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# ENGINE – OPERATION AND MAINTENANCE MANUAL

## EX 200 – Hydraulic Excavator

DS Cat/part No.

SUPPLY ORDER NO: AT No.51021 – Proc/55x Hyd Exc 20 Ton /GS 2010 -11 /DGBR / E3ES Dt 07 Mar 2011


**SUPPLIED BY:**

**TELCON**

**TELCO CONSTRUCTION EQUIPMENT CO. LTD**

**KIADB BLOCK NO.2, BELLUR INDUSTRIAL ESTATE, MUMMIGATTI, DHARWAD – 580 007**

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**CONTTROLLERRATE OF QUALITY ASSURANCE OF ENGINEERING EQUIPMENT**
**AUNDH CAMP - PUNE – 411 027**

Mar 2011


**SERVICE HOTLINE TOLL FREE NO-1800 3456 500**

# INDEX

## NOTES

# INTRODUCTION

This is an engine Operation & Maintenance Manual, not a repair manual. This manual contains information needed to correctly operate and maintain your engine as recommended by Cummins. This manual does not cover equipment maintenance procedures. Please consult the equipment manufacturer for specific maintenance recommendations.

This engine is manufactured by Tata Cummins Limited and engineered by Cummins Low Horsepower Business Unit to suit specific application. Service for this engine will be rendered by Cummins Diesel Sales & Services (CDS & S) through its authorised dealer's network. Please contact local service dealer or CDS & S Area / Regional / Zonal Office for any type of service / technical support. Please refer Section No. 12 for phone numbers and addresses of CDS & S offices and their dealers.

In order to get the optimum performance of the engine, please,

- adhere to maintenance practices specified in this manual
- use recommended fuel & oils
- use genuine Cummins parts
- get service only from authorised dealers of CDS & S
- use all safety & recommended installation practices.

In case you need any type of assistance, please contact Cummins India Ltd. - LHP Business Unit or CDS & S on the following addresses :

# GENERAL SAFETY INSTRUCTIONS

Improper practices or carelessness can cause burns, cuts, mutilation or other bodily injury or death.

Read & understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that must be followed to provide personal safety.

- Make sure that the work area surrounding the product is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances.
- Always wear protective glasses and protective shoes while working on the engine.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do no wear loose fitting or torn clothing.
- Disconnect the battery (negative) cable first and discharge before beginning any repair work.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the crankshaft by pulling or prying the fan. This practice can cause serious personal injury, property damage or damage to fan bladed causing premature failure of the engine.
- . If the engine has been operating and the coolant is hot, allow the engine to cool before you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do not work on anything that is supported only by lifting jacks or a hoist. Always use blocks or proper stands to support the product before performing any service work.
- Be alert for possible pressure when disconnecting any device from a system that utilises pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause serious injury.
- Corrosion inhibitor contains alkali. Do not get the substance in your eyes. Avoid prolonged or repeated contact with your skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water.
- To avoid burns, be alert for hot parts and hot fluids in lines, tubes and compartments.
- Always use tools that are in good condition. Use only genuine Cummins replacement parts.
- Always use the same fastener part number when replacing fasteners. Do not use fasteners of lessor quality of replacements are necessary.
- Avoid inhalation of vapours, ingestion and prolonged contact with used engine oil.

# GENERIC SYMBOLS

## Generic Symbols

The following group of symbols have been used in this manual to help communicate the intent of the instructions. When one of the symbols appears, it conveys the meaning defined below :

**WARNING :** Serious personal injury or extensive property damage can result if the warning instructions are not followed.

**CAUTION :** Minor personal injury can result or a part, an assembly or the engine can be damaged if the caution instructions are not followed.

Indicates a **REMOVAL or DISASSEMBLY** step.

Indicates an **INSTALLATION or ASSEMBLY** step.

**INSPECTION** is required.

**CLEAN** the part or assembly.

**PERFORM** a mechanical or time **MEASUREMENT.**

**LUBRICATE** the part or assembly.

Indicates that a **WRENCH or TOOL SIZE** will be given.

**TIGHTEN** to a specific torque.

**PERFORM** an electrical **MEASUREMENT.**

Refer to another location in this manual or another publication for additional information.

The component weighs 23 kg (50 lb) or more. To avoid personal injury, use a hoist or get assistance to lift the component.

# GENERAL ENGINE SPECIFICATIONS

## GENERAL ENGINE DATA

Bore ..... 102 mm (4.02 in)

Stroke ..... 120 mm (4.72 in)

Displacement

4B ..... 3.92 liters (239 in³)

6B ..... 5.88 liters (359 in³)

Compression ratio .....

4B 3.9 / 6B 5.9 Industrial, naturally aspirated ..... 18.5 : 1

4BT 3.9 / 6BT 5.9 Industrial, turbocharged ..... 17.5 : 1

4BTA 3.9 / 6BTA 5.9 Industrial, turbocharged and aftercooled ..... 16.5 : 1

B3.9 / B5.9* Automotive, charge air cooled ..... 17.6 : 1

Firing order

6 cylinder ..... 1-5-3-6-2-4

4 cylinder ..... 1-3-4-2

Valve Settings

Intake Valve Adjustment ..... 0.25 mm (0.01 in)

Exhaust Valve Adjustment ..... 0.51 mm ( 0.020 in)

Engine rotation (viewed from front of engine) ..... clockwise

Engine weight (with standard accessories)

4 cylinder engines ..... 325 to 350 kg (715 to 770 lb)

6 cylinder engines ..... 410 to 440 kg (910 to 970 lb)

## LUBRICATION SYSTEM

Oil pressure

At idle (minimum allowable) ..... 69 kPa (10 psi)

At rated speed (minimum allowable) ..... 207 kPa (30 psi)

Regulating valve opening pressure ..... (1991) 449 kPa (65 psi)

(1994) 517 kPa (75 psi)

Differential pressure to open oil filter bypass valve ..... (1991) 138 kPa (20 psi)

(1994) 172 kPa (25 psi)

Oil capacity of standard engine

4 cylinder engines ..... 9.5 liters (10 U.S. Qts.)

6 cylinder engines ..... 14.2 liters (15 U.S. Qts.)

Total system capacity

4 cylinder engines ..... 11.0 liters (11.6 U.S. Qts.)

6 cylinder engines ..... 16.4 liters (17.3 U.S. Qts.)

**COOLING SYSTEM**

Thermostat

Begins to open ..... 81°C (180°F)

Fully open ..... 95°C (203°F)

Pressure cap for 99°C (210°F) system ..... 50 kPa (7 psi)

Pressure cap for 104°C (220°F) system ..... 103 kPa (15 psi)

Coolant capacity (engine only)

4 cylinder (non-aftercooled, charge air cooled)* ..... 7.0 liters (7.4 U.S. Qts)

4 cylinder (jacket water aftercooled) ..... 7.9 liters (8.4 U.S. Qts.)

6 cylinder (non aftercooled, charge air cooled)* ..... 9.0 liters (9.5 U.S. Qts.)

6 cylinder (jacket water aftercooled) ..... 9.9 liters (10.5 U.S. Qts.)

**INTAKE AIR AND EXHAUST SYSTEM**

Maximum allowable intake restriction at rated speed and load (wit dirty air filter element)

Naturally Aspirated ..... 50.8 cm $H_2O$ (20 in $H_2O$)

Turbocharged ..... 63.5 cm $H_2O$ (25 in $H_2O$)

Maximum turbocharger outlet restriction at rated speed and load ..... 76.2 mm Hg (3 in Hg)

Maximum exhaust restriction at rated speed and load

Automotive with oxidation catalyst load ..... 152.4 mm Hg (6 in Hg)

Automotive ..... 114.3 mm Hg (4.5 in Hg)

Industrial ..... 76.2 mm Hg (3 in Hg)

**FUEL SYSTEM**

Fuel transfer pump maximum inlet restriction ..... 100 mm Hg (4 in Hg)

Fuel transfer pump output pressure at rated speed

Distributor fuel injection pumps (maximum) ..... 70 kPa (10 psi)

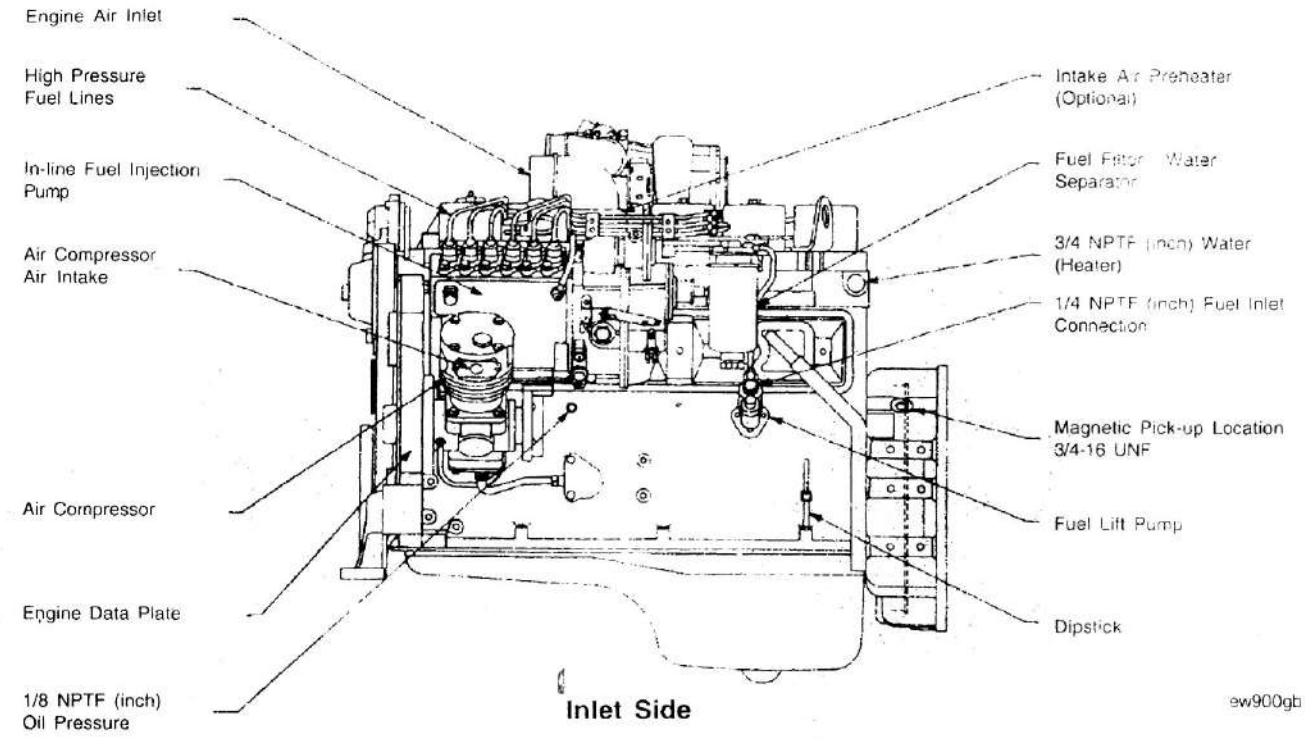
In-line fuel injection pumps (minimum) ..... 172 kPa (25 psi)

