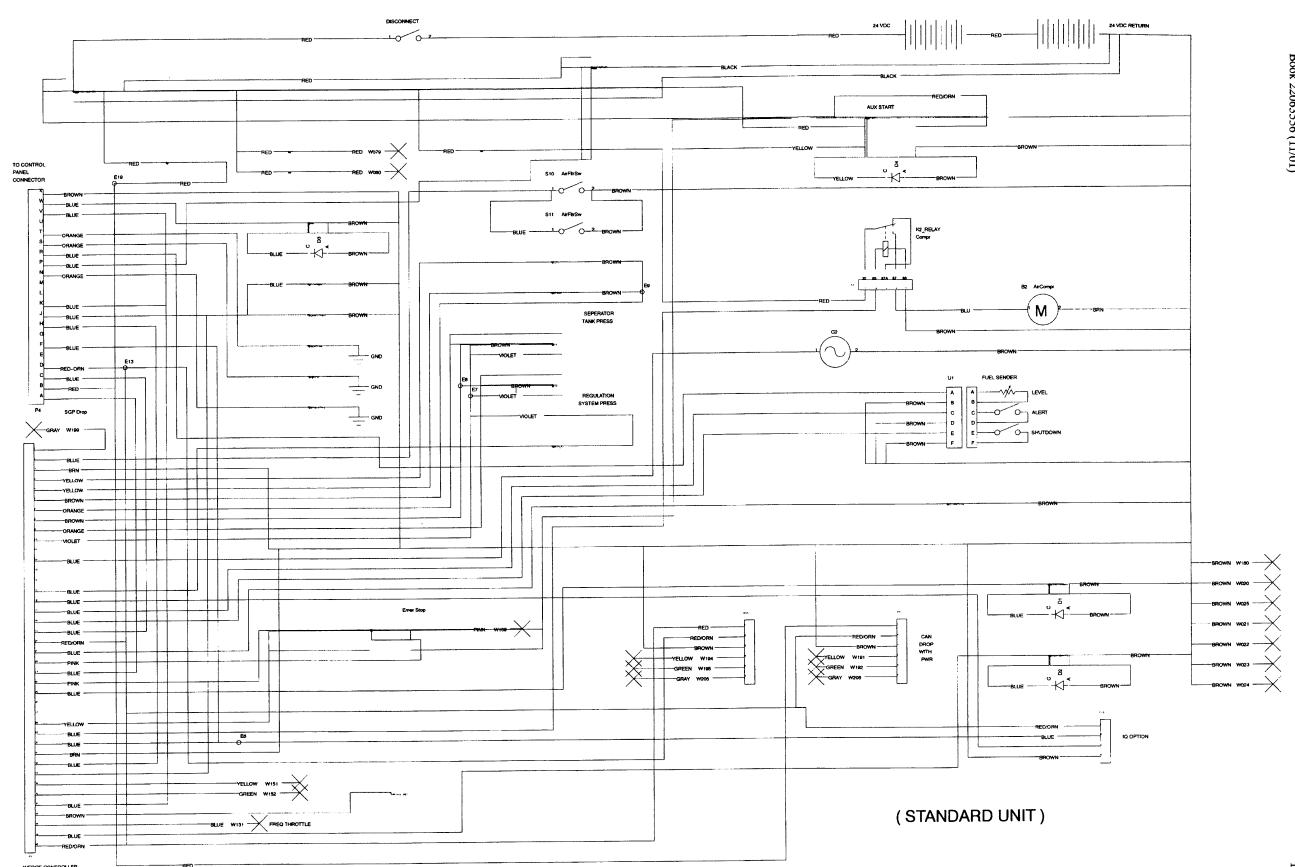
PART NO.	QTY	DESCRIPTION	PART NO.	QTY	DESCRIPTION
54757224	1	IQ WIRING HARNESS	35577873	1	AUXILARY START RELAY
54474572	1	COOLANT LEVEL SWITCH	54720701	1	ENG. TEMP. SENDER ADAPTOR
36896975	1	BATTERY DISCONNECT SWITCH	36841526	1	CONTROL ORIFICE HEATER
36920825	1	0-100 PSI PRESSURE TRANSDUCER	∺ 36864677	1	REGULATOR HEATER
→ 54765946	1	0-500 PSI PRESSURE TRANSDUCER	54765367	1	NEGATIVE BATTERY CABLE
36892362	1	24V SEALED RELAY	54765375	1	POSITIVE BATTERY CABLE
36785319	1	MAG SPEED SENSOR	54765383	1	POSITIVE JUMPER BATTERY CABLE
36898922	2	THERMISTOR TEMPERATURE PROBE	35128982	1	BATTERY JUMPER
 → 36842300	1	START / RUN SOLENOID	35578194	1	FRAME GROUND STRAP
 ★ 36842318	1	COMPRESSOR SOLENOID	35293075	1	ENGINE GROUND STRAP
★ ★36840841	2	SOLENOID VALVE	54672803	1	FUEL LEVEL SENDER (WAGON WHEEL)
36847838	2	AIR FILTER SWITCH	54672811	1	FUEL LEVEL SENDER (HIGH SPEED)
36870608	1	ENGINE OIL PRESSURE SENDER	54688411	1	WEDGE CONTROLLER
36841138	2	ENG. & COMP. TEMP SENDER	54654918	1	W1 CHASSIS HARNESS
★ ★36757581	1	COMP. OIL PRESSURE SWITCH	¥ 54765953	1	ADDRESS PLUG
36850691	1	START-UP COMPRESSOR	★ ★54765649	1	ADDRESS PLUG
★ ★54496773	1	0-225 PSI PRESS. TRANSDUCER	★ 36841526	1	REGULATOR-HEATER
36792083	2	FUSE 20 AMP BLADE			
22071591	2	FUSE 10 AMP BLADE			
35376169	4	DIODE			

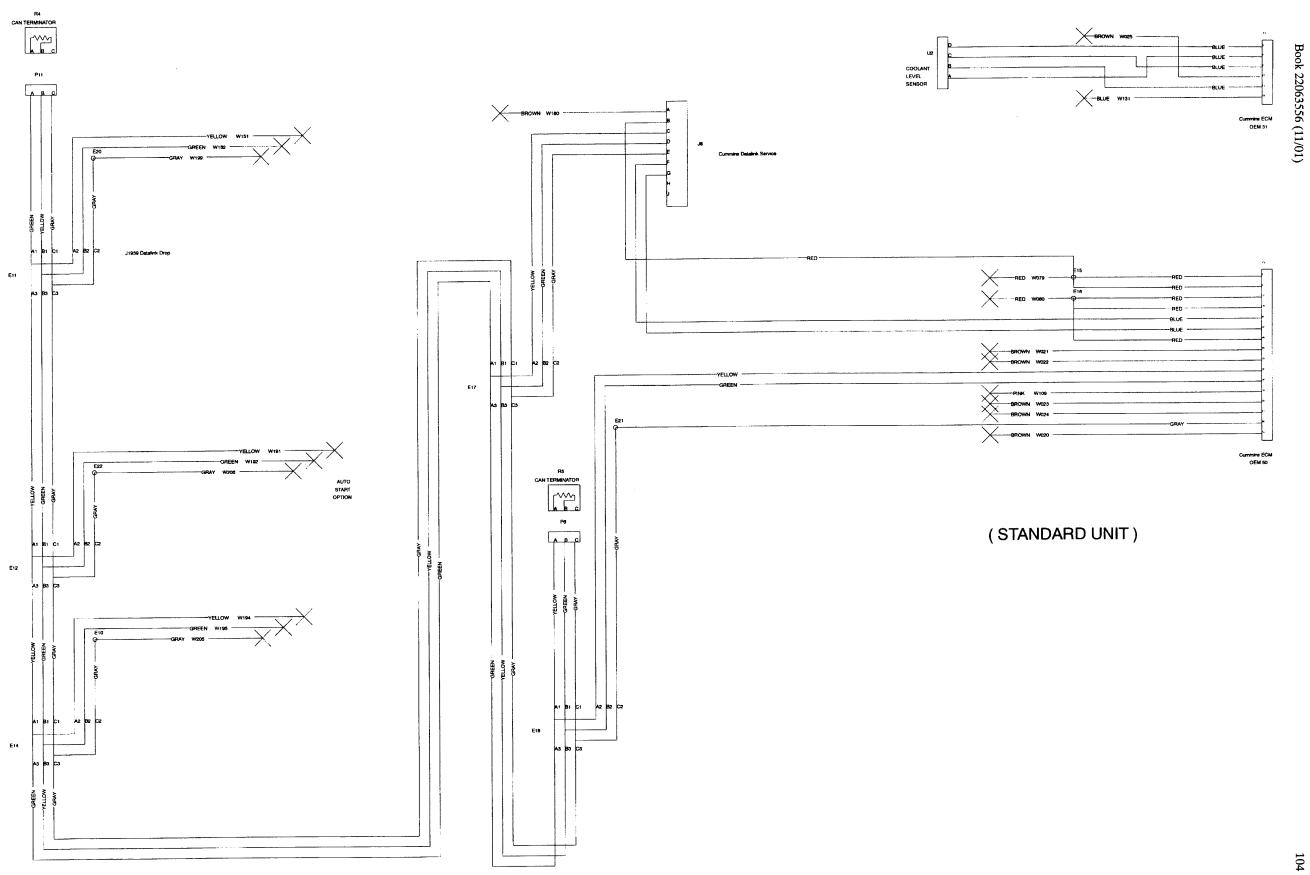
IQ OPTION				
PART NO.	QTY	DESCRIPTION		
54757224	1	IQ WIRING HARNESS		
54775887	1	IQ HEATER HARNESS		
36841526	5	IQ ORIFICE HEATERS		
36898310	1	ACTUATOR		
36898922	1	THERMISTOR TEMP. PROBE		
36892362	1	24V SEALED RELAY		
36920643	1	ICU		
36899599	1	IQ FILTER SWITCH		
36899615	1	IQ FILTER SWITCH		

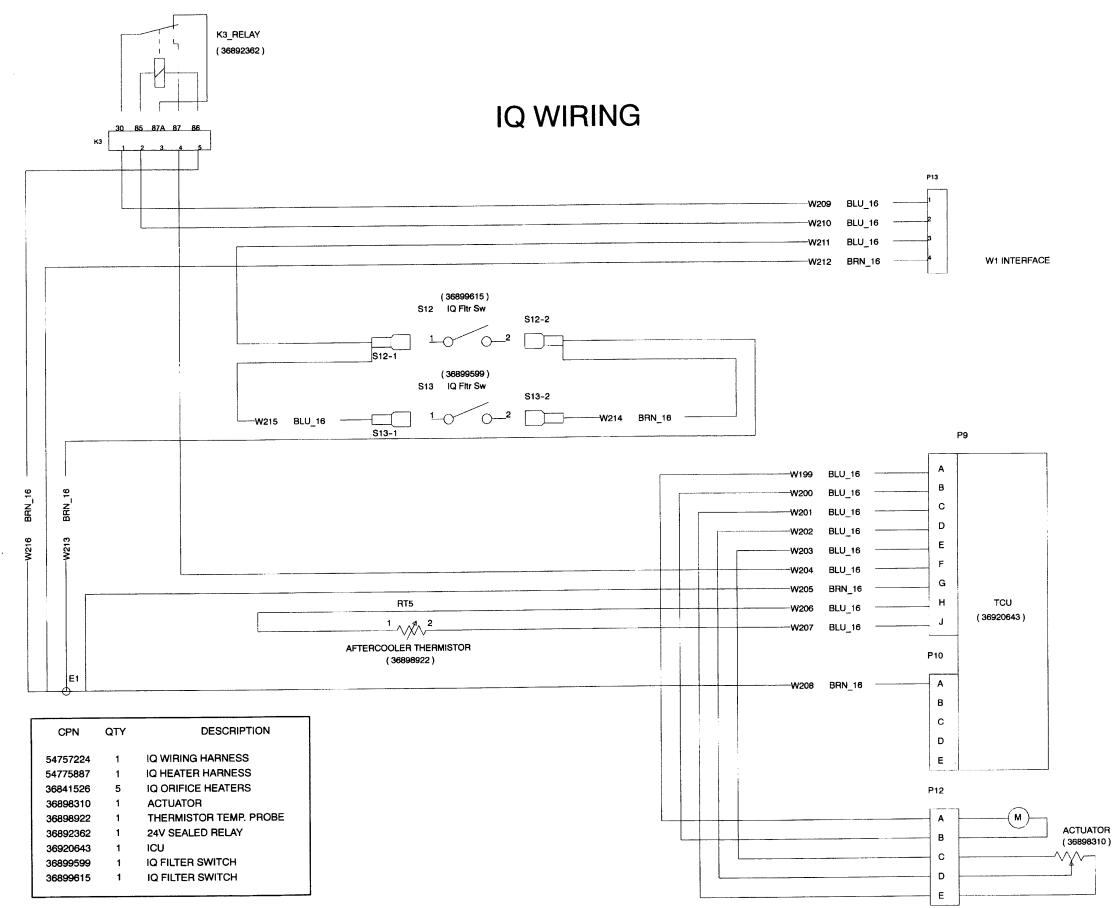
★ DENOTES XHP MACHINES ONLY★★ DENOTES HP MACHINES ONLY

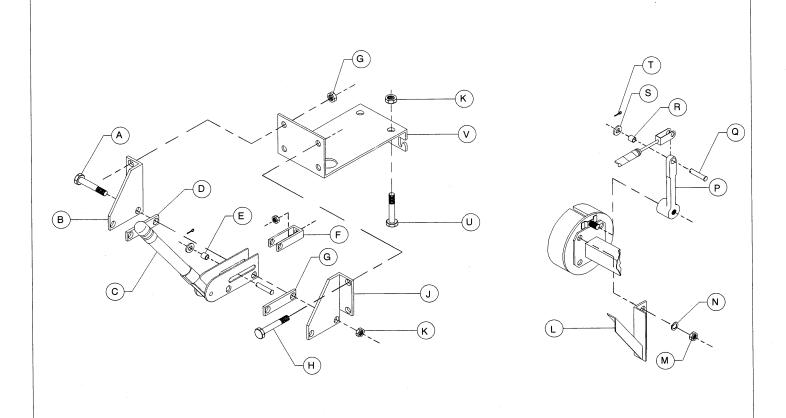
MANUAL NO. — DRAWING NO. DATE / REV: 22063556 38 09/01 A



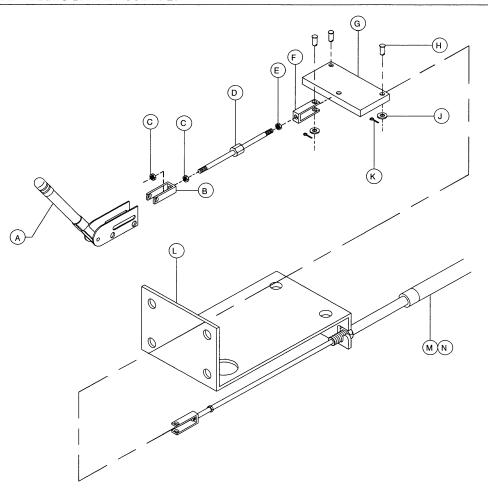






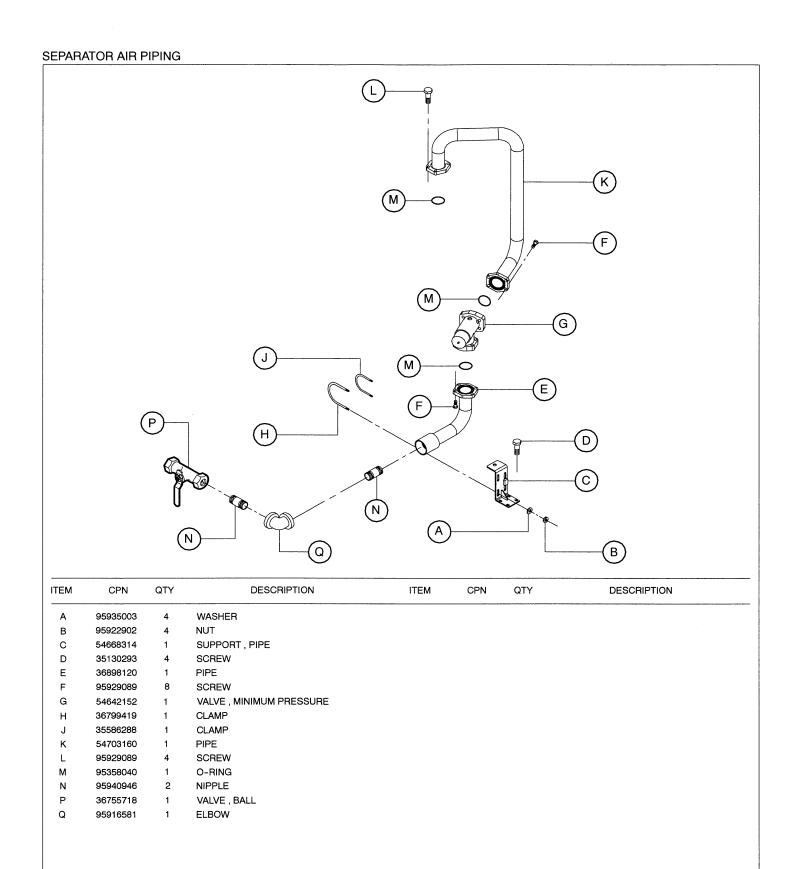


A 95941100 2 SCREW B 36847432 1 BRACKET, RH LEVER C 36782878 1 LEVER, BRAKE D 35603224 2 PLATE, SPACER E 2 FURNISHED WITH LEVER G 35525618 4 NUT H 36877793 4 SCREW J 36847440 1 BRACKET, LH LEVER K 36879195 4 NUT L 36786887 1 BRACKET, LH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, CLEVIS R 3680995 2 SCREW	ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
C 36782878 1 LEVER, BRAKE D 35603224 2 PLATE, SPACER E 2 FURNISHED WITH LEVER F 35603208 1 CLEVIS, BRAKE LEVER G 35252618 4 NUT H 36877793 4 SCREW J 36847440 1 BRACKET, LH LEVER K 36879195 4 NUT L 36786887 1 BRACKET, LH CABLE LATCH 36786895 1 BRACKET, RH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	Α	95941100	2	SCREW				
D 35603224 2 PLATE , SPACER E 2 FURNISHED WITH LEVER F 35603208 1 CLEVIS , BRAKE LEVER G 35252618 4 NUT H 36877793 4 SCREW J 36847440 1 BRACKET , LH LEVER K 36879195 4 NUT L 36786887 1 BRACKET , LH CABLE LATCH 36786895 1 BRACKET , RH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM , BRAKE Q 36763785 2 PIN , CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN , COTTER U 36880995 2 SCREW	В	36847432	1	BRACKET, RH LEVER				
E	С	36782878	1	LEVER , BRAKE				
F 35603208 1 CLEVIS , BRAKE LEVER G 35252618 4 NUT H 36877793 4 SCREW J 36847440 1 BRACKET , LH LEVER K 36879195 4 NUT L 36786887 1 BRACKET , LH CABLE LATCH 36786895 1 BRACKET , RH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM , BRAKE Q 36783785 2 PIN , CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN , COTTER U 36880995 2 SCREW	D	35603224	2	PLATE , SPACER				
G 35252618 4 NUT H 36877793 4 SCREW J 36847440 1 BRACKET, LH LEVER K 36879195 4 NUT L 36786887 1 BRACKET, LH CABLE LATCH 36786895 1 BRACKET, RH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	E		2	FURNISHED WITH LEVER				
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36786895 1 BRACKET, RH CABLE LATCH M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	K	36879195	4	NUT				
M 95916573 8 NUT N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	L	36786887	1	BRACKET , LH CABLE LATCH				
N 95934741 8 WASHER P 36782035 2 ARM, BRAKE Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW		36786895	1	BRACKET , RH CABLE LATCH				
P 36782035 2 ARM , BRAKE Q 36783785 2 PIN , CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN , COTTER U 36880995 2 SCREW	M	95916573	8	NUT				
Q 36783785 2 PIN, CLEVIS R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	N	95934741	8	WASHER				
R 36786697 2 BUSHING S 95935037 2 WASHER T 95928867 2 PIN, COTTER U 36880995 2 SCREW	Р	36782035	2	ARM , BRAKE				
S 95935037 2 WASHER T 95928867 2 PIN , COTTER U 36880995 2 SCREW	Q	36783785	2	PIN , CLEVIS				
T 95928867 2 PIN , COTTER U 36880995 2 SCREW	R	36786697	2	BUSHING				
U 36880995 2 SCREW	S	95935037	2	WASHER				
	Т	95928867	2					
V 36793306 1 BDACKET EBONT CABLE LATCH	U	36880995	2					
V 30763300 T BRACKET, THORT CABLE EXTOT	V	36783306	1	BRACKET , FRONT CABLE LATCH				
	MANUAL NO. 2063556		E/REV:					

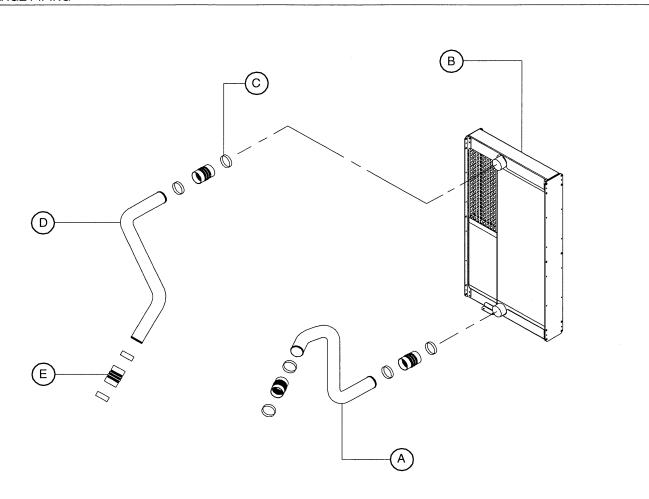


TEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36782878	1	LEVER , BRAKE				
В	35603208	1	CLEVIS , BRAKE LEVER				
С	35118728	2	NUT				
D	35603182	1	ROD , LINK				
E	95935086	2	NUT				
F	35603216	1	EQUALIZER , CLEVIS				
G	35602846	1	EQUALIZER , CABLE				
Н	35357151	3	PIN , CLEVIS				
J	95934998	3	WASHER				
K	95928867	з .	PIN, COTTER				
L	36783306	1	BRACKET, FRONT CABLE LATCH				
M	22064141	1	CABLE , LH BRAKE				
N	22064000	1	CABLE , RH BRAKE				

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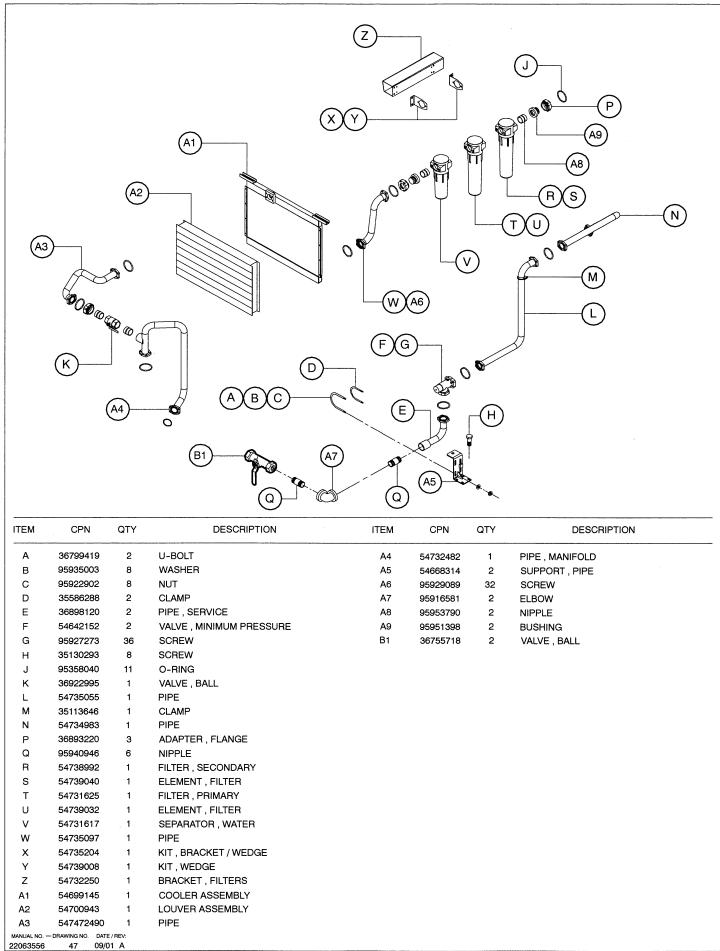


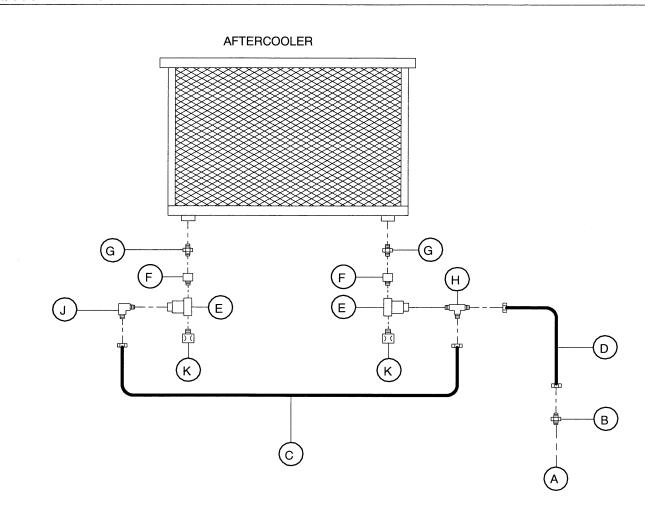
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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54632690	1	TUBE , BOTTOM A/C				
В	54501846	1	COOLER, AIR CHARGE				
С	54444427	8	CLAMP				
D	54632682	1	TUBE , UPPER A/C				
E	54422522	4	HOSE , RIBBED				

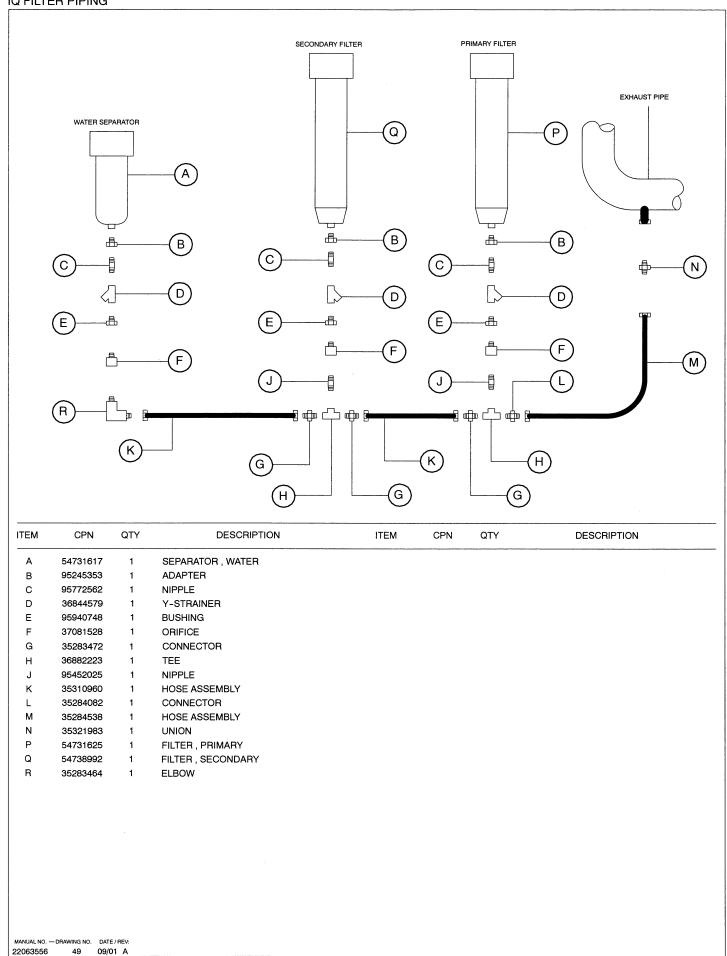
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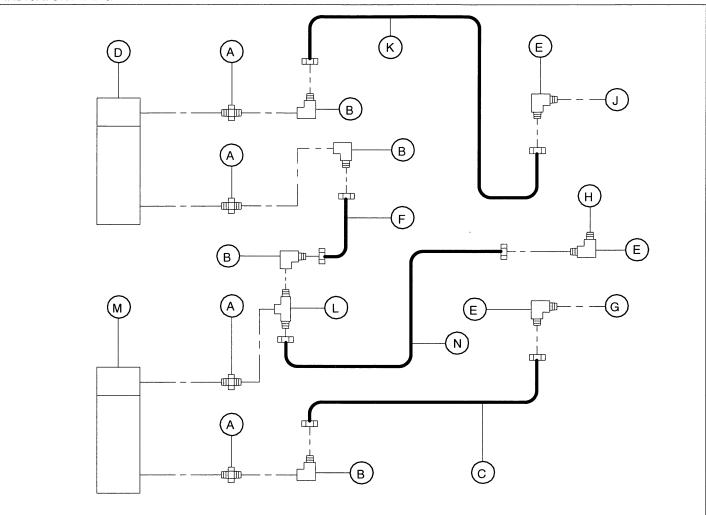




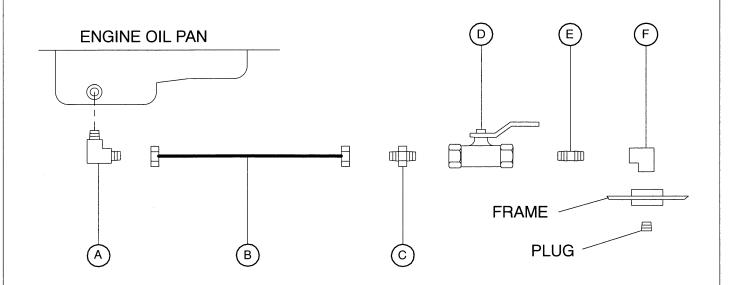
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	TO SIDE OU	JTLET OF	TEE LH SIDE OF AUTO-BLOWDOWN VALVE				
В	35284082	1	CONNECTOR				
С	36844074	1	HOSE ASSEMBLY				
D	35311471	1	HOSE ASSEMBLY				
Ε	35322379	1	VALVE , BLOWDOWN				
	35379064	1	DIAPHRAM KIT				
F	35367846	1	REDUCER				
G	35284082	1	CONNECTOR				
н	35306075	1	TEE				
J	35279934	1	ELBOW				
K	35248319	1	ORIFICE, .094				
	36898922	1	PROBE, TEMPERATURE				

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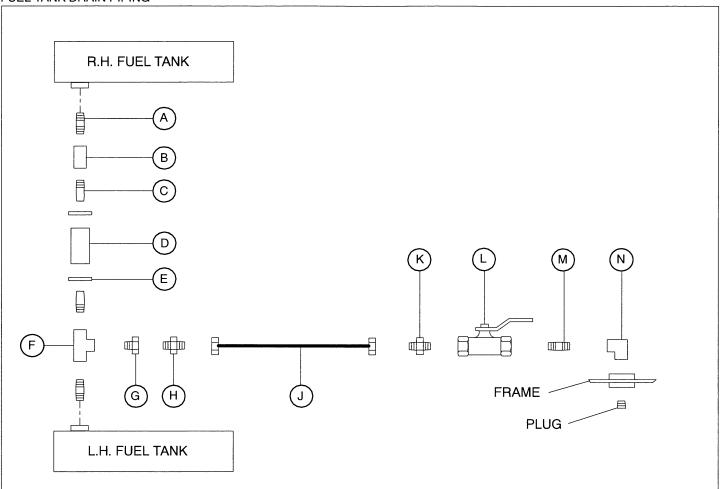


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	36898401	1	CONNECTOR				
В	35290352	1	ELBOW				
С	35310226	1	HOSE ASSEMBLY				
D	36899599	1	INDICATOR , 20 PSI				
E	35283464	1	ELBOW				
F	35310960	1	HOSE ASSEMBLY				
G	TO WATER	SEPARA	TOR TUBE				
Н	TO FILTER	CROSSO	VER TUBE				
J	TO FILTER	OUTLET :	TUBE				
K	35323757	1	HOSE ASSEMBLY				
L	35323591	1	TEE				
М	36899615	1	INDICATOR , 25 PSI				
N	36920650	1	HOSE ASSEMBLY				
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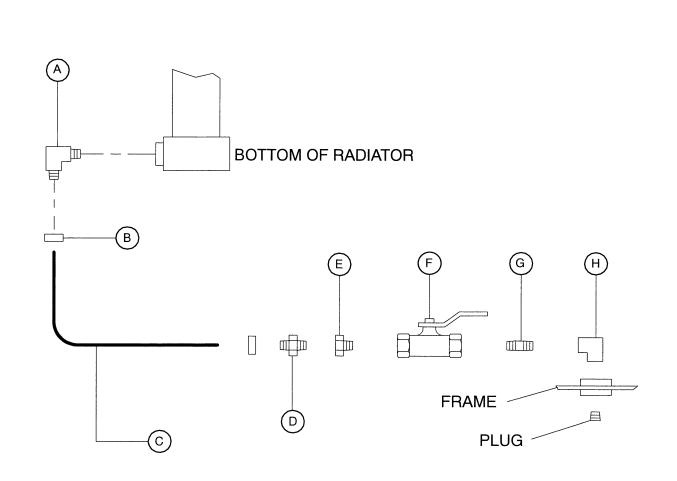


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	35294750	1	ELBOW				
В	35323880	1	HOSE ASSEMBLY				
С	95219747	. 1	CONNECTOR				
D	35576115	1	VALVE, BALL				
Ε	95647939	1	NIPPLE				
F	95928172	1	ELBOW				

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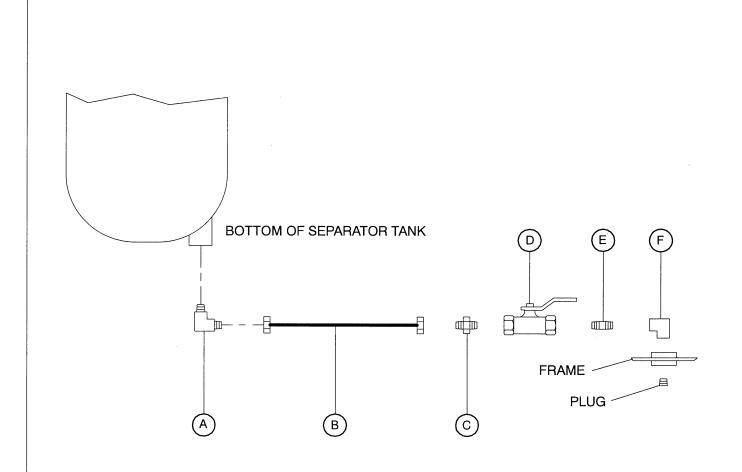


TEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	95953535	2	NIPPLE				
В	95937454	1	CONNECTOR				
С	54762190	2	FITTING, HOSE				
D	54762182	1	HOSE (19 INCHES)				
E	35221662	2	CLAMP				
F	95954285	1	TEE				
G	95953873	1	REDUCER				
Н	95219747	1	CONNECTOR				
J	36893828	1	HOSE ASSEMBLY				
K	95219747	1	CONNECTOR				
L	35576115	1	VALVE, BALL				
M	95647939	1	NIPPLE				
N	95928172	1	ELBOW				



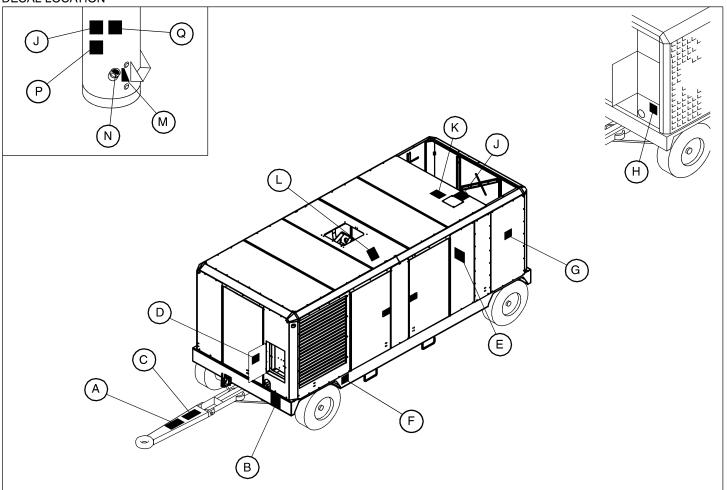
ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	35366665	1	ELBOW				
В	95220844	2	CLAMP				
С	35326578	1	HOSE (115 INCHES)				
D	35326560	1	FITTING , HOSE				
E	95953949	1	REDUCER				
F	35576115	1	VALVE, BALL				
G	95647939	1	NIPPLE				
н	95928172	1	ELBOW				

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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
A	35294750	1	ELBOW				
В	36878254	1	HOSE ASSEMBLY				
С	95219747	1	CONNECTOR				
D	35576115	1	VALVE, BALL				
E	95647939	1	NIPPLE				
F	95928172	1	ELBOW				

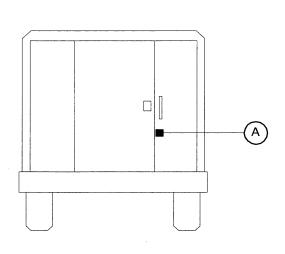
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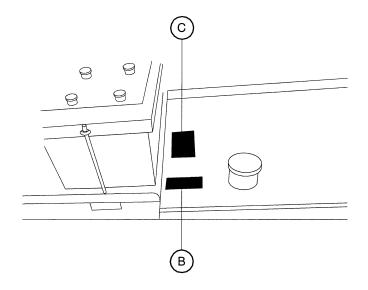


ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54568803	1	TOWING DECAL (HIGH SPEED RUNNING GE.	AR)			
В	54629902	1	3-PART WARNING DECAL				
С	22055701	1	TOWING DECAL (WAGON WHEEL)				
D	54568787	1	IMPROPER OPERATION DECAL				
Е	54568779	4	ROTATING FAN DECAL				
F	54749205	4	NO WELD DECAL				
G	54604939	4	FALL OFF UNIT DECAL				
Н	36514602	1	NOISE EMISSION DECAL				
J	54568761	2	HIGH PRESSURE FLUID DECAL				
K	54604962	1	RADIATOR FILL DECAL				
L	54699400	2	LIFT POINT DECAL				
М	22053847	1	OIL LEVEL DECAL				
N	54604970	1	OIL FILL DECAL				
Р	54568795	1	HIGH PRESSURE AIR DECAL				
Q	22054365	1	IQ OPERATION DECAL				

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ITEM	CPN	QTY	DESCRIPTION	ITEM	CPN	QTY	DESCRIPTION
Α	54604988	1	DOOR UNDER PRESSURE DECAL				
В	54625207	2	DIESEL FUEL DECAL				
С	54568753	1	BATTERY GAS DECAL				

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CATERPILLAR®

Operation and Maintenance Manual

C-15 and C-16 Industrial Engines

BEM1-Up (Engine) BFM1-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. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.

MARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

Operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

A 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.

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Foreword

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 Caterpillar 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 Caterpillar 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 extremely 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 generally accepted as proof of maintenance or repair. Your authorized Caterpillar 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 Caterpillar dealer. Your Caterpillar dealer offers a variety of options regarding overhaul programs. If you experience a major engine failure, there are also numerous after failure overhaul options available from your Caterpillar dealer. Consult with your dealer for information regarding these options.

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.

Battery posts, terminals and related accessories contain lead and lead compounds. **Wash hands after handling.**

Safety Section

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Safety Signs and Labels

SMCS Code: 1000; 7405

There may be several specific warning signs on an engine. The exact location of the hazards and the description of the hazards are reviewed in this section. Please become familiar with all warning signs.

Ensure that all of the warning signs are legible. Clean the warning signs or replace the warning signs if the words cannot be read or if the pictures are not visible. When the warning signs are cleaned, use a cloth, water, and soap. Do not use solvent, gasoline, or other harsh chemicals to clean the warning signs. Solvents, gasoline, or harsh chemicals could loosen the adhesive that secures the warning signs. The warning signs that are loosened could drop off of the engine.

Replace any damaged warning signs or missing warning signs. If a warning sign is attached to a part of the engine that is replaced, install a new warning sign on the replacement part. Any Caterpillar dealer can provide new warning signs.

A WARNING

Do not operate or work on this engine unless you have read and understand the instructions and warnings in the Operation and Maintenance Manual. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Caterpillar dealer for replacement manuals. Proper care is your responsibility.

The warning labels that may be found on the engine are illustrated and described below.

Starting Aids

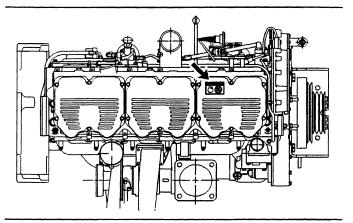


Illustration 1

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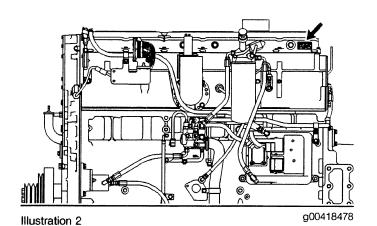
The warning label is located on the valve cover.



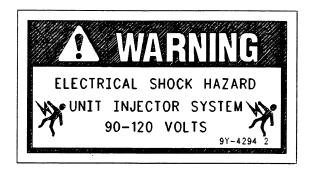
g00398202

If the engine is equipped with an air inlet heater, do not use aerosol starting aids such as ether for cold weather starting. Such use could result in an explosion and personal injury.

Unit Injector



The warning label for the unit injector is located on the valve cover base.



g00103125

WARNING

Electrical shock hazard. The electronic unit injector system uses 90-120 volts.

The Electronic Control Module (ECM) sends a high voltage signal to the injector solenoid. To help prevent personal injury, disconnect the electronic unit injector enable circuit connector. Do not come in contact with the electronic unit injector terminals while the engine is running.

Clutch

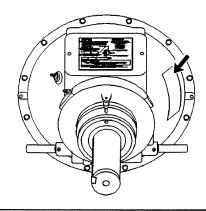
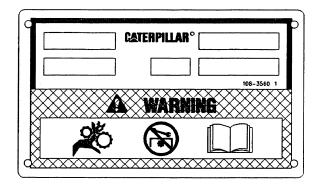


Illustration 3 g00107406

The warning label for the clutch is located on the clutch housing (if equipped).



g00107407

Rotating gears can cause finger entanglement or hand entanglement. Do not service this component without first reading the operator manual.

Engine Lifting

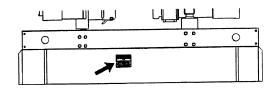


Illustration 4

g00367054

The warning label for lifting the engine with a fuel tank is located on the fuel tank (if equipped).



LIFT EYES OR TANK CAN FAIL WHEN LIFTING TANK CONTAINING FLUIDS RESULTING IN POSSIBLE PERSONAL INJURY. DRAIN TANK OF ALL FLUIDS BEFORE LIFTING.

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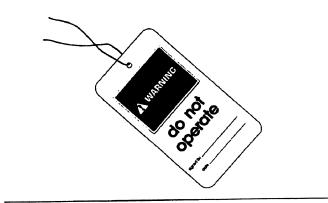
WARNING

Lift eyes or tank can fail when lifting tank containing fluids resulting in possible personal injury. Drain tank of all fluids before lifting.

i01377208

General Hazard Information

SMCS Code: 1000; 7405



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 it is appropriate, disconnect the starting controls.

Do not allow unauthorized personnel on the engine, or around the engine when the engine is being serviced.

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 located at opposite ends of the cover plate or the device. Before removing the last two bolts or nuts, pry the cover loose in order to relieve any spring pressure or other pressure.

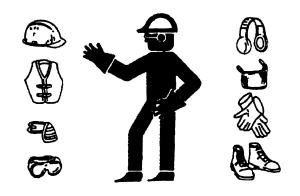


Illustration 6

g0070202

- Wear a hard hat, protective glasses, and other protective equipment, as required.
- When work is performed around an engine that is operating, wear protective devices for ears in order 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 in order 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.

Pressure Air and Water

Pressurized air and/or water can cause debris and/or hot water to be blown out. This could result in personal injury.

When pressure air and/or pressure 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

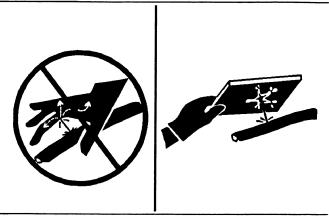


Illustration 7 g00687600

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 in order to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the engine. Prepare to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Tools and Shop Products Guide" for the following items:

- Tools that are suitable for collecting fluids and equipment that is suitable for collecting fluids
- Tools that are suitable for containing fluids and equipment that is suitable for containing fluids

Obey all local regulations for the disposal of liquids.

Asbestos Information

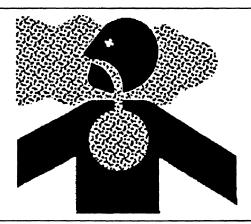


Illustration 8

g00702022

Caterpillar equipment and replacement parts that are shipped from Caterpillar are asbestos free. Caterpillar recommends the use of only genuine Caterpillar 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 in order 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 iobs.
- 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

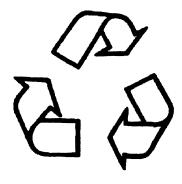


Illustration 9

g00706404

Improperly disposing of waste can threaten the environment. Potentially harmful fluids should be disposed of according to local regulations.

Always use leakproof containers when you drain fluids. Do not pour waste onto the ground, down a drain, or into any source of water.

i01480768

Burn Prevention

SMCS Code: 1000: 7405

Do not touch any part of an operating engine. Allow the engine to cool before any maintenance is performed on the engine. Relieve all pressure in the air system, in the hydraulic system, in the lubrication system, in the fuel system, or in the cooling system before any lines, fittings or related items are disconnected.

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 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 in order 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

Hot oil and hot lubricating components can cause personal injury. Do not allow hot oil to contact the skin. Also, do not allow hot components to contact the skin.

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.

i01372254

Fire Prevention and Explosion Prevention

SMCS Code: 1000; 7405



Illustration 10 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 fifteen 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 materials such as fuel, oil, and debris from the engine. Do not allow any flammable 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 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. All electrical wires must be 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.

Inspect all lines and hoses for wear or for deterioration. The hoses must be properly routed. The lines and hoses must have adequate support and secure clamps. Tighten all connections to the recommended torque. Leaks can cause fires.

Oil filters and fuel filters must be properly installed. The filter housings must be tightened to the proper torque.



Illustration 11

g00704059

g00704135

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.



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. This 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.

Use ether in well ventilated areas. Do not smoke while you are replacing an ether cylinder or while you are using an ether spray.

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

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

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

Lines, Tubes and Hoses

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

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

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

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

- End fittings are damaged or leaking.
- Outer coverings are chafed or cut.
- Wires are exposed.
- Outer coverings are ballooning.
- Flexible part of the hoses are kinked.
- Outer covers have embedded armoring.
- End fittings are displaced.

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

i01359666

Crushing Prevention and Cutting Prevention

SMCS Code: 1000; 7405

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

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

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

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

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

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

i01372247

Mounting and Dismounting

SMCS Code: 1000; 7405

Inspect the steps, the handholds, and the work area before mounting the engine. Keep these items clean and keep these items in good repair.

Mount the engine and dismount the engine only at locations that have steps and/or handholds. Do not climb on the engine, and do not jump off the engine.

Face the engine in order to mount the engine or dismount the engine. Maintain a three-point contact with the steps and handholds. Use two feet and one hand or use one foot and two hands. Do not use any controls as handholds.

Do not stand on components which cannot support your weight. Use an adequate ladder or use a work platform. Secure the climbing equipment so that the equipment will not move.

Do not carry tools or supplies when you mount the engine or when you dismount the engine. Use a hand line to raise and lower tools or supplies.

i01421840

Before Starting Engine

SMCS Code: 1000

Inspect the engine for potential hazards.

Before starting the engine, ensure that no one is on, underneath, or close to the engine. Ensure that the area is free of personnel.

Ensure that the engine is equipped with a lighting system that is suitable for the conditions. Ensure that all lights work properly.

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

Do not bypass the automatic shutoff circuits. Do not disable the automatic shutoff circuits. The circuits are provided in order to help prevent personal injury. The circuits are also provided in order to help prevent engine damage.

For the initial start-up of a new engine and for start-up of an engine that has been serviced, prepare to stop the engine if an overspeed occurs. This may be accomplished by shutting off the fuel and/or the air supply to the engine.

See the Service Manual for repairs and for adjustments.

i01103904

Engine Starting

SMCS Code: 1000

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

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

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

Always start the engine according to the procedure that is described in this Operation and Maintenance Manual, "Engine Starting" topic (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 properly, check the water temperature gauge and the oil temperature gauge during the heater operation.

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

Ether

Ether is poisonous and flammable.

Do not inhale ether, and do not allow ether to contact the skin. Personal injury could result.

Do not smoke while ether cylinders are changed.

Use ether in well ventilated areas.

Use ether with care in order to avoid fires.

Keep ether cylinders out of the reach of unauthorized persons.

Store ether cylinders in authorized storage areas only.

Do not store ether cylinders in direct sunlight or at temperatures above 49 °C (120 °F).

Discard the ether cylinders in a safe place. Do not puncture the ether cylinders. Do not burn the ether cylinders.

i01462046

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. This may be accomplished by shutting off the fuel supply to the engine and/or shutting off the air supply to the engine.

To stop an electronically controlled engine, cut the power to the engine.

i0148198

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 "—" jump start cable should be connected last from the external power source to the negative "—" terminal of the starting motor. If the starting motor is not equipped with a negative "—" terminal, connect the jump start cable to the engine block.

Check the electrical wires daily for wires that are loose or frayed. Tighten all loose electrical wires 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

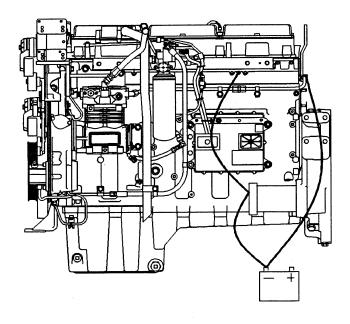


Illustration 13 Typical example Grounding Stud To Battery Ground

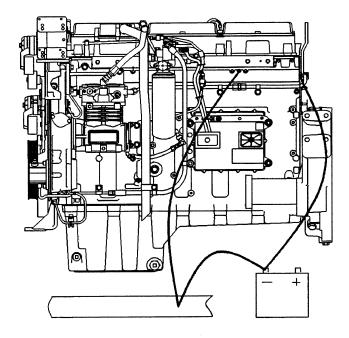


Illustration 14

g00771448

-

g00771487

Typical example

Alternate Grounding Stud To Battery Ground

Proper grounding for the engine electrical system is necessary for optimum engine performance and reliability. Improper grounding will result in uncontrolled electrical circuit paths and in unreliable electrical circuit paths.

Uncontrolled electrical circuit paths can result in damage to main bearings, to 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 properly, 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 starting motor ground, a starting motor ground to the frame, or a direct engine ground to the frame.

All grounds should be tight and free of corrosion. The engine alternator must be grounded to the negative "-" battery terminal with a wire that is adequate to handle the full charging current of the alternator.

i01563743

Engine Electronics

SMCS Code: 1000; 1400; 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.

This engine has a comprehensive, programmable Engine Monitoring System. The Engine 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, DERATE, and SHUTDOWN. These engine monitoring modes have the ability to limit engine speed and/or the engine power.

Many of the parameters that are monitored by the ECM can be programmed for the engine monitoring functions. The following parameters can be monitored as a part of the Engine Monitoring System:

- Operating Altitude
- Engine Coolant Level
- Engine Coolant Temperature
- Engine Oil Pressure
- Engine Speed
- Fuel Temperature
- Intake Manifold Air Temperature
- System Voltage

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 the Electronic Troubleshooting Manual for more information on the Engine Monitoring System.

Product Information Section

General Information

i01456258

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.

Proper welding procedures are necessary in order to avoid damage to the engine's 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 that is equipped with a Caterpillar 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.

- **1.** Stop the engine. Turn the switched power to the OFF position.
- 2. Disconnect the negative battery cable from the battery. If a battery disconnect switch is provided, open the switch.
- **3.** Disconnect the J1/P1 and J2/P2 connectors from the ECM. Move the harness to a position that will not allow the harness to accidentally move back and make contact with any of the ECM pins.

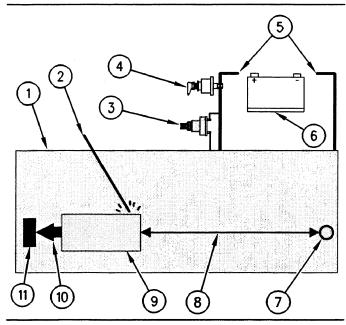


Illustration 15

g00765012

Use the example above. The current flow from the welder to the ground clamp of the welder will not cause damage to any associated components.

- (1) Engine
- (2) Welding rod
- (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) Maximum distance between the component that is being welded and any electrical/electronic component
- (9) The component that is being welded
- (10) Current path of the welder
- (11) Ground clamp for the welder
- 4. Connect the welding ground cable directly to the part that will be welded. Place the ground cable as close as possible to the weld in order to reduce the possibility of welding current damage to 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.

- **5.** Protect the wiring harness from welding debris and spatter.
- **6.** Use standard welding practices to weld the materials.

Model Views

i01504539

Model View Illustrations

SMCS Code: 1000

The following model views show typical C-15 and C-16 Industrial Engine features. Due to individual applications, your engine may appear different from the illustrations.

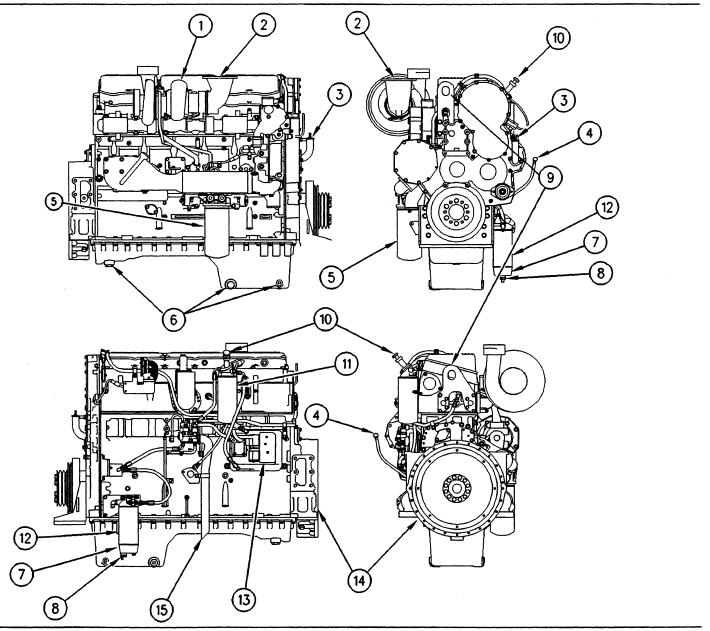


Illustration 16

(1) Turbocharger

(2) Exhaust

(3) Oil filler cap

(4) Oil level gauge

(5) Oil filter

(6) Oil drain plugs

(7) Water separator bowl

(8) Fuel drain

(9) Lifting eyes

(10) Fuel priming pump

(11) Secondary fuel filter

(12) Primary fuel filter

(13) Electronic Control Module (ECM)

(14) Flywheel housing

(15) Fumes disposal tube

g00677072

i01504551

Engine Description

SMCS Code: 1000

The Caterpillar C-15 and C-16 Industrial Engines provide the following features:

- Four cycle
- Direct fuel injection
- Mechanically actuated electronic unit injection
- Turbocharged
- Air-to-air aftercooled

Electronic Engine Features

The Caterpillar C-15 and C-16 Industrial Engines are designed for electronic controls. The integral on board computer controls the operation of the engine. Current 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 and auxiliary monitoring
- Engine speed governing
- Automatic air/fuel ratio control
- Torque rise shaping
- Injection timing control
- System diagnostics

An electronic governor controls the output of the unit injection pump. This maintains the desired rpm.

Electronically controlled, mechanically actuated unit injectors combine the pumping, the electronic fuel metering (duration and timing) and injecting elements. This produces very high injection pressures.

Each cylinder has one individual unit injection pump. Each unit injection pump meters the fuel. The unit injection pump also pumps the fuel under very high pressure to each cylinder. High injection pressures will help to reduce fuel consumption. The high injection pressures also help to reduce emissions. The use of this type of unit fuel injector provides total electronic control of injection timing. The injection timing varies with engine operating conditions. This optimizes the engine's performance for the following items: starting, emissions, noise, and fuel consumption.

These engines are equipped with a vandalism protection arrangement. The vandalism protection arrangement prevents any tampering of the fuel ratio control setting. This is required by emissions regulations. Standard bolts have been replaced by tamper resistant bolts.

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

Engine Cooling and Lubrication

The cooling system consists of the following components:

- Centrifugal pump that is driven by gears
- Water temperature regulators which regulate the engine coolant temperature
- Oil cooler

The engine lubricating oil, that is supplied by a gear type pump, is cooled. The engine lubricating oil is also filtered. Bypass valves provide unrestricted flow of lubrication oil to the engine components during the following conditions:

- High oil viscosity
- Plugged oil cooler or plugged oil filter elements (paper cartridge)

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.

C-15 Industrial Engines

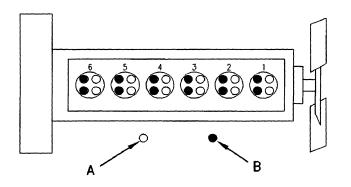


Illustration 17

g00284836

Cylinder and valve locations

- (A) Inlet valves (B) Exhaust valves

Table 1

C-15 Industrial Engine Specifications		
Cylinders and Arrangement	6 cylinder in-line block	
Bore	137 mm (5.4 inch)	
Stroke	165 mm (6.5 inch)	
Compression Ratio	16:25:1	
Aspiration	T(1), ATAAC(2)	
Displacement	14.6 L (893 in³)	
Firing Order	1-5-3-6-2-4	
Rotation (flywheel end)	Counterclockwise	
Valve Lash (inlet)	0.38 mm (.015 inch)	
Valve Lash (exhaust)	0.76 mm (.030 inch)	

- (1) Turbocharged
- (2) Air-to-air aftercooled

C-16 Industrial Engines

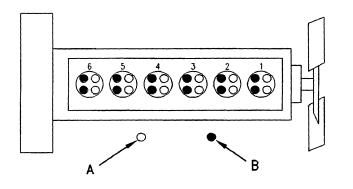


Illustration 18

g00284836

Cylinder and valve locations

- (A) Inlet valves (B) Exhaust valves

Table 2

C-16 Industrial Engine Specifications			
Cylinders and Arrangement	6 cylinder in-line block		
Bore	140 mm (5.5 inch)		
Stroke	171.0 mm (6.7 inch)		
Compression Ratio	15.9:1		
Aspiration	T(1)ATAAC@		
Displacement	15.8 L (964 in³)		
Firing Order	1-5-3-6-2-4		
Rotation (flywheel end) .	Counterclockwise		
Valve Lash (inlet)	0.38 mm (.015 inch)		
Valve Lash (exhaust)	0.76 mm (.030 inch)		

- (1) Turbocharged
- (2) Air-to-air aftercooled

Product Identification Information

i01484579

Engine Identification

SMCS Code: 1000

Caterpillar engines are identified with model numbers, and serial numbers, with performance specification numbers, and with arrangement numbers. These numbers are shown on the serial number plate that is mounted on the engine.

The numbers for fuel setting information for electronic engines are stored within the personality module. These numbers can be read by using Caterpillar electronic service tools.

Caterpillar dealers need these numbers in order to determine the components that were included with the engine. This permits accurate identification of replacement part numbers.

i00722073

Serial Number Plate

SMCS Code: 1000

ENGINE MODEL			
SERIAL NUMBER			
CATE	RPILLAR®	CAT®)
ARRANGEMENT NUMBER			
(ALWAYS GIVE MADE IN U.S.A.	ALL NUMBERS)	3N-3790 1	12

Illustration 19

g00123229

Typical serial number plate

The Serial Number Plate is located on the left side of the cylinder block near the rear of the engine.

The following information is stamped on the Serial Number Plate: engine serial number, model, and arrangement number.

i01441486

Information Plate

SMCS Code: 1000

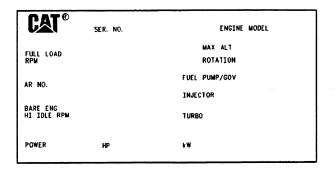


Illustration 20

g00755014

The Information Plate is on the valve cover. The following information is stamped on the Information Plate: engine's maximum altitude, horsepower, high idle, full load rpm, fuel settings, and other information.

i01462682

Reference Numbers

SMCS Code: 1000

Information for the following items may be needed to order parts. Locate the information for your engine. Record the information on the appropriate space. Make a copy of this list for a record. Retain the information for future reference.

Record for Reference

Engine Model
Engine Serial Number
Engine Arrangement Number
Modification Number
Programmed Engine Low Idle Speed
Programmed Engine High Idle Speed
Engine Full Load Speed
Programmed Top Engine RPM Limit
Programmed Engine Intermediate Speed
Performance Specification Number

Number for the Primary Fuel Filter
Number for the Water Separator Element
Number for the Secondary Fuel Filter Element
Number for the Lubrication Oil Filter Element
Number for the Auxiliary Oil Filter Element
Number for the Supplemental Coolant Additive Maintenance Element (If Equipped)
Total Lubrication System Capacity
Total Cooling System Capacity
Number of the Air Cleaner Element
Number of the Fan Drive Belt
Number of the Alternator Belt

i01542360

Emissions Certification Film

SMCS Code: 1000; 7405

Note: This information is pertinent in the United States and in Canada.

A typical example is shown.

CAT		CATERPILLAR INC. : Model : 3116 - Dis		ENGINE INFORMATION ALVE LASH: 0.38mm IN	2000 ITAKE 0.64mm EXHAU	JDM00001 st
ENGINE FAMILY XCPXL06.6MRB	MAXIMUM ADVERTISED kW (HP) 164 (220)	MAXIMUM RATED SPEED (RPM) 2600	MAXIMUM LOW IDLE SPEED (RPM) 875	MAX. FUEL RATE @MAXIMUM (mm/stroke) 104	MAXIMUM INITIAL TIMING DEGREES BTDC 11.5	ECHAUST EMISSION CONTROL SYSTEM EM.DI.TG.SPL.CAG
THIS 3116 EI	THIS 3116 ENGINE CONFORMS TO DIRECTIVE 97/69/EC FOR NON-ROAD ENGINES. EC TYPE APPROVAL NO. wirl 97/69/A4 *0001*00 THIS 3116 ENGINE CONFORMS TO 2000 U.S. EPA AND CALIFORNIA REGULATIONS LARGE NON-ROAD COMPRESSION-IGNITION ENGINES. THIS ENGINE IS CERTIFIED TO OPERATE ON COMMERICIALLY AVAILABLE DIESEL FUEL. DATE OF MANUFACTURE MONTH: 08 7E-8050 01					

FMT:3500

The EPA/EU Emissions Certification Film (if applicable) is located either on the side, the top, or the front of the engine.

CAT"	MODÈ	CATERPILLAR INC. LE MOTEUR : 3116 - I		N IMPORTANTE SUR LE MOTE APES : 0,38 mm ADMIS		PPEMENT
FAMILLE DE MOTEURS : XCPXL06.6MRB	Kw (HP) MAXI PUBLES : 164 (220)	MAXI RÉGIME NOMINAL (tr/mn) : 2600	MAXI RÉGIME RALENTI (tr/mn) : 875	MAXI DÉBIT D'INJ. A PUIS. MAXI (anti ³ /STROKE) (PISTON) : 104	MAXI CALAGE INITIAL D'INJ. (DEGRÉS) (AVANT PMH) : 11.5	DISPOSITIF ANT-POLLUANT: FM.DLTC.SPL.CAC
CE MOTEUR 3116 EST CONFORME AUX DIRECTIVES 97.88.4°C POUR LES MOTEURS NON ROUTIERS. CE MOTEUR 3116 EST CONFORME AUX RÉGLEMENTATIONS 2000 DE L'AGENCE AMÉRICAINE DE PROTECTION E CE MOTEUR EST HOMOLOGUÉ POUR FONCTIONNER AVEC LE CARBURANT DIESEL DU COMMERGE. DATE DE FABRICATION (MOIS) 08						I Moteurs non routiers à compression-contact.

Étiquette d'homolegation anti-pollution

i01462732

L'autocollant d'homologation du dispositif antipollution EPA/EU (selon équipement) est situé soit sur le côté du moteur, soit sur le dessus du moteur, soit sur le devant du moteur.

Illustration 21

g00776690

Customer Specified Parameters

SMCS Code: 1000

To record programmed specifications, use the following blanks.

Customer Passwords

- First Password ______
- Second Password ______

Power Rating (hp at rpm) _____

Datina	Salastian	
rauna	Selection	

Air/Fuel Ratio

Parameters for the PTO Engine Governor

PTO Speed Ramp Rate _____ rpm/sec

Engine Parameters

- Top Engine Limit (TEL) at 100 percent load (If Applicable)
- Torque Limit _______
- High Idle (If Applicable) ______
- Low Idle _____

Product Information Section
Product Identification Information

Operation Section

Lifting and Storage

i01028344

Engine Lifting

SMCS Code: 1000; 1122

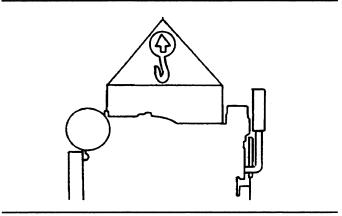


Illustration 22

g00103219

NOTICE

Never bend the eyebolts and the brackets. 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.

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.

Some removals require lifting the fixtures in order to obtain proper balance and safety.

To remove the engine ONLY, use the lifting eyes that are on the engine.

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. Consult your Caterpillar dealer for information regarding fixtures for proper engine lifting.

i00777190

Engine Storage

SMCS Code: 1000

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 of the lubrication recommendations that are listed in this Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section).
- If freezing temperatures are expected, check the cooling system for adequate protection against freezing. See this Operation and Maintenance Manual, "General Coolant Information" (Maintenance Section).

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 one month, a complete protection procedure is recommended.

For more detailed information on engine storage, see Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products".

Your Caterpillar dealer can assist in preparing the engine for extended storage periods.

Gauges and Indicators

i01456082

Gauges and Indicators

SMCS Code: 1900; 7450

Your engine may not have the same gauges or all of the gauges that are described. For more information about the gauge package, see the literature that is from the OEM of the vessel.

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 of time.

Noticeable changes in gauge readings indicate a potential problem with a gauge or with the engine. Problems may also be indicated by gauge readings that change even if the readings are within specifications. Determine the cause of any significant change in the readings and/or correct the cause of any significant change in the readings. Consult your Caterpillar dealer for assistance. Caterpillar requires two lamps in addition to the gauge package that is normally provided.

The "Diagnostic" lamp is yellow or amber. The "Diagnostic" lamp will communicate the status of the electronic system of the engine.

The "Warning" lamp is red. This red "Warning" lamp warns the operator of engine problems.

The following conditions are some examples of the problems:

- low oil pressure
- high coolant temperature
- low coolant level
- high inlet air temperature

NOTICE

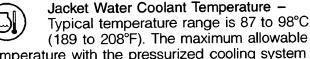
Be ready to activate the engine shutoff manually, if there is no oil pressure. Damage to the engine will result if the engine continues to run without the correct oil pressure.

Engine Oil Pressure - Typical oil pressure for an engine at rated speed with SAE 10W30 or with SAE 15W40 is 275 to 606 kPa (40 to 88 psi).

A lower oil pressure is normal at low idle. If the load is stable and the gauge reading changes, perform the following procedure:

- 1. Remove the load.
- 2. Reduce engine speed to low idle.
- 3. Shut down the engine, and allow time for the oil to settle back into the engine oil pan.
- 4. Check the oil level. Maintain the oil level at the proper amount.

The diagnostic lamp will turn on if the oil pressure drops below a safe range. A safe range for the oil pressure is determined by the engine protection package. The diagnostic code will be logged in the Engine Control Module (ECM).



temperature with the pressurized cooling system is 102°C (216°F). Higher temperatures may occur under certain conditions. The water temperature reading may vary according to load. The reading should never exceed the boiling point for the pressurized system that is being used.

If the engine is operating above the normal range and steam becomes apparent, perform the following procedure:

- 1. Reduce the load and the engine speed.
- 2. Inspect the cooling system for leaks.
- 3. Determine if the engine must be shut down immediately or if the engine can be cooled by reducing the load.



System Voltage – This gauge indicates the amount of charge or discharge in the battery charging circuit.

Tachometer - This gauge indicates engine speed. When the throttle is moved to the full throttle position without load, the

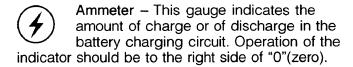
engine is running at high idle. The engine is running at the full load rpm when the throttle is at the full throttle position with maximum rated load.

NOTICE

Engine overspeed may cause serious damage.

Keep the tachometer indicator in the green operating range.

Note: The high idle rpm and the full load rpm are stamped on the Information Plate.



Fuel Level – This gauge indicates the fuel level in the fuel tank. The fuel level gauge is electrically operated. The fuel level gauge only registers the fuel level when the "START/STOP" switch is "ON".

Service Hour Meter – This gauge indicates the total number of hours of engine operation. Hours of operation are logged in the ECM. A service tool is needed to retrieve the hours from the ECM. A Service Hour Meter may be installed on the engine.

Fuel Pressure – This gauge indicates fuel pressure to the electronic unit injectors from the fuel filter. The indicator should indicate the "NORMAL" range. Typical fuel pressure at low idle is 310 kPa (45 psi). Typical operating fuel pressure is 515 kPa (75 psi). Minimum fuel pressure is 240 kPa (35 psi) when the engine is under load. Maximum fuel pressure is 690 kPa (100 psi) when the engine is under load. A decrease in fuel pressure usually indicates a plugged fuel filter.

Inlet Air Temperature – This gauge indicates inlet manifold air temperature. As the inlet air increases in temperature the following conditions occur: expansion of the air, less oxygen in the cylinders, and less available power. If the temperature of the inlet air is too high during full speed and load operation, the engine may be overfueled. Maximum inlet manifold air temperature is 85°C (185°F).



Exhaust Stack Temperature – This gauge indicates exhaust gas temperature.

Features and Controls

i00810663

Monitoring System

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

A WARNING

If the Shutdown mode has been selected and the warning indicator activates, engine shutdown may take as little as 20 seconds from the time the warning indicator is activated. Depending on the application, special precautions should be taken to avoid personal injury. The engine can be restarted following shutdown for emergency maneuvers, if necessary.