Fuel filter restriction (maximum pressure drop across filters) ..... 35 kPa (5 psi)

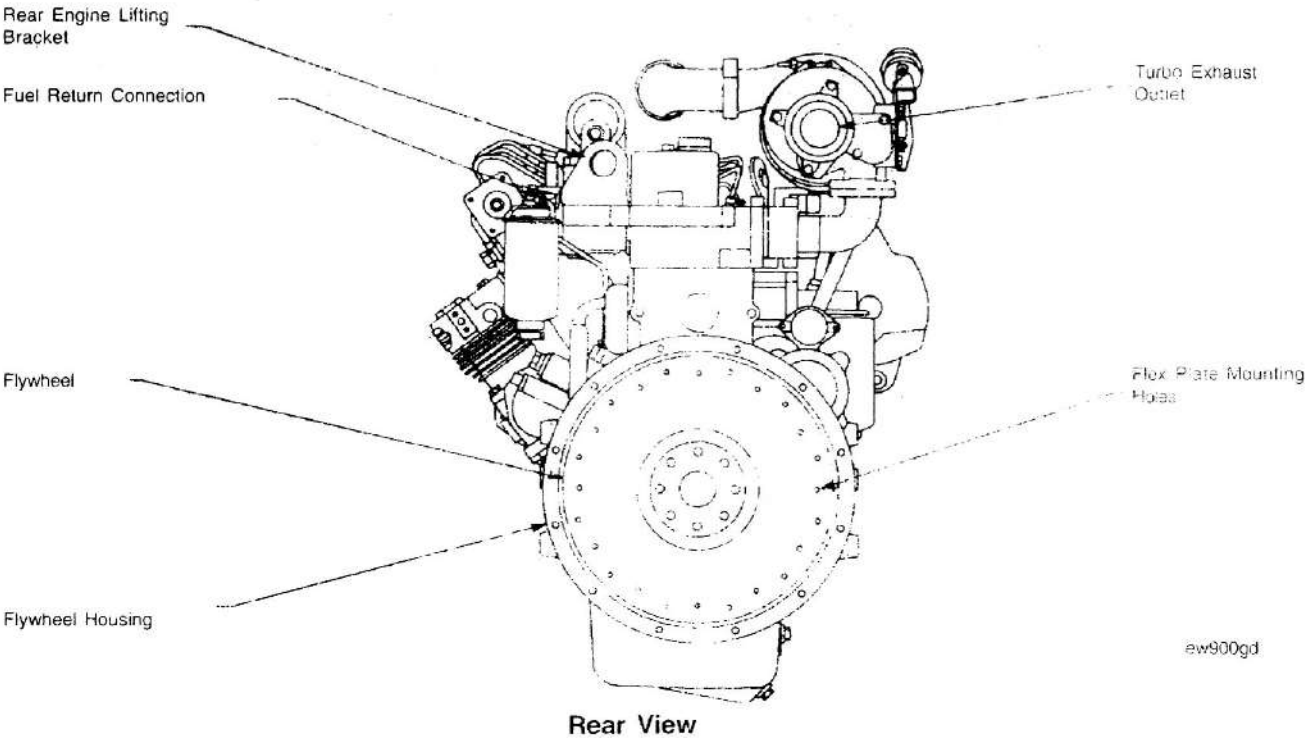
Fuel return restriction (maximum) ..... 518 mm Hg (20.4 in Hg)

# ENGINE DIAGRAMS

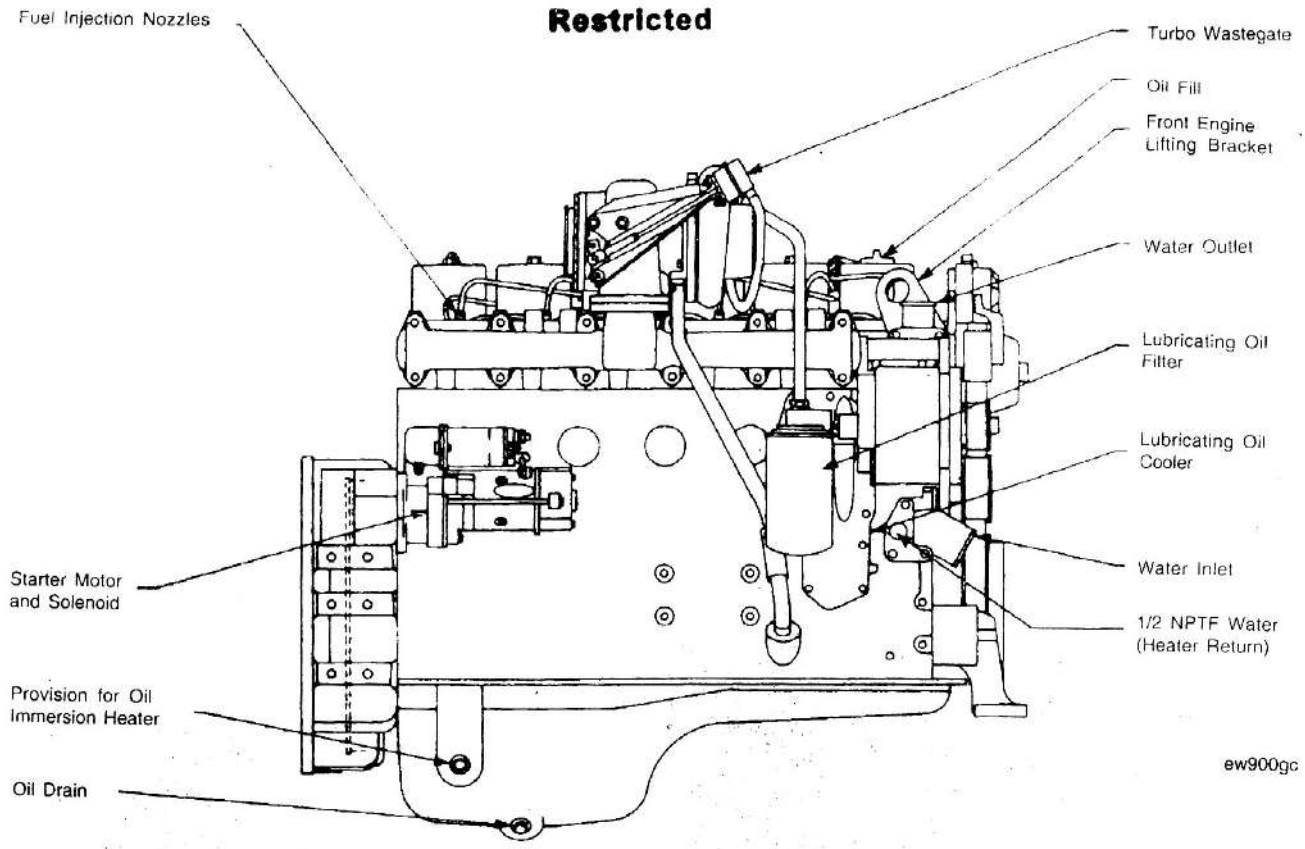
The illustrations which follow show the locations of the major external engine components, the filters, and other service and maintenance points. Some external components will be at different locations for different engine models.



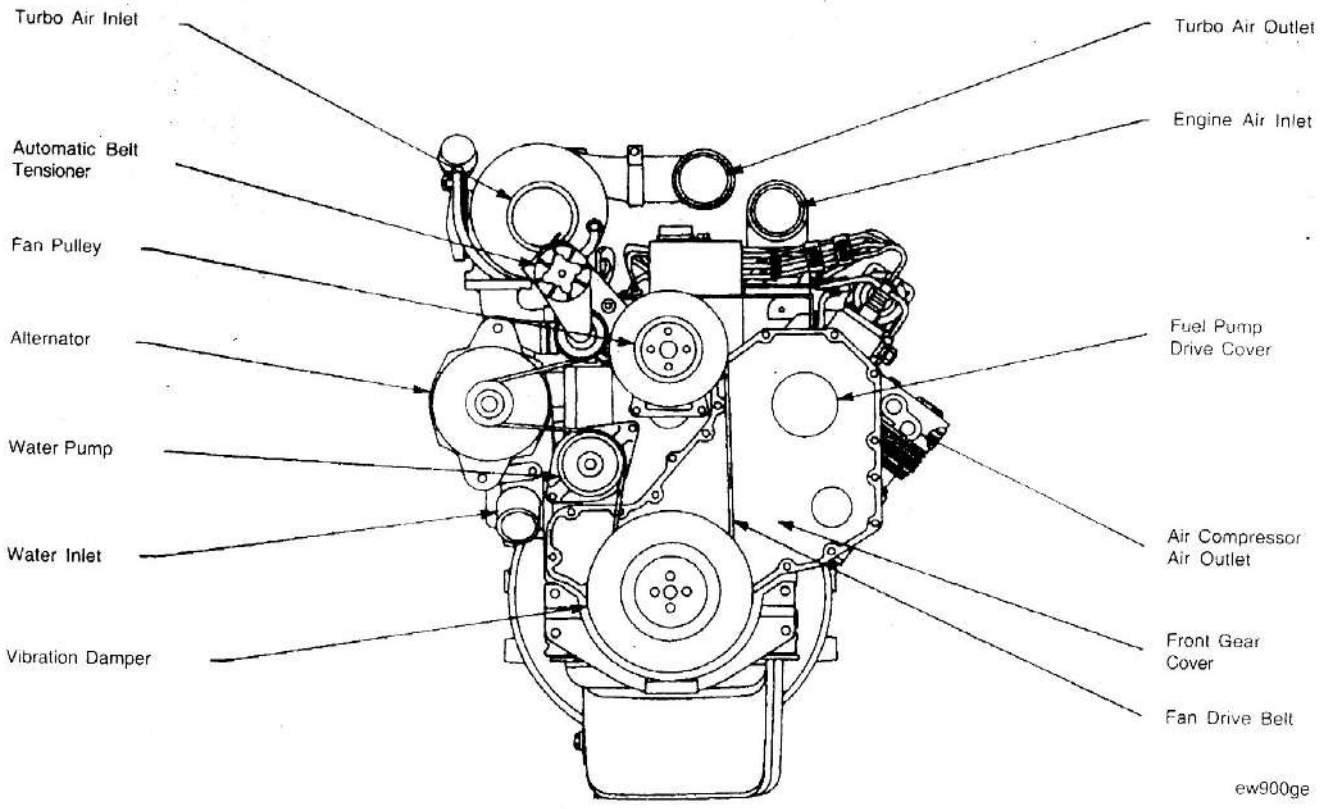

**Inlet Side**




**Rear View**




**Turbocharger Side View**



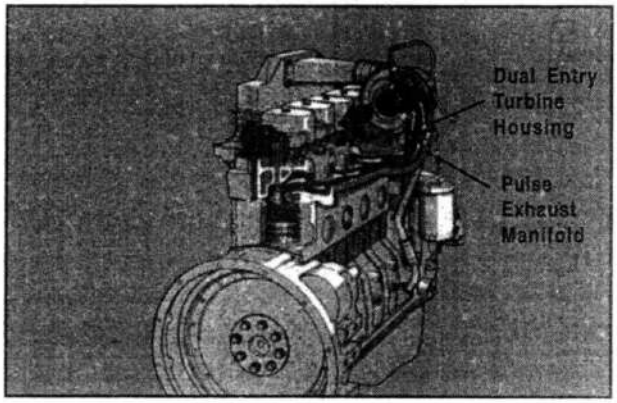

**Front View**

# ENGINE SYSTEMS OVERVIEW

This section describes flow through various engine systems. The information given here are of general nature. This is intended to help the user to understand four principle engine systems viz. Air, Fuel, Lub & Cooling system. Good understanding in engine systems will help in troubleshooting and preventive maintenance.

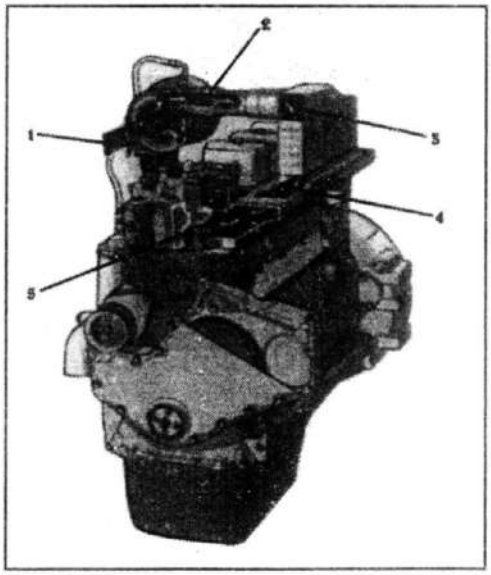
## 4.1 Air System :

Air enters through air cleaner to turbocharger inlet. Turbocharged air passes through intake manifold, gets distributed to all six power cylinders. After combustion, burnt gases go out through exhaust manifold & rotates the turbine wheel. Exhaust gases emit out through flexible bellow & muffler.




**Exhaust System**

1. Exhaust Valve
2. Exhaust Manifold (Pulse-Type)
3. Dual Entry to Turbocharger
4. Turbocharger Exhaust Outlet.

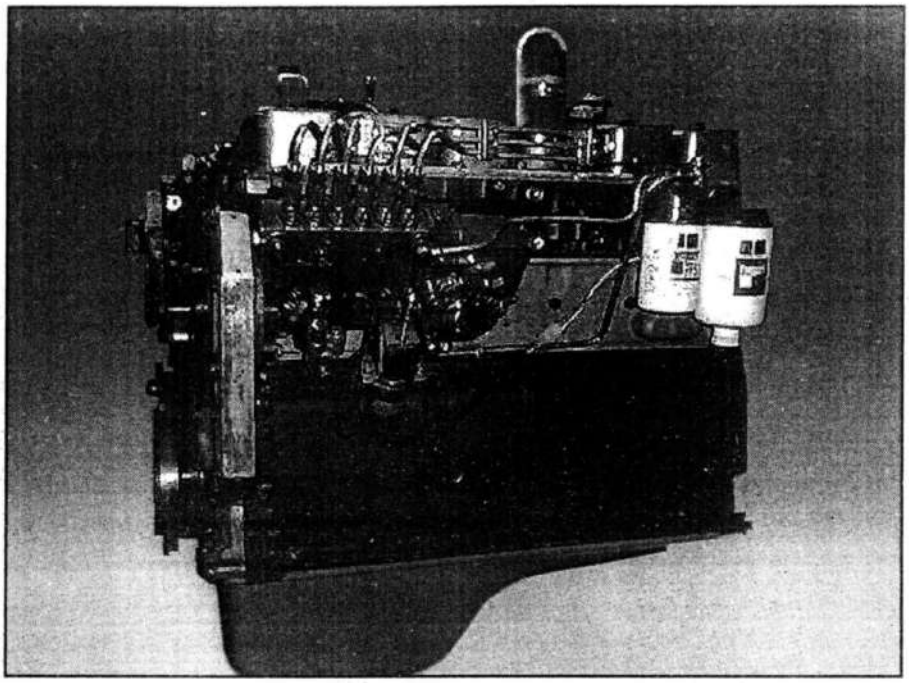


**Intake System**

1. Intake Air Inlet to Turbocharger
2. Turbocharger Air to Aftercooler
3. Aftercooler
4. Intake Manifold (Integral part of Cylinder Head)
5. Intake Valve

## 4.2 Fuel System :

Fuel is sucked from base tank (1) by suction inlet pipe (2) and suction strainer (3). Lift pump (4) lifts the fuel & delivers to the filtration system. There is a two stage cleaning of fuel; once by water separator (5) & then by microfine fuel filter (6). Cleaned fuel enters to MICO fuel injection pump (7) which pressurise and delivers the high pressured fuel to MICO DSLA type injectors fitted on each cylinder. Returned fuel is routed back to the tank through return pipe (8).

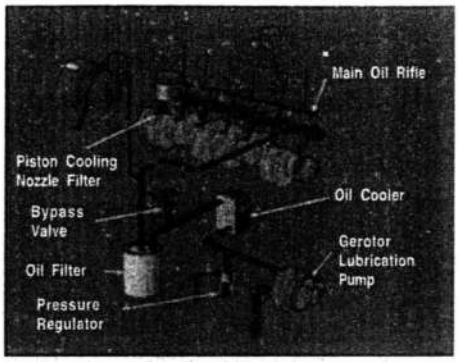


## 4.3 Lub system :

Lubricating pump draws oil from the oil pan & forces it to the lubrications system. The pressure regulating valve controls oil pressure. The filter bypass valve ensures supply of oil when filter gets choked. The piston pines are lubricated by the splash from piston cooling nozzles. Oil pump idler gear is forced lubricated. The reminder of the front gear train is lubricated by oil carry over splash.

The schematic given under shows the flow of lubricating oil to all parts of the engine.

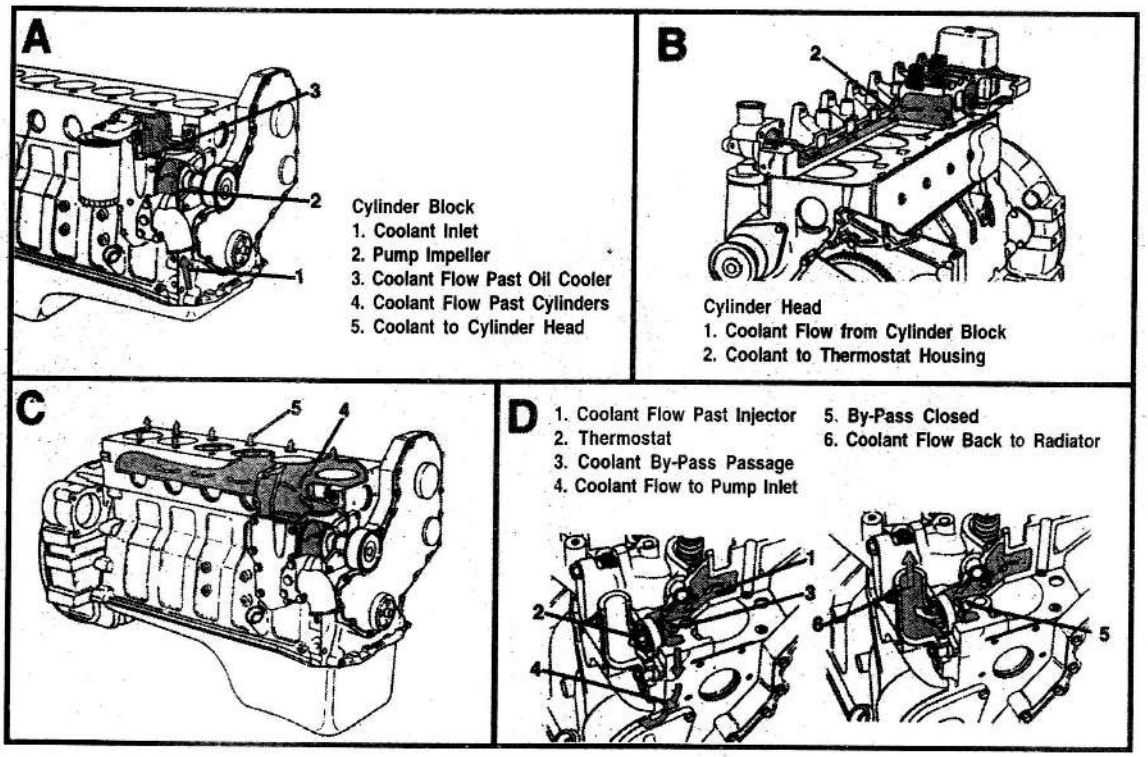
1. Lubricating Oil Pump
2. Pressure Regulating Valve
3. Oil Cooler
4. Filter Bypass Valve
5. Oil Filter
6. Turbocharger Oil Supply
7. Oil Return to Pan
8. Piston Cooling Nozzle
9. Oil Pump idler Gear



## 4.4 Cooling System :

Coolant is sucked by the engine driven water pump from the bottom tank of the radiator. Coolant passes through oil cooler, all cylinder jackets and cylinder head to reach finally at thermostat housing. Coolant get divided either to the inlet of the water pump or to the radiator depending on coolant temperature. Complete coolant get diverted to the radiator after coolant temperature reached 90 deg. C.

Flow of coolant through the engine is shown in the following sketch.



# ENGINE OPERATION

## 5.1 Starting the engine :

Before starting the engine, perform daily maintenance checks. Please refer Section 7 & 8 of this manual for details of maintenance checks.

**Normal Starting Procedure :**

1. Press starter push button, simultaneously turn the key to "Start" position.
2. Release the key switch immediately when engine cranks. Key will come to "Run" position.
3. Watch the lub oil pressure indication. Release the push button when engine oil pressure indicated is more than 1 kg/cm$^2$.