NOTICE

The Engine Monitoring System is not a guarantee against catastrophic failures. Programmed delays and derate schedules are designed to minimize false alarms and provide time for the operator to stop the engine.

Programmable features monitor the following conditions:

- Coolant temperature
- Oil pressure
- Inlet manifold air temperature (if equipped)
- Cooling system level (if equipped)
- Fuel temperature
- Fuel pressure (if equipped)

Coolant Level Sensor (If Equipped)

Note: The coolant level sensor is an optional feature.

The system can be programmed with one of the following options:

"ENABLED" – The system will monitor the input from the coolant level sensor. The system is programmed to this value when the engine is shipped by Caterpillar.

"DISABLED" – The system will not monitor the input from the coolant level sensor.

Programmable Options and Systems Operation

A WARNING

If the Warning/Derate/Shutdown mode has been selected and the warning indicator activates, bring the engine to a stop whenever possible. Depending on the application, special precautions should be taken to avoid personal injruy.

The engine can be programmed to the following modes:

- "OFF"
- "Warning"
- "Warning/Derate"
- "Warning/Derate/Shutdown"

"Warning"

The "DIAGNOSTIC" lamp and the warning signal (red lamp or buzzer) turn "ON" and the warning signal is activated continuously in order to alert the operator that one or more of the engine parameters is not within normal operating range.

"Warning/Derate"

The "DIAGNOSTIC" lamp turns "ON" and the warning signal (red lamp or buzzer) is activated. After the warning, the engine will derate rpm and power. The warning lamp will begin to flash when the derating occurs.

When the engine is fully derated, the engine power is limited to 120 kW (160 hp). During a low oil pressure condition, the engine can be limited to 1350 rpm.

"Warning/Derate/Shutdown"

The "DIAGNOSTIC" lamp turns "ON" and the warning signal (red lamp or buzzer) is activated. After the warning, the engine will derate rpm and power. The engine will continue to derate rpm until shutdown of the engine occurs. The engine can be restarted after a shutdown for use in an emergency

A shutdown of the engine may occur in as little as 20 seconds. The engine can be restarted after a shutdown for use in an emergency. However, the cause of the initial shutdown may still exist. The engine may shut down again in as little as 20 seconds.

If there is a signal for coolant loss, there will be a 10 second delay in order to verify the condition. The system will derate the engine rpm for 40 seconds before the engine will shut down if the engine has been programmed to shut down.

If there is a signal for low oil pressure or for coolant temperature, there will be a two second delay in order to verify the condition. The system will derate the engine rpm for 30 seconds before the engine will shut down if the engine has been programmed to shutdown.

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

Note: The Customer Specified Parameters may be secured by customer passwords. The engine may have all of the parameters that are programmed or any combination of the parameters that are programmed. Refer to the Operation and Maintenance Manual, "Customer Specified Parameters" topic (Product Information Section) for more information on the programmed parameters of the engine. Refer to the Electronic Troubleshooting for more information.

i01582172

Sensors and Electrical Components

SMCS Code: 1900; 7400

Your engine may be equipped with various optional engine features and controls that are not pictured here. This section discusses the general information about various features and the engine control systems.

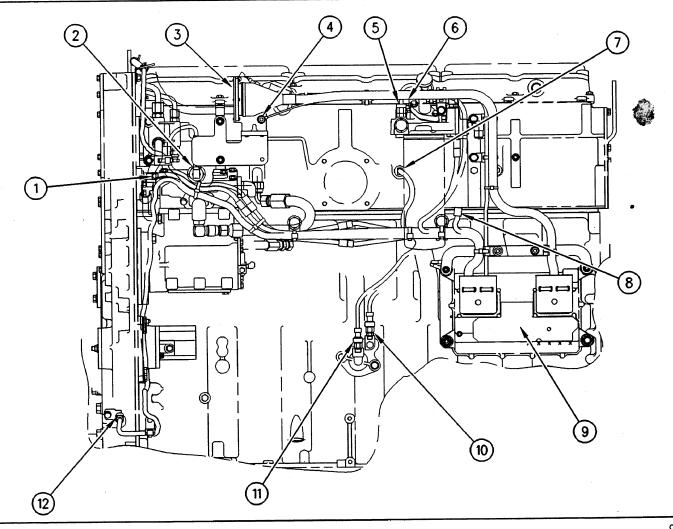


Illustration 23

- Secondary speed/timing sensor
 Inlet manifold boost pressure sensor
 Customer connector
 Electronics ground stud

- (5) Fuel pressure sensor(6) Fuel temperature sensor
- (7) Inlet manifold temperature sensor (8) TDC probe connector

- (9) Electronic control module (ECM)(10) Engine oil pressure sensor(11) Atmospheric pressure sensor(12) Primary speed/timing sensor

g00764826

Coolant Temperature Sensor

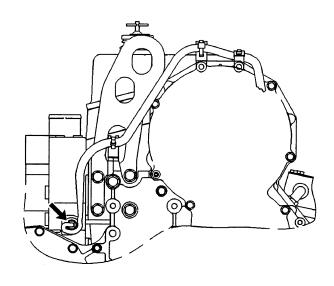


Illustration 24
Location of the coolant temperature sensor

The engine coolant temperature sensor monitors the temperature of the engine coolant. The coolant temperature signal is sent to the Electronic Control Module (ECM) for engine monitoring and for improved engine control. The signal is used by the ECM for all of the following engine functions:

- Engine timing control
- Engine operating mode
- Engine protection

The ECM is capable of adjusting the engine timing relative to the engine operating temperature. The concept of dynamic timing provides the engine with the ability to control exhaust emissions. Timing control also aids in white smoke cleanup during cold engine operation.

The ECM also uses the signal from the engine coolant temperature sensor to determine the mode of operation for the engine. Several aspects of engine operation are affected by the engine operating mode: acceleration ramp rates, engine timing, and fuel injector timing

High Coolant Temperature Warning

Excessive engine coolant temperature is an undesirable operating condition. Serious damage to the engine can result if an engine is allowed to overheat. The "High Engine Coolant Temperature" parameter for the programmable monitoring system must be programmed to "Derate" or "Shutdown" in order to protect the engine against damage from overheating.

Coolant Level Sensor

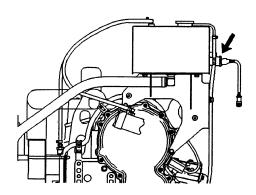


Illustration 25

g00764853

Typical example

Location of the coolant level sensor

The coolant level sensor is an optional sensor. This sensor monitors the engine coolant level in the cooling system expansion tank. The coolant level sensor signal is sent to the ECM for the purpose of engine monitoring.

Low Coolant Level Warning

Low engine coolant level is an undesirable operating condition. Serious damage to the engine can result if the coolant level is too low and the engine is allowed to overheat. The "Low Coolant Level" parameter for the programmable monitoring system must be programmed to "Derate" or "Shutdown" in order to protect the engine against damage from a low coolant level.

g00761897

Engine Oil Pressure Sensor

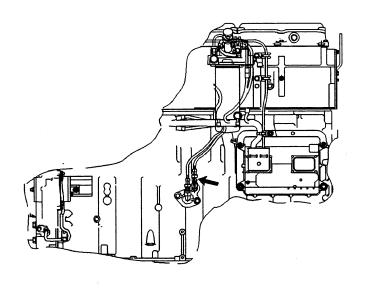


Illustration 26 g00764686

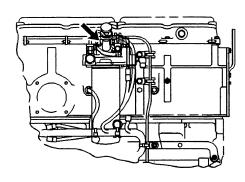
Location of the engine oil pressure sensor

The engine oil pressure sensor provides an oil pressure signal to the Electronic Control Module (ECM) for the purpose of engine monitoring. The electronic signal is compared to an Oil Pressure Map that is stored in ECM memory. The Oil Pressure Map is derived from a direct relationship between engine speed and the oil pressure that is expected at that speed. The engine monitoring system records a low engine oil pressure condition in ECM memory if the sensor value is not within the proper range.

Low Oil Pressure Warning

Low engine oil pressure is an undesirable operating condition. When a low oil pressure condition exists in the engine, there is a possibility of damage to major engine components. The "Low Engine Oil Pressure" parameter for the programmable monitoring system must be programmed to "Derate" or "Shutdown" in order to protect the engine against damage from low engine oil pressure.

Fuel Temperature Sensor



g00764773

Illustration 27
Location of the fuel temperature sensor

The fuel temperature sensor monitors the inlet fuel temperature. The Electronic Control Module (ECM) utilizes the signal from the fuel temperature sensor to provide fuel temperature compensation for the engine fuel control system. Fuel temperature compensation provides the following benefits:

- Rated engine horsepower regardless of fuel temperature
- Highly accurate fuel rates and fuel consumption rates
- Optimum fuel economy

Changes in the temperature of the fuel affects the power output of the engine. The ECM adjusts the engine fuel rate according to the temperature of the fuel. This feature allows full engine power to be realized by the operator at any fuel temperature.

Fuel temperature will also affect the calculation of fuel consumption rate that is performed by the ECM. The ECM utilizes the fuel temperature signal to provide an adjusted value for these calculations.

High Fuel Temperature Warning

High fuel temperature is an undesirable operating condition. The "High Fuel Temperature" parameter for the programmable monitoring system must be programmed to "Derate" or "Shutdown" in order to protect the engine.

Fuel Pressure Sensor

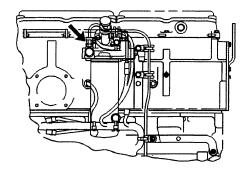


Illustration 28
Location of fuel pressure sensor

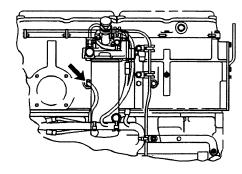
g00764778

The fuel pressure sensor monitors filtered fuel pressure. Although fuel pressures that are outside the normal operating range may adversely affect engine performance, there should not be any noticeable reduction in the engine horsepower. Abnormal fuel pressure will not cause an engine shutdown. A low filtered fuel pressure may indicate that the low pressure fuel system requires maintenance.

The fuel pressure sensor measures the fuel pressure after the fuel has been filtered. The sensor connector for the fuel pressure sending unit is located on the machine side of the machine connector. For more information, refer to the Troubleshooting Guide for this engine.

For more information on fuel system maintenance, refer to the maintenance section in this Operation and Maintenance Manual.

Air Inlet Temperature Sensor



g00764780

temperature of the air that is passing through the inlet manifold. A signal is sent to the Electronic Control Module (ECM) for interpretation.

The air inlet temperature sensor detects the

The ECM uses the information from the inlet air temperature sensor in order to accurately control the emissions levels of the engine. As the inlet air temperature changes, the fuel injection timing is advanced. This is done in order to maintain the exhaust emission standards.

High Air Inlet Temperature Warning

Excessive inlet air temperature is an undesirable operating condition. The "High Engine Air Inlet Temperature" parameter for the programmable monitoring system must be programmed to "Derate" in order to protect the engine.

Atmospheric Pressure Sensor

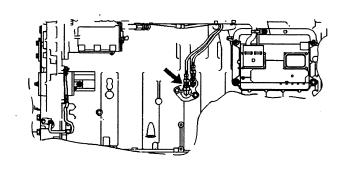


Illustration 30

g00764782

Location of the atmospheric pressure sensor

The atmospheric pressure sensor measures the pressure in the crankcase. This sensor assumes that crankcase pressure is a representation of atmospheric pressure. A signal is sent to the Electronic Control Module (ECM).

The ECM utilizes the value that is read by the atmospheric pressure sensor for the following functions:

- Reference source for pressure sensor calibrations
- Calculating the operating altitude
- Calculating boost pressure
- · Checking for air inlet restriction

Illustration 29
Location of the air inlet temperature sensor

When the ECM is powered, all of the pressure sensors that are used for engine monitoring receive an automatic calibration. The ECM uses the value that is received from the atmospheric pressure sensor to calculate the pressure offset value.

The ECM also utilizes atmospheric pressure to determine the active engine derate during high elevation operation. The engine monitoring system compares the current atmospheric pressure value to the programmed derate setpoint. The engine is derated by limiting the fuel delivery at a rate of approximately 3 percent for each 304 m (1000 ft) of elevation.

Actual boost pressure is calculated by the ECM. The difference between the turbocharger outlet pressure and the atmospheric pressure is equal to the actual boost pressure. Boost pressure is used for calculating fuel system adjustments.

i01516479

Alarm Switches

SMCS Code: 1900; 7400

Engines may be equipped with alarms in order to alert the operator when undesirable operating conditions occur. When an alarm is activated, corrective measures must be made before the situation becomes an emergency.

Alarm systems are electrically operated. The operation of all electric alarms utilize components that actuate switches in a sensing unit.

Alarms are set at critical operating conditions for the following items:

- operating temperatures
- operating pressures
- operating levels
- operating speeds

A history of all of the engine faults and events are maintained in the Electronic Control Module (ECM). These faults can be either Active Codes or Logged Codes. Refer to the Operation and Maintenance Manual for the definitions of the codes.

System diagnostics can be connected to a visual signal (lamp) and/or an audio signal (bell or horn). The signal will continue until the condition is corrected.

A switch may be installed in the alarm circuit in order to disable the alarm signal while the engine is stopped for repairs. Ensure that the alarm switch is reset after repairs have been made.

Speed Sensing Loss Alarm

SMCS Code: 1900; 1907; 1912

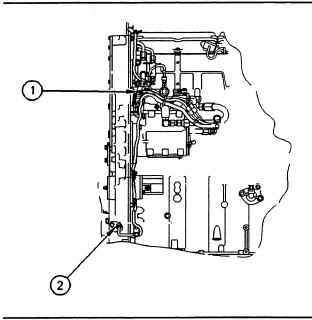


Illustration 31

g00764795

- (1) Secondary speed-timing sensor
- (2) Primary speed-timing sensor

If primary speed-timing sensor (2) cannot sense engine speed, the "DIAGNOSTIC" lamp will indicate a diagnostic fault code. The diagnostic fault code will be logged in the memory of the Electronic Control Module.

If primary speed-timing sensor (2) cannot sense engine speed, the automatic default will use secondary speed-timing sensor (1). The secondary speed-timing sensor will be used until the primary speed-timing sensor is replaced. The engine will shut down if both speed-timing sensors fail.

Failure of the Speed-Timing Sensor

If any of the following conditions are present, a failure of the speed-timing sensor may have occurred:

- The speed-timing sensor output has opened.
- The speed-timing sensor is shorted to ground.
- The speed-timing sensor is shorted to supply.
- The speed-timing sensor is missing pulses.
- The speed-timing sensor has extra pulses.

Intermittent failure causes erratic engine control. The electronic control system will detect a failure of the primary speed-timing sensor. The operator will be warned through the "DIAGNOSTIC" lamp.

i00078545

Engine Shutoff Control

SMCS Code: 1900; 7418

Secondary shutoff controls are electrically operated. Know the types and the locations of the shutoff controls, the conditions which cause each control to function, and the resetting procedure that is required to start the engine.

Always determine the cause of the shutdown. Before the engine is restarted, make the necessary repairs.

i01060024

Engine Speed Governing

SMCS Code: 1900; 1901; 1907; 1912

The engine speed governor monitors the throttle position and the actual engine speed in order to help control the following items: engine speed, response, torque output, and smoke limiting. The engine speed governor also helps to maintain constant engine speed.

The engine speed is controlled by the governing of the fuel injection duration of the electronic unit injectors. Throttle input is used to calculate the desired engine speed.

Engine Diagnostics

i01563934

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, the "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 the following components:

- Caterpillar electronic service tools
- "DIAGNOSTIC" lamp

Note: The "DIAGNOSTIC" lamp must be installed by the OEM or by the customer.

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. If a code is active, the "DIAGNOSTIC" lamp will flash the flash code at five second intervals.

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.

i01463253

Diagnostic Lamp

SMCS Code: 1000; 1900; 1901; 1902; 7451

The "DIAGNOSTIC" lamp is used to indicate the existence of an active fault by flashing codes.

When the ignition switch is first turned on, the "DIAGNOSTIC" lamp will go through the following procedure:

- The "DIAGNOSTIC" lamp will come on and the "DIAGNOSTIC" lamp will remain on for five seconds. This checks the operation of the lamp.
- The "DIAGNOSTIC" lamp will turn off.
- The "DIAGNOSTIC" lamp will come on again and the "DIAGNOSTIC" lamp will flash codes for any active diagnostic codes. Not all diagnostic codes have a unique flash code.
- The "DIAGNOSTIC" lamp will turn off for five seconds.
- The "DIAGNOSTIC" lamp repeats all active diagnostic codes.

A fault diagnostic code will remain active until the problem is repaired. The electronic control module will continue flashing the flash code at five second intervals until the problem is repaired.

i0158139

Diagnostic Flash Code Retrieval

SMCS Code: 1000; 1900; 1901; 1902

"Diagnostic" Lamp

Use the "DIAGNOSTIC" lamp or a Caterpillar electronic service tool to determine the diagnostic flash code. Not all diagnostic codes have a unique flash code.

Note: Flash codes should only be used to indicate the nature of a diagnostic condition. Do not use flash codes to perform detailed troubleshooting.

Use the following procedure to retrieve the diagnostic codes if the application is equipped with an engine DIAGNOSTIC lamp:

- 1. The "DIAGNOSTIC" lamp will flash in order to indicate a two-digit code. The sequence of flashes represents the system diagnostic message. Each digit of the two-digit code is determined by counting the number of flashes. The lamp flashes at a rate of two times per second. The lamp will pause for one second between digits. The lamp will pause for two seconds between codes.
- Turn the start/run key to the ON position. The engine does not need to be started in order to view codes. The engine does not need to be running while the start/run switch is in the ON position.

The "DIAGNOSTIC" lamp blinks on and off at five second intervals.

 When the start/run key is in the ON position, the lamp is checked for proper operation. If there are any active codes except for Code 34, the codes are displayed at this time.

Note: The "DIAGNOSTIC" lamp will illuminate for five seconds. The lamp will stay on if there is an active diagnostic code.

Active diagnostic codes will always be flashed. There is no toggle switch that will shut off the lamp.

Table 3 indicates the potential effect on the engine performance with active flash codes. Table 3 also forms a list of Electronic diagnostic codes and descriptions.

Possible Performance Effect of Active Diagnostic Codes

Table 3

		Possit	ole Performance Effec	ct of Active D	iagnostic Co	odes	
Flash Code	CID-FMI Code	SPN-FMI Code	Description of Code	Engine Misfires	Low Power	Reduced Engine Speed	Engine Shutdown
00	545-05	545-05	Ether Start Relay open/short to +batt				
	545-06	545-06	Ether Start Relay short to ground				
12	266-02	266-02	Incorrect Crank- without-inject inputs				
13	174-03	174-03	Fuel Temperature open/short to +batt				
	174-04	174-04	Fuel Temperature short to ground				

(Table 3, contd)

Flash Code	CID-FMI Code	SPN-FMI Code	Description of Code	Engine Misfires	Low Power	Reduced Engine Speed	Engine Shutdown
	262-03	620-03	5 Volt Sensor DC Power Supply short to +batt				
	262-04	620-04	5 Volt Sensor DC Power Supply short to ground				
21	263-03	678-03	Digital Sensor Supply short to +batt				
	263-04	678-04	Digital Sensor Supply short to ground				
24	100-03	100-03	Engine Oil Pressure open/short to +batt			·	
	100-04	100-04	Engine Oil Pressure short to ground				
	273-00	102-00	Turbo Outlet Pressure above normal				
25	273-03	102-03	Turbo Outlet Pressure open/short to +batt				
	273-04	102-04	Turbo Outlet Pressure short to ground				
26	274-03	108-03	Atmospheric Pressure open/short to +batt				
20	274-04	108-04	Atmospheric Pressure short to ground				
27	110-03	110-03	Engine Coolant Temperature open/short to +batt	x	x	x	
	110-04	110-04	Engine Coolant Temperature short to ground	x	X	X	
28	91-13	91-13	Throttle Position calibration required		x	x	
32	91-08	91-08	Throttle Position signal abnormal		x	x	

(Table 3, contd)

Flash Code	CID-FMI Code	SPN-FMI Code	Description of Code	Engine Misfires	Low Power	Reduced Engine Speed	Engine Shutdown
	320-02	190-02	Speed/Timing Sensor Loss of Signal	х			X (1)
34	320-11	190-11	Speed/Timing Sensor mechanical failure	х			X (1)
34	342-02	723-02	Loss of Secondary Engine Speed signal	X			X (1)
	342-11	723-11	Secondary Engine Speed Sensor mechanical failure	x			X (1)
	94-03	94-03	Fuel Pressure open/short to +batt				
	94-04	94-04	Fuel Pressure short to ground				
37	175-03	175-03	Engine Oil Temperature open/short to +batt				
	175-04	175-04	Engine Oil Temperature short to ground				
00	172-03	172-03	Intake Manifold Air Temp open/short to +batt	x	x	x	
38	172-04	172-04	Intake Manifold Air Temp short to ground	x	x	x	
42	261-13	228-13	Engine Timing calibration required	x	x	x	x
51	168-02	168-02	System Voltage intermittent/erratic	x	x		X
53	254-12		Electronic Control Module Error	Х	х	x	Х
	253-02	234-02	Personality Module mismatch				X (2)
56	268-02	1111-02	Check Programmable Parameters		x	x	
58	247-09	639-09	J1939 Data Link communications				
	1-11	651-11	Injector Cylinder #1 fault	X	x		,
72	2-11	652-11	Injector Cylinder #2 fault	Х	х		

(Table 3, contd)

	Possible Performance Effect of Active Diagnostic Codes						
Flash Code	CID-FMI Code	SPN-FMI Code	Description of Code	Engine Misfires	Low Power	Reduced Engine Speed	Engine Shutdown
70	3-11	653-11	Injector Cylinder #3 fault	x	х		
73	4-11	654-11	Injector Cylinder #4 fault	X	x		
74	5-11	655-11	Injector Cylinder #5 fault	x	x		
74	6-11	656-11	Injector Cylinder #6 fault	X	x		

⁽¹⁾ The engine will shut down if both speed/timing sensors are lost.

Event Codes

The ECM can log events. Events refer to engine operating conditions such as low oil pressure or high coolant temperature. Table 4 is a cross-reference for event codes. Logged events usually indicate a mechanical problem instead of an electronic system problem.

⁽²⁾ Fuel injection will not occur and the engine will not start.

Table 4 **Cross-Reference for Event Codes** SPN-FMI **Description of** Flash FID Codes Codes Codes Code **Engine Overspeed** 35 004 0190-16 Shutdown Fuel Filter 005 0094-15 63 **Restriction Derate** Fuel Filter 63 006 0094-16 Restriction Shutdown **High Engine Coolant** 61 015 0110-16 Temperature Derate **High Engine Coolant** 016 Temperature 61 0110-00 Shutdown **High Engine Coolant** 61 017 0110-15 Temperature Warning High Inlet Air 64 025 0172-16 Temperature Derate High Inlet Air 64 027 0172-15 Temperature Warning Low Engine Oil 039 0100-18 46 Pressure Derate Low Engine Oil 46 040 0100-01 Pressure Shutdown High Fuel 65 054 0174-16 **Temperature Derate** High Fuel 055 0174-00 Temperature 65 Shutdown High Fuel 056 0174-15 65 Temperature Warning Low Engine Coolant 057 0111-18 62 Level Derate Low Engine Coolant 62 058 0111-01 Level Shutdown Low Engine Coolant 62 059 0111-17 **Level Warning** Fuel Filter 095 0094-00 63 **Restriction Warning High Fuel Pressure** 63 096 0094-00 Low Engine Oil 46 100 0100-17 **Pressure Warning Engine Overspeed** 35 190 0190-00 Warning

For further information or assistance for repairs, consult an authorized Caterpillar dealer.

i01463504

Fault Logging

SMCS Code: 1000; 1900; 1901; 1902

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

i01563981

Engine Operation with Active Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the diagnostic lamp starts to flash codes during normal engine operation, the system has identified a situation that is not within the specification. Use Caterpillar 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. Refer to Operation and Maintenance Manual, "Diagnostic Flash Code Retrieval" for more information on flash codes.

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 Operation and Maintenance Manual for more information on the relationship between these active diagnostic codes and engine performance.

i00160113

Engine Operation with Intermittent Diagnostic Codes

SMCS Code: 1000; 1900; 1901; 1902

If the diagnostic lamp starts to flash codes 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.

Customer Specified Parameters

SMCS Code: 1000; 1900; 1901; 1902

Customer specified parameters that will enhance the fuel efficiency and the operator's convenience can be programmed into the Electronic Control Module (ECM). Some parameters may affect engine operation. This may lead to complaints from the operator about power or about performance. The following engine related parameters may be programmed by the customer by using Caterpillar electronic service tools in order to influence the operation of the engine:

- Customer Passwords
- Power Rating (hp at rpm)
- Rating Selection (A-E)
- Air/Fuel Ratio
- PTO Ramp Rate
- Engine Parameters: Low Idle, High Idle, Top Engine Limit, Torque Limit, and Intermediate Speed
- Engine Monitoring Mode
- Equipment ID
- Maintenance Indicator
- Auxiliary Pressure
- Auxiliary Temperature
- Parameter Lock Out

The customer specified parameters can be changed as often as needed. Password protection is provided so that the customer can change the parameters. The customer can authorize someone else to change the parameters. Ensure that a record of the parameters is kept in the Operation and Maintenance Manual. For detailed instructions on programming the engine for optimum performance and for optimum fuel economy, consult your Caterpillar dealer.

Engine Starting

i01486758

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 at a later date. Refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for more information.

- For the maximum service life of the engine, make a thorough inspection before the engine is started. Look for the following items: oil leaks, coolant leaks, loose bolts, and trash buildup. Remove trash buildup and arrange for repairs, as needed.
- Inspect the cooling system hoses for cracks and for loose clamps.
- Inspect the alternator and accessory drive belts for cracks, breaks, and other damage.
- Inspect the wiring for loose connections and for worn wires or frayed wires.
- Check the fuel supply. Drain water from the water separator (if equipped). Open the fuel supply valve.

NOTICE

All valves in the fuel return line must be open before and during engine operation to help prevent high fuel pressure. High fuel pressure may cause filter housing failure or other damage.

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.

WARNING

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.
- Ensure that the areas around the rotating parts are clear.
- All of the guards must be put in place. Check for damaged guards or for missing guards. Repair any damaged guards. Replace damaged guards and/or missing guards.
- Disconnect any battery chargers that are not protected against the high current drain that is created when the electric starting motor (if equipped) is engaged. Check electrical cables and check the battery for poor connections and for corrosion.
- Reset all of the shutoffs or alarm components.
- Check the engine lubrication oil level. Maintain the oil level between the "ADD" mark and the "FULL" mark on the oil level gauge.
- Check the coolant level. Observe the coolant level in the coolant recovery tank (if equipped).
 Maintain the coolant level to the "FULL" mark on the coolant recovery tank.
- If the engine is not equipped with a coolant recovery tank maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe.
 If the engine is equipped with a sight glass, maintain the coolant level in the sight glass.
- Observe the air cleaner service indicator (if equipped). Service the air cleaner when the yellow diaphragm enters the red zone, or when the red piston locks in the visible position.
- Ensure that any driven equipment has been disengaged. Minimize electrical loads or remove any electrical loads.

Starting the Engine

SMCS Code: 1000; 1450

This start procedure may be used for all engines that are not equipped with an Air Inlet Heater regardless of ambient temperature.

Refer to the Owner's Manual of the OEM for your type of controls. Use the following procedure to start the engine.

- Place the transmission in NEUTRAL. Disengage the flywheel clutch in order to allow the engine to start faster. This also reduces the draining of the battery.
- 2. Turn the ignition switch to the ON position.

The "CHECK ENGINE/DIAGNOSTIC" lamp will flash while the engine is cranking. The lamp should turn off after proper engine oil pressure is achieved. If the lamp fails to flash, notify your authorized Caterpillar dealer. If the lamp continues to flash, the Electronic Control Module (ECM) has detected a problem in the system. Refer to the Operation and Maintenance Manual, "Diagnostic Flash Code Retrival" (Operation Section) for more information on engine diagnostics.

3. Push the start button or turn the ignition switch to the START position in order to crank the engine.

Do not push down or hold the throttle down while the engine is cranked. The system will automatically provide the correct amount of fuel that is needed to start the engine.

4. If the engine fails to start within 30 seconds, release the start button, or the ignition switch. Wait for two minutes in order to allow the starting motor to cool before attempting to start the engine again.

Note: The "CHECK ENGINE/DIAGNOSTIC" lamp may come on after the engine is started. If this occurs, the ECM has detected a problem with the system. Refer to the Operation and Maintenance Manual, "Diagnostic Flash Code Retrival" (Operation Section) for more information on engine diagnostics.

NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine rpm until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

5. Allow the engine to idle for approximately three minutes. Idle the engine until the water temperature gauge has begun to rise. Check all gauges during the warm-up period.

Note: Oil pressures and fuel pressures should be in the normal range on the instrument panel. Do not apply a load to the engine or increase engine rpm until the oil pressure gauge indicates at least normal pressure. Inspect the engine for leaks and/or unusual noises.

i01463542

Cold Weather Starting

SMCS Code: 1000; 1250; 1450; 1453; 1456; 1900

Refer to the Owner's Manual of the OEM for your type of controls. Use the following procedure in order to start the engine.

MARNING

DO NOT USE ETHER (starting fluids) unless specifically instructed to do so. If the engine is equipped with an Air Inlet Heater (electrically o fuel ignited manifold heater), DO NOT use ethe (starting fluids) at any time. The use could resul in engine damage and/or personal injury.

Startability will be improved at temperatures below 10°C (50°F) from the use of a cylinder block coolar heater or from other means that are used to heat the crankcase oil. Some engine applications use a jacket water heater to improve startability. This will help reduce white smoke and misfire during start-up in cold weather.

NOTICE

When using ether (starting fluid), follow the manufacturer's instructions carefully, use it sparingly and sprait only while cranking the engine. Excessive ether cacause piston and ring damage. Use ether (starting fluid) for cold weather starting purposes only.

For engines that are not equipped with an Air Inlet Heater, use ether when temperatures are below 0° (32°F). If the engine is equipped with an injection system for starting fluid, crank the engine. Depres the ether switch for three seconds. Additional injections may be necessary in order to start the engine.

Note: If the engine has not been run for several weeks, fuel may have drained. Air may have moved into the filter housing. Also, when fuel filters have been changed, some air will be left in the filter housing. Refer to the Operation and Maintenance Manual, "Fuel System - Prime" (Maintenance Section) for more information on priming the fuel system.

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.

- Place the transmission in NEUTRAL. Disengage the flywheel clutch in order to allow the engine to start faster. This also reduces draining of the battery.
- 2. Turn the ignition switch to the ON position.

The "CHECK ENGINE/DIAGNOSTIC" lamp will flash while the engine is cranking. The lamp should turn off after proper engine oil pressure is achieved. If the lamp fails to flash, notify your authorized Caterpillar dealer. If the lamp continues to flash, the Electronic Control Module (ECM) has detected a problem in the system. Refer to the Operation and Maintenance Manual, "Diagnostic Flash Code Retrival" for more information.

3. Push the start button or turn the ignition switch to the START position in order to crank the engine.

Do not push down or hold the throttle down while the engine is cranked. The system will automatically provide the correct amount of fuel that is needed to start the engine.

4. If the engine fails to start within 30 seconds, release the start button, or the ignition switch. Wait for two minutes in order to allow the starting motor to cool before attempting to start the engine again.

NOTICE

Oil pressure should rise within 15 seconds after the engine starts. Do not increase engine speed until the oil pressure gauge indicates normal. If oil pressure is not indicated on the gauge within 15 seconds, DO NOT operate the engine. STOP the engine, investigate and correct the cause.

Note: The "CHECK ENGINE/DIAGNOSTIC" lamp may come on after the engine is started. If this occurs, the Electronic Control Module (ECM) has detected a problem with the system. Refer to the Operation and Maintenance Manual, "Diagnostic Flash Code Retrival" for more information.

5. Allow the engine to idle for approximately three minutes. Idle the engine until the water temperature gauge has begun to rise. Check all gauges during the warm-up period.

Note: The oil pressures and fuel pressures should be in the normal range on the instrument panel. Do not apply a load to the engine or increase engine rpm until the oil pressure gauge indicates at least normal pressure. Inspect the engine for leaks and/or unusual noises.

i01037941

Starting with Jump Start Cables

SMCS Code: 1000; 1401; 1402; 1900

A 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.

If the installation is not equipped with a backup battery system, it may be necessary to start the engine from an external electrical source.

First, determine the reason that it is necessary to start with power from an external source. Refer to Special Instruction, SEHS7768, "Use of the 6V-2150 Starting/Charging Analyzer".

Many batteries which are considered unusable are still rechargeable. After jump starting, the alternator may not be able to fully recharge batteries that are severely discharged. The batteries must be charged to the proper voltage with a battery charger. For information on testing and charging, refer to the Special Instruction, SEHS7633, "Battery Test Procedure".

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.

When using an external electrical source to start the engine, turn the engine control switch to the "OFF" position. 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.

- Turn the start switch on the stalled engine to the OFF position. Turn off all 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 combustible gases that are produced by some batteries.
- Charge the batteries. The engine will not continue to run after starting if the batteries have not been charged.
- 5. Start the engine.
- Immediately after the stalled engine is started, disconnect the jump start cables in reverse order.

Refer to the Electrical Schematic for your engine. Consult your Caterpillar dealer for more information.

After Starting Engine

SMCS Code: 1000

Note: In temperatures from 0 to 60°C (32 to 140°F), the warm-up time is approximately five minutes. In temperatures below 0°C (32°F), additional warm-up time may be required.

Note: Ensure that the self test for the monitoring system (if equipped) is completed before operating the engine under load.

When the engine idles during warm-up, observe the following conditions:

- Check for any fluid or for any air leaks at idle rpm and at one-half full rpm (no load on the engine) before operating the engine under load. This is not possible in some applications.
- Operate the engine at low idle until all systems achieve operating temperatures. Check all gauges during the warm-up period.

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.

Air Starting

SMCS Code: 1451

For good life of the air starting motor, the air supply must be free from dirt and water.

- Open the drain valve and close the drain valve in order to drain condensation and oil carryover. This drain valve is located on the bottom of the air tank.
- 2. Check the air supply pressure. The air starting motor requires a minimum of 690 kPa (100 psi) air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal operating air pressure will be 758 to 965 kPa (110 to 140 psi).

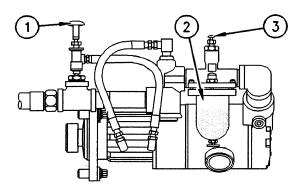


Illustration 32

g00381232

- (1) Air valve
- (2) Lubricator bowl
- (3) Adjustment knob
- Check the oil level in lubricator bowl (2). Keep the bowl at least half full and add lubricant, if necessary.
- **4.** Press air valve (1) or press the start button for the engine in order to crank the engine. After the engine starts, release the air valve or release the start button.

Engine Operation

i00718869

Engine Operation

SMCS Code: 1000

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

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

After the engine is started and after the engine reaches normal operating temperature, the engine can be operated at the rated rpm. The engine will reach normal operating temperature faster when the engine is at rated speed. The engine will reach normal operating temperature faster when the engine is at 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.