**Caution :**

To prevent damage to the starter, do not engage the starting motor more than 30 seconds. Wait 2 minutes between each attempt to start.

If the engine does not start after three attempts, check the fuel supply system. Absence of blur or white exhaust smoke during cranking indicates that no fuel is being delivered.

Move the throttle position to idle as soon as the engine starts.

Engine oil pressure must be indicated on the gauge within 15 seconds after starting.

**Caution :**

Avoid idling the engine for more that 10 Minutes.

Long idling periods may be harmful to your engine because combustion chamber temperatures can drop so low that the fuel will not burn completely. Carbon can then form which may clog the injector spray holes and also cause valve and piston rings to stick.

## 5.2 Stopping the engine :

Idle the engine a few minutes before routine shut down.

After full load operation, idle the engine 3 to 5 minutes before shutting it off. It will allow the lubricating oil and coolant to carry heat away from the combustion chamber, bearings, shafts etc. This is especially important **for Turbocharged engines.**

Turn the switch to the "Off" Position.

**Do NOT Operate the engine on load when :**

1. temperature of the coolant exceeds 98°C. (200°F).
2. lubricating oil pressure is low. 18 psi (210°F).

| | | |
|---|---|---|
| **Minimum oil pressures required** | | |
| **Idle** | : | **10 PSI** |
| **Full Speed & Load** | : | **30 PSI** |

5.3 Operating the engine :

- Do not operate the engine at full throttle below peak torque engine speed for extended periods (More than 1 minute) of time.
- Allow the engine to idle 3 to 5 minutes before shutting it off after a full load operation.
- Monitor the oil pressure and coolant temperature gauges frequently. Shut off the engine if oil pressure or coolant temperature does not meet specifications.
- Continuous operation of the engine with low or high coolant temperature can damage the engine.
- Most failures give an early warning. Look and listen for changes in performance, sound or engine appearance that can indicate service or engine repair is needed. Some changes to look for are as follow:

◆ Engine misfires

◆ Vibration

◆ Unusual engine noise

◆ Fuel, oil or coolant leakage

◆ Sudden change in engine operating temperature or oil pressure

◆ Excessive smoke

◆ Loss of power

◆ An increase in oil consumption

◆ An increase in fuel consumption

# Engine preservation procedure

## Introduction

On any engine not in service, whether installed in equipment or waiting to be installed, the unpainted surfaces and various internal passages are subject to rust and corrosion.

Every engine going out of factory is processed and is suitable for storage upto six months from the date of despatch. However sometimes engines are required to be stored for more than six months, also on many occasions engines as installed in equipment are not put in service. Hence it is necessary to process such engines for storage. Based on above the procedure for preservation can be catagorised as below.

i. Engine preservation procedure for engines to be stored upto six months, from the date of engine shipment from factory.

ii. Engine preservation procedure to be carried out for engine storage beyond six months from date of shipment from factory.

iii. Engine preservation procedure for engines installed in equipment.

**Note**

The rate of corrosion varies with climatic condition. Variance in climatic condition makes it very difficult to state the length of time an engine can be stored without rust and corrosion damage. However the procedures outlined below are useful for various climatic conditions except for arctic conditions and vary low temperatures. For such conditions, please refer to Cummins India Limited for engine storage requirements.

## 1. Engine preservation procedure for engines to be stored upto six months, from the date of engine shipment from factory.

**Note**

Every engine going out of factory is processed for storage upto six months. Hence no additional processing is required except proper storage, as given on next page.

i) If engine has to be stored in the engine box, as received from factory

| Sr. No. | Description |
|---|---|
| a | Store engine box along with kit boxes, in enclosed place protected from water / rain water, dust etc. |
| b | Tag all these boxes indicating following,<br>**ENGINE SHIPMENT DATE :**<br>**THE ENGINE HAS BEEN TREATED FOR PRESERVATION FOR A PERIOD OF SIX MONTHS FROM THE ENGINE SHIPMENT DATE MENTIONED ABOVE.** |
| c | Do not stack any material on engine box to avoid damage to engine / engine box. |

ii) If engine has to be stored with out engine box, and / or skid.

| Sr No. | Description |
|---|---|
| a | Store engine along with kit boxes, in enclosed place protected from water / rain water, dust etc. |
| b | Tag all these boxes indicating following,<br>**ENGINE SHIPMENT DATE :**<br>**THE ENGINE HAS BEEN TREATED FOR PRESERVATION FOR A PERIOD OF SIX MONTHS FROM ENGINE SHIPMENT DATE MENTIONED ABOVE.** |
| c | Ensure that all engine openings and opening on kit items such as radiators, air cleaners, silencers etc. are covered by water proof protective caps / plastic tapes. |
| d | Do not rotate the engine, as engine is in dry condition. |

**2) Engine preservation procedure to be carried out for engine storage beyond six months from date of shipment from factory.**

**The engine system wise details of the process are described below.**

**Cooling System Passage :**

| SR. NO. | DESCRIPTION | REMARKS |
|---|---|---|
| a | Prepare engine for Ensis, Long storage Process. | Fabricate and install a plate to close the water pump inlet connection. |
| b | Fill the cooling system with Ensis oil Rustilo DW 901, (Castrol India make) up to thermostat outlet connection, using external priming pump trolley. | Leave the drain cocks open until all air is completely vented out. Progressively close the cocks until the ensis oil flows from the thermostat housing. |
| c | Keep the Ensis oil in the engine for 5 minutes and then drain it completely, from engine. | Remove the fabricated plate at water pump inlet and close the opening by plastic cap. (Collect the drained oil in clean container for reuse.) |

**ii) Fuel Passage :**

No external treatment is required.

**iii) Lubricating Oil Passage :**

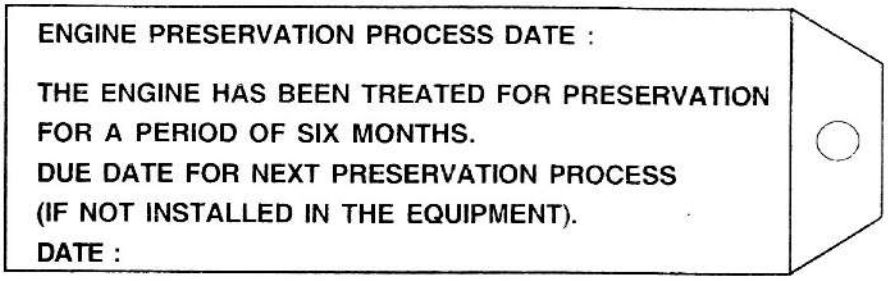
| SR. NO. | DESCRIPTION | REMARKS |
|---|---|---|
| a | Prepare engine for Lub oil priming. | Use lub oil priming pump for priming. |
| b | Prime the engine with engine lub oil 15W40. (CF-4 category) | Use engine Lub oil trolley pump for priming. Circulate the lub oil till the lub pressure gauge shows 1 kg/cm sq. pressure. It will take max five min. to reach this lub oil pressure. Bar the engine during the process. |
| c | Drain the Lub oil from the oil pan. | |

Note :

a) The above procedure for engine preservation is to be carried out / repeated at the end of every six months during the storage period. The procedure may have to be done at OEM works or at customer's place depending upon location of engine.

b) Loosen the belt tension on fan belt, alternator belt, water pump belt and other accessories driven by belt.

c) Tag the engine indicating preservation process date and due date for next preservation (6 months period).




3) **Engine preservation procedure for engines installed in equipments.**

Many times, the engines shipped from factory are installed on the equipment or Genset within six months from date of shipment from factory. However these engines as installed in the equipment are not put in the service for a long period. For such engines the engine coolant and engine lub oil is generally filled in the engine. Hence no special ensis process is required, but periodic running of engine as given below is mandatory requirement.

**Run the engine once in eery week for 5 to 10 min. at Low idle RPM. "B" check to be carried out at every six months as mentioned in Section 6.**

4) **Preparing a preserved (treated) engine for putting in service.**

When an engine is removed from storage and put into service the operation listed below should be performed.

i) Clean off all accumulated dirt from exterior of engine

ii) Remove all protective caps, tape and wrappings from connections such as Breathers, Fuel in and out, connection Water in and out connections etc.

iii) Use suitable solvent, cleaner or decreaser to remove rust preventive compound from unpainted external surfaces of the engine.

iv) Refill oil pan with fresh lubricating oil. Replace the fuel, lub oil filters and lub oil bypass filters only in case wherein engine is stored beyond six months from the date of shipment.

v) Check and correct the engine belt tensioning.

vi) Refer Section 1 for engine starting instructions.

vii) In case of any doubts, contact CSS & S / Dealer.

**Down-Hill Operation**

**The Cummins Diesel Engine is effective as a brake on downhill grades, but care must be exercised not to overspeed the engine going downhill. The governor has no control over engine speed when it is being pushed by the loaded vehicle. Overspeeding will cause severe damage to the engine.**

# FUEL, OIL & COOLANT SPECIFICATIONS

**Engine Oil Recommendations for Cummins Engines**

Quality of Lubricating oil is one of the key drive factors to decide the performance, Durability and total cost of operation of diesel engine. Hence we have always been recommending the best available / suitable engine oil to be used in our engine.

**Cummins India Limited** has been continuously upgrading the products to incorporate latest technology such as low temp. aftercooling, two stage turbocharging, electronics, air to air charge air cooling, high power to weight ratio etc. for meeting customer expectations of engine performance, durability and cost of operation.

Lubricating oil have also undergone various improvements to meet the requirements of these changes in diesel engine technology. With this, SAE 15W40 grade Lubricating oil with API CH-4 classification is now available in India from most of oil companies. This is the best engine oil currently available in India suitable for Cummins engines. However we recommend to use Valvoline Cummins Premium Blue for Cummins engine.

This provides several advantages such as,
- Reduced wear and tear.
- Better high temp oxidation stability
- Optimum Lub oil consumption.
- Lesser crown land deposits on piston and valves.
- Better emission control
- Better cleanliness of internal passages and components.
- Less sludge formation due to improved dispersancy.
- Increased control on acid formation resulting in less corrosion of bearings and other components.

Cummins India Limited strongly recommends the use of SAE 15W40 Lub oil with API CH-4, CES 20071 & CES 20076 classification for all Cummins engines to get the various advantages and optimum performance from the engine.

As a comparative advantage we strongly recommend following brand of lube oil for Cummins engines.


**Valvoline Cummins Premium Blue, API CH-4, CES 20071 & CES 20076.**

This oil have a minimum TBN of 10.5 to counteract the higher sulphur content of high speed diesel available in India.