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.

i00808595

Engine Warm-up

SMCS Code: 1000

- 1. Run the engine at low idle for three to five minutes, or run the engine at low idle until the jacket water temperature starts to rise.
 - More time may be necessary when the temperature is below -18° C (0° F).
- 2. Check all of the gauges during the warm-up period.
- **3.** Perform another walk-around inspection. Check the engine for fluid leaks and air leaks.
- 4. Increase the rpm to the rated rpm. Check for fluid leaks and air leaks. The engine may be operated at full rated rpm and at full load when the engine oil temperature reaches 60° C (140° F).

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.

- 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.
- **4.** 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.

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. When the engine is operated at reduced load, the engine should be fully loaded in four hour increments. This procedure burns excess carbon from the cylinders. Check the gauges and equipment frequently when the engine is operated under load.

i01457002

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 so that the proper air/fuel ratio is maintained. Clean exhaust indicates proper functioning.
- Maintain a good electrical system.

One faulty battery cell will overwork the alternator. This will consume excess power and excess fuel.

- Ensure that the belts are properly adjusted. The belts should be in good condition. Refer to the Specifications manual 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.

Engine Stopping

i01057253

Emergency Stopping

SMCS Code: 1000; 7418

NOTICE

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

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

Emergency Stop Button



Illustration 33

g00104303

Typical emergency stop button

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

i01488025

Manual Stop Procedure

SMCS Code: 1000

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

- **1.** Remove the load, when possible. Reduce the engine rpm to low idle.
- 2. Increase the engine rpm to no more than one-half of the rated rpm. Perform this procedure for three to five minutes in order to cool the engine. Reduce the engine rpm to low idle.
- **3.** After the cool down period, turn the start/run switch to the OFF position.

After Stopping Engine

SMCS Code: 1000

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

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

NOTICE

Only use antifreeze/coolant mixtures recommended in the Coolant Specifications that are in the Operation and Maintenance Manual. Failure to do so can cause engine damage.

- Allow the engine to cool. Check the coolant level.
 Maintain the cooling system at 13 mm (0.5 inch) from the bottom of the pipe for filling.
- If freezing temperatures are expected, check the coolant for proper antifreeze protection. The cooling system must be protected against freezing to the lowest expected outside temperature. Add the proper coolant/water mixture, if necessary.
- Perform all required periodic maintenance on all driven equipment. This maintenance is outlined in the instructions from the OEM.

Cold Weather Operation

i01457051

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

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 in order 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. 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). Temperatures that exceed this limit can cause power loss and potential engine damage.

i01190421

Fuel and the Effect from Cold Weather

SMCS Code: 1000; 1250

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

- No. 1
- No. 2
- Blend of No. 1 and No. 2

No. 2 diesel fuel is the most commonly used fuel. Either No. 1 diesel fuel or a blend of No. 1 and No. 2 is best suited for cold weather operation. Quantities of No. 1 diesel fuel are limited. No. 1 diesel fuels are usually available during the months of the winter in the colder climates. During cold weather operation, if No. 1 diesel fuel is not available, use No. 2 diesel fuel, if necessary.

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

- Lower cloud point
- Lower pour point
- Lower rating of 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 within the area that the engine will be operated. Engines that are fueled in one climate may not operate well if the engines are moved to another climate. Problems can result due to changes in temperature.

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

When No. 2 diesel fuel is used the following components provide 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, se Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations".

Fuel Related Components in Cold Weather

SMCS Code: 1000; 1250

Fuel Tanks

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

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

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

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

Fuel Filters

It is possible that a primary fuel filter is installed between the fuel tank and the engine fuel inlet. After you change the fuel filter, always prime the fuel system in order to remove air bubbles from the fuel system. Refer to the Operation and Maintenance Manual in the Maintenance Section for more information on priming the fuel system.

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

NOTICE

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

Fuel Heaters

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

The following fuel heaters are recommended for Caterpillar engines:

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

For further information on fuel heaters, consult your Caterpillar dealer.

Disconnect the fuel heater in warm weather.

Note: Fuel heaters that are controlled by the water temperature regulator or self-regulating fuel heaters should be used with this engine. Fuel heaters that are not controlled by the water temperature regulator can heat the fuel in excess of 65°C (149°F). A loss of engine power can occur if the fuel supply temperature exceeds 37°C (100°F).

Note: Heat exchanger type fuel heaters should have a bypass provision in order to prevent overheating of the fuel in warm weather operation.

Maintenance Section

Torque Specifications

i01252954

General Torque Information

SMCS Code: 7553

WARNING

Mismatched or incorrect fasteners can result in damage or malfunction, or personal injury.

Take care to avoid mixing metric dimensioned fasteners and inch dimensioned fasteners.

Exceptions to these torques are given in the Service Manual, if necessary.

Prior to installation of any hardware, ensure that components are in near new condition. Bolts and threads must not be worn or damaged. Threads must not have burrs or nicks. Hardware must be free of rust and corrosion. Clean the hardware with a noncorrosive cleaner. Do not lubricate the fastener threads except for the rust preventive. The rust preventive should be applied by the supplier of that component for purposes of shipping and storage. Other applications for lubricating components may also be specified in the Service Manual.

i00621349

Standard Torque for Inch Fasteners

SMCS Code: 7553

Table 5

1	Inch Nuts and Bolts				
Thread Size Inch	Standard Torque				
1/4	12 ± 3 N·m (9 ± 2 lb ft)				
5/16	25 ± 6 N·m (18 ± 4 lb ft)				
3/8	47 ± 9 N·m (35 ± 7 lb ft)				
7/16	70 ± 15 N·m (50 ± 11 lb ft)				
1/2	105 ± 20 N·m (75 ± 15 lb ft)				
9/16	160 ± 30 N·m (120 ± 22 lb ft)				
5/8	215 ± 40 N·m (160 ± 30 lb ft)				
3/4	370 ± 50 N·m (275 ± 37 lb ft)				
7/8	620 ± 80 N·m (460 ± 60 lb ft)				
1	900 ± 100 N·m (660 ± 75 lb ft)				
1 1/8	1300 ± 150 N·m (960 ± 110 lb ft)				
1 1/4	1800 ± 200 N·m (1320 ± 150 lb ft)				
1 3/8	2400 ± 300 N·m (1780 ± 220 lb ft)				
1 1/2	3100 ± 350 N·m (2280 ± 260 lb ft)				

Table 6

ir	nch Taperlock Studs
Thread Size Inch	Standard Torque
1/4	8 ± 3 N·m (6 ± 2 lb ft)
5/16	17 ± 5 N·m (13 ± 4 lb ft)
3/8	35 ± 5 N·m (26 ± 4 lb ft)
7/16	45 ± 10 N·m (33 ± 7 lb ft)
1/2	65 ± 10 N·m (48 ± 7 lb ft)
5/8	110 ± 20 N·m (80 ± 15 lb ft)
3/4	170 ± 30 N·m (125 ± 22 lb ft)
7/8	260 ± 40 N·m (190 ± 30 lb ft)
1	400 ± 60 N·m (300 ± 44 lb ft)
1 1/8	525 ± 60 N·m (390 ± 44 lb ft)
1 1/4	750 ± 80 N·m (550 ± 60 lb ft)
1 3/8	950 ± 125 N·m (700 ± 90 lb ft)
1 1/2	1200 ± 150 N·m (880 ± 110 lb ft)

Standard Torque for Metric Fasteners

SMCS Code: 7553

Table 7

М	Metric Nuts and Bolts				
Thread Size Metric	Standard Torque				
M6	12 ± 3 N·m (9 ± 2 lb ft)				
M8	28 ± 7 N·m (21 ± 5 lb ft)				
M10	55 ± 10 N·m (41 ± 7 lb ft)				
M12	100 ± 20 N·m (75 ± 15 lb ft)				
M14	160 ± 30 N·m (120 ± 22 lb ft)				
M16	240 ± 40 N·m (175 ± 30 lb ft)				
M20	460 ± 60 N·m (340 ± 44 lb ft)				
M24	800 ± 100 N·m (590 ± 75 lb ft)				
M30	1600 ± 200 N·m (1180 ± 150 lb ft)				
M36	2700 ± 300 N·m (2000 ± 220 lb ft)				

Table 8

Me	Metric Taperlock Studs				
Thread Size Metric	Standard Torque				
M6	8 ± 3 N·m (6 ± 2 lb ft)				
M8	17 ± 5 N·m (13 ± 4 lb ft)				
M10	35 ± 5 N·m (26 ± 4 lb ft)				
M12	65 ± 10 N·m (48 ± 7 lb ft)				
M16	110 ± 20 N·m (80 ± 15 lb ft)				
M20	170 ± 30 N·m (125 ± 22 lb ft)				
M24	400 ± 60 N·m (300 ± 44 lb ft)				
M30	750 ± 80 N·m (550 ± 60 lb ft)				
M36	1200 ± 150 N·m (880 ± 110 lb ft)				

i01206505

Standard Torque for Worm Drive Band Hose Clamps

SMCS Code: 7553; 7554



Illustration 34

g00280501

Table 9

Width of Clamp	Initial Installation Torque On New Hose
7.9 mm (0.31 inch)	0.9 ± 0.2 N·m (8 ± 2 lb in)
13.5 mm (0.53 inch)	4.5 ± 0.5 N⋅m (40 ± 4 lb in)
15.9 mm (0.63 inch)	7.5 ± 0.5 N·m (65 ± 4 lb in)
Width of Clamp	Reassembly or Retightening Torque
7.9 mm (0.31 inch)	0.7 ± 0.2 N·m (6 ± 2 lb in)
13.5 mm (0.53 inch)	3.0 ± 0.5 N·m (27 ± 4 lb in)
15.9 mm (0.63 inch)	4.5 ± 0.5 N⋅m (40 ± 4 lb in)

i01394891

Standard Torque for Constant Torque Hose Clamps

SMCS Code: 7553; 7554

Use a constant torque hose clamp in place of any standard hose clamp. Ensure that the constant torque hose clamp is the same size as the standard hose clamp. Due to extreme temperature changes, the hose will heat set. Heat setting can cause hose clamps to loosen. Loose hose clamps can result in leaks. There have been reports of component failures that have been caused by hose clamps that have loosened. The constant torque hose clamp will help prevent these failures.

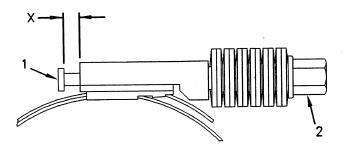


Illustration 35

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Use a torque wrench for proper installation of the constant torque hose clamps. The constant torque hose clamp is installed correctly under the following conditions:

- Screw tip (1) extends 6.35 mm (0.25 inch) (X) beyond the housing.
- The belleville washers are collapsed nearly flat after screw (2) is tightened to a torque of 11 ± 1 N·m (98 ± 9 lb in).

Lubricant Specifications

i01111306

Lubricant Information

SMCS Code: 1000; 1300; 7581

General Information

Because of government regulations regarding the certification of engine exhaust emissions, the lubricant recommendations must be followed.

Engine Manufacturers Association (EMA) Oils

The "Engine Manufacturers Association Recommended Guideline on Diesel Engine Oil" is recognized by Caterpillar. For detailed information about this guideline, see the latest edition of EMA publication, "EMA LRG-1".

API Oils

The Engine Oil Licensing and Certification System by the American Petroleum Institute (API) is recognized by Caterpillar. For detailed information about this system, see the latest edition of the "API publication No. 1509". Engine oils that bear the API symbol are authorized by API.

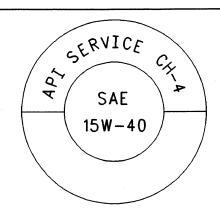


Illustration 36

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Typical API symbol

Diesel engine oils CC, CD, CD-2, and CE have not been API authorized classifications since 1 January 1996. Table 10 summarizes the status of the classifications.

Table 10

API Classifications	
Current	Obsolete
CF-4, CG-4, CH-4	CE
CF	CC, CD
CF-2 ⁽¹⁾	CD-2 ⁽¹⁾

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

Note: API CF is not the same classification as API CF-4. API CF oils are only recommended for Caterpillar 3600 Series Diesel Engines and Caterpillar engines with precombustion chamber (PC) fuel systems.

Grease

The classifications of grease are based on the "ASTM D217" worked penetration characteristics. These characteristics for grease are given a defined consistency number.

Terminology

Certain abbreviations follow the nomenclature of "SAE J754". Some classifications follow "SAE J183" abbreviations, and some classifications follow the "EMA Recommended Guideline on Diesel Engine Oil". In addition to Caterpillar definitions, there are other definitions that will be of assistance in purchasing lubricants. Recommended oil viscosities can be found in this publication, "Engine Oil" topic (Maintenance Section).

i01539915

Engine Oil

SMCS Code: 1300; 1348; 7581

Caterpillar Diesel Engine Oil

Caterpillar Oils have been developed and tested in order to provide the full performance and service life that has been designed and built into Caterpillar Engines. Caterpillar Oils are currently used to fill diesel engines at the factory. These oils are offered by Caterpillar dealers for continued use when the engine oil is changed. Consult your Caterpillar dealer for more information on these oils.

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

• Caterpillar Diesel Engine Oil (10W30)

• Caterpillar Diesel Engine Oil (15W40)

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

Caterpillar multigrade Diesel Engine Oil is available in two viscosity grades (10W30 and 15W40). For direct injection engines, see Table 11 in order to choose the correct viscosity grade for the ambient temperature. Multigrade oils provide the correct viscosity for a broad range of operating temperatures.

Multigrade oils are effective in maintaining low oil consumption and low levels of piston deposits.

Caterpillar multigrade Diesel Engine Oil can be used in other diesel engines and in gasoline engines. See the engine manufacturer's guide for the recommended specifications. Compare the specifications to the specifications of Caterpillar multigrade Diesel Engine Oil. The current industry standards for Caterpillar Diesel Engine Oil are listed on the product label and on the data sheets for the product.

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

Commercial Oils

The performance of commercial diesel engine oils is based on American Petroleum Institute (API) classifications. These API classifications are developed in order to provide commercial lubricants for a broad range of diesel engines that operate at various conditions.

If Caterpillar multigrade Diesel Engine Oil is not used, only use commercial oils that meet the following classifications:

- EMA LRG-1 multigrade oil (preferred oil)
- API CH-4 multigrade oil (preferred oil)
- API CG-4 multigrade oil (preferred oil)
- API CF-4 multigrade oil (acceptable oil)

In order to make the proper choice of a commercial oil, refer to the following explanations:

EMA LRG-1 – The Engine Manufacturers Association (EMA) has developed lubricant recommendations as an alternative to the API oil classification system. LRG-1 is a Recommended Guideline that defines a level of oil performance for these types of diesel engines: high speed, four stroke cycle, heavy-duty, and light duty. LRG-1 oils may be used in Caterpillar engines when the following oils are recommended: API CH-4, API CG-4, and API CF-4. LRG-1 oils are intended to provide superior performance in comparison to API CG-4 and API CF-4.

LRG-1 oils will meet the needs of high performance Caterpillar diesel engines that are operating in many applications. The tests and the test limits that are used to define LRG-1 are similar to the new API CH-4 classification. Therefore, these oils will also meet the requirements of the low emissions diesel engines. LRG-1 oils are designed to control the harmful effects of soot with improved wear resistance and improved resistance to plugging of the oil filter. These oils will also provide superior piston deposit control for engines with either two-piece steel pistons or aluminum pistons.

All LRG-1 oils must complete a full test program with the base stock and with the viscosity grade of the finished commercial oil. The use of "API Base Oil Interchange Guidelines" are not appropriate for LRG-1 oils. This feature reduces the variation in performance that can occur when base stocks are changed in commercial oil formulations.

LRG-1 oils are recommended for use in extended oil change interval programs that optimize oil life. These oil change interval programs are based on oil analysis. LRG-1 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has the specific guidelines for optimizing oil change intervals.

API CH-4 – API CH-4 oils were developed in order to meet the requirements of the new high performance diesel engines. Also, the oil was designed to meet the requirements of the low emissions diesel engines. API CH-4 oils are also acceptable for use in older diesel engines and in diesel engines that use high sulfur diesel fuel. API CH-4 oils may be used in Caterpillar engines that use API CG-4 and API CF-4 oils. API CH-4 oils will generally exceed the performance of API CG-4 oils in the following criteria: deposits on pistons, control of oil consumption, wear of piston rings, valve train wear, viscosity control, and corrosion.

Three new engine tests were developed for the API CH-4 oil. The first test specifically evaluates deposits on pistons for engines with the two-piece steel piston. This test (piston deposit) also measures the control of oil consumption. A second test is conducted with moderate oil soot. The second test measures the following criteria: wear of piston rings, wear of cylinder liners, and resistance to corrosion. A third new test measures the following characteristics with high levels of soot in the oil: wear of the valve train, resistance of the oil in plugging the oil filter, and control of sludge.

In addition to the new tests, API CH-4 oils have tougher limits for viscosity control in applications that generate high soot. The oils also have improved oxidation resistance. API CH-4 oils must pass an additional test (piston deposit) for engines that use aluminum pistons (single piece). Oil performance is also established for engines that operate in areas with high sulfur diesel fuel.

All of these improvements allow the API CH-4 oil to achieve optimum oil change intervals. API CH-4 oils are recommended for use in extended oil change intervals. API CH-4 oils are recommended for conditions that demand a premium oil. Your Caterpillar dealer has specific guidelines for optimizing oil change intervals.

API CG-4 – API CG-4 oils were developed primarily for diesel engines that use a 0.05 percent level of fuel sulfur. However, API CG-4 oils can be used with higher sulfur fuels. The TBN of the new oil determines the maximum fuel sulfur level for API CG-4 and API CF-4 oils. See Illustration 37.

API CG-4 oils are the first oils that are required to pass industry standard tests for foam control and viscosity shear loss. API CG-4 oils must also pass tests that were developed for corrosion, wear and oxidation.

API CF-4 – These oils service a wide variety of modern diesel engines. API CF-4 oils provide more stable oil control and reduced piston deposits in comparison to API CF and the obsolete CE and CD classifications of oil. API CF-4 oils provide improved soot dispersancy in comparison to API CF and obsolete CD oils. The API CF-4 classification was developed with a 0.40 percent sulfur diesel fuel. This represents the type of diesel fuels that are commonly available worldwide.

Note: Do not use single grade API CF oils or multigrade API CF oils in Caterpillar Direct Injection (DI) Commercial Diesel Engines. Some commercial oils that meet the API classifications may require reduced oil change intervals. To determine the oil change interval, closely monitor the condition of the oil and perform a wear metal analysis. Caterpillar's S·O·S oil analysis program is the preferred method.

NOTICE

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

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

The Total Base Number (TBN) for an oil depends on the fuel sulfur level. For direct injection engines that use distillate fuel, the minimum TBN of the new oil must be 10 times the fuel sulfur level. The TBN is defined by "ASTM D2896". The minimum TBN of the oil is 5 regardless of fuel sulfur level. Illustration 37 demonstrates the TBN.

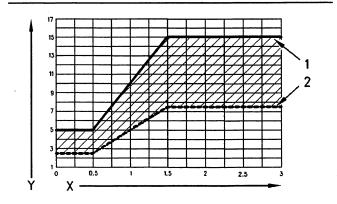


Illustration 37

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- (Y) TBN by "ASTM D2896"
- (X) Percentage of fuel sulfur by weight
- (1) TBN of new oil
- (2) Change the oil when the TBN deteriorates to 50 percent of the original TBN.

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

- Choose an oil with the highest TBN that meets one of these classifications: EMA LRG-1, API CH-4, API CG-4, and API CF-4.
- Reduce the oil change interval. Base the oil change interval on the oil analysis. Ensure that the oil analysis includes the condition of the oil and a wear metal analysis.

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

NOTICE

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

Lubricant Viscosity Recommendations for Direct Injection (DI) Diesel Engines

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 Table 11 (minimum temperature) in order to determine the required oil viscosity for starting a cold engine.

Refer to Table 11 (maximum temperature) in order to select the oil viscosity for engine operation at the highest ambient temperature that is anticipated.

Generally, use the highest oil viscosity that is available to meet the requirement for the temperature at start-up.

Table 11

Engine Oil Viscosity		
Caterpillar DEO	Ambient Temperature	
Multigrade EMA LRG-1 API CH-4 API CG-4 and API CF-4 Viscosity Grade	Minimum	Maximum
SAE 0W20	–40 °C (–40 °F)	10 °C (50 °F)
SAE 0W30	–40 °C (–40 °F)	30 °C (86 °F)
SAE 0W40	–40 °C (–40 °F)	40 °C (104 °F)
SAE 5W30	–30 °C (–22 °F)	30 °C (86 °F)
SAE 5W40	–30 °C (–22 °F)	40 °C (104 °F)
SAE 10W30	–20 °C (–4 °F)	40 °C (104 °F)
SAE 15W40	–15 °C (5 °F)	50 °C (122 °F)

i01111406

Synthetic Base Stock Oils

SMCS Code: 1300; 1348; 7581

Synthetic base oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified for the engine compartment.

Synthetic base oils generally perform better than conventional oils in the following two areas:

- Synthetic base oils have improved flow at low temperatures especially in arctic conditions.
- Synthetic base oils have improved oxidation stability especially at high operating temperatures.

Some synthetic base oils have performance characteristics that enhance the service life of the oil. However, Caterpillar does not recommend the automatic extension of oil change intervals for any type of oil. Oil change intervals for Caterpillar engines can only be adjusted after an oil analysis program that contains the following tests: oil condition and wear metal analysis (Caterpillar's S·O·S oil analysis), trend analysis, fuel consumption, and oil consumption.

i01111412

Re-refined Base Stock Oils

SMCS Code: 1300; 7581

Re-refined base stock oils are acceptable for use in Caterpillar engines if these oils meet the performance requirements that are specified by Caterpillar. Re-refined base stock oils can be used exclusively in finished oil or in a combination with new base stock oils. The US military specifications and the specifications of other heavy equipment manufacturers also allow the use of re-refined base stock oils that meet the same criteria.

The process that is used to make re-refined base stock oil should adequately remove all wear metals that are in the used oil and all additives that are in the used oil. The process that is used to make re-refined base stock oil generally involves the processes of vacuum distillation and hydrotreating the used oil. Filtering is inadequate for the production of high quality re-refined base stock oils from used oil.

Cold Weather Lubricants

SMCS Code: 1300; 1348; 7581

When an engine is started and an engine is operated in ambient temperatures below -20 °C (-4 °F), use multigrade oils that are capable of flowing in low temperatures.

These oils have lubricant viscosity grades of SAE 0W or SAE 5W.

When an engine is started and operated in ambient temperatures below -30 °C (-22 °F), use a synthetic base stock multigrade oil with a 0W viscosity grade or with a 5W viscosity grade. Use an oil with a pour point that is lower than -50 °C (-58 °F).

The number of acceptable lubricants is limited in cold weather conditions. Caterpillar recommends the following lubricants for use in cold weather conditions:

First Choice – use an oil with an EMA LRG-1 Recommended Guideline or use a CH-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade. A CG-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used. A CF-4 oil that is API licensed with an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade may also be used.

Second Choice – use an oil that contains the CH-4, CG-4, or CF-4 additive package although the oil has not been tested for the requirements of the API license. The oil must have an SAE 0W20, SAE 0W30, SAE 0W40, SAE 5W30, or SAE 5W40 lubricant viscosity grade.

NOTICE

Shortened engine service life could result if second choice oils are used.

i01123104

Aftermarket Oil Additives

SMCS Code: 1300; 1348; 7581

Caterpillar does not recommend the use of aftermarket additives in oil. It is not necessary to use aftermarket additives in order to achieve the engine's maximum service life or rated performance. Fully formulated, finished oils consist of base oils and of commercial additive packages. These additive packages are blended into the base oils at precise percentages in order to help provide finished oils with performance characteristics that meet industry standards.

There are no industry standard tests that evaluate the performance or the compatibility of aftermarket additives in finished oil. Aftermarket additives may not be compatible with the finished oil's additive package, which could lower the performance of the finished oil. The aftermarket additive could fail to mix with the finished oil. This could produce sludge in the crankcase. Caterpillar discourages the use of aftermarket additives in finished oils.

To achieve the best performance from a Caterpillar engine, conform to the following guidelines:

- Select the proper Caterpillar oil or a commercial oil that meets the "EMA Recommended Guideline on Diesel Engine Oil" or the recommended API classification.
- See the appropriate "Lubricant Viscosities" table in order to find the correct oil viscosity grade for your engine.
- At the specified interval, service the engine compartment. Use new oil and install a new oil filter.
- Perform maintenance at the intervals that are specified in the Operation and Maintenance Manual, "Maintenance Interval Schedule".

i01164576

Lubricating Grease

SMCS Code: 7581

Caterpillar provides greases in order to cover a variety of applications and extreme temperature conditions. Consult your Caterpillar dealer for part numbers and for available sizes of containers.

Note: Some greases may not be used with other greases. When a commercial grease is used, ensure that the grease is compatible with the grease that is currently used in the system. If the commercial grease is not compatible, the system must be purged. If any questions arise concerning the compatibility of a grease, consult the supplier.

Multipurpose Greases

Multipurpose Lithium Complex Grease (MPGL)

Multipurpose Lithium Complex Grease (MPGL) is a general purpose lithium complex grease for medium-duty applications. This product has good characteristics at high temperatures such as a dropping point of 260 °C (500 °F). MPGL contains unleaded extreme pressure additives, antiwear inhibitors, and corrosion inhibitors that provide extra protection in the following applications:

- Construction
- Agricultural
- Automotive

MPGL meets the requirements for extended service intervals of automotive chassis points. MPGL also meets the requirements for extended service intervals of wheel bearings with disc brakes in automobiles, in vans and in light trucks. This product meets the NLGI certification of "GC-LB". MPGL is also available in a NLGI No. 2 grade. Normal operating temperatures for this product are –28 to 149 °C (–18 to 300 °F). This product is also available as a white lithium complex grease.

Multipurpose Lithium Complex Grease with Molybdenum (MPGM)

Multipurpose Lithium Complex Grease with Molybdenum (MPGM) is a general purpose lithium complex grease that is used for light-duty applications and for medium-duty applications. The MPGM is available in the following grades: NLGI No. 2 and NLGI No. 0. The MPGM is strengthened with a molybdenum disulfide and a polymer for extra lubrication and protection. MPGM contains unleaded additives. MPGM also contains antiwear inhibitors, rust inhibitors, and corrosion inhibitors that are for protection and lubrication in many environments. The MPGM is formulated with a base fluid that has high viscosity.

The MPGM has the following features:

• Increased protection against water washout

- Increased retention
- Resistance to heavy loads

This product is recommended for heavily loaded pin joints and for journal bearings. This product meets the certification of "GC-LB". Normal operating temperatures for this product are –28 to 149 °C (–18 to 300 °F) for the NLGI No. 0. Normal operating temperatures for this product are –18 to 149 °C (0 to 300 °F) for the NLGI No. 2.

Note: If MPGM is not available, use a multipurpose type grease which contains three to five percent molybdenum.

Special Purpose Grease (SPG)

Bearing Lubrication (SPG)

Bearing Lubricant (SPG) is available in a NLGI No. 2 grade with a polyurea thickener. This grease is recommended for high temperature antifriction bearings in the following applications: electric starting motors, alternators, fan drives, and generators. The Bearing Lubricant (SPG) has an effective operating range of –29 to 177 °C (–20 to 350 °F).

Water and Temperature Resistant Grease (WTR)

The Water and Temperature Resistant Grease is designed for use whenever the following conditions are a concern: water washout, severe corrosion. and high operating temperatures. The Water and Temperature Resistant Grease provides extreme pressure protection, antiwear protection, rust protection and corrosion protection. The Water and Temperature Resistant Grease is an environmentally friendly grease which does not contain the following materials; antimony, sulfur, barium, zinc, lead, and phosphorous materials. The Water and Temperature Resistant Grease has excellent shear stability. Water and Temperature Resistant Grease can also resist breakdown in the presence of water. The Water and Temperature Resistant Grease works well in the following applications:

- Construction
- Agricultural
- Automotive
- Industrial
- Marine

This product meets the NLGI certification of "GC-LB". Normal operating temperatures for this product are -40 to 204°C (-40 to 400°F).

Caterpillar Premium Grease (CPG)

Desert Gold (CPG)

Desert Gold is a heavy-duty, premium synthetic grease that is developed for the most extreme operating environments. This grease is formulated with the following characteristics: high viscosity synthetic base fluid, polymers, molybdenum disulfide, high viscosity index, and high dropping point.

Desert Gold will protect equipment against heavy shock loads. Desert Gold protects against corrosion in extreme heat, in moist conditions, or in dusty conditions. This product has excellent characteristics of adhesion and of stability. Desert Gold provides longer protection than other greases. Desert Gold is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, lead, and phosphorous materials. Normal operating temperatures are –6 to 230 °C (21 to 450 °F). Desert Gold can operate at higher temperatures for short time periods. Desert Gold has additional extreme pressure protection for highly loaded pin joints.

Arctic Platinum (CPG)

Arctic Platinum is a super-premium extreme pressure lubricating grease that is developed for lubrication in temperatures that are below zero to moderate operating temperatures. Arctic Platinum is available in grades 000, 00, 0, 1, and 2. These grades ensure pumpability in central lube systems in a variety of ambient temperatures from –60 to 18 °C (–76 to 65 °F). Arctic Platinum has a high dropping point. Arctic Platinum contains a five percent concentrate of molybdenum disulfide for protection against extra heavy loads. Arctic Platinum provides excellent corrosion protection and rust protection. Arctic Platinum is an environmentally friendly grease which does not contain the following materials: antimony, sulfur, barium, zinc, and phosphorous.

Arctic Platinum is designed for long life lubrication of the following components: horizontal pivot bearings, lower link bearings, steering cylinders, kingbolt bearings, upper hitch link bearings, and ejector carrier roller bearings. This grease is extra tacky for retention on excavator carbody bearings. Arctic Platinum has additional extreme pressure protection for highly loaded pin joints.

i01141502

Transmission/Drive Train Oil

SMCS Code: 3080

Refer to the lubrication recommendations of the OEM for the transmission.

i01065849

S-O-S Oil Analysis

SMCS Code: 1348; 7542; 7581

Caterpillar recommends the use of the S·O·S oil analysis program in order to monitor the condition and the maintenance requirements of the equipment. The S·O·S oil analysis program will complement the preventive maintenance program.

The S·O·S oil analysis is a diagnostic tool that is used to determine oil performance and component wear rates. Contamination can be identified and measured through the use of the S·O·S oil analysis. The S·O·S oil analysis includes the following tests:

- The Wear Rate Analysis monitors the wear of the engine's metals. The amount of wear metal and type of wear metal that is in the oil is analyzed. The increase in the rate of engine wear metal in the oil is as important as the quantity of engine wear metal in the oil. For this reason, regular sampling at specified intervals is necessary in order to establish wear rates. Intermittent sampling does not allow wear rate trend lines to be established. Engine wear metals in the oil sample are compared to established Caterpillar norms in order to determine acceptability.
- Tests are conducted in order to detect contamination of the oil by water, glycol or fuel.
- The Oil Condition Analysis determines the loss of the oil's lubricating properties. An infrared analysis is used to compare the properties of new oil to the properties of the used oil sample. This analysis allows technicians to determine the amount of deterioration of the oil during use. This analysis also allows technicians to verify the performance of the oil according to the specification during the entire oil change interval.

The test results of the oil samples will then be used as a basis for determining the oil change interval for the engine. The results of the S·O·S oil analysis may allow the engine to operate longer between oil changes without the risk of engine damage.

Table 12

S·O·S Oil Analysis Interval		
Compartment Interval		
Engine crankcase Every 250 Service He		

For more information, see Special Publication, PEDP7036, "S·O·S Fluid Analysis". Consult your Caterpillar dealer for complete information and assistance about the program.

Fuel Specifications

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Fuel Recommendations

SMCS Code: 1250; 1280

Diesel engines have the ability to burn a wide variety of fuels. These fuels are divided into two general groups. The two groups are called the preferred fuels and the permissible fuels.

The preferred fuels provide maximum engine service life and performance. The preferred fuels are distillate fuels. These fuels are commonly called diesel fuel, furnace fuel, gas oil, or kerosene.

The permissible fuels are crude oils or blended fuels. Use of these fuels can result in higher maintenance costs and in reduced engine service life.

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

Table 13

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	Requirements	ASTM Test
Aromatics	35% maximum	"D1319"
Ash	0.02% maximum (weight)	"D482"
Carbon Residue on 10% Bottoms	0.35% maximum (weight)	"D524"
Cetane Number	40 minimum (DI engines)	"D613"
Cetane Number	35 minimum (PC engines)	
Cloud Point	The cloud point must not exceed the lowest expected ambient temperature.	-
Copper Strip Corrosion	No. 3 maximum	"D130"

(continued)

(Table 13, contd)

Caterpillar Specifications for Distillate Diesel Fuel		
Specifications	Requirements	ASTM Test
Distillation	10% at 282 °C (540 °F) maximum	"D86"
Distillation	90% at 360 °C (680 °F) maximum	
Flash Point	legal limit	"D93"
ADI Crosite	30 minimum	"D287"
API Gravity	45 maximum	
Pour Point	6 °C (10 °F) minimum below ambient temperature	"D97"
Sulfur (1)	3% maximum	"D3605" or "D1552"
Kinematic Viscosity ⁽²⁾	1.4 cSt minimum and 20.0 cSt maximum at 40 °C (104 °F)	"D445"
Water and Sediment	0.1% maximum	"D1796"
Water	0.1% maximum	"D1744"
Sediment	0.05% maximum (weight)	"D473"
Gums and Resins (3)	10 mg per 100 mL maximum	"D381"
	3100 g minimum	"D6078"
Lubricity (4)	0.45 mm (0.018 inch) maximum at 60 °C (140 °F)	"D6079"
	0.38 mm (0.015 inch) maximum at 25 °C (77 °F)	

- (1) Caterpillar fuel systems and engine components can operate on high sulfur fuels. Fuel sulfur levels affect exhaust emissions. High sulfur fuels also increase the potential for corrosion of internal components. Fuel sulfur levels above 1.0 percent may significantly shorten the oil change interval. For additional information, see this publication, "Engine Oil" topic (Maintenance Section).
- (2) The values of the fuel viscosity are the values as the fuel is delivered to the fuel injection pumps. If a fuel with a low viscosity is used, cooling of the fuel may be required to maintain a 1.4 cSt viscosity at the fuel injection pump. Fuels with a high viscosity might require fuel heaters in order to bring down the viscosity to a 20 cSt viscosity. For additional information, see Special Publication, SEBD0717, "Diesel Fuel and Your Engine".
- (3) Follow the test conditions and procedures for gasoline (motor).
- (4) The lubricity of a fuel is a concern with low sulfur fuel. To determine the lubricity of the fuel, use either the "ASTM D6078 Scuffing Load Wear Test (SBOCLE)" or the "ASTM D6079 High Frequency Reciprocating Rig (HFRR)" test. If the lubricity of a fuel does not meet the minimum requirements, consult your fuel supplier. Do not treat the fuel without consulting the fuel supplier. Some additives are not compatible. These additives can cause problems in the fuel system.

NOTICE

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

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

NOTICE

Heavy Fuel Oil (HFO), Residual fuel, or Blended fuel must NOT be used in Caterpillar diesel engines (except in 3600 Series HFO engines). Severe component wear and component failures will result if HFO type fuels are used in engines that are configured to use distillate fuel.