**CAUTION**

**Beware of the spurious oils in the market. Bad oil quality is detrimental to engine performance. Hence oil should always be procured from the original manufacturer or the authorised distributor.**

**Lubricating oil to be used in the engine must meet all qualities as per manufacturer's specifications. Cummins India recommends audit checks of fresh engine oil to ensure the quality of oil. Facility to check suitability of oil for using it in the engine is available with Cummins service network.**

**If in doubt about the quality of lub oil, contact lub oil manufacturing company / Cummins service network and get oil analysed in laboratories.**

**Do not intermix different brands of oil as two different brands of oils may not be compatible with each other. It is there fore recommended that the brand which is used for initial fill / oil change, should only be used for top-up. Different brand of oil may be used after draining all the existing oil i.e., at the oil drain interval and after flushing the lub oil system with new brand of oil.**

**Note**

**The responsibility of meeting oil quality lies with the oil manufacturer & Cummins will not be responsible for problems occurring on engines due to poor quality of oil.**

**Grease Recommendations**

Cummins India Limited Pune, recommends the use of grease meeting the specifications of MIL-G-3545, excluding those of sodium or soda soap thickeners. Contact lubricant supplier for grease meeting these specifications.

| TEST | TEST PROCEDURE |
|---|---|
| **High-Temperature Performance** | |
| Dropping point, °F | ASTM D 2265<br>350 min. |
| Bearing life, hours<br>at 300°F.<br>10,000 rpm | *FTM 331<br>600 min. |
| **Low-Temperature Properties** | |
| Torque, GCM<br>Start at 0°F.<br>Run at 0°F. | ASTM D 1478<br>15,000 max.<br>5,000 max. |
| **Rust Protection and Water Resistance** | |
| Rust test | ASTM D 1743<br>Pass |
| Water resistance, % | ASTM D 1264<br>20 max. |
| **Stability** | |
| Oil separation, %<br>30 Hours @ 212°F. | *FTM 321<br>5 max. |

| | |
|---|---|
| **Penetration** | |
| Worked | ASTM D 217<br>250-300 |
| Bomb Test, PSI Drop | ASTM D 942 |
| 100 Hours | 10 max. |
| 500 Hours | 25 max. |
| Copper, Corrosion | *FTM 5309<br>Pass |
| Dirt Count, Particles/cc | *FTM 3005 |
| 25 Microns + | 5,000 max. |
| 75 Microns + | 1,000 max. |
| 125 Microns + | None |
| Rubber Swell | *FTM 3606<br>10 max. |

* Federal Test Method Std. No. 791a

**Caution: Do not mix brands of grease as damage to bearings may result. Excessive lubrication is as harmful as inadequate lubrication. After lubricating fan hub, replace both pipe plugs. Use of fittings will allow lubricant to be thrown out, due to rotative speed.**

**Fuel Oil Recommendations**

Cummins Diesel Engines have been developed to take the advantage of high energy content and generally lower cost of No. 2 Diesel Fuels. Experience has shown that a Cummins Diesel Engine will also operate satisfactorily on No. 1 fuels or other fuels within the following specifications .

**Table 11-3 : Recommended Fuel Oil Properties :**

| **Property** | **Recommended Specifications** |
|---|---|
| Viscosity (ASTM D445) | 1.3 to 5.8 centistokes (1.3 to 5.8 mm per second) at 104°F (40°C) |
| Cetane Number (ASTM D-613) | 40 Minimum above 32°F.<br>45 Minimum below 32°F. |
| Sulfur Content (ASTM D-129 or 1552) | Not to exceed 0.25 % mass percent. |
| Active Sulfur (ASTM D130) | Copper Strip Corrosion not to exceed No. 2 rating after three hours at 122°F (50°C). |
| Water and Sediment (ASTM D1796) | Not to exceed 0.1 volume percent. |
| Carbon Residue (Rams bottom, ASTM D524 or Conradson, ASTM D189) | Not to exceed 0.35 mass percent on 10 volume percent residuum. |
| Density (ASTM D287) | 42 to 30° API gravity at 60°F (0.816 to 0.876 g/cc at 15°C). |
| Cloud Point (ASTM D97) | 10°F (6°C) below lowest ambient temperature at which the fuel is expected to operate |
| Ash (ASTM D482) | Not to exceed 0.02 mass percent (0.05 mass percent with lubricating oil blending). |
| Distillation (ASTM D86) | The distillation curve must be smooth and continuous. |
| Acid Number (ASTM D664) | Not to exceed 0.1 Mg KOA per 100 ML. |

**TABLE 11-4: REQUIREMENTS FOR HIGH SPEED DIESEL FUEL AS PER IS 1460 : 2000**

| Sr. No | Characteristics | Requirement | | Method of test Annex if this Standard | Ref. to (P : of IS 1448) |
|---|---|---|---|---|---|
| | | HSD | LDO | | |
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Acidity, Inorganic | Nil | Nil | — | P : 2 |
| 2 | Acidity, total mg. of KOH/g *max* | 0.20 | — | — | P : 2 |
| 3 | Ash, percent by mass *max.* | 0.01 | 0.02 | — | P : 4 |
| 4 | Carbon residue (Ramsbottom) on 10 percent residue, percent by mass, *max* | 0.30 | 1.5 (on whole sample) | — | P : 8 |
| 5 | Cetane Number, *min.* | 48 | — | — | P : 9 |
| | or Cetane idex, *min.* | 46 | — | — | P* |
| 6 | Pour point, *max.* | | | | P : 10 |
| | a) Winter | 3°C | 12°C | — | |
| | b) Summer | 15°C | 21°C | — | |
| 7 | Copper strip corrosion for 3 hours at 100°C | Not worse than No. 1 | Not worse than No. 2 | — | P : 15 |
| 8 | Distillation percent *v/v*, recovered | | | | |
| | a) at 350°C, *min.* | 85 | — | — | P : 18 |
| | b) at 370°C, *min.* | 95 | — | — | |
| 9 | Flash point : (a) Abel, °C *min.* | 35 | — | — | P : 20 |
| | b) Pensky Martens, °C, *min.* | 66 | 66 | — | P : 21 |
| 10 | Kinematic viscosity CSt at 40°C | 2.0 to 5.0 | 2.0 to 15.7 | — | P : 25 |
| 11 | Sediment, percent by mass *max.* | 0.05 | 0.10 | — | P : 30 |
| 12 | Total sulphur, percent by mass *max.* | a) 0.25[1)]<br>b) 0.05[2)] | 1.8 | — | P : 33 |
| 13. | Water content, percent by volume, *max.* | 0.05 | 0.25 | — | P : 40 |
| 14. | Cold Filter Plugging Point (CFPP), *max.* | | | | P : 110 |
| | a) Winter | 6°C | — | — | |
| | b) Summer | 18°C | — | — | |
| 15 | Total sediments, mg. per 100 ml *max.* | 1.6 | — | A | — |

1. Total sulphur content for HSD supplied to Indian Navy for defence use shall be 0.20 percent by mass, *max.* 2.The requirement of sulphur content 0.05 percent by mass, *Max* is applicable for notified areas. Such fuels shall be tested for the requirement of lubricity using the high-frequency reciprocating rig (HFRR) test stipulated in ISO 12156-1 : 1997 'Diesel fuel - Assessment of lubricity using the high-frequency reciprocating rig (HFRR) - Part 1 : Test method'. Lubricity test requirement of corrected wear scar diameter (wsd 1.4) at 60°C shall be 460 microns, *max*

## Coolant Recommendations / Specifications

**Antifreeze is essential in any climate.**

It broadens the operating temperature range by lowering the coolant freezing point and by raising its boiling point. Do not use more than 50 percent antifreeze in the mixture unless additional freeze protection is required. Never use more than 68 percent antifreeze under any condition.

Use soft water in the Coolant mixture contaminants in hard water neutralize the corrosion inhibitor Components. Water must not exceed 300 ppm hardness or contain more than 100 ppm of either chloride or sulphate.

**Specification :** Use low silicate antifreeze which meets ASTM 4985 test criteria.

**Concentration :** Antifreeze must be used in any climate for both freeze and boiling point protection.

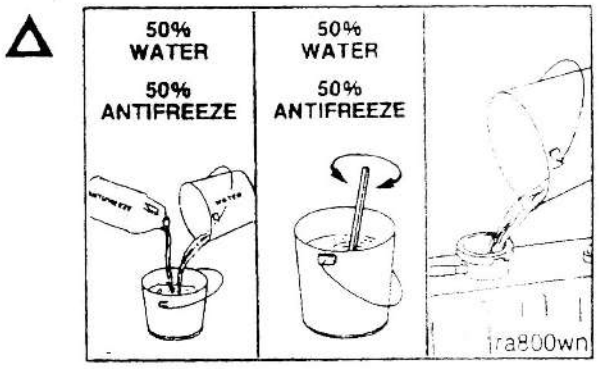
Use a 50 percent concentration level (40 percent to 60 percent range) of ethylene glycol or propylene glycol in most climates.

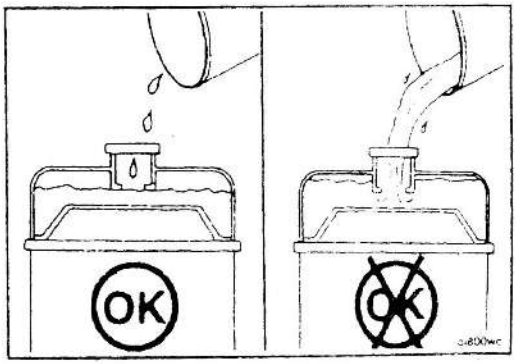
Antifreeze at 68 percent concentration provides the maximum freeze protection and must never be exceeded under any condition. Antifreeze protection decreases above 68 percent.

| Ethylene Glygcol | Propylene Glycol |
|---|---|
| 40% = -23C | 40% = -21C |
| 50% = 37C | 50% = -33C |
| 60% = 54C | 60% = - 49C |
| 68% = -71C | 68% = -63C |

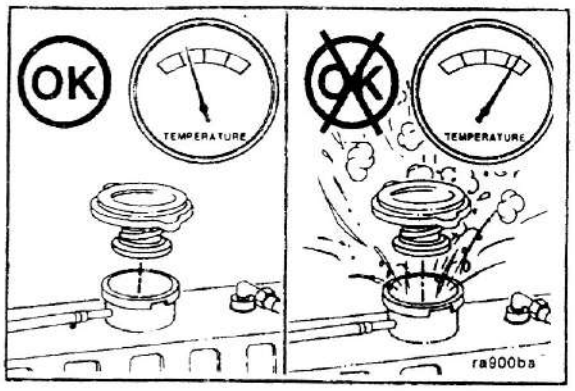
**Caution : Do not add cold coolant to a hot engine. Engine castings can be damaged. Allow the engine to cool to below 50C (120F) before adding coolant.**

**NOTE :** On applications that use a coolant recovery system, check to make sure the coolant is at the appropriate level on the coolant recovery tank depending on engine temperature.