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

Table 14

Distillate Fuels (1)		
Specification Grade		
"MIL-T-5624R"	JP-5	
"ASTM D1655"	Jet-A-1	
"MIL-T-83133D"	JP-8	

(1) The fuels that are listed in this Table may not meet the requirements that are specified in the "Caterpillar Specifications for Distillate Diesel Fuel" Table. Consult the supplier for the recommended additives in order to maintain the proper fuel lubricity.

These fuels are lighter than the No. 2 grades of fuel. The cetane number of the fuels in Table 14 must be at least 40. If the viscosity is below 1.4 cSt at 38 °C (100 °F), use the fuel only in temperatures below 0 °C (32 °F). Do not use any fuels with a viscosity of less than 1.2 cSt at 38 °C (100 °F). Fuel cooling may be required in order to maintain the minimum viscosity of 1.4 cSt at the fuel injection pump.

There are many other diesel fuel specifications that are published by governments and by technological societies. Usually, those specifications do not review all the requirements that are addressed in this specification. To ensure optimum engine performance, a complete fuel analysis should be obtained before engine operation. The fuel analysis should include all of the properties that are listed in Table 13.

Cooling System Specifications

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General Coolant Information

SMCS Code: 1350; 1395

NOTICE

Never add coolant to an overheated engine. Engine damage could result. Allow the engine to cool first.

NOTICE

If the engine is to be stored in, or shipped to an area with below freezing temperatures, the cooling system must be either protected to the lowest outside temperature or drained completely to prevent damage.

NOTICE

In cold weather, frequently check the specific gravity of the coolant solution to ensure adequate protection.

Clean the cooling system for the following reasons:

- Contamination of the cooling system
- Overheating of the engine
- Foaming of the coolant

Note: Air pockets can form in the cooling system if the cooling system is filled at a rate that is greater than 20 L (5 US gal) per minute.

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

NOTICE

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

Refer to Special Instruction, SEBD0518, "Know Your Cooling System" and Special Instruction, SEBD0970, "Coolant and Your Engine" for more detailed information.

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

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

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

Water

NOTICE

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

NOTICE

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

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

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

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

If distilled water or deionized water is not available, use water with the properties that are listed in Table 15.

Table 15

Caterpillar Minimum Acceptable Water Requirements		
Property	Maximum Limit	ASTM Test
Chloride (CI)	40 mg/L (2.4 grains/US gal)	"D512", "D4327"
Sulfate (SO₄)	100 mg/L (5.9 grains/US gal)	"D516"
Total Hardness	170 mg/L (10 grains/US gal)	"D1126"
Total Solids	340 mg/L (20 grain/US gal)	"D1888"
Acidity	pH of 5.5 to 9.0	"D1293"

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

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

Additives

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

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

Many additives are depleted during engine operation. These additives must be replaced periodically. This can be done by adding Supplemental Coolant Additives (SCA) to Diesel Engine Antifreeze/Coolant (DEAC) or by adding ELC Extender to Extended Life Coolant (ELC).

Additives must be added at the proper concentration. Overconcentration of additives can cause the inhibitors to drop out-of-solution. The deposits can enable the following problems to occur:

- Formation of gel compounds
- Reduction of heat transfer
- Leakage of the water pump seal
- Plugging of radiators, coolers, and small passages

Glycol

Glycol in the coolant helps to provide protection against the following conditions:

- Boiling
- Freezing
- Cavitation of the water pump and the cylinder liner

For optimum performance, Caterpillar recommends a 1:1 mixture of a water/glycol solution.

NOTICE

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

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

Note: 100 percent pure glycol will freeze at a temperature of -23 °C (-9 °F).

Most conventional heavy-duty coolant/antifreezes use ethylene glycol. Propylene glycol may also be used. In a 1:1 mixture with water, ethylene and propylene glycol provide similar protection against freezing and boiling. See Tables 16 and 17.

Table 16

Ethylene Glycol		
Concentration	Freeze Protection	Boil Protection
50 Percent	-36 °C (-33 °F)	106 °C (223 °F)
60 Percent	-51 °C (-60 °F)	111 °C (232 °F)

NOTICE

Do not use propylene glycol in concentrations that ex ceed 50 percent glycol because of propylene glycol's reduced heat transfer capability. Use ethylene glyco in conditions that require additional protection agains boiling or freezing.

Table 17

Propylene Glycol		
Concentration Freeze Protection		Boil Protection
50 Percent	–29 °C (–20 °F)	106 °C (223 °F)

To check the concentration of glycol, use the 1U-7298 Coolant/Battery Tester (Degree Celsius) or use the 1U-7297 Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or propylene glycol.

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Coolant Recommendations

SMCS Code: 1350; 1395

The following two coolants are used in Caterpillar diesel engines:

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

Acceptable – A Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) or a commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications

NOTICE

Do not use a commercial coolant/antifreeze that only meets the ASTM D3306 or D4656 specification. This type of coolant/antifreeze is made for light duty automotive applications.

Caterpillar recommends a 1:1 mixture of water and glycol. This mixture of water and glycol will provide optimum heavy-duty performance as a coolant/antifreeze.

Note: Caterpillar DEAC DOES NOT require a treatment with an SCA at the initial fill. Commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" 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.

In stationary engine applications and marine engine applications that do not require anti-boil protection or freeze protection, a mixture of SCA and water is acceptable. Caterpillar recommends a six percent to eight percent concentration of SCA in those cooling systems. Distilled water or deionized water is preferred. Water which has the recommended properties may be used.

NOTICE

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

Table 18

Coolant Service Life		
Coolant Type	Service Life	
Caterpillar ELC	6000 Service Hours or Six Years	
Caterpillar DEAC	3000 Service Hours or Three Years	
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D5345"	3000 Service Hours or Two Years	
Commercial Heavy-Duty Coolant/Antifreeze that meets "ASTM D4985"	3000 Service Hours or One Year	
Caterpillar SCA and Water	3000 Service Hours or Two Years	
Commercial SCA and Water	3000 Service Hours or One Year	

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S.O.S Coolant Analysis

SMCS Code: 1352; 1395; 7542

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

NOTICE

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

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

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

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

New Systems, Refilled Systems, and Converted Systems

Perform a coolant analysis (Level 2) at 500 service hours for new systems, for refilled systems, or for converted systems that use ELC or use DEAC. This 500 hour check will also check for any residual cleaner that may have contaminated the system.

Recommended Interval for S-O-S Coolant Sample

Perform a coolant analysis (Level 1) at every 500 service hour interval. Perform a coolant analysis (Level 2) annually.

Note: Check the standard coolant's Supplemental Coolant Additive at every oil change.

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
- Ability to protect from erosion and corrosion
- pH
- Conductivity
- Water hardness
- Visual analysis
- Odor analysis

The results are reported, and appropriate recommendations are made.

S.O.S Coolant Analysis (Level 2)

Level 2 coolant analysis is a comprehensive chemical evaluation of the coolant. This analysis is also a check of the overall condition of the inside of the cooling system.

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

- Full analysis of Level 1
- Identification of the source of metal corrosion and of contaminants

- Identification of buildup of the impurities that cause corrosion
- Identification of buildup of the impurities that cause scaling
- Determination of possible electrolysis within the engines' cooling system

The results are reported, and appropriate recommendations are made.

For more information on S·O·S Coolant Analysis, consult your Caterpillar dealer.

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Extended Life Coolant (ELC)

SMCS Code: 1350; 1395

Caterpillar provides Extended Life Coolant (ELC) for use in the following applications:

- Heavy-duty spark ignited gas engines
- Heavy-duty diesel engines
- Automotive applications

The anti-corrosion package for Caterpillar ELC is different from the anti-corrosion package for other coolants. Caterpillar ELC is an ethylene glycol base coolant. However, Caterpillar ELC contains organic corrosion inhibitors and antifoam agents with low amounts of nitrite. Caterpillar ELC has been formulated with the correct amount of these additives in order to provide superior corrosion protection for all metals in engine cooling systems.

ELC extends the service life of the coolant to 6000 service hours or six years. ELC does not require a frequent addition of a Supplemental Coolant Additive (SCA). An Extender is the only additional maintenance that is needed at 3000 service hours or one half of the ELC service life.

ELC is available in a 1:1 premixed cooling solution with distilled water. The Premixed ELC provides freeze protection to -36 °C (-33 °F). The Premixed ELC is recommended for the initial fill of the cooling system. The Premixed ELC is also recommended for topping off the cooling system.

ELC Concentrate is also available. ELC Concentrate can be used to lower the freezing point to -51 °C (-60 °F) for arctic conditions.

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

Note: Caterpillar developed the EC-1 specification. The EC-1 specification is an industry standard. The EC-1 specification defines all of the performance requirements that are needed for an engine coolant to be sold as an extended life coolant for Caterpillar engines. ELC can be used in most OEM engines of the following types: diesel, gasoline, and natural gas. ELC meets the performance requirements of "ASTM D4985" and "ASTM D5345" for heavy-duty low silicate antifreeze/coolants. ELC also meets the performance requirements of "ASTM D3306" and "ASTM D4656" for automotive applications.

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Extended Life Coolant (ELC) Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

Proper additions to the Extended Life Coolant

NOTICE

Use only Caterpillar products or commercial products that have passed Caterpillar's EC-1 specification for pre-mixed or concentrated coolants.

Use only Caterpillar Extender with Extended Life Coolant.

Mixing Extended Life Coolant with other products reduces the Extended Life Coolant service life. Failure to follow the recommendations can reduce cooling system components life unless appropriate corrective action is performed.

In order to maintain the correct balance between the antifreeze and the additives, you must maintain the recommended concentration of Extended Life Coolant (ELC). Lowering the proportion of antifreeze lowers the proportion of additive. This will lower the ability of the coolant to protect the system from pitting, from cavitation, from erosion, and from deposits.

NOTICE

Do not use a conventional coolant to top-off a cooling system that is filled with Extended Life Coolant (ELC).

Do not use standard supplemental coolant additive (SCA). Only use ELC Extender in cooling systems that are filled with ELC.

Caterpillar ELC Extender

Caterpillar ELC Extender is added to the cooling system halfway through the ELC service life. Treat the cooling system with ELC Extender at 3000 hours or one half of the coolant service life. Use Table 19 in order to determine the proper amount of ELC Extender that is required.

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

Table 19

Caterpillar ELC Extender Additions by Cooling System Capacity		
Cooling System Capacity	Addition of ELC Extender	
22 to 30 L (6 to 8 US gal)	0.57 L (20 fl oz)	
31 to 38 L (9 to 10 US gal)	0.71 L (24 fl oz)	
39 to 49 L (11 to 13 US gal)	0.95 L (32 fl oz)	
50 to 64 L (14 to 17 US gal)	1.18 L (40 fl oz)	
65 to 83 L (18 to 22 US gal)	1.60 L (54 fl oz)	
84 to 114 L (23 to 30 US gal)	2.15 L (72 fl oz)	
115 to 163 L (31 to 43 US gal)	3.00 L (100 fl oz)	
164 to 242 L (44 to 64 US gal)	4.40 L (148 fl oz)	

For cooling system capacities that exceed the capacities that are specified in Table 19, use the equation that is in Table 20 in order to determine the proper amount of ELC Extender that is required.

Table 20

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X

Equation For Adding ELC Extender To ELC		
$V \times 0.02 = X$		
is the total volume of the cooling system.		
is the amount of ELC Extender that is required.		

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

Table 21

Example Of The Equation For Adding ELC Extender To ELC		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of ELC Extender that is Required (X)
946 L (250 US gal)	× 0.02	19 L (5 US gal)

NOTICE

When using Caterpillar ELC, do not use standard SCA's or SCA filters. To avoid SCA contamination of an ELC system, remove the SCA filter base and plug off or by-pass the coolant lines.

ELC Cooling System Cleaning

Note: If the cooling system is already using ELC, cleaning agents are not required to be used at the specified coolant change interval. Cleaning agents are only required if the system has been contaminated by the addition of some other type of coolant or by cooling system damage.

Clean water is the only cleaning agent that is required when ELC is drained from the cooling system.

ELC can be recycled. The drained coolant mixture can be distilled in order to remove the ethylene glycol and the water. The ethylene glycol and the water can be reused. Consult your Caterpillar dealer for more information.

After the cooling system is drained and after the cooling system is refilled, operate the engine while the cooling system filler cap is removed. Operate the engine until the coolant level reaches the normal operating temperature and until the coolant level stabilizes. As needed, add the coolant mixture in order to fill the system to the proper level.

Changing to Caterpillar ELC

To change from heavy-duty coolant/antifreeze to the Caterpillar ELC, perform the following steps:

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, "Caterpillar Tools and Shop Products Guide" for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

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

NOTICE

Do not leave an empty SCA filter on an ELC system.

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

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

- Remove the empty SCA filter and remove the filter base. Plug the coolant lines or bypass the coolant lines.
- **4.** Flush the system with clean water in order to remove any debris.
- **5.** Use Caterpillar cleaner to clean the system. Follow the instruction on the label.
- **6.** Drain the cleaner into a suitable container. Flush the cooling system with clean water.
- 7. Fill the cooling system with clean water and operate the engine until the engine is warmed to 49° to 66°C (120° to 150°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.

8. Drain the cooling system into a suitable container and flush the cooling system with clean water.

Note: The cooling system cleaner must be thoroughly flushed from the cooling system. Cooling system cleaner that is left in the system will contaminate the coolant. The cleaner may also corrode the cooling system.

- **9.** Repeat Steps 7 and 8 until the system is completely clean.
- Fill the cooling system with the Caterpillar premixed ELC.
- **11.** Attach the Special Publication, PEEP5027, "Label" to the cooling system filler for the engine in order to indicate the use of Caterpillar ELC.

ELC Cooling System Contamination

NOTICE

Mixing ELC with other products reduces the effectiveness of the ELC and shortens the ELC service life. Use only Caterpillar products or commercial products that have passed the Caterpillar EC-1 specification for premixed or concentrate coolants. Use only Caterpillar ELC Extender with Caterpillar ELC. Failure to follow these recommendations can result in shortened cooling system component life.

ELC cooling systems can withstand contamination to a maximum of ten percent of conventional heavy-duty coolant/antifreeze or SCA. If the contamination exceeds ten percent of the total system capacity, perform ONE of the following procedures:

- Drain the cooling system into a suitable container.
 Dispose of the coolant according to local regulations. Flush the system with clean water. Fill the system with the Caterpillar ELC.
- Drain a portion of the cooling system into a suitable container according to local regulations.
 Then, fill the cooling system with premixed ELC.
 This should lower the contamination to less than 10 percent.
- Maintain the system as a conventional Diesel Engine Antifreeze/Coolant (DEAC). Treat the system with an SCA. Change the coolant at the interval that is recommended for the conventional Diesel Engine Antifreeze/Coolant (DEAC).

Commercial ELC

If Caterpillar ELC is not used, then select a commercial ELC that meets the Caterpillar specification of EC-1 and either the "ASTM D5345" specification or the "ASTM D4985" specification. Do not use an extended life coolant that does not meet the EC-1 specification. Follow the maintenance guide for the coolant from the supplier of the commercial ELC. Follow the Caterpillar guidelines for the quality of water and the specified coolant change interval.

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Diesel Engine Antifreeze/ Coolant (DEAC)

SMCS Code: 1350; 1395

Caterpillar recommends using Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) for cooling systems that require a heavy-duty coolant/antifreeze. Caterpillar DEAC is an alkaline single-phase ethylene glycol type antifreeze that contains corrosion inhibitors and antifoam agents.

Caterpillar DEAC is formulated with the correct amount of Caterpillar Supplemental Coolant Additive (SCA). Do no use SCA at the initial fill when DEAC is used.

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

If concentrated DEAC is used, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water is not available or deionized water is not available, use water which has the required properties. For the water properties, see this publication, "General Coolant Information" topic (Maintenance Section).

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Supplemental Coolant Additive (SCA)

SMCS Code: 1350; 1352; 1395

The use of SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liners
- Foaming of the coolant

Caterpillar Diesel Engine Antifreeze/Coolant (DEAC) is formulated with the correct level of Caterpillar SCA. When the cooling system is initially filled with DEAC, adding more SCA is not necessary until the concentration of SCA has been depleted. To ensure that the correct amount of SCA is in the cooling system, the concentration of SCA must be tested on a scheduled basis. Refer to the specific engine's Operation and Maintenance Manual, "Maintenance Interval Schedule".

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

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Commercial Heavy-Duty Coolant/Antifreeze and SCA

SMCS Code: 1350: 1395

If Caterpillar DEAC is not used, select a coolant/antifreeze with low silicate content for heavy-duty applications that meets "ASTM D5345" or "ASTM D4985" specifications.

Note: When you are not using Caterpillar DEAC the cooling system must be drained one time during every year. The cooling system must be flushed at this time as well.

When a heavy-duty coolant/antifreeze is used, treat the cooling system with three to six percent Caterpillar SCA by volume. For more information, see this publication, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

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

Coolant/antifreeze that meets "ASTM D5345" or "ASTM D4985" specifications MAY require treatment with SCA at the initial fill. These coolants WILL require treatment with SCA on a maintenance basis.

When concentrated coolant/antifreeze is mixed, Caterpillar recommends mixing the concentrate with distilled water or with deionized water. If distilled water or deionized water is not available, water which has the required properties may be used. For the water properties, see this publication, "General Coolant Information" topic (Maintenance Section).

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Water/Supplemental Coolant Additive (SCA)

SMCS Code: 1350; 1352; 1395

NOTICE

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

NOTICE

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

Note: Premix the coolant solution in order to provide protection to the lowest ambient temperature that is expected.

Note: Pure undiluted antifreeze freezes at -23 °C (-9 °F).

In engine cooling systems that use water alone, Caterpillar recommends the use of SCA. SCA helps to prevent the following conditions from occurring:

- Corrosion
- Formation of mineral deposits
- Cavitation erosion of the cylinder liner
- Foaming of the coolant

If Caterpillar SCA is not used, select a commercial SCA. The commercial SCA must provide a minimum of 2400 mg/L or 2400 ppm (140 grains/US gal) of nitrites in the final coolant mixture.

The quality of the water is a very important factor in this type of cooling system. Distilled water or deionized water is recommended for use in cooling systems. If distilled water or deionized water is not available, use water that meets the minimum requirements that are listed in the table for recommended water properties in this publication, "General Coolant Information" topic (Maintenance Section).

A cooling system that uses a mixture of SCA and water only needs more SCA than a cooling system that uses a mixture of glycol and water. The SCA concentration in a cooling system that uses SCA and water should be six to eight percent by volume. Refer to Table 22 for the amount of SCA that is required for various capacities of the cooling system.

Table 22

Caterpillar SCA Requirements for SCA and Water Cooling Systems				
Cooling System Capacity				
22 to 30 L (6 to 8 US gal)	1.75 L (64 fl oz)	0.44 L (15 fl oz)		
31 to 38 L (9 to 10 US gal)	2.30 L (80 fl oz)	0.57 L (20 fl oz)		
39 to 49 L (11 to 13 US gal)	3.00 L (100 fl oz)	0.75 L (25 fl oz)		
50 to 64 L (14 to 17 US gal)	3.90 L (128 fl oz)	0.95 L (32 fl oz)		
65 to 83 L (18 to 22 US gal)	5.00 L (168 fl oz)	1.25 L (42 fl oz)		
84 to 110 L (23 to 29 US gal)	6.60 L (224 fl oz)	1.65 L (56 fl oz)		
111 to 145 L (30 to 38 US gal)	8.75 L (296 fl oz)	2.19 L (74 fl oz)		
146 to 190 L (39 to 50 US gal)	11.50 L (392 fl oz)	2.88 L (98 fl oz)		
191 to 250 L (51 to 66 US gal)	15.00 L (512 fl oz)	3.75 L (128 fl oz)		

Refer to Table 23 for part numbers and for quantities of SCA.

Table 23

Caterpillar Liquid SCA			
Part Number	Quantity		
6V-3542	0.24 L (8 oz)		
111-2372	0.36 L (12 oz)		
8T-1589	0.47 L (16 oz)		
3P-2044	0.94 L (32 oz)		
8C-3680	19 L (5 US gal)		
5P-2907	208 L (55 US gal)		

Maintain the SCA in the same way as you would maintain a cooling system that uses heavy-duty coolant/antifreeze. Adjust the maintenance for the amount of SCA additions. See Table 22 for the amount of SCA that is required.

Cooling Systems with Larger Capacities

Adding the SCA to Water at the Initial Fill

Use the equation that is in Table 24 to determine the amount of Caterpillar SCA that is required at the initial fill. This equation is for a mixture of only SCA and water.

Table 24

Equation For Adding The SCA To Water At The Initial Fill			
V × 0.07 = X			
V is the total volume of the cooling system.			
X is the amount of SCA that is required.			

Table 25 is an example for using the equation that is in Table 24.

Table 25

Example Of The Equation For Adding The SCA To Water At The Initial Fill		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
946 L (250 US gal)	× 0.07	66 L (18 US gal)

Adding the SCA to Water for Maintenance

For the recommended service interval, refer to the Operation and Maintenance Manual, "Maintenance Interval Schedule" for your engine.

Use the 8T-5296 Coolant Conditioner Test Kit to test the concentration of SCA. Make the following modifications to Steps 3 and 5 of the 8T-5296 Coolant Conditioner Test Kit instructions:

STEP 3 – Add tap water to the vial up to the "20 ml" mark.

STEP 5 – When the defined procedure is used, a concentration of six to eight percent will yield between 20 drops and 27 drops. If the number of drops is below 20 drops, the concentration of SCA is low. If the number of drops is above 27 drops, the concentration of SCA is high. Make the appropriate adjustments to the concentration of SCA.

Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, "S·O·S Coolant Analysis" topic (Maintenance Section).

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is required.

Use the equation that is in Table 24 to determine the amount of Caterpillar SCA that is required for maintenance, if necessary:

Table 26

SCA To Water Addition Equation For Maintenance $V \times 0.023 = X$

V is the total volume of the cooling system.

X is the amount of SCA that is required.

Table 27 is an example for using the equation that is in Table 24.

Table 27

SCA To Water Addition Equation Example For Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
946 L (250 US gal)	× 0.023	22 L (6 US gal)

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

Table 23 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

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Conventional Coolant/ Antifreeze Cooling System Maintenance

SMCS Code: 1350; 1352; 1395

NOTICE

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

Check the coolant/antifreeze (glycol concentration) in order to ensure adequate protection against boiling or freezing. Caterpillar recommends the use of a refractometer for checking the glycol concentration. Use the 1U-7298 Coolant/Battery Tester (Degree Celsius) or use the 1U-7297 Coolant/Battery Tester (Degree Fahrenheit). The testers give readings that are immediate and accurate. The testers can be used with ethylene or with propylene glycol.

Caterpillar engine cooling systems should be tested at 250 hour intervals for the concentration of Supplemental Coolant Additive (SCA). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer at 250 hour intervals. Refer to S·O·S Coolant Analysis for more information on this topic.

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

Table 28 lists the amount of Caterpillar SCA that is needed at the initial fill in order to treat coolant/antifreeze. These amounts of SCA are for systems that use heavy-duty coolant/antifreeze.

Table 28 also lists additions of SCA for liquid and for maintenance elements at 250 hours. The additions are required for Caterpillar DEAC and for commercial coolant/antifreezes.

Table 28

Caterpillar SCA Requirements for Heavy-Duty Coolant/Antifreeze			
Cooling System Capacity	Initial Fill ⁽¹⁾	250 Service Hour Maintenance ⁽²⁾	Spin-on Element at 250 Service Hour Maintenance (If Equipped)(3)
22 to 30 L (6 to 8 US gal)	0.95 L (32 fl oz)	0.24 L (8 fl oz)	111-2370 (1)
31 to 38 L (9 to 10 US gal)	1.18 L (40 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
39 to 49 L (11 to 13 US gal)	1.42 L (48 fl oz)	0.36 L (12 fl oz)	111-2369 (1)
50 to 64 L (14 to 17 US gal)	1.90 L (64 fl oz)	0.47 L (16 fl oz)	9N-3368 (1)
65 to 83 L (18 to 22 US gal)	2.37 L (80 fl oz)	0.60 L (20 fl oz)	111-2371 (1)
84 to 114 L (23 to 30 US gal)	3.32 L (112 fl oz)	0.95 L (32 fl oz)	9N-3718 (1)
115 to 163 L (31 to 43 US gal)	4.75 L (160 fl oz)	1.18 L (40 fl oz)	111-2371 (2)
164 to 242 L (44 to 64 US gal)	7.60 L (256 fl oz)	1.90 L (64 fl oz)	9N-3718 (2)

⁽¹⁾ When the coolant system is first filled, the SCA is not required to be used with Caterpillar DEAC.

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

Refer to Table 29 for part numbers and for quantities of SCA.

Table 29 ·

Caterpillar Liquid SCA		
Part Number Quantity		
6V-3542	0.24 L (8 oz)	
111-2372	0.36 L (12 oz)	
8T-1589	0.47 L (16 oz)	
3P-2044	0.94 L (32 oz)	
8C-3680	19 L (5 US gal)	
5P-2907	208 L (55 US gal)	

Cooling Systems with Larger Capacities

Adding the SCA to Conventional Coolant/Antifreeze at the Initial Fill

Note: Caterpillar DEAC DOES NOT require an addition of SCA when the cooling system is initially filled.

Commercial heavy-duty coolant/antifreeze that meets "ASTM D4985" or "ASTM D5345" specifications MAY require an addition of SCA at the initial fill. Read the label or the instructions that are provided by the OEM of the product.

Use the equation that is in Table 30 to determine the amount of Caterpillar SCA that is required when the cooling system is initially filled with the following fluids:

- "ASTM D4985"
- "ASTM D5345"

⁽²⁾ Do not exceed the six percent maximum concentration. Check the concentration of SCA with a SCA test kit.

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

Table 30

Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill		
V × 0.045 = X		
V is the total volume of the cooling system.		
X is the amount of SCA that is required.		

Table 31 is an example for using the equation that is in Table 30.

Table 31

Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze At The Initial Fill		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
946 L (250 US gal)	× 0.045	43 L (11 US gal)

Adding the SCA to Conventional Coolant/Antifreeze For Maintenance

Heavy duty coolant/antifreeze of all types REQUIRE periodic additions of an SCA.

Test the coolant/antifreeze periodically for the concentration of SCA. For the interval, see the Operation and Maintenance Manual, "Maintenance Interval Schedule" (Maintenance Section). SCA test kits are available from your Caterpillar dealer. Test the concentration of SCA or submit a coolant sample to your Caterpillar dealer. See this publication, "S·O·S Coolant Analysis" topic (Maintenance Section).

Additions of SCA are based on the results of the test or based on the results of the coolant analysis. The size of the cooling system determines the amount of SCA that is needed.

Use the equation that is in Table 32 to determine the amount of Caterpillar SCA that is required, if necessary:

Table 32

Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance

 $V \times 0.014 = X$

V is the total volume of the cooling system.

X is the amount of SCA that is required.

Table 33 is an example for using the equation that is in Table 32.

Table 33

Example Of The Equation For Adding The SCA To Conventional Coolant/Antifreeze For Maintenance		
Total Volume of the Cooling System (V)	Multiplication Factor	Amount of SCA that is Required (X)
946 L (250 US gal)	× 0.014	9 L (4 US gal)

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

Table 29 lists part numbers and quantities of SCA that is available from your Caterpillar dealer.

Cleaning the System of Heavy-Duty Coolant/Antifreeze

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

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

Refill Capacities

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Refill Capacities

SMCS Code: 1348; 1395; 7560

Lubrication System

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 additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" (Maintenance Section) for more information.

Table 34

C-15 And C-16 Industrial Engine Approximate Refill Capacities		
Compartment or System Liters Quart		
Crankcase Oil Sump (Standard)(1)	34.0	36.0
External System (OEM)(2)		
Total Lubrication System (3)		

- (1) These values are the approximate capacities for the crankcase oil sump which include the standard oil filters that are installed at the factory.
- (2) Enter the capacity for the External System in this row. Refer to either Caterpillar specifications or OEM specifications for further information. Engines with auxiliary oil filters will require additional oil. Refer to the OEM specifications for the capacity of the auxiliary oil filter.
- (3) The Total Lubrication System includes the capacity for the Crankcase Oil Sump plus the capacity for the External System. Enter the total in this row.

Cooling System

To maintain the cooling system, the Total Cooling System capacity must be known. The approximate capacity for the "Engine Only" cooling system is listed. External System capacities will vary among applications. Refer to the OEM specifications for the External System capacity. This capacity information will be needed in order to determine the amount of coolant/antifreeze that is required for the Total Cooling System.

Table 35

C-15 And C-16 Industrial Engine Approximate Refill Capacities		
Compartment or System Liters Qu		Quarts
Engine Only	22.7	24.0
External System (OEM)(1)		
Total Cooling System ⁽²⁾		

- (1) The External System includes a radiator or an expansion tank with the following components: heat exchanger, aftercooler, and piping. Enter the capacity for the External System in this row. Refer to either Caterpillar specifications or OEM specifications for further information.
- (2) The Total Cooling System includes the capacity for the "Engine Only" plus the capacity for the External System. Enter the total in this row.

Maintenance Interval Schedule (C-15)

SMCS Code: 1000; 7500

S/N: BEM1-Up

Operating conditions and oil API Classifications will determine the amount of service hours for the PM Level 1 Maintenance Interval Schedule. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for your specific oil change interval.

Note: Ensure that the Safety Information, warnings, and instructions are read and understood before operation or maintenance procedures are performed.

Note: Use fuel consumption, service hours, or calendar time, **whichever occurs first** in order to determine the maintenance intervals. Engines that operate in severe operating conditions may require more frequent maintenance.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must also be performed.

When Required

Battery - Replace	97 03 08 10
Severe Service Application - Check 1	19
Daily	
Air Starting Motor Lubricator Oil Level - Check Air Tank Moisture and Sediment - Drain Cooling System Coolant Level - Check Driven Equipment - Check Engine Air Cleaner Service Indicator - Inspect 1 Engine Air Precleaner - Check/Clean 1 Engine Oil Level - Check	86 93 96 00 101 102 111
Initial 20 to 40 Service Hours	

Belt - Inspect 88

Between 250 Service Hours and 1000 Service Hours

Electronic Unit Injector - Inspect/Adjust	9
Every 6000 Service Hours or 6 Years	
Cooling System Coolant (ELC) - Change 91	1
PM Level 1 - Every 12 750 L (3375 US gal) of Fuel or 250 Service Hours or 6 Months	
Air Compressor Filter - Clean/Replace	77 4 7 714480t1234
PM Level 1 - Every 25 500 L (6750 US gal) of Fuel or 500 Service Hours or 6 Months	2
Air Compressor Filter - Clean/Replace 8 Alternator - Inspect 8 Battery Electrolyte Level - Check 8 Cooling System Supplemental Coolant Additive (SCA) - Test/Add 9 Electronics Grounding Stud - Inspect/Clean/Tighten 9 Engine Air Cleaner Element (Dual Element) -	7 7 4 7
Clean/Replace	14480 nt 12
Hoses and Clamps - Inspect/Replace	4

PM Level 2 - Every 102 000 L (27 000 US gal) of Fuel or 2000 Service Hours or 1 Year
Aftercooler Core - Clean/Test
PM Level 3 - Every 153 000 L (40 500 US gal) of Fuel or 3000 Service Hours or 2 Years
Aftercooler Core - Clean/Test
Every 256 000 L (67 500 US gal) of Fuel or 5000 Service Hours
Starting Motor - Inspect
Every 380 000 L (100 000 US gal) of Fuel or 10 000 Service Hours
Overhaul Considerations 115

Maintenance Interval Schedule (C-16)

SMCS Code: 1000; 7500

S/N: BFM1-Up

Operating conditions and oil API Classifications will determine the amount of service hours for the PM Level 1 Maintenance Interval Schedule. Refer to Operation and Maintenance Manual, "Engine Oil and Filter - Change" for your specific oil change interval.

Note: Ensure that the Safety Information, warnings, and instructions are read and understood before operation or maintenance procedures are performed.

Note: Use fuel consumption, service hours, or calendar time, **whichever occurs first** in order to determine the maintenance intervals. Engines that operate in severe operating conditions may require more frequent maintenance.

Before each consecutive interval is performed, all of the maintenance requirements from the previous interval must also be performed.

When Required

Battery - Replace	87
Battery or Battery Cable - Disconnect	
Engine Air Cleaner Element (Dual Element) -	
Clean/Replace	97
Engine Oil Level Gauge - Calibrate	103
Engine Storage Procedure - Check	108
Ether Starting Aid Cylinder - Replace	110
Fuel System - Prime	110
Severe Service Application - Check	119
Daily	
Air Starting Motor Lubricator Oil Level - Check	
At T. I. & A. Calamant Drain	

All Starting Motor Lubricator On Level Check	
Air Tank Moisture and Sediment - Drain	86
Cooling System Coolant Level - Check	93
Driven Equipment - Check	96
Engine Air Cleaner Service Indicator - Inspect	100
Engine Air Precleaner - Check/Clean	101
Engine Oil Level - Check	102
Fuel System Primary Filter/Water Separator -	
Drain	111
Power Take-Off Clutch - Check/Adjust/	
Lubricate	118
Walk-Around Inspection	

Initial 20 to 40 Service Hours

Belt - Inspe	ct	8	8
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Between 250 Service Hours and 1000 Service Hours

1104.10	
Electronic Unit Injector - Inspect/Adjust	
Every 6000 Service Hours or 6 Years	
Cooling System Coolant (ELC) - Change 91	
PM Level 1 - Every 14 500 L (3850 US gal) of Fuel or 250 Service Hours or 6 Months	
Air Compressor Filter - Clean/Replace 85 Alternator - Inspect 87 Battery Electrolyte Level - Check 87 Cooling System Supplemental Coolant Additive (SCA) - Test/Add 94 Electronics Grounding Stud - Inspect/Clean/Tighten 97 Engine Air Cleaner Element (Dual Element) - Clean/Replace 97 Engine Crankcase Breather - Clean 101 Engine Oil Sample - Obtain 104 Engine Protective Devices - Check 108 Fan Drive Bearing - Lubricate 110 Fuel System Primary Filter/Water Separator Element - Replace 111 Fuel System Secondary Filter - Replace 112 Fuel Tank Water and Sediment - Drain 113 Hoses and Clamps - Inspect/Replace 114 Radiator - Clean 118	
PM Level 1 - Every 29 000 L (7700 US gal) of Fuel or 500 Service Hours or 6 Months	
Air Compressor Filter - Clean/Replace	77 4 7 7144
Fuel System Primary Filter/Water Separator Elemen	3

Radiator - Clean 118

PM Level 2 - Every 116 000 L (30 800 US gal) of Fuel or 2000 Service Hours or 1 Year
Aftercooler Core - Clean/Test
PM Level 3 - Every 174 000 L (46 200 US gal) of Fuel or 3000 Service Hours or 2 Years
Aftercooler Core - Clean/Test
Every 290 000 L (77 000 US gal) of Fuel or 500 Service Hours
Starting Motor - Inspect
Every 380 000 L (100 000 US gal) of Fuel or 10 000 Service Hours
Overhaul Considerations 115

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

SMCS Code: 1064-070; 1064-081

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

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

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

WARNING

Personal injury can result from air pressure.

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

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

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

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

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

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

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

Note: If parts of the aftercooler system are repaired or replaced, a leak test is highly recommended.

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

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

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Aftercooler Core - Clean/Test

SMCS Code: 1064-070; 1064-081

- **1.** Remove the core. Refer to the Service Manual for the procedure.
- Turn the aftercooler core upside-down in order to remove debris.

NOTICE

Do not use a high concentration of caustic cleaner to clean the core. A high concentration of caustic cleaner can attack the internal metals of the core and cause leakage. Only use the recommended concentration of cleaner.

3. Back flush the core with cleaner.

Caterpillar recommends the use of Hydrosolv liquid cleaner. Table 36 lists Hydrosolv liquid cleaners that are available from your Caterpillar dealer.

Table 36

Hydrosolv Liquid Cleaners(1)		
Part Number	Description	Size
1U-5490	Hydrosolv 4165	19 L (5 US gallon)
174-6854	Hydrosolv 100	19 L (5 US gallon)

- (1) Use a two to five percent concentration of the cleaner at temperatures up to 93°C (200°F). Refer to Application Guide, NEHS0526 or consult your Caterpillar dealer for more information.
- 4. Steam clean the core in order to remove any residue. Flush the fins of the aftercooler core. Remove any other trapped debris.
- **5.** Wash the core with hot, soapy water. Rinse the core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

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

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

- **6.** Dry the core with compressed air. Direct the air in the reverse direction of the normal flow.
- 7. Inspect the core in order to ensure cleanliness. Pressure test the core. Many shops that service radiators are equipped to perform pressure tests. If necessary, repair the core.
- **8.** Install the core. Refer to the Service Manual for the procedure.

For more information on cleaning the core, consult your Caterpillar dealer.

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Air Compressor - Inspect

SMCS Code: 1803-040

WARNING

Do not disconnect the air line from the air compressor governor without purging the air brake and the auxiliary air systems. Failure to purge the air brake and the auxiliary air systems before removing the air compressor and/or the air lines could cause personal injury.

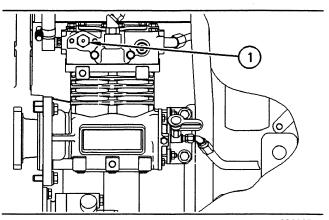


Illustration 38 g00633741

(1) Air compressor pressure relief valve

WARNING

If the air compressor pressure relief valve that is mounted in the air compressor cylinder head is bypassing compressed air, there is a malfunction in the air system, possibly ice blockage. Under these conditions, your engine may have insufficient air for normal brake operation.

Do not operate the engine until the reason for the air bypass is identified and corrected. Failure to heed this warning could lead to property damage, personal injury, or death to the operator or bystanders.

The function of the air compressor pressure relief valve is to bypass air when there is a malfunction in the air compressor system.

The air compressor pressure relief valve releases air at 1723 kPa (250 psi). It is very important that all personnel stand clear of the air compressor pressure relief valve when compressed air is released. All personnel should also stay clear of the air compressor when the engine is operating and the air compressor is exposed.

Refer to the Service Manual or refer to the OEM specifications in order to find information concerning the air compressor. Consult your Caterpillar dealer for assistance.

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Air Compressor Filter - Clean/Replace

SMCS Code: 1803-070-FQ; 1803-510-FQ

One of the single most important aspects of preventive maintenance for the air compressor is the induction of clean air. The type of maintenance that is required for the air compressor and the maintenance interval depends on the type of air induction system that is used. Operating conditions (dust, dirt and debris) may require more frequent service.

Refer to the Service Manual for the type of air compressor that is installed on the engine. Follow the maintenance recommendations that are provided by the OEM of the air compressor. Some engines use boost air pressure so the engine air cleaner will require servicing.

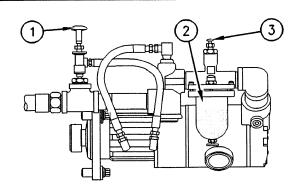
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Air Starting Motor Lubricator Oil Level - Check (If Equipped)

SMCS Code: 1451-535

NOTICE

Never allow the lubricator bowl to become empty. The air starting motor will be damaged by a lack of lubrication. Ensure that sufficient oil is in the lubricator bowl.



etration 30

Illustration 39

- (1) Air valve
- (2) Lubricator bowl
- (3) Adjustment knob
- The vanes of the air starting motor are lubricated with a fine mist of oil from the air starting motor lubricator. Check the level of oil in lubricator bowl (2). If the oil level is less than 1/2, add oil to the lubricator bowl.
- 2. Ensure that the air supply to the lubricator is OFF.
- 3. Remove the plug. Pour oil into lubricator bowl (2). Use "10W" oil for temperatures that are greater than 0° C (32° F). Use air tool oil for temperatures that are below 0° C (32° F).
- 4. Install the plug.

Oiler Feed Adjustment

If necessary, adjust the lubricator in order to release approximately two drops of fluid per 30 seconds into the starting motor air stream.

- 1. Ensure that the fuel supply to the engine is OFF.
- 2. Turn adjustment knob (3) clockwise until the adjustment knob locks.
- **3.** Turn adjustment knob (3) counterclockwise for 1/4 turns.

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.

4. Crank the starting motor for ten seconds and observe the exhaust air from the mufflers of the starting motor. Look for oil mist. A slight oil mist should be barely visible.

If no mist is observed, or if the mist is excessive, rotate adjustment knob (3) in increments of 1/16 in order to increase or decrease the oil mist. Repeat the starting motor cranking and observe until the mist is satisfactory.

Note: Drip rates should only be made under an average steady flow condition. Once a steady flow condition is established, the lubricator will automatically adjust the drip rate in proportion to the variations in air flow.

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Air Tank Moisture and Sediment - Drain (If Equipped)

SMCS Code: 1466-543-M&S

Moisture and sediment in the air starting system can cause the following conditions:

- Freezing
- Corrosion of internal parts
- Malfunction of the air starting system

WARNING

When opening the drain valve, wear protective gloves, a protective face shield, protective clothing, and protective shoes. Pressurized air could cause debris to be blown and result in personal injury.

- 1. Open the drain valve that is on the bottom of the air tank. Allow the moisture and sediment to drain.
- 2. Close the drain valve.

3. Check the air supply pressure. The air starting motor requires a minimum of 620 kPa (90 psi) of air pressure to operate properly. The maximum air pressure must not exceed 1550 kPa (225 psi). The normal air pressure will be 758 to 965 kPa (110 to 140 psi).

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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. Refer to the Service Manual.

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. If the battery is too cold, the battery will not crank the engine. The battery will not crank the engine, even if the engine is warm. 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.

i01492550

Battery - Replace

SMCS Code: 1401-510

A WARNING

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.

A 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.** Turn the key start switch to the OFF position. Remove the key and all electrical loads.
- 2. Turn OFF the battery charger. Disconnect the charger.
- 3. The NEGATIVE "-" cable connects the NEGATIVE "-" battery terminal to the ground plane. Disconnect the cable from the NEGATIVE "-" battery terminal.
- 4. The POSITIVE "+" cable connects the POSITIVE "+" battery terminal to the starting motor. Disconnect the cable from the POSITIVE "+" battery terminal.

Note: Always recycle a battery. Never discard a battery. Return used batteries to an appropriate recycling facility.

- 5. Remove the used battery.
- 6. Install the new battery.

Note: Before the cables are connected, ensure that the key start switch is OFF.

- Connect the cable from the starting motor to the POSITIVE "+" battery terminal.
- **8.** Connect the cable from the ground plane to the NEGATIVE "-" battery terminal.

i01206348

Battery Electrolyte Level - Check

SMCS Code: 1401-535

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.

MARNING

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.

- Check the condition of the electrolyte with the 1U-7298 Coolant/Battery Tester (°C) or the 1U-7297 Coolant/Battery Tester (°F).
- 3. Keep the batteries clean.

Clean the battery case with one of the following cleaning solutions:

- A mixture of 0.1 L (0.11 qt) of baking soda and 1 L (1 qt) of clean water
- A mixture of 0.1 L (0.11 qt) of ammonia and 1 L (1 qt) of clean water

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 grease.

i01492654

Battery or Battery Cable - Disconnect

SMCS Code: 1402-029

A 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.** 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.
- 2. Disconnect the negative battery terminal at the battery that goes to the start switch. Ensure that the cable cannot contact the terminal. When four 12 volt batteries are involved, the negative side of two batteries must be disconnected.
- **3.** Tape the leads in order to help prevent accidental starting.
- **4.** Proceed with necessary system repairs. Reverse the steps in order to reconnect all of the cables.

i00951407

Belt - Inspect

SMCS Code: 1357-040; 1357; 1397-040; 1397

Inspection

Belt tension should be checked initially between the first 20 to 40 hours of engine operation.

After the initial check, the belt tension should be checked at Every PM Level 1 or Three Months.

To maximize the engine performance, inspect the belts for wear and for cracking. Replace belts that are worn or damaged.

For applications that require multiple drive belts, replace the belts in matched sets. Replacing only one belt of a matched set will cause the new belt to carry more load because the older belt is stretched. The additional load on the new belt could cause the new belt to break.

If the belts are too loose, vibration causes unnecessary wear on the belts and pulleys. Loose belts may slip enough to cause overheating.

If the belts are too tight, unnecessary stresses are placed on the pulley bearings and on the belts. This may shorten the service life of the components.

Remove the belt guard. Inspect the condition and adjustment of the alternator belts and accessory drive belts (if equipped).

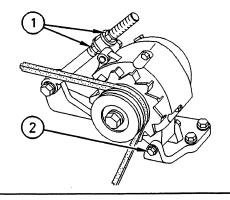
To check the belt tension, apply 110 N (25 lb ft) of force midway between the pulleys. A correctly adjusted belt will deflect 9 mm (0.35 inch) to 15 mm (0.59 inch).

If the belt does not require replacement or adjustment, install the belt guard. If the belt requires adjustment or replacement, perform the following procedure to adjust the belt tension.

- If the engine is equipped with a refrigerant compressor (air conditioner), the belt for the fan drive, the alternator, and the accessories will have an automatic belt tensioner.
- If the engine is not equipped with a refrigerant compressor, the alternator is used to adjust the belt tension.

Adjustment

Alternator Belt



g00485289

Illustration 40

Typical alternator mounting

- (1) Adjusting nuts
- (2) Mounting bolts
- Slightly loosen mounting bolt (2) and adjusting nut (1).
- 2. Move the pulley in order to adjust the belt tension.
- 3. Tighten adjusting nuts (1) and mounting bolts (2). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section).
- 4. Install the belt guard.

If new belts are installed, check the belt tension again after 30 minutes of engine operation at the rated rpm.

i01555583

Belt Tensioner - Inspect (If Equipped)

SMCS Code: 1358-040

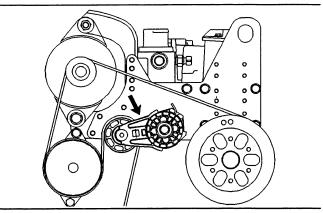


Illustration 41
Belt tensioner

g00426964

Inspect the belt tensioner for unusual noise, excessive looseness and/or shaking of the bearings.

If the belt tensioner should require disassembly, refer to the Service Manual for the procedure.

i01206425

Cooling System 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.

Note: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

A WARNING

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

- Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
- Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove one of the drain plugs.

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 Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL Inside Illinois: 1-800-541-TOOL Canada: 1-800-523-TOOL

Flush

- **1.** Flush the cooling system with clean water in order to remove any debris.
- Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

- 3. Fill the cooling system with a mixture of clean water and Caterpillar Fast Acting Cooling System Cleaner. Add 0.5 L (1 pint) of cleaner per 15 L (4 US gal) of the cooling system capacity. Install the cooling system filler cap.
- **4.** Start and run the engine at low idle for a minimum of 30 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

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

Cooling Systems with Heavy Deposits or Plugging

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

- 1. Flush the cooling system with clean water in order to remove any debris.
- 2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

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

4. Start and run the engine at low idle for a minimum of 90 minutes. The coolant temperature should be at least 82 °C (180 °F).

NOTICE

Improper or incomplete rinsing of the cooling system can result in damage to copper and other metal components.

To avoid damage to the cooling system, make sure to completely flush the cooling system with clear water. Continue to flush the system until all signs of the cleaning agent are gone.

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

Fill

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

- Fill the cooling system with coolant/antifreeze. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
- 2. Start and run the engine at low idle. Increase the engine rpm to 1500 rpm. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
- 3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).

- 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 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 proper operating temperature.

i01206445

Cooling System 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: Inspect the water pump and the water temperature regulator after the cooling system has been drained. This is a good opportunity to replace the water pump, the water temperature regulator and the hoses, if necessary.

Drain

WARNING

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

- 1. Stop the engine and allow the engine to cool. Loosen the cooling system filler cap slowly in order to relieve any pressure. Remove the cooling system filler cap.
- Open the cooling system drain valve (if equipped). If the cooling system is not equipped with a drain valve, remove the cooling system drain plugs.

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 Caterpillar Service Technology Group:

Outside Illinois: 1-800-542-TOOL Inside Illinois: 1-800-541-TOOL Canada: 1-800-523-TOOL

Flush

- **1.** Flush the cooling system with clean water in order to remove any debris.
- 2. Close the drain valve (if equipped). Clean the drain plugs. Install the drain plugs. Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for more information on the proper torques.

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

- **3.** Fill the cooling system with clean water. Install the cooling system filler cap.
- Start and run the engine at low idle until the temperature reaches 49 to 66 °C (120 to 150 °F).

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

Fill

NOTICE

Fill the cooling system no faster than 19 L (5 US gal) per minute to avoid air locks.

- Fill the cooling system with Extended Life Coolant (ELC). Refer to the Operation and Maintenance Manual, "Cooling System Specifications" topic (Maintenance Section) for more information on cooling system specifications. Do not install the cooling system filler cap.
- 2. Start and run the engine at low idle. Increase the engine rpm to high idle. Run the engine at high idle for one minute in order to purge the air from the cavities of the engine block. Stop the engine.
- 3. Check the coolant level. Maintain the coolant level within 13 mm (0.5 inch) below the bottom of the pipe for filling. Maintain the coolant level within 13 mm (0.5 inch) to the proper level on the sight glass (if equipped).
- 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 is not damaged, use a 9S-8140 Pressurizing Pump in order 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 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 proper operating temperature.

Cooling System Coolant Extender (ELC) - Add

-SMCS Code: 1352-045; 1395-081

Caterpillar Extended Life Coolant (ELC) does not require the frequent Supplemental Coolant Additive (SCA) additions associated with the present conventional coolants. The Extender only needs to be added once.

Check the cooling system only when the engine is stopped and cool.

- Loosen the cooling system filler cap slowly in order to relieve pressure. Remove the cooling system filler cap.
- 2. It may be necessary to drain enough coolant from the cooling system in order to add the Extender.
- 3. Add Extender according to the requirements for your engine's cooling system capacity. Refer to the Operation and Maintenance Manual, "Refill Capacities" in the Maintenance Section for the capacity of the cooling system for your engine. Refer to the Operation and Maintenance Manual, "Cooling System Specifications" information for the Caterpillar ELC Extender additions.
- 4. Clean the cooling system filler cap. Inspect the cooling system filler cap gaskets. Replace the cooling system filler cap if the cooling system filler cap gaskets are damaged. Install the cooling system filler cap.

i01197583

Cooling System Coolant Level - Check

SMCS Code: 1395-082

Check the coolant level when the engine is stopped and cool.

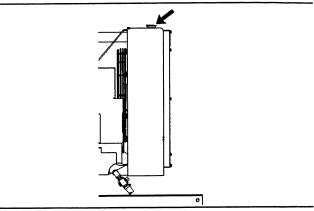


Illustration 42
Cooling system filler cap

g00285520

WARNING

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

- 1. Remove the cooling system filler cap slowly in order to relieve pressure.
- 2. Maintain the coolant level within 13 mm (0.5 inch) of the bottom of the filler pipe. If the engine is equipped with a sight glass, maintain the coolant level to the proper level in the sight glass.

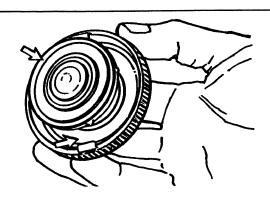


Illustration 43
Typical filler cap gaskets

g00103639

- 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.
- **4.** Inspect the cooling system for leaks.

Cooling System Supplemental Coolant Additive (SCA) - Test/Add

SMCS Code: 1352-045; 1395-081

WARNING

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·O·S Coolant Analysis.

Test for SCA Concentration

Coolant/Antifreeze 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 the Operation and Maintenance Manual 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 Operation and Maintenance Manual, "Water/Supplemental Coolant Additive (SCA)" topic (Maintenance Section). Refer to the Operation and Maintenance Manual, "Conventional Coolant/Antifreeze Cooling System Maintenance" topic (Maintenance Section).

S.O.S Coolant Analysis

S·O·S coolant samples can be analyzed at your Caterpillar dealer. S·O·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·O·S Coolant Analysis.

Level 2

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

Add the SCA, If Necessary

NOTICE

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

WARNING

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

 Slowly loosen the cooling system filler cap in order to relieve the pressure. Remove the cooling system filler cap. Note: Always discard drained fluids according to local regulations.

- 2. If necessary, drain some coolant from the cooling system into a suitable container in order to allow space for the extra SCA.
- **3.** Add the proper amount of SCA. Refer to the Operation and Maintenance Manual 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.

i00912898

Cooling System Water Temperature Regulator -Replace

SMCS Code: 1355-510

Replace the water temperature regulator before the water temperature regulator fails. This is a recommended preventive maintenance practice. Replacing the water temperature regulator reduces the chances for unscheduled downtime.

A water temperature regulator that fails in a partially opened position can cause overheating or overcooling of the engine.

A water temperature regulator that fails in the closed position can cause excessive overheating. Excessive overheating could result in cracking of the cylinder head or piston seizure problems.

A water temperature regulator that fails in the open position will cause the engine operating temperature to be too low during partial load operation. Low engine operating temperatures during partial loads could cause an excessive carbon buildup inside the cylinders. This excessive carbon buildup could result in an accelerated wear of the piston rings and wear of the cylinder liner.

NOTICE

Failure to replace your water temperature regulator on a regularly scheduled basis could cause severe engine damage.

Caterpillar engines incorporate a shunt design cooling system and require operating the engine with a water temperature regulator installed.

If the water temperature regulator is installed incorrectly, the engine may overheat, causing cylinder head damage. Ensure that the new water temperature regulator is installed in the original position. Ensure that the water temperature regulator vent hole is open.

Do not use liquid gasket material on the gasket or cylinder head surface.

Refer to the Service Manual for the replacement procedure of the water temperature regulator, or consult your Caterpillar dealer.

Note: If only the water temperature regulators are replaced, drain the coolant from the cooling system to a level that is below the water temperature regulator housing.

i00934535

Crankshaft Vibration Damper - Inspect

SMCS Code: 1205-040

Damage to the crankshaft vibration damper or failure of the crankshaft vibration damper can increase torsional vibrations. This can result in damage to the crankshaft and to other engine components. A damper that is damaged can cause excessive gear train noise at variable points in the speed range.

The damper is mounted to the crankshaft which is located behind the belt guard on the front of the engine.

Visconic Damper

The visconic damper has a weight that is located inside a fluid filled case. The weight moves in the case in order to limit torsional vibration.

Inspect the damper for evidence of fluid leaks. If a fluid leak is found, determine the type of fluid. The fluid in the damper is silicone. Silicone has the following characteristics: transparent, viscous, smooth, and difficult to remove from surfaces.

If the fluid leak is oil, inspect the crankshaft seals for leaks. If a leak is observed, replace the crankshaft seals.

Inspect the damper and repair or replace the damper for any of the following reasons:

- The damper is dented, cracked, or leaking.
- The paint on the damper is discolored from heat.
- The engine has had a failure because of a broken crankshaft.
- Analysis of the oil has revealed that the front main bearing is badly worn.
- There is a large amount of gear train wear that is not caused by a lack of oil.

Refer to the Service Manual or consult your Caterpillar dealer for information about damper replacement.

i00174798

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.

i01117091

Electronic Unit Injector - Inspect/Adjust

SMCS Code: 1251-025; 1251-040; 1290-025;

1290-040

A WARNING

Be sure the engine cannot be started while this maintenance is being performed. To prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting the unit injectors.

The electronic unit injectors use high voltage. Disconnect the unit injector enable circuit connector in order to prevent personal injury. Do not come in contact with the injector terminals while the engine is running.

Adjust the electronic unit injector at the same interval as the valve lash adjustment. The operation of Caterpillar engines with improper adjustments of the electronic unit injector can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

Electronics Grounding Stud - Inspect/Clean/Tighten

SMCS Code: 7423-040; 7423-070; 7423-079

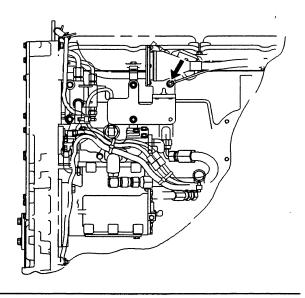


Illustration 44

g00765094

Electronics grounding stud (side view)

Inspect the OEM harness for good connections. Inspect the condition of the OEM harness.

The electronics grounding stud must have a wire ground to the battery. Tighten the electronics grounding stud at every oil change. Ground wires and straps should be combined at engine grounds. All grounds should be tight and free of corrosion.

- Clean the electronics grounding stud and the terminals for the electronics ground strap with a clean cloth.
- If the connections are corroded, clean the connections with a solution of baking soda and water.
- Keep the electronics grounding stud and the strap clean and coated with MPGM grease or petroleum jelly.

i01239442

Engine - Clean

SMCS Code: 1000-070

A 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

Water and/or condensation can cause damage to electrical components. Protect all electrical components from exposure to water.

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

i01553486

Engine Air Cleaner Element (Dual Element) - Clean/Replace

SMCS Code: 1054-037; 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

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. Your Caterpillar dealer has the proper air cleaner elements for your application. Consult your Caterpillar dealer for the correct air cleaner element.

- Check the precleaner (if equipped) daily for accumulation of dirt and debris. Remove any dirt and debris, as needed.
- Operating conditions (dust, dirt and debris) may require more frequent service of the air cleaner element.
- The air cleaner element may be cleaned up to six times if the element is properly cleaned and inspected.
- The air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Replace the dirty paper air cleaner elements with clean air cleaner elements. Before installation, the 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.

Dual Element Air Cleaners

The dual element air cleaner contains a primary air cleaner element and a secondary air cleaner element. The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

The secondary air cleaner element is not serviceable or washable. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element. When the engine is operating in environments that are dusty or dirty, air cleaner elements may require more frequent replacement.

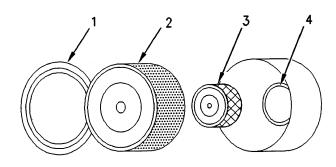


Illustration 45

g00736431

- (1) Cover
- (2) Primary air cleaner element
- (3) Secondary air cleaner element
- (4) Turbocharger air inlet
- 1. Remove the cover. Remove the primary air cleaner element.
- 2. The secondary air cleaner element should be removed and discarded for every three cleanings of the primary air cleaner element.

Note: Refer to "Cleaning the Primary Air Cleaner Elements".

- 3. Cover the turbocharger air inlet with tape in order to keep dirt out.
- **4.** Clean the inside of the air cleaner cover and body with a clean, dry cloth.
- Remove the tape for the turbocharger air inlet. Install the secondary air cleaner element. Install a primary air cleaner element that is new or cleaned.
- 6. Install the air cleaner cover.
- 7. Reset the air cleaner service indicator.

Cleaning the Primary Air Cleaner Elements

NOTICE

Caterpillar recommends certified air filter cleaning services that are available at Caterpillar dealers. The Caterpillar cleaning process uses proven procedures to assure consistent quality and sufficient filter life.

Observe the following guidelines if you attempt to clean the filter element:

Do not tap or strike the filter element in order to remove dust.

Do not wash the filter element.

Use low pressure compressed air in order to remove the dust from the filter element. Air pressure must not exceed 207 kPa (30 psi). Direct the air flow up the pleats and down the pleats from the inside of the filter element. Take extreme care in order to avoid damage to the pleats.

Do not use air filters with damaged pleats, gaskets, or seals. Dirt entering the engine will cause damage to engine components.

The primary air cleaner element can be used up to six times if the element is properly cleaned and inspected. When the primary air cleaner element is cleaned, check for rips or tears in the filter material. The primary air cleaner element should be replaced at least one time per year. This replacement should be performed regardless of the number of cleanings.

Use clean primary air cleaner elements while dirty elements are being cleaned.

NOTICE

Do not clean the air cleaner elements by bumping or tapping. This could damage the seals. Do not use elements with damaged pleats, gaskets or seals. Damaged elements will allow dirt to pass through. Engine damage could result.

Visually inspect the primary air cleaner elements before cleaning. Inspect the air cleaner elements for damage to the seal, the gaskets, and the outer cover. Discard any damaged air cleaner elements.

There are two common methods that are used to clean primary air cleaner elements:

- Pressurized air
- Vacuum cleaning

Pressurized Air

Pressurized air can be used to clean primary air cleaner elements that have not been cleaned more than two times. Pressurized air will not remove deposits of carbon and oil. Use filtered, dry air with a maximum pressure of 207 kPa (30 psi).

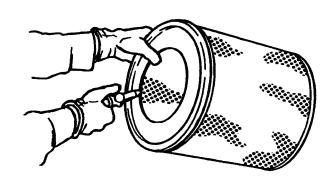


Illustration 46

g00281692

Note: When the primary air cleaner elements are cleaned, always begin with the clean side (inside) in order to force dirt particles toward the dirty side (outside).

Aim the hose so that the air flows inside the element along the length of the filter in order to help prevent damage to the paper pleats. Do not aim the stream of air directly at the primary air cleaner element. Dirt could be forced further into the pleats.

Note: Refer to "Inspecting the Primary Air Cleaner Elements".

Vacuum Cleaning

Vacuum cleaning is a good method for cleaning primary air cleaner elements which require daily cleaning because of a dry, dusty environment. Cleaning with pressurized air is recommended prior to vacuum cleaning. Vacuum cleaning will not remove deposits of carbon and oil.

Note: Refer to "Inspecting the Primary Air Cleaner Elements".

Inspecting the Primary Air Cleaner Elements

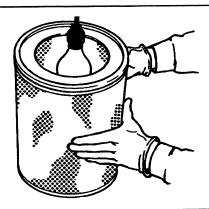


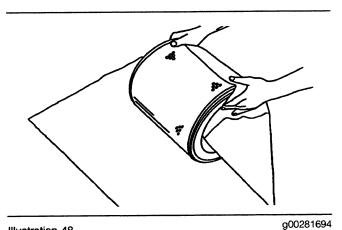
Illustration 47 g00281693

Inspect the clean, dry primary air cleaner element. Use a 60 watt blue light in a dark room or in a similar facility. Place the blue light in the primary air cleaner element. Rotate the primary air cleaner element. Inspect the primary air cleaner element for tears and/or holes. Inspect the primary air cleaner element for light that may show through the filter material. If it is necessary in order to confirm the result, compare the primary air cleaner element to a new primary air cleaner element that has the same part number.

Do not use a primary air cleaner element that has any tears and/or holes in the filter material. Do not use a primary air cleaner element with damaged pleats, gaskets or seals. Discard damaged primary air cleaner elements.

Storing Primary Air Cleaner Elements

If a primary air cleaner element that passes inspection will not be used, the primary air cleaner element can be stored for future use.



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

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

- Date of cleaning
- Number of cleanings

Store the box in a dry location.

i01175055

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.

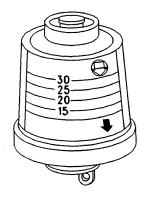


Illustration 49
Typical service indicator

g00103777

Illustration 48

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 approximately 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 plugged.

The service indicator may need to be replaced frequently in environments that are severely dusty, if necessary. Replace the service indicator annually regardless of the operating conditions. Replace the service indicator when the engine is overhauled, and whenever major engine components are replaced.

Note: When a new service indicator is installed, excessive force may crack the top of the service indicator. Tighten the service indicator to a torque of 2 N·m (18 lb in).

i00720883

Engine Air Precleaner - Check/Clean

SMCS Code: 1055-070; 1055-535

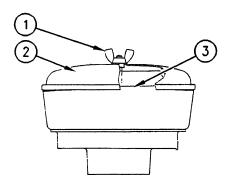


Illustration 50

g00287039

Typical engine 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 applications, more frequent cleaning is required.

i00906289

Engine Crankcase Breather - Clean

SMCS Code: 1317-070

NOTICE

Perform this maintenance with the engine stopped.

If the crankcase breather is not maintained on a regular basis, the crankcase breather will become plugged. A plugged crankcase breather will cause excessive crankcase pressure that may cause crankshaft seal leakage.

3

Illustration 51

g00463048

Typical example

- (1) Hose clamp
- (2) Breather assembly
- (3) Retaining clamp
- **1.** Loosen hose clamp (1) and remove the hose from breather assembly (2).
- 2. Loosen the retaining clamp (3). Remove breather assembly (2) and the seal.
- Wash the breather element in solvent that is clean and nonflammable. Allow the breather element to dry before installation.
- 4. Install a breather element that is clean and dry. Install breather assembly and seal (2) and install clamp (3). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.
- **5.** Install the hose. Install hose clamp (1). Refer to the Operation and Maintenance Manual, "Torque Specifications" topic (Maintenance Section) for the proper torques.

i00687861

Engine Mounts - Inspect

SMCS Code: 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 the Service Manual for the recommended torques. Refer to your Caterpillar dealer for more information.

Engine Oil Level - Check

SMCS Code: 1348-535-FLV

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

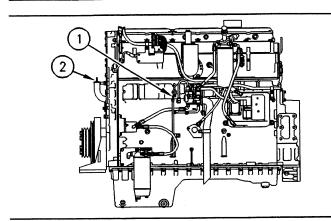


Illustration 52

g00409363

Left side view

- (1) Oil level gauge
- (2) Oil filler cap

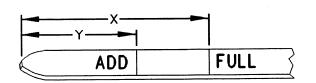


Illustration 53

q00110310

- (Y) "ADD" mark
- (X) "FULL" mark

NOTICE

Perform this maintenance with the engine stopped.

 Maintain the oil level between "ADD" mark (Y) and "FULL" mark (X) on oil level gauge (1). Do not fill the crankcase above "FULL" mark (X).

NOTICE

Operating your engine when the oil level is above the "FULL" mark could cause your crankshaft to dip into the oil. The air bubbles created from the crankshaft dipping into the oil reduces the oil's lubricating characteristics and could result in the loss of power.

2. Remove oil filler cap (2) and add oil, if necessary. Clean the oil filler cap. Reinstall the oil filler cap.

Engine Oil Level Gauge - Calibrate

SMCS Code: 1326-524

The angle of the installation and the slant of the installation will affect the engine oil level. The angle is the front to back tilt of the engine. The slant is the sideways tilt of the engine.

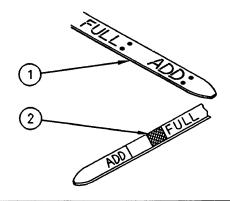


Illustration 54

g00403460

The engine will be equipped with either dipstick.

(1) Traditional dipstick. (2) Full range dipstick.

Verify that the markings on the engine oil level gauge are correct. Verify the markings at the first oil change.

Use the following procedure in order to verify that "ADD" mark is correct. Use the following procedure in order to establish actual "FULL" mark on the engine oil level gauge.

NOTICE

The engine must be on a level surface to perform this maintenance procedure.

 Operate the engine until normal operating temperature is achieved. Stop the engine. Remove the drain plugs from the engine crankcase. Allow the engine oil to drain.

NOTICE

Do not fill the oil filters with oil before installing them.

This oil would not be filtered and could be contaminated.

Contaminated oil will cause accelerated wear to the engine.

2. Remove the used engine oil filter(s). Install the new engine oil filter(s). Install the drain plug for the engine crankcase. Tighten the drain plug for the engine crankcase to $70 \pm 14 \text{ N} \cdot \text{m}$ (50 \pm 10 lb ft).

Note: The engine may be equipped with auxiliary engine oil filters. The oil filters may require a different volume than the standard amount. Refer to the OEM specifications.

- 3. Pour 26.5 L (28 qt) of engine oil into the engine crankcase. DO NOT pour oil into the oil filler that is located on top of the engine. Pour oil into one of the oil fill locations on the side of the engine. Allow enough time for the engine oil to drain into the engine crankcase. Check the engine oil level. Wait for a few minutes. Check the engine oil level again. Proceed after the engine oil level stops changing.
- **4.** The oil level should be at the "ADD" mark. If the oil is not at the "ADD" mark, grind off the existing "ADD" mark. Mark the new level as "ADD" using an engraving pen.
- 5. Pour 5.7 L (6 qt) of engine oil into the engine crankcase. Allow enough time for the engine oil to drain into the engine crankcase. Allow a minimum of five minutes.
- 6. Install the oil level gauge. Remove the gauge and note the oil level on the gauge. This is the new "FULL" mark on the dipstick. If the oil is not at the "FULL" mark, grind off the existing "FULL" mark. Mark the new level as "FULL" using an engraving pen.
- 7. Pour 5.7 L (6 qt) of engine oil into the engine crankcase for the filter or filters and margin.
- **8.** Start the engine. Ensure that the lubrication system is filled. Inspect the lubrication system for leaks.
- **9.** Stop the engine and allow enough time for the engine oil to drain into the engine crankcase. Allow a minimum of five minutes.
- 10. Check the engine oil level on the engine oil level gauge. If the engine oil level is not at the calibrated "FULL" mark, fill the sump to the calibrated "FULL" mark. Record the amount of oil that is added. This additional engine oil is the system capacity plus the 38 L (40 qt) in the sump. This additional engine oil is the amount of engine oil that is required when the engine oil is changed. Record the engine oil capacity for the system for future changes of the engine oil.

Engine Oil Sample - Obtain

SMCS Code: 1000-008; 1348-554-SM; 7542-554-OC, SM

In addition to a good preventive maintenance program, Caterpillar recommends using S·O·S oil analysis at regularly scheduled intervals in order to monitor the condition of the engine and the maintenance requirements of the engine.

Obtain the Sample and the Analysis

A WARNING

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. In order 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, well 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 in order 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

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

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

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

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

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, PEHP6001, "How To Take A Good Oil Sample". Consult your Caterpillar dealer for complete information and assistance in establishing an S·O·S program for your engine.

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Engine Oil and Filter - Change

SMCS Code: 1318-510; 1348-044

Selection of Oil Change Interval

NOTICE

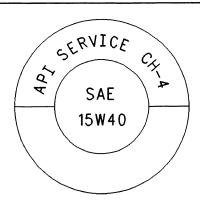
This engine meets EPA Tier 2, Euro Stage II, or MOC Step 2 emission regulations. A 500 hour engine oil change interval is available, provided that operating conditions and recommended multigrade oil types are met. When these requirements are not met, shorten the oil change interval to 250 hours, or use an S·O·S oil sampling and analysis program to determine an acceptable oil change interval.

If you select an interval for oil and filter change that is too long, you may damage the engine.

WARNING

Hot oil and hot components can cause personal injury. Do not allow hot oil or hot components to contact the skin.

Caterpillar oil filters are recommended for oil changes. Recommended multigrade oil types are listed in Table 37. Do not use single grade oils.



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Illustration 55

API Trademark

Commercial oils that are licensed by the American Petroleum Institute (API) bear this trademark. Commercial oils that do not bear this trademark are not licensed and these oils are not recommended. Oils that are not listed in Table 37 are not recommended.

Abnormally harsh operating cycles or harsh environments can shorten the service life of the engine oil. Arctic temperatures, corrosive environments, or extremely dusty conditions may require a reduction in engine oil change intervals from the recommendations in Table 37 and Table 38. Poor maintenance of air filters or of fuel filters requires reduced oil change intervals. See your Caterpillar dealer for more information if this product will experience abnormally harsh operating cycles or harsh environments.