**Coolant Level Check**




Warning : Do not remove the radiator cap from a hot engine. Wait until the temperature is below 50C (120F) before removing the pressure cap. Failure to do so can result in personal injury from heated coolant spray or steam. Remove the filler cap slowly to relieve coolant system pressure.

**NOTE :** Never use a sealing additive to stop leaks in the coolant system. This can result in coolant system plugging and inadequate coolant flow causing the engine to overheat. The coolant level must be checked daily.

**Properties of Water :**

**Coolant used in cooling system is mixture of water & corrosion inhibitor :** Water quality is important for cooling system performance. Therefore it is important that high quality water is used which is free from suspended matter/mud. Distilled or Deionised water can be used in cooling system, however coolant treatment by using corrosion inhibitor is must. Waterused in cooling system must meet following specifications.

| | | |
|---|---|---|
| Hardness (as $CaCO_3$) | - | 170 ppm max. |
| Chlorides (as Cl) | - | 40 ppm max. |
| Sulfur (as $SO_4$) | - | 100 ppm max. |
| pH | - | 5 to 9 |

It is suggested to get Water quality checked from authorised laboratories if water quality is in doubt.

**NOTE :** For optimum cooling system efficiency always operate engine with radiator cap in place.

# MAINTENANCE SCHEDULE

| A Check | B Check | C Check | D Check |
|---|---|---|---|
| ❑ 0-50 hrs / 0-30 days | ❑ 225-250 hours / every 3 months | ❑ 475-500 hours / every 6 months | ❑ 950-1000 hours / every 12 months |
| **Cooling System** | ❑ Repeat all A Checks. | ❑ Repeat all A & B Checks | ❑ Repeat all A, B & C Checks |
| ❑ Fill coolant and recommended ensure proper venting. | **Lubrication** | ❑ Check Toppet clearances and adjust, if necessary. | ❑ Check Fan belt tension, replace if necessary. |
| ❑ Check coolant level in Radiator. | ❑ Change engine oil. | **Lubrication** | ❑ Fuel tank cleaning. |
| **Fuel System** | ❑ May be switched over to equivalent oil of CF-4, Grade 15W40 including Cummins Volvoline Oil. | ❑ Check dipstick clamping and correct if required. | ❑ Check operating parameters & record. |
| ❑ Clean fuel strainer, fuel tank breather. | ❑ Change engine full flow oil filter. | ❑ Clean condition of hoses. | **Cooling System** |
| ❑ Check fuel shut off mounting & tighten the mounting screw. | ❑ Record oil pressure. | **Cooling System** | ❑ Replace the coolant. |
| ❑ Adjust the speed control level if required. | **Cooling System** | ❑ Check condition of hoses and replace if faulty. | ❑ Check radiator fins and radiator fan blades for damage. |
| **Air System** | ❑ Check coolant level & top up if necessary. | ❑ Check fan drive belt. | **Fuel System** |
| ❑ Check plugs in intake pipe for proper sealing. | ❑ Check the condition and tension of radiator drive belt. | **Fuel System** | ❑ Check fuel lift pump diaphragm. |
| ❑ Check function of vacuum indicator. | ❑ Check the radiator fins for contamination or blockage. | ❑ Check fuel shut off mounting & tighten the mounting screw. | ❑ Clean and check fuel injector nozzles. |
| ❑ Check hoses and clamp for proper sealing. | **Fuel System** | ❑ Check fan drive belt. | **Lubrication System** |
| **Other** | ❑ Change fuel/water separator element. | ❑ Check fuel pipes and replace if required. | ❑ Check leakage and replace hoses if required. |
| ❑ Check leaks if any. | ❑ Clean fuel strainer, fuel tank breather. | **Air System** | **Air System** |
| ❑ Check G / set and G/ set room. | ❑ Check fuel shut off mounting & tighten the mounting screw. | ❑ Check air cleaner sealing. | ❑ Check hump hose and replace if required. |
| **Exhaust System** | ❑ Adjust the throttle lever if required. | ❑ Check sealing of radiator. | **Mechanical System** |
| ❑ Ensure smoke level is normal and no leak from Piping. | **Air System** | **Mechanical System** | ❑ Adjust valve lashes and recommended. |
| ❑ Check for Proper support to Exh. pipe. | ❑ Clean element in reverse direction with clean dry air pressure. | ❑ Adjust valve lashes as recommended. | **Electrical System** |
| ❑ Check and record exhaust back pressure (inches of Hg) | **Electrical System** | **Electrical System** | ❑ Check battery switches and replace if required. |
| **Electrical System** | ❑ Check battery terminals. | ❑ Clean battery terminals. | ❑ Check starter / battery charging alternator and repair if required. |
| ❑ Check battery condition. | | ❑ Check wiring harness for tightness of terminal clamping. | |
| | | ❑ Check wiring harness and connections and tighten if required. | |

# NOTES

**1ST FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (0 TO 50 HOURS OR WITHIN 30 DAYS FROM INSTALLATION)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick mark |
|---|---|
| **COOLING SYSTEM :** | |
| ❑ FILL COOLANT AS RECOMMENDED & ENSURE PROPER VENTING | ☐ |
| ❑ ENSURE THE COOLING SYSTEM IS FREE FROM LEAKAGES | ☐ |
| ❑ ENSURE COOLANT LEVEL IN RESERVOIR BOTTLE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CLEAN FUEL STRAINER & FUEL TANK BREATHER | ☐ |
| ❑ CHECK PROPER MOUNTING OF FUEL SHUTT OFF COIL | ☐ |
| ❑ ENSURE THE SPEED CONTROL LEVER IS ADJUSTED PROPERLY | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ ENSURE ALL PLUGS ARE TIGHT & PROPERLY SEALED | ☐ |
| ❑ ENSURE ALL HOSES AND CLAMP ARE PROPERLY TIGHTENED | ☐ |
| ❑ CHECK PROPER FUNCTIONING OF VACUUM INDICATOR | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ ENSURE SMOKE LEVEL IS NORMAL & NO LEAKAGE FROM PIPING | ☐ |
| ❑ CHECK FOR PROPER SUPPORT TO EXH PIPE | ☐ |
| ❑ CHECK & RECORD EXHAUST BACK PRESSURE (INCH OF Hg ) | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION AS RECOMMENDED. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

1ST Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**1ST FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (0 TO 50 HOURS OR WITHIN 30 DAYS FROM INSTALLATION)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick mark |
|---|---|
| **COOLING SYSTEM :** | |
| ❑ FILL COOLANT AS RECOMMENDED & ENSURE PROPER VENTING | ☐ |
| ❑ ENSURE THE COOLING SYSTEM IS FREE FROM LEAKAGES | ☐ |
| ❑ ENSURE COOLANT LEVEL IN RESERVOIR BOTTLE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CLEAN FUEL STRAINER & FUEL TANK BREATHER | ☐ |
| ❑ CHECK PROPER MOUNTING OF FUEL SHUTT OFF COIL | ☐ |
| ❑ ENSURE THE SPEED CONTROL LEVER IS ADJUSTED PROPERLY | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ ENSURE ALL PLUGS ARE TIGHT & PROPERLY SEALED | ☐ |
| ❑ ENSURE ALL HOSES AND CLAMP ARE PROPERLY TIGHTENED | ☐ |
| ❑ CHECK PROPER FUNCTIONING OF VACUUM INDICATOR | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ ENSURE SMOKE LEVEL IS NORMAL & NO LEAKAGE FROM PIPING | ☐ |
| ❑ CHECK FOR PROPER SUPPORT TO EXH PIPE | ☐ |
| ❑ CHECK & RECORD EXHAUST BACK PRESSURE (INCH OF Hg ) | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION AS RECOMMENDED. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

1ST Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**1ST FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (0 TO 50 HOURS OR WITHIN 30 DAYS FROM INSTALLATION)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick mark |
|---|---|
| **COOLING SYSTEM :** | |
| ❑ FILL COOLANT AS RECOMMENDED & ENSURE PROPER VENTING | ☐ |
| ❑ ENSURE THE COOLING SYSTEM IS FREE FROM LEAKAGES | ☐ |
| ❑ ENSURE COOLANT LEVEL IN RESERVOIR BOTTLE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CLEAN FUEL STRAINER & FUEL TANK BREATHER | ☐ |
| ❑ CHECK PROPER MOUNTING OF FUEL SHUTT OFF COIL | ☐ |
| ❑ ENSURE THE SPEED CONTROL LEVER IS ADJUSTED PROPERLY | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ ENSURE ALL PLUGS ARE TIGHT & PROPERLY SEALED | ☐ |
| ❑ ENSURE ALL HOSES AND CLAMP ARE PROPERLY TIGHTENED | ☐ |
| ❑ CHECK PROPER FUNCTIONING OF VACUUM INDICATOR | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ ENSURE SMOKE LEVEL IS NORMAL & NO LEAKAGE FROM PIPING | ☐ |
| ❑ CHECK FOR PROPER SUPPORT TO EXH PIPE | ☐ |
| ❑ CHECK & RECORD EXHAUST BACK PRESSURE (INCH OF Hg ) | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION AS RECOMMENDED. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

1ST Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

Restricted

# 2ND FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (225 TO 250 HOURS OR WITHIN 3 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | ☐ |
| ❑ CHANGE LUBE OIL WITH CF4 – SAE 15W40 OR EQUIVALENT & MAINTAIN LEVEL | ☐ |
| ❑ CHANGE ENGINE FULL FLOW LUBE OIL FILTER | ☐ |
| ❑ RECORD LUBE OIL PRESSURE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK COOLANT LEVEL & TOP UP IF NECESSARY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & ADJUST TENSION IF REQD | ☐ |
| ❑ CLEAN RADIATOR FINS & ENSURE FREE FROM DUST/ BLOCKAGE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHANGE FUEL FILTER / WATER SEPARATOR | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CLEAN ELEMENT WITH DRY AIR IN REVERSE DIRECTION | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CLEAN BATTERY TERMINALS. | ☐ |
| ❑ CHECK THE BATTERY CONDITION. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

2ND Free Check :
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

Restricted

# 2ND FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (225 TO 250 HOURS OR WITHIN 3 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | ☐ |
| ❑ CHANGE LUBE OIL WITH CF4 – SAE 15W40 OR EQUIVALENT & MAINTAIN LEVEL | ☐ |
| ❑ CHANGE ENGINE FULL FLOW LUBE OIL FILTER | ☐ |
| ❑ RECORD LUBE OIL PRESSURE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK COOLANT LEVEL & TOP UP IF NECESSARY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & ADJUST TENSION IF REQD | ☐ |
| ❑ CLEAN RADIATOR FINS & ENSURE FREE FROM DUST/ BLOCKAGE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHANGE FUEL FILTER / WATER SEPARATOR | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CLEAN ELEMENT WITH DRY AIR IN REVERSE DIRECTION | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CLEAN BATTERY TERMINALS. | ☐ |
| ❑ CHECK THE BATTERY CONDITION. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