Table 37

Oil Change Interval for C-15 Industrial Engines (1)					
	Operating Conditions				
				Severe	
Multigrade Oil Type	Normal ⁽²⁾	High Load Factor above 51 L (13.5 US gal)per hour	Fuel Sulfur from 0.3% to 0.5%	Altitude above 1830 m (6000 ft)	
Cat DEO Preferred	500 hr	500 hr	500 hr	250 hr ⁽⁶⁾	
API CH-4 11.0 minimum TBN ⁽⁴⁾ Preferred	500 hr	500 hr	500 hr	250 hr [©]	
API CH-4 TBN ⁽⁴⁾ below 11.0	500 hr	500 hr	250 hr ⁽⁵⁾	250 hr [©]	
API CG-4	500 hr	250 hr®	250 hr®	250 hr ⁽⁶⁾	
API CF-4	250 hr(5)	250 hr ⁽⁶⁾	250 hr ⁽⁶⁾	250 hr ⁽⁶⁾	

- (1) The standard oil change interval for this engine is 500 hours, if the operating conditions and recommended oil types that are listed in this table are met. The traditional oil change interval for engines is 250 hours. Improvements in the engine allow this engine oil change interval. This new standard interval is not permitted for other engines. Refer to the applicable Operation and Maintenance Manuals for the other engines.
- (2) Normal conditions include these factors: Fuel sulfur below 0.3%, altitude below 1830 m (6000 ft), and good air filter and fuel filter maintenance. Normal conditions do not include high load factor, harsh operating cycles, or harsh environments.
- (3) High load factors can shorten the service life of your engine oil. Continuous heavy load cycles and very little idle time result in increased fuel consumption and oil contamination. These factors deplete the oil additives more rapidly. If the average fuel consumption of your engine exceed 51 L (13.5 US gal) per hour, follow the "High Load Factor" recommendations in Table 37. To determine average fuel consumption for your engine, measure average fuel consumption for a period of 50 to 100 hours. If the application of the engine is changed, the average fuel consumption may change.
- (4) For sulfur content above 0.5%, refer to Operation and Maintenance Manual, "Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines" in the "Lubricant" section of this manual. Also, you may refer to this topic in Manual, SEBU6251.
- (5) In order to verify an oil change interval of 500 hours, refer to "Program A" below.
- (6) Use "Program B" below to determine an appropriate interval.

Table 38

Oil Change Interval for C-16 Industrial Engines (1)					
	Operating Conditions				
			Severe		
Multigrade Oil Type	Normal ⁽²⁾ High Load Factor above 58.3 L (15.4 US gal)		Fuel Sulfur from 0.3% to 0.5%	Altitude above 1830 m (6000 ft)	
Cat DEO Preferred	500 hr	500 hr	500 hr	250 hr ⁽⁶⁾	
API CH-4 11.0 minimum TBN ⁽⁴⁾ Preferred	500 hr	500 hr	500 hr	250 hr [©]	
API CH-4 TBN ⁽⁴⁾ below 11.0	500 hr	500 hr	250 hr ⁽⁵⁾	250 hr ⁽⁶⁾	
API CG-4	500 hr	250 hr ⁽⁵⁾	250 hr(5)	250 hr6	
API CF-4	250 hr(5)	250 hr6	250 hr6	250 hr®	

- (1) The standard oil change interval for this engine is 500 hours, if the operating conditions and recommended oil types that are listed in this table are met. The traditional oil change interval for engines is 250 hours. Improvements in the engine allow this engine oil change interval. This new standard interval is not permitted for other engines. Refer to the applicable Operation and Maintenance Manuals for the other engines.
- (2) Normal conditions include these factors: Fuel sulfur below 0.3%, altitude below 1830 m (6000 ft), and good air filter and fuel filter maintenance. Normal conditions do not include high load factor, harsh operating cycles, or harsh environments.
- (3) High load factors can shorten the service life of your engine oil. Continuous heavy load cycles and very little idle time result in increased fuel consumption and oil contamination. These factors deplete the oil additives more rapidly. If the average fuel consumption of your engine exceed 58.3 L (15.4 US gal) per hour, follow the "High Load Factor" recommendations in Table 37. To determine average fuel consumption for your engine, measure average fuel consumption for a period of 50 to 100 hours. If the application of the engine is changed, the average fuel consumption may change.
- (4) For sulfur content above 0.5%, refer to Operation and Maintenance Manual, "Total Base Number (TBN) and Fuel Sulfur Levels for Direct Injection (DI) Diesel Engines" in the "Lubricant" section of this manual. Also, you may refer to this topic in Manual, SEBU6251.
- (5) In order to verify an oil change interval of 500 hours, refer to "Program A" below.
- (6) Use "Program B" below to determine an appropriate interval.

Adjustment of the Oil Change Interval

Note: Your Caterpillar dealer has additional information on these programs.

Program A

Verification for an Oil Change Interval of 500 Hours

This program consists of three oil change intervals of 500 hours. Oil sampling and analysis is done at 250 hours and 500 hours for each of the three intervals for a total of six oil samples. The analysis includes oil viscosity and infrared (IR) analysis of the oil. If all of the results are satisfactory, the 500 hour oil change interval is acceptable for the engine in that application. Repeat Program A if you change the application of the engine.

If a sample does not pass the oil analysis, take one of these actions:

- Shorten the oil change interval to 250 hours.
- Proceed to Program B.
- Change to a preferred oil type in Table 37.

Program B

Optimizing Oil Change Intervals

Begin with a 250 hour oil change interval. The oil change intervals are adjusted by increments. Each interval is adjusted an additional 50 hours. Periodic oil sampling and analysis is done during each interval. The analysis includes oil viscosity and infrared (IR) analysis of the oil. Repeat Program B if you change the application of the engine.

If an oil sample does not pass the analysis, shorten the oil change interval, or change to a preferred multigrade oil type in the listing above.

References

Reference: Form, PEDP7035, "Optimizing Oil Change Intervals"

Reference: Form, PEDP7036, "S·O·S Fluid Analysis"

Reference: Form, PEDP7076, "Understanding the S·O·S Oil Analysis Tests"

Drain the Engine Oil

After the engine has been run at the normal operating temperature, stop the engine. Attach a "DO NOT OPERATE" or a similar warning tag to the ignition keyswitch before the engine is serviced. Catch the oil in a suitable container. Recycle the used oil, or dispose of the used oil properly.

- **1.** Remove the oil drain plug in order to allow the oil to drain.
- 2. After the oil has drained, the oil drain plug should be cleaned and installed.

Replace the Oil Filter

NOTICE

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

 Remove the oil filter with a 1U-8760 Chain Wrench.

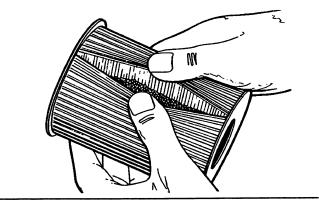


Illustration 56
Element with debris

g00588944

2. Cut the oil filter open with a 4C-5084 Oil Filter Cutter. Break apart the pleats and inspect the oil filter for metal debris. An excessive amount of metal debris in the oil filter may indicate early wear or a pending failure.

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

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

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



Illustration 57

g00103713

Typical filter mounting base and filter gasket

- Clean the sealing surface of the filter mounting base. Ensure that all of the old oil filter gasket is removed.
- **4.** Apply clean engine oil to the new oil filter gasket.

NOTICE

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

5. Install the oil filter. Tighten the oil filter until the oil filter gasket contacts the base. Tighten the oil filter by hand according to the instructions that are shown on the oil filter. Do not overtighten the oil filter.

Fill the Engine Crankcase

 Remove the oil filler cap. Refer to the Operation and Maintenance Manual, "Lubricant Specifications" topic (Maintenance Section) for more information. Fill the crankcase with the proper amount of oil. Refer to the Operation and Maintenance Manual, "Refill Capacities" topic (Maintenance Section) for more information.

NOTICE

If equipped with an auxiliary oil filter or system, extra oil must be added when filling the crankcase. Follow the OEM or filter manufacturer's recommendations. If the extra oil is not added, the engine may starve for oil.

NOTICE

To help prevent crankshaft or bearing damage, crank engine to fill all filters before starting. Do not crank engine for more than 30 seconds.

- 2. Start the engine and run the engine at "LOW IDLE" for two minutes. Perform this procedure in order to ensure that the lubrication system has oil and that the oil filters are filled. Inspect the oil filter for oil leaks.
- **3.** Stop the engine and allow the oil to drain back to the sump for a minimum of ten minutes.
- 4. Remove the oil level gauge in order to check the oil level. Maintain the oil level between the "ADD" and "FULL" marks on the "ENGINE STOPPED" side of the oil level gauge.

Engine Protective Devices - Check

SMCS Code: 7400-535

Alarms and shutoffs must function properly. Alarms provide timely warning to the operator. Shutoffs help to prevent damage to the engine. It is impossible to determine if the engine protective devices are in good working order during normal operation. Malfunctions must be simulated in order to test the engine protective devices.

A calibration check of the engine protective devices will ensure that the alarms and shutoffs activate at the setpoints. Ensure that the engine protective devices are functioning properly.

NOTICE

During testing, abnormal operating conditions must be simulated.

The tests must be performed correctly in order to prevent possible damage to the engine.

To prevent damage to the engine, only authorized service personnel or your Caterpillar dealer should perform the tests.

Visual Inspection

Visually check the condition of all gauges, sensors and wiring. Look for wiring and components that are loose, broken, or damaged. Damaged wiring or components should be repaired or replaced immediately.

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Engine Speed/Timing Sensors - Check/Clean/Calibrate

SMCS Code: 1912-040; 1912-070; 1912-524

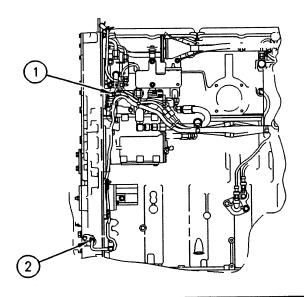


Illustration 58

g00765246

Left side view

- (1) Secondary speed/timing sensor
- (2) Primary speed/timing sensor
- Remove the speed/timing sensors from the front housing. Check the condition of the plastic end of the speed/timing sensors for wear and/or contaminants.
- 2. Clean the metal shavings and other debris from the face of the speed/timing sensors. Use the procedure in the Service Manual in order to calibrate the speed/timing sensors.

Refer to the Service Manual for more information on the speed/timing sensors.

i01430860

Engine Storage Procedure - Check

SMCS Code: 1000-535

Caterpillar requires all engines that are stored for more than 3 months to follow storage procedures and start-up procedures. These procedures provide maximum protection to internal engine components. Refer to Special Instruction, SEHS9031, "Storage Procedure For Caterpillar Products" for information on these procedures.

An extension of the oil change interval to 12 months is permitted if you follow the required procedures for storage and start-up. This extension is permitted if the following intervals in the Operation and Maintenance Manual, "Maintenance Interval Schedule" have not been reached:

- Operating hours
- Fuel consumption

i00869628

Engine Valve Lash - Inspect/Adjust

SMCS Code: 1102-025

The initial valve lash adjustment on new engines, rebuilt engines, or remanufactured engines is recommended at the first scheduled oil change. The adjustment is necessary due to the initial wear of the valve train components and to the seating of the valve train components.

This maintenance is recommended by Caterpillar as part of a lubrication and preventive maintenance schedule in order to help provide maximum engine life.

NOTICE

Only qualified service personnel should perform this maintenance. Refer to the Service Manual or your Caterpillar dealer for the complete valve lash adjustment procedure.

Operation of Caterpillar engines with improper valve adjustments can reduce engine efficiency. This reduced efficiency could result in excessive fuel usage and/or shortened engine component life.

WARNING

Ensure that the engine can not be started while this maintenance is being performed. To help prevent possible injury, do not use the starting motor to turn the flywheel.

Hot engine components can cause burns. Allow additional time for the engine to cool before measuring/adjusting valve lash clearance.

Ensure that the engine is stopped before measuring the valve lash. To obtain an accurate measurement, allow the valves to cool before this maintenance is performed.

Refer to the Service Manual for more information.

i00937014

Engine Valve Rotators - Inspect

SMCS Code: 1109-040

A WARNING

When inspecting the valve rotators, protective glasses or face shield and protective clothing must be worn, to help prevent being burned by hot oil or spray.

NOTICE

A valve rotator which does not operate properly will accelerate valve face wear and valve seat wear and shorten valve life. If a damaged rotator is not replaced, valve face guttering could result and cause pieces of the valve to fall into the cylinder. This can cause piston and cylinder head damage.

Valve rotators cause the valves to rotate when the engine runs. This helps to prevent deposits from building up on the valves and the valve seats.

Perform the following steps after the valve lash is set, but before the valve covers are installed:

1. Start the engine according to this Operation and Maintenance Manual, "Engine Starting" procedure (Operation Section).

Operate the engine at low idle.

2. Observe the top surface of each valve rotator. The valve rotators should turn slightly when the valves close.

If a valve fails to rotate, consult your Caterpillar dealer.

Ether Starting Aid Cylinder - Replace (If Equipped)

SMCS Code: 1456-510-CD

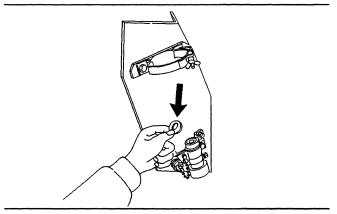


Illustration 59
Typical example

g00104888

- **1.** Loosen the ether cylinder clamp. Unscrew and remove the empty ether cylinder.
- 2. Remove the used gasket. Install the new gasket that is provided with each new ether cylinder.
- Install the new ether cylinder. Hand tighten the ether cylinder. Tighten the ether cylinder clamp securely.

i00175571

Fan Drive Bearing - Lubricate

SMCS Code: 1359-086-BD

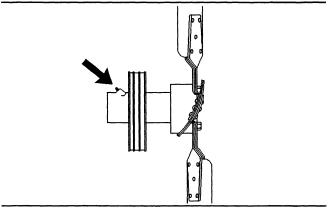


Illustration 60 g00123252

Typical Fan Drive Bearing Grease Fitting

Lubricate the fan drive bearing grease fitting with Bearing Lubricant Special Purpose Grease or the equivalent.

Inspect the fan drive pulley assembly. If the shaft is loose, an inspection of the internal components should be performed. Refer to the Service Manual.

i00838960

Fuel System - Prime

SMCS Code: 1258-548

A 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.

Priming the fuel system fills the fuel filters. Priming the fuel system also removes air from the fuel system. This procedure is used primarily when the engine runs out of fuel.

Note: DO NOT remove the fitting in the fuel filter base in order to release air from the fuel system during periodic service of the fuel filter. Periodic removal of the fitting will result in increased wear of the threads in the fuel filter base. This can lead to fuel leakage. However, the fitting in the fuel filter base can be used to purge air from the fuel system if the engine runs out of fuel.

- Loosen the fuel filter air purge plug two full turns. Unlock and operate the priming pump until fuel appears at the fitting. This procedure will require considerable strokes. Use a cloth or a container to catch the excess fuel.
- 2. Tighten the fuel filter air purge plug. Open fuel priming pump and operate the fuel priming pump until a strong pressure is felt on the fuel priming pump. Push the priming pump plunger inward. Tighten the plunger by hand, and promptly continue with the next step.
- **3.** Crank the engine after pressurizing the system.

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.

- 4. If the engine will not start, allow the starting motor to cool for 2 minutes. Repeat Steps 2 and 3 in order to start the engine. Further priming may be necessary to help purge the fuel lines of air, if:
 - The engine starts, but runs rough.
 - The engine started, but continues to misfire or smoke.
- **5.** Run the engine at low idle until the engine runs smoothly.

Fuel System Primary Filter/Water Separator - Drain

SMCS Code: 1260-543; 1263-543

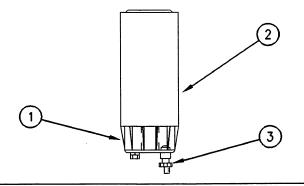


Illustration 61

g00668636

- (1) Bowl
- (2) Element
- (3) Drain

Bowl (1) should be monitored daily for signs of water. If water is present, drain the water from the bowl.

- 1. Open drain (3). The drain is a self-ventilated drain. Catch the draining water in a suitable container. Dispose of the water properly.
- 2. Close drain (3).

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.

i01254835

Fuel System Primary Filter/Water Separator Element - Replace

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

Water in the fuel can cause the engine to run rough. Water in the fuel may cause an electronic unit injector to fail. If the fuel has been contaminated with water, the element should be changed before the regularly scheduled interval.

The primary filter/water separator also provides filtration in order to help extend the life of the secondary fuel filter. The element should be changed regularly. If a vacuum gauge is installed, the primary filter/water separator should be changed if the pressure is at 50 to 70 kPa (15 to 20 inches Hg).

Replace the Element

A 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.

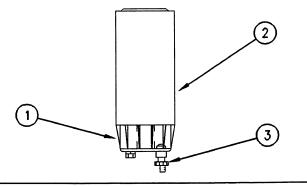


Illustration 62

g00668636

- (1) Bowl
- (2) Element
- (3) Drain
- 1. Stop the engine.
- **2.** Turn the start switch to the "OFF" position.
- 3. Shut off the fuel tank supply valve to the engine.

4. If the primary fuel filter is equipped with a drain valve (3), open the drain valve in order to drain any fuel from the filter case. Close the drain valve (3).

NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

- **5.** Remove the fuel filter bowl (1) and wash the fuel filter bowl with clean diesel fuel.
- 6. Remove the fuel filter (2).
- Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
- **8.** Apply clean diesel fuel to the new fuel filter gasket.

NOTICE

In order to maximize fuel system life and prevent premature wear out from abrasive particles in the fuel, use Caterpillar fuel filters.

Consult your Caterpillar dealer for proper part numbers.

9. Install the new fuel filter (2). Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional 3/4 turn by hand. Do not overtighten the filter.

NOTICE

Do not fill the fuel filters with fuel before installing them. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

Install the clean fuel filter bowl (1) on the new fuel filter.

NOTICE

The water separator is under suction during normal engine operation. Ensure that the vent plug is tightened securely to help prevent air from entering the fuel system.

- 11. Open the fuel tank supply valve.
- **12.** Start the engine and check for leaks. Run the engine for one minute. Stop the engine and check the engine for leaks again.

Leaks are difficult to detect while the engine is running. The primary filter/water separator is under suction. A leak will allow air to enter the fuel. The air in the fuel can cause low power due to aeration of the fuel. If air enters the fuel, check the components for overtightening or undertightening.

i01250684

Fuel System Secondary Filter - Replace

SMCS Code: 1261-510-SE

A 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.

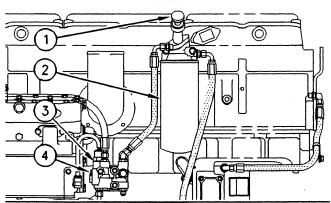


Illustration 63

g00410343

- (1) Fuel priming pump
- (2) Fuel filter
- (3) Fuel block
- (4) Fuel filter air purge plug

NOTICE

Do not allow dirt to enter the fuel system. Thoroughly clean the area around a fuel system component that will be disconnected. Fit a suitable cover over any disconnected fuel system components.

NOTICE

Use a suitable container to catch any fuel that might spill. Clean up any spilled fuel immediately.

 It may be necessary to relieve residual fuel pressure from the fuel system before removing the fuel filter. Loosen the fuel filter air purge plug (4) in order to purge any residual pressure.

NOTICE

Do not loosen fuel lines or fittings at the fuel manifold or ECM. The engine components may be damaged.

- 2. Remove the used fuel filter.
- **3.** Clean the gasket sealing surface of the fuel filter base. Ensure that all of the old gasket is removed.
- **4.** Apply clean diesel fuel to the new fuel filter gasket.

NOTICE

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

NOTICE

Do not fill the secondary fuel filter with fuel before installing. The fuel would not be filtered and could be contaminated. Contaminated fuel will cause accelerated wear to fuel system parts.

- 5. Install the new fuel filter. Spin the fuel filter onto the fuel filter base until the gasket contacts the base. Use the rotation index marks on the filters as a guide for proper tightening. Tighten the filter for an additional 3/4 turn by hand. Do not overtighten the filter.
- **6.** Open the fuel tank supply valve and prime the fuel system.

i00073301

Fuel Tank Water and Sediment - Drain

SMCS Code: 1273-543-M&S

Fuel Tank

Fuel quality is critical to the performance and to the service life of the engine. Water in the fuel can cause excessive fuel system wear. 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. Drain the water and sediment from the fuel tank after operating the engine or drain the water and sediment from the fuel tank after the fuel tank has been filled. Allow five to ten minutes before performing this procedure.

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 during the following conditions:

- Weekly
- Oil change
- 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.

i00907072

Hoses and Clamps - Inspect/Replace

SMCS Code: 7554-040; 7554-510

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.

NOTICE

Do not bend or strike high pressure lines. Do not install bent or damaged lines, tubes or hoses. Repair any loose or damaged fuel and oil lines, tubes and hoses. Leaks can cause fires. Inspect all lines, tubes and hoses carefully. Tighten all connections to the recommended torque.

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 heat set. Heat setting causes 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

WARNING

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

- **1.** Stop the engine. Allow the engine to cool.
- Loosen the cooling system filler cap slowly in order 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.

Note: For torques on hose clamps, see this Operation and Maintenance Manual, "Torque Specifications" (Maintenance Section).

7. Install the hose clamps with a torque wrench.

Note: For the proper coolant to use, see this Operation and Maintenance Manual, "Coolant Recommendations" (Maintenance Section).

8. Refill the cooling system.

- 9. Clean the cooling system filler cap. Inspect the cooling system filler cap's gaskets. Replace the cooling system filler cap if the gaskets are damaged. Install the cooling system filler cap.
- Start the engine. Inspect the cooling system for leaks.

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 generally indicated by increased fuel consumption and by reduced power.

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 engine's 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 engine 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 should be between 40 percent and 50 percent of 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, a scheduled engine overhaul by your Caterpillar dealer is recommended. This 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.

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

Unit Fuel Injector

Clean the fuel injector body and replace the O-rings. Replace the O-rings and the gasket on the injector sleeve. Clean the area around the injector seating in the injector sleeve. Refer to the Service Manual for the complete procedure, or consult with your Caterpillar dealer for assistance.

Rebuild or Exchange

Cylinder Head Assembly, Connecting Rods, Pistons, Cylinder Liners, Turbocharger, Cylinder Packs, 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 out-of-spec parts or replacing out-of-spec parts.

Inspection and/or Replacement

Piston Rings, Crankshaft Bearings, Valve Rotators, and Crankshaft Seals

The following components may not last until the second overhaul.

- Thrust bearings
- Main bearings
- Rod bearings
- Valve rotators
- Crankshaft seals

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. Check these components by interpreting the wear patterns on the following components:

- Rod bearing
- Main bearings

Note: If the crankshaft is removed for any reason, use the magnetic particle inspection process to check for cracks in the crankshaft.

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
- Camshaft followers

Caterpillar Inc. recommends replacing the crankshaft vibration damper.

Oil Cooler Core and Aftercooler Core

During an overhaul, the removal of the oil cooler core and the aftercooler core is recommended. The oil cooler core and the aftercooler core should be cleaned and pressure tested.

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 and the aftercooler core.

- Remove the oil cooler core and the aftercooler core.
- 2. Remove any debris from the oil cooler core and the aftercooler core. To remove debris from the oil cooler core, turn the oil cooler core onto one end. To remove debris from the aftercooler core, turn the aftercooler core upside-down.
- 3. Flush the oil cooler core and the aftercooler core internally with cleaner in order to loosen foreign substances. This will also help to remove oil from the oil cooler core and the aftercooler core.

Note: The use of Hydrosolv Liquid Cleaners is recommended. Table 39 lists the Hydrosolv Liquid Cleaners that are available from your Caterpillar dealer.

Table 39

HydrosolvLiquid Cleaners				
Part Number	Description	Size		
1U-8812	Hydrosolv4165	4 L (1 US gallon)		
1U-5490		19 L (5 US gallon)		
8T-7570		208 L (55 US gallon)		
1U-8804	Hydrosolv100	4 L (1 US gallon)		
1U-5492	-	19 L (5 US gallon)		
8T-5571		208 L (55 US gallon)		

- 4. Use steam to clean the oil cooler core and the aftercooler core. This removes any remaining residue from the cleaner. Flush the fins of the oil cooler core and the aftercooler core. Remove any other trapped debris.
- 5. Wash the oil cooler core and the aftercooler core with hot, soapy water. Rinse the oil cooler core and the aftercooler core thoroughly with clean water.

WARNING

Personal injury can result from air pressure.

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

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

- **6.** Dry the oil cooler core and the aftercooler core with compressed air. Direct the air in the reverse direction of the normal flow.
- 7. Inspect the components in order to ensure cleanliness. The oil cooler core and the aftercooler core should be pressure tested. Repair the oil cooler core and the aftercooler core, if necessary. Install the oil cooler core and the aftercooler 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·O·S Coolant Analysis (Level 1). Further coolant analysis is recommended when the engine is overhauled.

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·O·S Coolant Analysis (Level 2).

S₂O₂S Coolant Analysis (Level 2)

An S·O·S Coolant Analysis (Level 2) is a comprehensive coolant analysis which completely analyzes the coolant and the effects on the cooling system. An S·O·S Coolant Analysis (Level 2) provides the following information:

- Complete S·O·S Coolant Analysis (Level 2)
- Visual inspection of properties
- Identification of metal corrosion
- Identification of contaminants
- Identification of built up impurities (corrosion and scale)

S·O·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, consult your Caterpillar dealer.

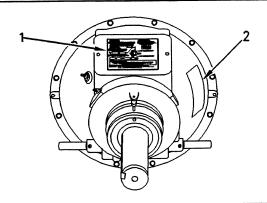
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Power Take-Off Clutch - Check/Adjust/Lubricate

SMCS Code: 3055-036; 3055-086

NOTICE

New power take-offs should have the clutch adjustment checked before being placed into service. The clutch adjustment should be checked again after the first ten hours of operation. New clutch plates have a "wear in" period, and the clutch may require several adjustments until the new plates are "worn in".



g00781502

Illustration 64

- (1) Instruction plate
- (2) Serial number plate

Check the clutch adjustment regularly after "wear in". Heavy-duty applications which have engagements that are frequent and relatively long periods of clutch slippage require more frequent adjustment than light-duty applications. The operating torque should be measured in order to determine if a clutch adjustment is required.

Refer to the OEM information and instruction plate (1) for instructions on lubrication, adjustment, and other recommendations for service. Perform the maintenance that is specified on the instruction plate.

MARNING

Do not operate the engine with the Instruction Plate cover removed from the clutch. Personal injury may result.

If the clutch is damaged to the point of burst failure, expelled pieces can cause personal injury to anyone in the immediate area. Proper safeguards must be followed to help prevent accidents.

i01206548

Radiator - Clean

SMCS Code: 1353-070

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

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

A WARNING

Personal injury can result from air pressure.

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

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

Pressurized air is the preferred method for removing loose debris. Direct the air in the opposite direction of the fan's air flow. Hold the nozzle approximately 6 mm (0.25 inch) away from the fins. Slowly move the air nozzle in a direction that is parallel with the tubes. This will remove debris that is between the tubes.

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

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

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

Inspect the fins for damage. Bent fins may be opened with a "comb". Inspect these items for good condition: welds, mounting brackets, air lines, connections, clamps, and seals. Make repairs, if necessary.

For more detailed information on cleaning and inspection, see Special Publication, SEBD0518, "Know Your Cooling System".

i00151038

Severe Service Application - Check

SMCS Code: 1000-535

Severe service is an application of an engine that exceeds current published standards for that engine. Caterpillar maintains standards for the following engine parameters:

- Performance (power range, speed range, and fuel consumption)
- Fuel quality
- Altitude range
- Maintenance intervals
- Oil selection and maintenance
- Coolant selection and maintenance
- Environmental qualities
- Installation

Refer to the standards for the engine or consult with your Caterpillar dealer in order to determine if the engine is operating within the defined parameters. Severe service operation can accelerate component wear. Engines that operate under severe conditions may need more frequent maintenance intervals in order to ensure maximum reliability and retention of full service life.

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

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

Environmental Factors

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

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

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

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

Improper Operating Procedures

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

Improper Maintenance Procedures

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

Starting Motor - Inspect

SMCS Code: 1451-040; 1453-040

Caterpillar Inc. 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 proper operation. Check the electrical connections and clean the electrical connections. Refer to the Service Manual for more information on the checking procedure and for specifications or consult your Caterpillar dealer for assistance.

i01539769

Turbocharger - Inspect

SMCS Code: 1052-040

Periodic inspection and cleaning is recommended for the turbocharger compressor housing (inlet side). Any fumes from the crankcase are filtered through the air inlet system. Therefore, by-products from oil and from combustion can collect in the turbocharger compressor housing. Over time, this buildup can contribute to loss of engine power, increased black smoke and overall loss of engine efficiency.

If the turbocharger fails during engine operation, damage to the turbocharger compressor wheel and/or to the engine may occur. Damage to the turbocharger compressor wheel can cause additional damage to the pistons, the valves, and the cylinder head.

NOTICE

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

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

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 repaired or replaced. An inspection of the turbocharger can minimize unscheduled downtime. An inspection of the turbocharger can also reduce the chance for potential damage to other engine parts.

Note: Turbocharger components require precision clearances. The turbocharger cartridge must be balanced due to high rpm. Severe Service Applications can accelerate component wear. Severe Service Applications require more frequent inspections of the cartridge.

Removal and Installation

For options regarding the removal, installation, repair and replacement, consult your Caterpillar dealer. Refer to the Service Manual for this engine for the procedure and specifications.

Cleaning and Inspecting

- Remove the exhaust outlet piping and remove the air inlet piping from the turbocharger. Visually inspect the piping for the presence of oil. Clean the interior of the pipes in order to prevent dirt from entering during reassembly.
- 2. Turn the compressor wheel and the turbine wheel by hand. The assembly should turn freely. Inspect the compressor wheel and the turbine wheel for contact with the turbocharger housing. There should not be any visible signs of contact between the turbine wheel or compressor wheel and the turbocharger housing. If there is any indication of contact between the rotating turbine wheel or the compressor wheel and the turbocharger housing, the turbocharger must be reconditioned.
- 3. Check the compressor wheel for cleanliness. If only the blade side of the wheel is dirty, dirt and/or moisture is passing through the air filtering system. If oil is found only on the back side of the 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 inlet air (plugged air filters), which causes the turbocharger to slobber.

- 4. Use a dial indicator to check the end clearance on the shaft. If the measured end play is greater than the Service Manual specifications, the turbocharger should be repaired or replaced. An end play measurement that is less than the minimum Service Manual specifications could indicate carbon buildup on the turbine wheel. The turbocharger should be disassembled for cleaning and for inspection if the measured end play is less than the minimum Service Manual specifications.
- **5.** Inspect the bore of the turbine housing for corrosion.
- **6.** Clean the turbocharger housing with standard shop solvents and a soft bristle brush.
- **7.** Fasten the air inlet piping and the exhaust outlet piping to the turbocharger housing.

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 proper place. Repair damaged guards or replace missing guards.
- Wipe all caps and plugs before the engine is serviced in order 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 or deck is a fire hazard. Remove this debris with steam cleaning or high pressure water.

- Ensure that the cooling lines are properly clamped and that the cooling lines are tight. Check for leaks. Check the condition of all pipes.
- Inspect the water pumps for coolant leaks.

Note: The water pump seal is lubricated by coolant in the cooling system. It is normal for a small amount of leakage to occur as the engine cools down and the parts contract.

Excessive coolant leakage may indicate the need to replace the water pump seal. For the removal of water pumps and the installation of water pumps and/or seals, refer to the Service Manual for the engine or consult your Caterpillar dealer.

- Inspect the lubrication system for leaks at the front crankshaft seal, the rear crankshaft seal, the oil pan, the oil filters and the valve cover.
- Inspect the fuel system for leaks. Look for loose fuel line clamps or for loose fuel line tie-wraps.
- Inspect the piping for the air inlet system and the elbows for cracks and for loose clamps. Ensure that hoses and tubes are not contacting other hoses, tubes, wiring harnesses, etc.
- Inspect the alternator belt and the accessory drive belts for cracks, breaks or other 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.

- Drain the water and the sediment from fuel tanks on a daily basis in order to ensure that only clean fuel enters the fuel system.
- Inspect the wiring and the wiring harnesses for loose connections and for worn wires or frayed wires.
- Inspect the ground strap for a good connection and for good condition.
- Inspect the ECM to the cylinder head 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 can not be calibrated.

Water Pump - Inspect

SMCS Code: 1361-040; 1361

A failed water pump might 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

Visually inspect the water pump for leaks. If any leaking is observed, replace the water pump seal or the water pump assembly. Refer to the Service Manual for the disassembly and assembly procedure.

Note: Refer to the Service Manual or consult your Caterpillar dealer if any repair is needed or any replacement is needed.

Reference Information Section

Engine Ratings

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Engine Rating Conditions

SMCS Code: 1000

All engine ratings are in compliance with the following standard ambient air conditions of "SAE J1349":

- 99 kPa (29.3 inches of Hg)
- 30 percent relative humidity
- A temperature of 25 °C (77 °F)

Ratings relate to the standard conditions of "ISO8665", of "ISO3046/1", of "DIN6271", and of "BS5514".

The engine ratings are based on the following fuel specifications:

- Low heat value (LHV) of the fuel of 42 780 kJ/kg (18,390 Btu/lb) at 29 °C (84 °F)
- Gravity (API) of 35 degrees at 15 °C (60 °F)
- Specific gravity of .849 at 15 °C (60 °F)
- Density of 850 kg/m³ (7.085 lb/US gal)

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 will produce the net power that is available for the external load (flywheel). i00819749

Engine Rating Definitions

SMCS Code: 1000

It is important to know the use of the engine so that the rating will match the operating profile. The proper rating selection is also important so that the customer's perception of price and value is realized.

In selecting a rating for a specific application, the most important consideration is the time that is spent at full throttle. These rating definitions identify the percent of time at full throttle. The definitions also identify the corresponding times below rated rpm.

Note: The examples of the applications are only for reference. For an exact determination of the appropriate rating, follow the OEM specifications or consult your Caterpillar dealer.

A Rating – This rating is used for heavy-duty applications that are operated at rated load and at rated rpm up to 100 percent. This rating is used for engines that operate without interruption of load cycling. Typical applications include the following examples: pipeline pumping and ventilation.

B Rating – This rating is used when power and/or rpm are cyclic. The engine should be run at full load. The engine should not exceed 80 percent of the duty cycle. Typical applications include the following examples: irrigation, operation where normal pump demand is 85 percent of the engine rating, oil pumping/drilling, field mechanical pumping/drilling, and stationary/plant air compressors.

C Rating – This rating is used when power and/or rpm are cyclic. The horsepower and the rpm of the engine can be utilized continuously for one hour. This is followed by one hour of operation at the A rating or below the A rating. The engine should be run at full load. The engine should not exceed 50 percent of the duty cycle. Typical applications include the following examples: agricultural tractors, harvesters and combines, off-highway trucks, fire pumps, blast hole drills, rock curshers, wood chippers with high torque rise, and oil field hoisting.

D Rating – This rating is used when 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 minutes. This is followed by one hour of operation at the C rating. The engine should be run at full load. The engine should not exceed 10 percent of the duty cycle. Typical applications include the following examples: offshore cranes, runway snow blowers, water well drills, portable air compressors, and fire pump certification power.

E Rating – This rating is used when rated power is required for a short time for initial starting or for sudden overload. The rating is also used for emergency service when standard power is not available. The horsepower and the rpm of the engine can be utilized continuously for a maximum of 15 minutes. This is followed by one hour of operation at the C rating or by the duration of the emergency. The engine should be run at full load. The engine should not exceed 5 percent of the duty cycle. Typical applications include the following examples: standby centrifugal water pumps, oil field well servicing, crash trucks, portable air compressors, and gas turbine starting motors.

NOTICE

Operating engines above the rating definitions can result in shorter service life before overhaul.

Customer Service

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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.
- 2. 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.

3. 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 A
P.O. Box 600
Peoria, Illinois 61552-0600

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 USA

Phone: 305-476-6876 Fax: 305-476-6850

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

Phone: 22-849-444 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, Hong Kong
China
Phone: 852-2848-0333

Fax: 852-2848-0440

Japan Shin Caterpillar Mitsubishi Ltd. Setagaya Business Square Tower 10-1, Yoga 4-chome Setagaya, Tokyo

Japan

Phone: 81-3-5717-1121 Fax: 81-3-5717-1177

Japar

Caterpillar Power Systems, Inc. Japan Branch Sanno Grand Bldg. 2-14-2 Nagatacho Chiyoda-ku, Tokyo, 100 Japan

Phone: 81-335-93-3237 Fax: 81-335-93-3238

Australia and New Zealand Caterpillar of Australia Ltd. 1 Caterpillar Drive Private Mail Bag 4 Tullamarine, Victoria 3043 Australia

Phone: 03-9339-9333 Fax: 03-9335-3366

Ordering Replacement Parts

SMCS Code: 7567

WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

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

When you order parts, please specify the following information:

- 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.

When a Caterpillar engine requires maintenance and/or repair, provide the dealer with all the information that is stamped on the Information Plate. This information is described in this Operation and Maintenance Manual (Product Information Section).

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

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Reference Material

SMCS Code: 1000

The following literature can be obtained through any Caterpillar dealer.

Lubricants

- Special Publication, PEHP7041, "Data Sheet
 Caterpillar Diesel Engine Oils (DEO) (CG-4) (International only)"
- Special Publication, PEHP1026, "Data Sheet
 Caterpillar Diesel Engine Oil (DEO) (CF-4) (International only)"
- Special Publication, PEHP8038, "Data Sheet
 Caterpillar Diesel Engine Oils (DEO) (CH-4) (North America and Australia)"
- Special Publication, PEWP9733, "Cat Fluids Selector Dial"
- Special Publication, PEWP3014, "Cat Fluids Selector Dial (International)"
- Special Publication, NEDG6022, "Data Sheet -Multipurpose Lithium Complex Grease (MPG)"
- Special Publication, PEHP0002, "Data Sheet
 Multipurpose Lithium Complex Grease with Molybdenum (MPGM)"
- Special Publication, PEHP0017, "Data Sheet -Special Purpose Grease (SPG) Bearing Lubricant"
- Special Publication, NEHP5621, "How To Select The Right Grease For Any Job"
- Special Publication, PEHP6001, "How To Take A Good Oil Sample"
- Special Publication, SEBD0640, "Oil and Your Engine"
- Special Publications, PEDP7036, "SOS Fluids Analysis Cornerstone"

Fuels

 Special Publication, SEBD0717, "Diesel Fuels and Your Engine"

Coolants

- Special Publication, SEBD0970, "Coolant and Your Engine"
- Special Publication, PEHP4036, "Data Sheet-Extended Life Coolant"
- Special Publication, SEBD0518, "Knowing Your Cooling System"
- Special Publication, PEEP5027, "Label ELC Radiator Label"
- Special Publication, PEHP7057, "S·O·S Coolant Analysis"

Miscellaneous

- Special Publication, SEBU6251, "Caterpillar Commercial Diesel Engine Fluids Recommendations"
- Special Publication, PECP6026, "One Safe Source"
- Special Publication, SEHS7654, "Alignment -General Instructions"
- Operation and Maintenance Manual, SEBU5898, "Cold Weather Recommendations"
- Special Instruction, SMHS7001, "Assembly of Fan Drive Pulley Assemblies"
- Special Instruction, SEHS7633, "Battery Test Procedure"
- Special Instruction, SEHS7332, "Do Not Operate Tag"
- Special Publication, SEBF8062, "Guideline for Reusable Parts - Cleaning and Inspection of Air Filters"
- Special Publication, SEBF8029, "Index of Publications for Reusable Parts and Salvage Operations"
- Special Publication, LEBH0504, "Industrial Application and Installation Guide"
- Service Manual, REG1139F, "Service Manual Contents Microfiche"
- Special Publication, NEHS0526, "Service Technician Application Guide"
- Special Instruction, SEHS9031, "Storage Procedure for Caterpillar Products"

- Special Instruction, NENG2500, "Tools and Shop Products Guide"
- Specifications, SENR3130, "Torque Specifications"
- Special Instruction, SEHS7768, "Use of 6V-2150 Starting/Charging Analyzer"
- Special Instruction, SEHS8622, "Using the FT-1984 Air-To-Air Aftercooler Leak Test Group"

Emissions Warranty

This engine may be Certified and this engine may be covered by an Emissions Warranty. A detailed explanation of the Emissions Warranty that is applicable to Certified engines is found in Supplement, SEBU6981, "Federal Emissions Control Warranty Information". The Engine is Certified if the engine has a special label that states that the engine is certified. A Caterpillar dealer can also inform you if the engine is Certified.

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Additional Reference Material

SMCS Code: 1000

The "EMA Lubricating Oils Data Book" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult EMA at the following address:

Engine Manufacturers Associaton 401 N. Michigan Ave. Chicago, IL, USA 60611 Telephone: (312) 644-6610 ext. 3626

The "Society of Automotive Engineers (SAE) Specifications" can be found in your SAE handbook. This publication can also be obtained from the following locations: local technological society, local library, and local college. If necessary, consult SAE at the following address:

SAE International 400 Commonwealth Drive Warrendale, PA, USA 15096-0001 Telephone: (724) 776-4841

The "American Petroleum Institute Publication No. 1509" can be obtained from the following locations: local technological society, local library, and local college. If necessary, consult API at the following address:

American Petroleum Institute 1220 L St. N.W. Washington, DC, USA 20005 Telephone: (202) 682-8000 The International Organization for Standardization (ISO) offers information and customer service regarding international standards and standardizing activities. ISO can also supply information on the following subjects that are not controlled by ISO: national standards, regional standards, regulations, certification, and related activities. Consult the member of ISO in your country.

International Organization for Standardization (ISO)

1, rue de Varembé Case postale 56 CH-1211 Genève 20 Switzerland

Telephone: +41 22 749 01 11 Facsimile: +41 22 733 34 30

E-mail: central@iso.ch Web site: http://www.iso.ch

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

CIMAC Central Secretariat Lyoner Strasse 18 60528 Frankfurt Germany

Telephone: +49 69 6603 1567 Facsimile: +49 69 6603 1566

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Maintenance Records

SMCS Code: 1000

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

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

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

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

Records should be kept for the following items:

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

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

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

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

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

Maintenance Log

SMCS Code: 1000

Table 40

Engine Model Customer Identifier						
Serial Nu	mber		Arrangement Number	rrangement Number		
Service Hours	Quantity Of Fuel	Servic	Service Item		Authorization	

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Product and Dealer Information

Delivery Date: _____

Note: For product identification plate locations, see the section "Product Identification Information" in the Operation and Maintenance Manual.

Product	Information		
Model:			
Product Identi	fication Number:		
Engine Serial	Number:		
Transmission :	Serial Number:		
Generator Ser	ial Number:	····	
Attachment Se	erial Numbers:		
Attachment In	formation:		
Customer Equ	uipment Number:		
Dealer Equipr	nent Number:		
Dealer In	nformation		
Name:		Branch:	
Address:			
	Dealer Contact	Phone Number	<u>Hours</u>
Sales:			
Parts:			
Service:			

Supplement

Emissions Control Warranty Information for U.S., Canada & California

Garantie du dispositif anti-pollution pour les Etats-Unis et le Canada

Warranty Information For Certified Engines Used In Mobile Nonroad Machines and Equipment

Renseignements de garantie pour les moteurs homologués utilisés par les machines non routières mobiles et l'équipement

Emissions Warranty

Caterpillar Inc. or any of its subsidiaries ("Caterpillar") warrants that certified nonroad diesel engines (powering mobile machinery), are:

- 1. Designed, built, and equipped so as to conform, at the time of sale, with all applicable regulations adopted by the United States Environmental Protection Agency (EPA).
- 2. Free from defects in materials and workmanship in specific emission-related parts for a period of 60 months, or 3,000 hours of operation, whichever occurs first, after date of delivery to the first user.

If an emission-related part fails during the warranty period, it will be repaired, or replaced. Any such part repaired or replaced under warranty is warranted for the remainder of the warranty period.

The engine is certified if it has a special certification label. A Caterpillar dealer can also inform you if the engine is certified.

During the term of this warranty, Caterpillar will provide, through a Caterpillar dealer or other source approved by it, repair or replacement of any warranted part at no charge.

In an emergency, repairs may be performed at any service establishment, or by the user. Caterpillar will reimburse the user for their expenses, including diagnostic charges for such emergency repair. These expenses shall not exceed Caterpillar's suggested retail price for all warranted parts replaced, and labor charges based on Caterpillar's recommended time allowance for the warranty repair and the geographically appropriate hourly labor rate.

A part not being available within 30 days or a repair not being complete within 30 days constitutes an emergency.

As a condition of reimbursement, replaced parts and validated invoices must be presented at a place of business of a Caterpillar dealer or other source approved by Caterpillar.

Responsibilities & Limitations

The warranty is subject to the following:

Caterpillar Responsibilities

During the emission warranty period, if a defect in material or workmanship of an emission-related part or component is found, Caterpillar will provide:

 New, Remanufactured, or repaired parts and/or components, approved pursuant to EPA Regulations, required to correct the defect.

Note: Items replaced under warranty become the property of Caterpillar

 Reasonable or customary labor, during normal working hours, needed to correct the defect, including labor for removal and installation when necessary to make the repair.

User Responsibilities

During the emission warranty period, the user is responsible for:

- Providing proof of the delivery date to the first user.
- Premium or overtime labor costs.
- Costs to investigate complaints which are not caused by a defect in Caterpillar material or workmanship.
- Providing timely notice of a warrantable failure and promptly making the product available for repair.
- Performance of the required maintenance and use of proper fuel, oil, lubricants and coolant.
- Maintenance, replacement, or repair of the emission control devices and systems may be performed by any nonroad engine repair establishment or individual using certified noroad engine parts.

Limitations

Caterpillar is not responsible for resultant damages to an emission-related part or component resulting from:

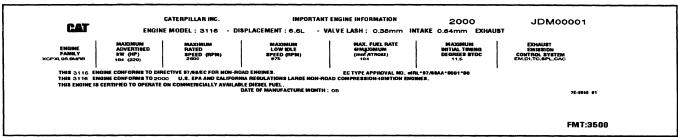
- Any use or installation which Caterpillar judges improper.
- Attachments, accessory items and parts not sold or approved by Caterpillar.
- Abuse, neglect and/or improper engine repair.
- User's delay in making the product available after being notified of a potential product problem.
- Unauthorized repair or adjustments and unauthorized fuel setting changes.

This warranty is in addition to Caterpillar's standard warranty, applicable to the nonroad diesel engine product involved.

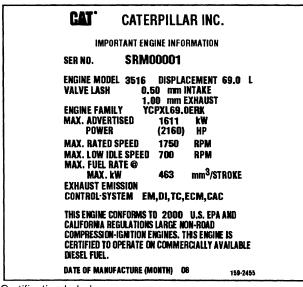
NEITHER THE FOREGOING EXPRESS WARRANTY NOR ANY OTHER WARRANTY BY CATERPILLAR, EXPRESS OR IMPLIED, IS APPLICABLE TO ANY ITEM CATERPILLAR SELLS WHICH IS WARRANTED DIRECTLY TO THE USER BY ITS MANUFACTURER.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. REMEDIES UNDER THIS WARRANTY ARE LIMITED TO THE PROVISION OF MATERIAL AND SERVICES, AS SPECIFIED HEREIN. CATERPILLAR IS NOT RESPONSIBLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

Emission Warranty Information



Certification Label



Certification Label

Maintenance Recommendations

Some Caterpillar nonroad diesel engines are certified by the United States Environmental Protection Agency (EPA) to comply with smoke and gaseous emission standards prescribed by Federal laws at the time of manufacture.

The engine is certified if it has a special certification label. Two types of labels that are used by Caterpillar are shown above. A Caterpillar dealer can also inform you if the engine is certified.

Efficiency of emission control and engine performance depends on adherence to proper operation and maintenance recommendations AND use of recommended fuels and lubricating oils. It is recommended that major adjustments and repair be made by your authorized Caterpillar dealer.

Various chemical fuel additives, which claim to reduce visible smoke, are available commercially. Although additives have been used by individuals to solve some isolated smoke problems in the field, they are not recommended for general use. Federal smoke regulations require that engines be certified without smoke depressants.

The corrective steps taken immediately on discovery of worn parts, which may affect emission levels, will help assure proper operation of emission control systems. The use of genuine Caterpillar parts is recommended. Suppliers of non-Caterpillar parts must assure the owner that the use of such parts will not adversely affect emission levels.

Regular maintenance intervals, along with special emphasis on the following items, are necessary to keep exhaust emissions within acceptable limits for the useful life of the engine. Refer to the Maintenance Section of the "Operation And Maintenace Manual". If the engine is operating under severe conditions, adjust the maintenance schedule accordingly.

See your authorized Caterpillar dealer to help analyze your specific application, operating environment and maintenance schedule adjustments.

The following is an explanation of maintenance for emission-related components. See the Maintenance Schedule for the specific interval for the following items.

FUEL INJECTORS OR NOZZLES - Fuel injectors or nozzles are subject to tip wear as a result of fuel contamination. This damage can cause an increase in fuel consumption, the engine to emit black smoke, misfire or run rough. Inspect, test and replace if necessary. Fuel injectors can be tested by an authorized Caterpillar dealer.

TURBOCHARGER - Check for any unusual sound or vibration in the turbocharger. Inspect inlet and exhaust piping and connections. Check bearing condition and perform maintenance as described in the Maintenance Schedule.

AIR/FUEL RATIO CONTROL -This component is a device to control the black smoke emission of an engine during its operation when low inlet manifold pressure exists.

Slow engine response and low power may indicate a need for adjustment or repair. Your Caterpillar dealer is equipped with the necessary tools, personnel, and procedures to perform this service.

Owner is encouraged to keep adequate maintenance records, but the absence of such, in and of itself, will not invalidate the warranty.

The machine or equipment owner may perform routine maintenance, repairs and other non warranty work or have it done at any repair facility. Such non warranty work need not be performed at a designated warranty station in order for the warranty to remain in force

Customer Assistance-Emission Control Systems Warranty

Caterpillar Inc. aims to ensure that the Emission Control Systems warranty is properly administered. In the event that you do not receive the warranty service to which you believe you are entitled under the Emission Control Systems Warranty, call or write:

Caterpillar Manager, Warranty Operations Peoria, IL 61629-1250 Ph. (309) 675-4037

Authorized dealers are recommended for major maintenance and repair work as they are staffed with trained personnel, proper tools and are aware of the latest maintenance methods and procedures. Owners and others who desire to perform their own work should purchase a Service Manual and obtain current service information from their Caterpillar dealer.

Emission Control Warranty For California

Owner Warranty Rights and Obligations

The California Air Resources Board (CARB) and Caterpillar are pleased to explain the emission control system warranty on your 2000 or later certified heavy duty off-road diesel engine. The engine is certified if it has a special certification label. Two types of labels that are used by Caterpillar are shown on previous pages. A Caterpillar dealer can also inform you if the engine is certified.

In California, new heavy duty off-road diesel engines must be designed, built, and equipped to meet the state's stringent anti-smog standards. Caterpillar must warrant the emission control system on your engine for the duration of time listed below provided there has been no abuse, neglect, or improper maintenance of your engine.

Your emission control system may include parts such as the fuel injection system, air induction system, and engine computer, if equipped. Also included may be hoses, connectors, clamps and other emission-related components.

Where a warrantable condition exists, Caterpillar will repair the heavy duty off-road diesel engine at no cost to the owner including diagnosis, parts, and labor.

Manufacturer's Warranty Coverage

- The emissions warranty period for new heavy duty off-road diesel engines is a duration of 60 months, or 3,000 hours of operation, whichever occurs first after date of delivery to the initial owner.
- If an emission-related part or component on your diesel engine is defective, the part or component will be repaired, or replaced by Caterpillar. This is your emission control system WARRANTY.

This warranty covers the following emission-related parts and components.

- Charge Air Cooling System (If equipped)
- Fuel Injection System
- Intake Manifold
- Exhaust Manifold
- Turbocharger System
- Air-Fuel Ratio Control System
- Electronic Control Module including Sensors and Personality Module (If equipped)

 Miscellaneous hoses, clamps, connectors and sealing devices used in the above systems.

Any replacement part may be used for maintenance or repairs. The owner should ensure that such parts are equivalent in design and durability to genuine Caterpillar parts. Use of non-genuine Caterpillar parts does not invalidate the warranty. However, Caterpillar is not liable for parts which are not genuine Caterpillar parts.

Owner's Warranty Responsibilities

- As the heavy duty off-road diesel engine owner, you are responsible for the performance of the required maintenance listed in the owner's manual (Operation and Maintenance Manual). Caterpillar recommends that you retain all receipts and records covering the maintenance on your engine, but cannot deny warranty solely for the lack of receipts and records or for your failure to ensure the performance of all scheduled maintenance.
- As the heavy duty off-road diesel engine owner, you should also be aware that Caterpillar may deny you warranty coverage if your heavy duty off-road diesel engine, or an emission component, or part has failed due to abuse, neglect, improper maintenance, or unapproved modifications.
- Your engine is designed to operate on commercial diesel fuel only. Use of any other fuel may result in your engine no longer operating in compliance with California's emission requirements.
- You are responsible for contacting your Caterpillar dealer as soon as any engine problem exists. The warranty repairs should be completed in a reasonable amount of time, not to exceed 30 days.

If you have questions regarding your warranty rights and responsibilities, contact:

Caterpillar Manager, Warranty Operations Peoria, IL 61629-1250 Phone (309) 675-4037

OR

California Air Resources Board (CARB) 9528 Telstar Ave. El Monte, CA 91731

Grantie sur le dispositif anti-pollution

Caterpillar Inc. ou toute filiale Caterpillar garantie que les moteurs diesel non routiers homologués (équipement mobile générateur de puissance) sont :

- 1. Etudiés, construits et équipés, au moment de la vente, selon les régulations adoptées par l'Agence pour la protection de l'environnement (United States Environmental Protection Agency -EPA).
- 2. Garantis sans défaut de fabrication spécialement les pièces du dispositif anti-pollution pour une période de 60 mois, ou 3,000 heures de service, quelque soit celui qui est atteint le premier, après la date de livraison au premier utilisateur.

Si une pièce du dispositif anti-pollution tombe en panne pendant la période de garantie, elle sera réparée ou remplacée. Une pièce réparée ou remplacée sous garantie est garantie pour le reste de la période de garantie.

Le moteur est homologué de la même façon que s'il possédait une étiquette d'homologation spéciale. Un concessionnaire Caterpillar peut également confirmer l'homologation du moteur.

Pendant la durée de la garantie, Caterpillar effectue, par l'intermédiaire d'un concessionnaire ou d'une filiale agréée, toute réparation ou remplacement de pièce qui est sous garantie, à ses propres frais.

En cas d'urgence, toute réparation peut être effectuée dans un établissement de service, ou par l'utilisateur. Dans ce cas, Caterpillar rembourse les frais qui ont été à la charge de l'utilisateur, y compris les frais de diagnostic pour le dépannage en urgence. Ces dépenses ne doivent pas excéder les prix de détail suggérés par Caterpillar pour toutes les pièces remplacées sous garantie de même que les frais de main d'oeuvre basés sur le temps qui est accordé pour la réparation ainsi que le tarif horaire de main d'oeuvre géographiquement approprié.

Une pièce non disponible sous 30 jours ou une réparation non effectuée sous 30 jours constitue une urgence.

Une des conditions de remboursement est que les pièces remplacées et les factures validées doivent être présentées au concessionnaire Caterpillar, ou à toute autre filiale Caterpillar.

Responsibilités et restrictions

La garantie est soumise aux conditions suivantes :

Responsibilités de Caterpillar

Caterpillar rembourse tout matériau défectueux ou tout défaut de fabrication d'une pièce ou d'un composant du dispositif anti-pollution si la période de garantie sur le dispositif anti-pollution est toujours en viqueur :

 Pièces et/ou composants neufs de dispositif anti-pollution, remanufacturés ou réparés, approuvés par la réglementation EPA, nécessaires à la réparation.

Nota: les objets remplacés lors de la garantie deviennent la propriété de Caterpillar.

 Frais de main d'oeuvre raisonnables et usuels, pendant les heures d'affaires, selon le temps nécessaire à la réparation, incluant la main d'oeuvre pour l'extraction et l'installation, si nécessaire.

Responsabilités de l'utilisateur

Pendant la période de garantie du dipositif anti-pollution, l'utilisateur a les responsabilités suivantes :

- Procurer la preuve de la date de livraison au premier utilisateur.
- Coûts de main d'oeuvre initiale ou supplémentaire.
- Coûts d'investigation des complaintes qui ne sont pas dues à un défaut du produit Caterpillar ou un défaut de fabrication.
- Fournir un avis rapide du défaut couvert par la garantie et rendre le produit disponible pour la réparation dans les plus brefs délais.
- Performance d'entretien nécessaire et utilisation du carburant approprié, huile, lubrifiants et liquide de refroidissement.
- Entretien, remplacement ou réparation des dispositifs ou systèmes anti-pollution doivent être effectués par un établissement de réparation de moteurs non routiers ou par quelqu'un qui utilise des pièces de moteurs non routiers homologués.

Restrictions

Caterpillar n'est pas responsable des dégats causés par une pièce ou un composant de dispositif anti-pollution résultant de :

- Toute utilisation ou installation que Caterpillar juge incorrecte.
- Tout équipement, accessoire et pièce non vendu ou non approuvé par Caterpillar.
- Tout abus, négligence et/ou réparation incorrecte du moteur.
- Tout retard de l'utilisateur dans la mise à disposition du produit après avoit été averti d'un éventuel problème avec le produit
- Toute réparation, réglage, changement de réglage d'injection non authorisé.

Cette garantie vient en plus de la garantie traditionnelle Caterpillar, applicable au produit de moteur diesel non routier.. NI LA GARANTIE PRECEDEMMENT CITEE NI TOUT AUTRE GARANTIE CATERPILLAR EXPRIMEE OU IMPLICITE N'EST APPLICABLE AUX VENTES DE PRODUITS CATERPILLAR QUI SONT GARANTIS DIRECTEMENT AUPRES DE L'UTILISATEUR PAR LE FABRIQUANT.

CETTE GARANTIE REMPLACE TOUTE AUTRE GARANTIE, EXPRIMEE OU IMPLICITE, Y COMPRIS TOUTE GARANTIE DE VALEUR COMMERCIALE OU DE CONVENANCE POUR UN OBJET PARTICULIER. LES SOLUTIONS SOUS CETTE GARANTIE SONT LIMITEES A LA PROVISION DE MATERIEL ET DE SERVICE, COMME SPECIFIES DANS LA PRESENTE. CATERPILLAR N'EST PAS RESPONSABLE POUR LES DEGATS ACCIDENTELS OU LES DOMMAGES-INTERETS INDIRECTS.

Renseignements sur la garantie du dispositif anti-pollution



Etiquette d'homologation

CAT* CATERPILLAR INC.

INFORMATION IMPORTANTE SUR LE MOTEUR
NO SÉRIE SRM00001

| MODÈLE MOTEUR 3516 | DÉBIT 69.0 | ADM. 0,50 mm | ECHAP. 1,00 mm | YCPXL69.0ERK | MAXI PUBLIÉS | 1611 | kW | PUISSANCE | MAXI RÉGIME NOMINAL | 1750 | tr/mn | MAXI RÉGIME RALENTI | MAXI DEBIT D'INJ. | TOO | tr/mn | MAXI DEBIT D'INJ. | TOO | tr/mn | TOO | tr/mn | TOO | T

À PUIS. MAXI 463 mm³/STROKE (PISTON) DISPOSITIF ANTI-POLLUANT EM,DI,TC,ECM,CAC

CE MOTEUR EST CONFORME AUX RÉGLEMENTATIONS DE L'AGENCE AMÉRICAINE DE PROTECTION DE L'ENVIRONNEMENT (EPA) ET DE LA CALIFORNIE POUR LES GROS MOTEURS NON ROUTIERS À COMPRESSION-CONTACT. CE MOTEUR EST HOMOLOGUÉ POUR FONCTIONNER AVEC LE CARBURANT DIESEL DU COMMERCE.
DATE DE FABRICATION (MOIS) 0B

·

Etiquette d'homologation

Recommandations d'entretien

Certains moteurs diesel non routiers Caterpillar sont homologués par l'Agence pour la protection de l'environnement (EPA) afin d'être conforme aux normes d'émissions de fumée et de gaz prescrites par les lois fédérales au moment de la fabrication.

Le moteur est homologué s'il possède une étiquette d'homologation spéciale. Deux types d'étiquettes généralement utilisées par Caterpillar sont montrés ci-dessus. Un concessionnaire Caterpillar peut également confirmer l'homologation du moteur.

L'efficacité du dispositif anti-pollution ainsi que la performance du moteur dépendent à la fois d'une bonne utilisation et d'une bonne conformité aux recommandations d'entretien ainsi qu'à la bonne utilisation des carburants recommandés et des huiles de graissage. Il est recommandé de faire régler et réparer le moteur par un concessionnaire Caterpillar agréé.

Différentes sortes d'additifs chimiques pour carburant sont disponibles dans le commerce pour réduir la fumée. Bien que ces additifs aient été utilisés par certains utilisateurs pour résoudre des cas de fumée isolés, ils ne sont pas recommandés pour l'utilisation générale. Les restrictions fédérales sur la fumée exigent que les moteurs soient homologués sans qu'ils aient eu recours aux produits inhibiteurs de fumée.

Si les mesures correctives sont prises immédiatement après la découverte de la pièce usée, qui peut affecter les niveaux d'émission, il est possible de recouvrer au bon fonctionnement des systèmes antipollution. L'utilisation de pièces d'origine Caterpillar est recommandée. Les autres fournisseurs de pièces doivent assurer à l'utilisateur que les pièces qui ne sont pas de marque Caterpillar n'endommageront pas les niveaux d'émissions.

Des intervalles réguliers d'entretien, spécialement sur les pièces suivantes, sont nécessaires au bon fonctionnement des émissions à l'échappement dans des limites acceptables d'utilisation du moteur. Se référer à la section "Entretien" de ce guide. Si le moteur fonctionne dans des conditions difficiles, régler le temps d'entretien en conséquence.

Voir le concessionnaire Caterpillar pour toute application spécifique, tout environnement de fonctionnement et toutes modifications du calendrier d'entretien.

Ce qui suit est une explication d'entretien de composants du dispositif antipollution. Voir le calendrier d'entretien pour les intervalles spécifiques pour les pièces suivantes.

INJECTEURS ET GICLEURS - Les injecteurs et les gicleurs sont soumis à une usure de la pointe en raison de la contamination du carburant. Ces dégats peuvent créer une augmentation de la consommation de carburant, des émissions de fumée noire, des ratés ou des tournages difficiles. Les injecteurs peuvent être testés par un concessionnaire Caterpillar agréé.

TURBOCOMPRESSEUR - Guetter tout bruit ou toute vibration inhabituels dans le turbocompresseur. Inspecter l'admission, le tuyau d'échappement et les connexions. Vérifier l'état du palier et procéder à un entretien régulier, comme décrit dans le calendrier d'entretien.

LIMITEUR D'INJECTION - Ce composant est un appareil qui permet de contrôler l'émission de fumée noire d'un moteur pendant son fonctionnement lorsqu'il y a une faible pression d'admission.

Une réponse lente du moteur de même qu'un manque de puissance peut indiquer qu'un réglage ou une réparation doit être effectué. Le concessionnaire Caterpillar possède les outils appropriés, le personnel compétent et les procédures adéquates au service.

Tout propriétaire est encouragé à la mise à jour des dossiers d'entretien, mais en l'absence d'un de ces derniers, la garantie ne sera pas pour autant invalide.

Tout propriétaire de machine ou d'équippement peut performer un entretien de routine, des réparations ou tout autre travail qui ne se trouve pas sous garantie ou peut le faire effectuer dans n'importe quel atelier de réparation. Tout travaux effectués hors garantie et hors stations de garantie n'invalidera pas la garantie.

Assistance consommateurs-Garantie des dispositifs anti-pollution.

Caterpillar Inc. a pour but d'assurer que la garantie des dispositifs antipollution est correctement respectée. Dans le cas de non-réception du service de garantie, appeler le numéro suivant ou écrire à :

Caterpillar Manager, Warranty Operations Peoria, IL 61629-1250 Tél. (309) 675-4037

Les concessionnaires agréés sont recommandés pour les travaux d'entretien principaux ainsi que pour les réparations dans la mesure où le personnel est formé à cet effet, les outils appropriés sont utilisés et les dernières procédures et méthodes d'entretien sont perfectionnées. Les propriétaires et les individus qui désirent exercer leurs propres travaux doivent se procurer un Guide de service et obtenir des informations actuelles de service de la part de leur concessionaire.



Warranty Registration Information

Dear Customer,

Caterpillar wishes to thank you for your purchase. We are committed to providing our customers with the finest products and product support available in any market today. To do this, we need to update our database with some specific information. Caterpillar will set the warranty date if you will complete the information below and return this form to us.

You may be entitled to a delivery inspection. To receive this special benefit, ask your servicing Caterpillar dealer if your engine qualifies for a delivery inspection as set forth in the Caterpillar Service Warranty Guide.

To have Caterpillar set the warranty start date, please do one of the following:

- 1. Take the completed form to your local Caterpillar dealer or
- 2. Fold the completed form, tape, and mail or
- **3.** Fax completed form to: Fax: 309-578-2559 International 01-309-578-2559, or
- 4. Complete the form on our web page at www.cat.com. Look under the tab marked "Engines", and then go to "Service & Support", and then go to "Engine Warranty Registration".

Engine	e is installed in:			
Manuf	facturer's Name:			
Manufacturer's Model: M			_ Manufacturer's Serial Nu	mber:
	engine installed in a truck eq tional trailers (boats, horses,			for personal reasons such as pulling
	engine installed in any one o e or Ambulance? (Y or N)		pes of vehicles: School Bus,	RV, Fire Truck, Emergency Service
Your N	Name:			
Addre	ss:			
City:		State:	ZIP Code:	Country:
Your T	Telephone Contact Number: _			
Engin	e Sales Model (example: 34	06E):		
1 st	Engine Serial Number:		Date of first use:	//
2 nd	Engine Serial Number:		(Twin Engine Insta	allation only)
3 rd	Engine Serial Number:		(Multiple Engine I	Installation only)
\Box I	have received a copy of the v need a warranty statement fo would like to receive inform	or my engine	, ,	ice Coverage for my engine.
Signe	d:			

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES



BOSINESS BEPLY MAIL

TARGETING MARKETING AC6110 PO BOX 610 POSSVILLE IL 61552-0610

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RAJJIGRETAR

Warranty Registration Information (Your Prompt Attention Required)



Effective with sales to the first user on or after March 1, 2001

CATERPILLAR LIMITED WARRANTY

Industrial Engine Products and Electric Power Generation Products Worldwide*

(*excluding the Commonwealth of Independent States)

Caterpillar Responsibilities

generation products sold by it (including any products of other

warrants new and Remanufactured engines and electric power

Caterpillar Inc. or any of its subsidiaries ("Caterpillar",

manufacturers packaged and sold by Caterpillar) and operating outside the Commonwealth of Independent States (formerly

USSR), to be free from defects in material and workmanship

If a defect in material or workmanship is found during the warranty period, Caterpillar will, during normal working hours and through a place of business of a Caterpillar dealer or other source approved by Caterpillar:

 Provide (at Caterpillar's choice) new, Remanufactured or Caterpillar-approved repaired parts or assembled components needed to correct the defect.

Note: Items replaced under this warranty become the property of Caterpillar.

 Replace lubricating oil, filters, coolant and other service items made unusable by the defect.

use in on-highway vehicle or marine applications, engines in

This warranty does not apply to CM product, engines sold for

Adams St., Peoria, IL USA 61629.

A different warranty statement applies to product operating in the Commonwealth of Independent States. Copies of this warranty may be obtained by writing Caterpillar Inc., 100 N.E.

covered by other Caterpillar warranties

This warranty is subject to the following

machines manufactured by or for Caterpillar, 3500 and 3600 Family engines used in locomotive applications, 3000 Family engines, or Caterpillar brand batteries. These products are

 Provide reasonable or customary labor needed to correct the defect, including labor to disconnect the product from and reconnect the product to its attached equipment, mounting, and support systems, if required.

For new 3114, 3116 and 3126 engines and electric power generation products (including any new products of the other manufacturers packaged and sold by Caterpillar):

· For Uninterruptible Power Systems (UPS), the warranty

period is 12 months after date of delivery to the first user

For new industrial engines and electric power generation products (excluding UPS), the warranty period is 12 months (24 months for mobile agricultural and standby electric power generation applications) after date of

delivery to the first user.

Warranty Period

 Provide travel labor, up to four hours round trip if, in the opinion of Caterpillar, the product cannot reasonably be transported to a place of business of a Caterpillar dealer or other source approved by Caterpillar (travel labor in excess of four hours round trip, and any meals, mileage, lodging, etc. is the user's responsibility).

For all other products:

For all Remanufactured engines, the warranty period is 6 months (12 months for mobile agricultural and standby electric power generation applications) after date of

delivery to the first user.

 Provide reasonable travel expenses for authorized mechanics, including meals, mileage, and lodging, when Caterpillar chooses to make the repair on-site.

User Responsibilities

The user is responsible for:

- · Providing proof of the delivery date to the first user
- Labor costs, except as stated under "Caterpillar Responsibilities", including costs beyond those required to disconnect the product from and reconnect the product to its attached equipment, mounting and support systems.
- Travel expenses not covered under "Caterpillar Responsibilities".
- All costs associated with transporting the product to and from the place of business of a Caterpillar dealer or other source approved by Caterpillar.
- Premium or overtime labor costs
- Parts shipping charges in excess of those which are usual and customary.
- Local taxes, if applicable.
- Costs to investigate complaints, unless the problem is caused by a defect in Caterpillar material or workmanship.
- Giving timely notice of a warrantable failure and promptly making the product available for repair.
- Performance of the required maintenance (including use of proper fuel, oil, lubricants and coolant) and items replaced due to normal wear and tear.
- Allowing Caterpillar access to all electronically stored data

(continued on reverse side . . .



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Caterpillar is not responsible for:

- Failures resulting from any use or installation which Caterpillar judges improper.
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- Damage to parts, fixtures, housings, attachments, and accessory items that are not part of the engine or electric power generation product (including any products of other manufacturers packaged and sold by Caterpillar).
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In USA and Canada: Caterpillar Inc., Engine Division, P. O. Box 610, Mossville, IL 61552-0610, Attention: Customer Service Manager, Telephone (800) 447-4986. Outside the USA and Canada: Contact your Caterpillar dealer.

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