2ND Free Check :
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

Restricted

# 2ND FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (225 TO 250 HOURS OR WITHIN 3 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | ☐ |
| ❑ CHANGE LUBE OIL WITH CF4 – SAE 15W40 OR EQUIVALENT & MAINTAIN LEVEL | ☐ |
| ❑ CHANGE ENGINE FULL FLOW LUBE OIL FILTER | ☐ |
| ❑ RECORD LUBE OIL PRESSURE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK COOLANT LEVEL & TOP UP IF NECESSARY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & ADJUST TENSION IF REQD | ☐ |
| ❑ CLEAN RADIATOR FINS & ENSURE FREE FROM DUST/ BLOCKAGE | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHANGE FUEL FILTER / WATER SEPARATOR | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CLEAN ELEMENT WITH DRY AIR IN REVERSE DIRECTION | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CLEAN BATTERY TERMINALS. | ☐ |
| ❑ CHECK THE BATTERY CONDITION. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

2ND Free Check :
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & Add | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**3RD FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (475 TO 500 HOURS OR WITHIN 6 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & ENSURE NO LEAKAGE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & REPLACE IF FAULTY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & REPLACE IF REQD | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK CONDITION OF ELEMENT & REPLACE IF FAULTY | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ CLEAN EXHAUST PIPING IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION. | ☐ |
| ❑ CHECK WIRING HARNESS & ALL BATTERY & CONTROL SAFETY TERMINALS. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

3rd Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |

Name & AddM

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**3RD FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (475 TO 500 HOURS OR WITHIN 6 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & ENSURE NO LEAKAGE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & REPLACE IF FAULTY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & REPLACE IF REQD | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK CONDITION OF ELEMENT & REPLACE IF FAULTY | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ CLEAN EXHAUST PIPING IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION. | ☐ |
| ❑ CHECK WIRING HARNESS & ALL BATTERY & CONTROL SAFETY TERMINALS. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

3rd Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |

Name & AddM

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**3RD FREE CHECK**

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (475 TO 500 HOURS OR WITHIN 6 MONTHS FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & ENSURE NO LEAKAGE | ☐ |
| **COOLING SYSTEM :** | |
| ❑ CHECK CONDITION OF HOSES & REPLACE IF FAULTY | ☐ |
| ❑ CHECK CONDITION OF FAN BELT & REPLACE IF REQD | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK CONDITION OF ELEMENT & REPLACE IF FAULTY | ☐ |
| **EXHAUST SYSTEM :** | |
| ❑ CLEAN EXHAUST PIPING IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK BATTERY CONDITION. | ☐ |
| ❑ CHECK WIRING HARNESS & ALL BATTERY & CONTROL SAFETY TERMINALS. | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

3rd Free Check:

All the checks-points attended by a service representative of M/S _____

To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |

Name & AddM

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**Restricted**

# 4TH FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (950 TO 1000 HOURS OR WITHIN 1 YEAR FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK LEAKAGE & REPLACE HOSES IF REQUIRED | ☐ |
| **COOLING SYSTEM :** | |
| ❑ REPLACE THE COOLANT AS RECOMMENDED & CLEAN THE RADIATOR PROPERLY. | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| ❑ CHECK FUEL LIFT PUMP DIAPHRAGM & REPLACE IF REQUIRED | ☐ |
| ❑ CHECK FUEL INJECTORS & CALIBRATE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK ALL HOSES & REPLACE IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK SAFETY CONTROL SWITCH & REPLACE IF REQUIRED. | ☐ |
| ❑ CHECK STARTER / BATTERY / CHARGING ALTERNATOR & REPAIR IF REQUIRED | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

4th Free Check:
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & AddM | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**Restricted**

# 4TH FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (950 TO 1000 HOURS OR WITHIN 1 YEAR FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK LEAKAGE & REPLACE HOSES IF REQUIRED | ☐ |
| **COOLING SYSTEM :** | |
| ❑ REPLACE THE COOLANT AS RECOMMENDED & CLEAN THE RADIATOR PROPERLY. | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| ❑ CHECK FUEL LIFT PUMP DIAPHRAGM & REPLACE IF REQUIRED | ☐ |
| ❑ CHECK FUEL INJECTORS & CALIBRATE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK ALL HOSES & REPLACE IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK SAFETY CONTROL SWITCH & REPLACE IF REQUIRED. | ☐ |
| ❑ CHECK STARTER / BATTERY / CHARGING ALTERNATOR & REPAIR IF REQUIRED | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

4th Free Check:
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & AddM | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

**Restricted**

# 4TH FREE CHECK

## FREE CHECK COUPON FOR 'B' SERIES ENGINE FOR INDUSTRIAL APPLICATION (950 TO 1000 HOURS OR WITHIN 1 YEAR FROM COMMISIONING)

ESN: _____ MACHINE SR. NO.: _____ HRS: _____ DATE: _____

MODEL: _____ RATING: _____ DELIVERY DATE: _____

| | √ Tick Mark |
|---|---|
| (REPEAT ALL EARLIER FREE CHECK POINTS) | ☐ |
| **LUBRICATION SYSTEM :** | |
| ❑ CHECK LEAKAGE & REPLACE HOSES IF REQUIRED | ☐ |
| **COOLING SYSTEM :** | |
| ❑ REPLACE THE COOLANT AS RECOMMENDED & CLEAN THE RADIATOR PROPERLY. | ☐ |
| **FUEL SYSTEM :** | |
| ❑ CHECK CONDITION OF FUEL PIPES & REPLACE IF REQD | ☐ |
| ❑ CHECK FUEL LIFT PUMP DIAPHRAGM & REPLACE IF REQUIRED | ☐ |
| ❑ CHECK FUEL INJECTORS & CALIBRATE IF REQD | ☐ |
| **INTAKE AIR SYSTEM :** | |
| ❑ CHECK ALL HOSES & REPLACE IF REQUIRED | ☐ |
| **MECHANICAL SYSTEM :** | |
| ❑ ADJUST VALVE LASHES AS RECOMMENDED | ☐ |
| **ELECTRICAL SYSTEM :** | |
| ❑ CHECK SAFETY CONTROL SWITCH & REPLACE IF REQUIRED. | ☐ |
| ❑ CHECK STARTER / BATTERY / CHARGING ALTERNATOR & REPAIR IF REQUIRED | ☐ |

Hours Run :_____ Lube Oil Press: _____ Kg/sq.cm Coolant Temp: _____ Deg C

**THE WARRANTY STANDS NULL AND VOID IF SERVICE IS NOT CARRIED OUT AS SITPULATED.**

***(# COST OF SPARES AND CONSUMABLES TO BE BORNE BY CUSTOMER. ANY OTHER REPAIRS NOT COVERED UNDER WARRANTY CLAUSE WILL BE BORNE BY CUSTOMER)***

4th Free Check:
All the checks-points attended by a service representative of M/S _____
To the satisfaction & the equipment is working in normal condition.

| | | | |
|---|---|---|---|
| Sign | : | Sign | : |
| Name | : | Name | : |
| Designation | : | Designation | : |
| Customer | : | Dealer | : |
| Name & AddM | | | |

(Copy – Customer / Dealer / HO) (Approved By ASM – CDSS)

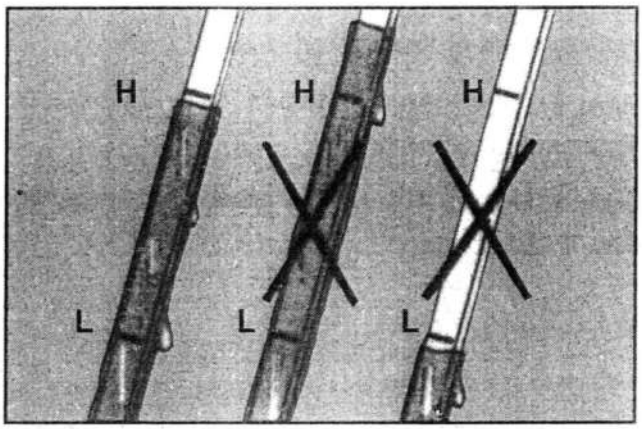
# ENGINE MAINTENANCE

## 8.1 Daily :

Preventive Maintenance begins with a day-to-day awareness of condition of the engine & its systems.

Before Start up, check oil & coolant level and look for leaks, loose parts, frayed belts etc.

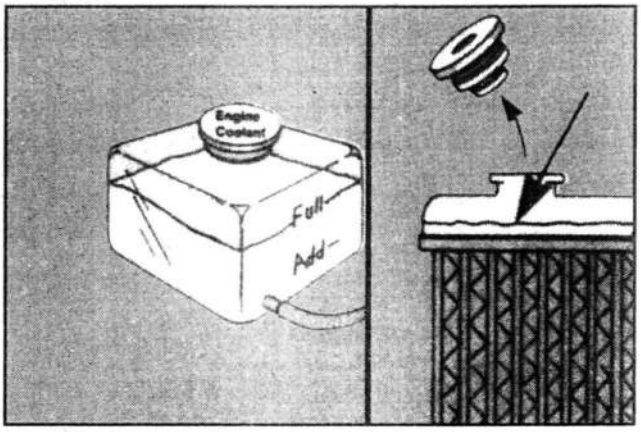
Check Oil Level :




**Never operate the engine with the oil level below "L" (Lower) mark or above "H" (Higher) mark.**

**Lubricating oil Capacity between Low & High marks is 2.10 Litres.**

Check Coolant Level :



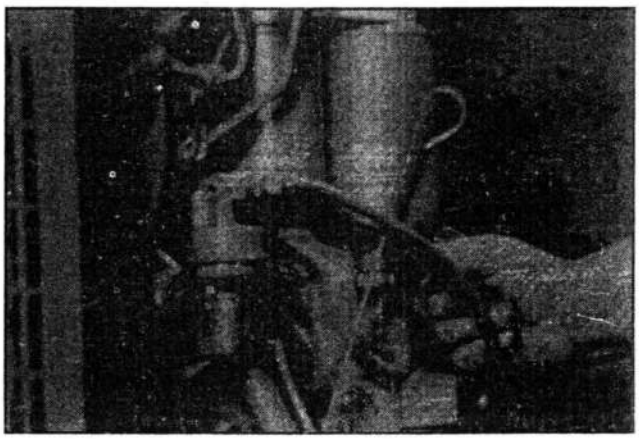

Check the coolant level by removing radiator cap.

**Caution :**

Never remove the cap when the coolant is Hot. Always use caution when removing the cap to avoid personal injury.

Check fuel water trap :

Drain the water from fuel/water separator.



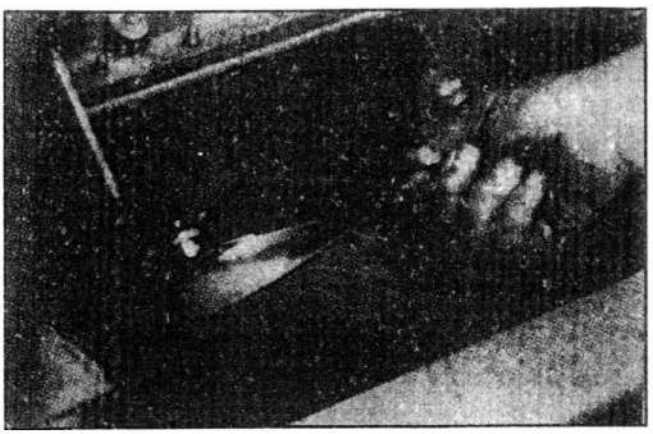
**8.2 Every 3 months or 250 Hours :**

Change / Replace Lub oil :

Warm up the engine.

Remove the plug and allow the oil to drain.

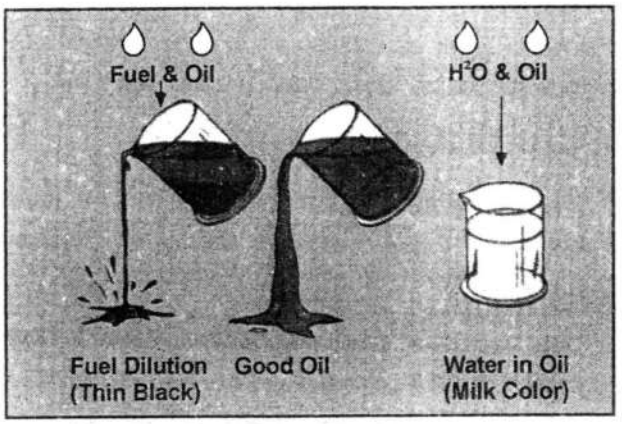
A drain pan with capacity of 20 litres will be adequate.



Check condition of fused oil :

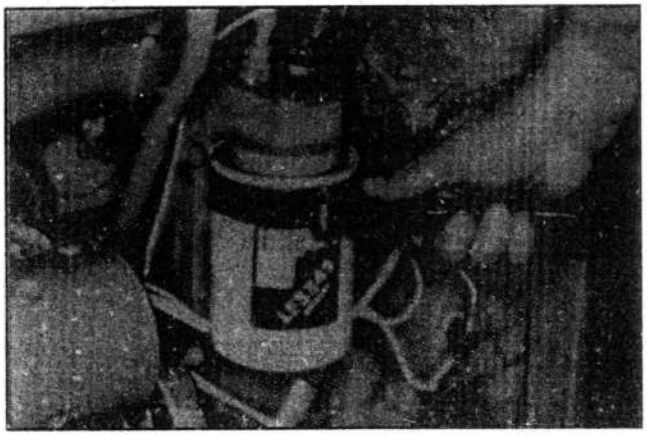
Thin/black oil indicates fuel dilution. Milky discoloration indicates coolant dilution.

**Contact the nearest Cummins Dealer for corrective action, if necessary.**




Change/Replace lub oil filter :

Clean around the filter head. Remove the filter & clean the gasket surface.

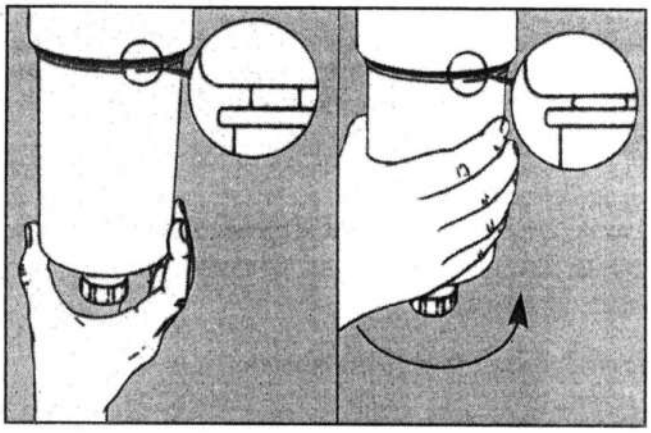


Fill the filter with clean lubricating oil.

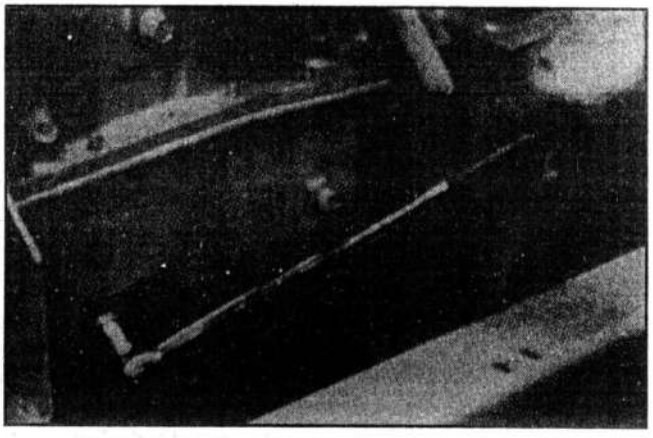
Apply a light film of lubricating oil to the gasket sealing surface before installing the filter.

**Caution :**

Mechanical Overtightening of the filter may distort the threads or damage the filter element seal.



Install the oil pan drain plug and tighten to 75 N. M. (55 ft-lbs).



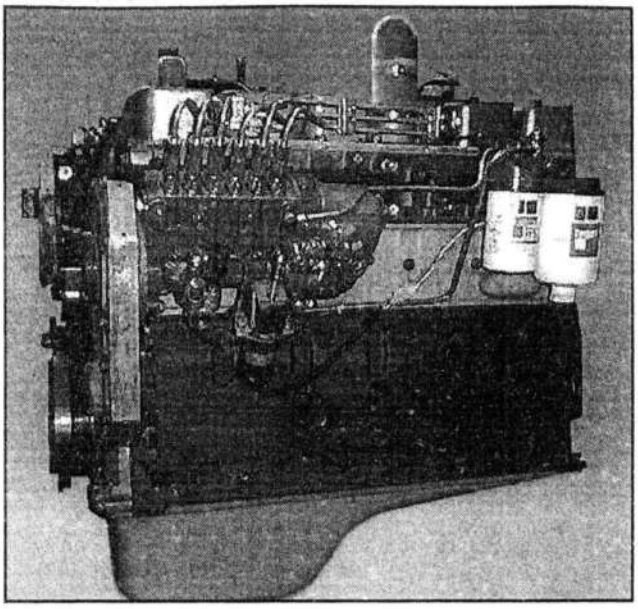
Ensure that proper brand & grade of lubricating oil is used.

Fill the engine with the required amount of oil.

Lubricating oil capacity : 14.3 Litres.

Operate the engine at idle speed & inspect for any leaks at drain plug or at the filter.

Shut the engine off. Allow 5 minutes for oil to drain down. Check the oil level with the dipstick.



Check Air Cleaner :

Check the vacuum indicator.

If it is showing red mark, clean/ replace the air cleaner element. Reset vacuum indicator.

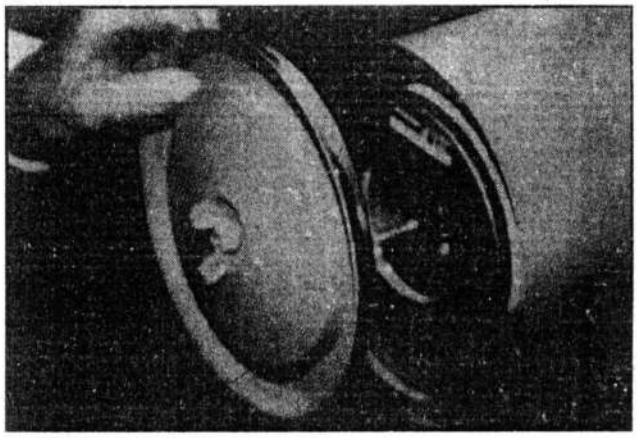
Check air intake system :

Inspect the intake piping for damage, cracked hoses, loose clamps etc.

Never operate the engine without air cleaner.

Check coolant concentration :

Please refer Section 6 for details.

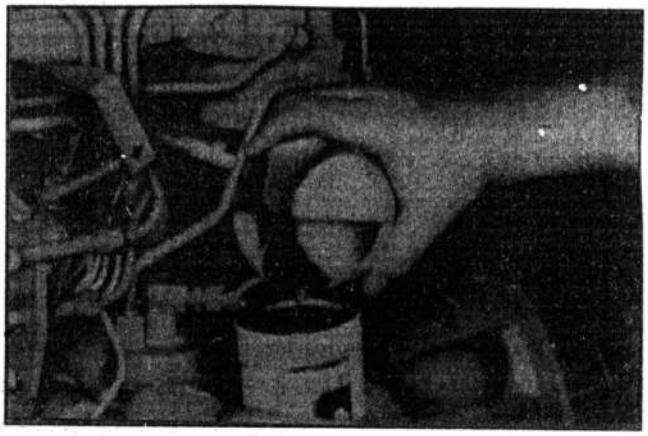


8.3 Every 3 months or 250 Hours :

Change Fuel Filter :

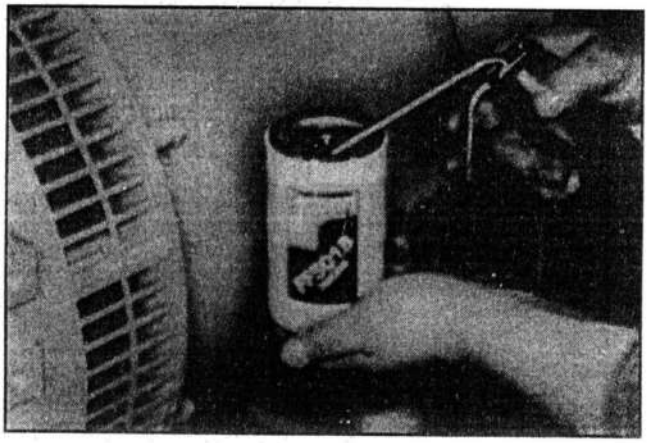
Remove the two filters from the dual filter adapter.

Fill the new filters with clean fuel.



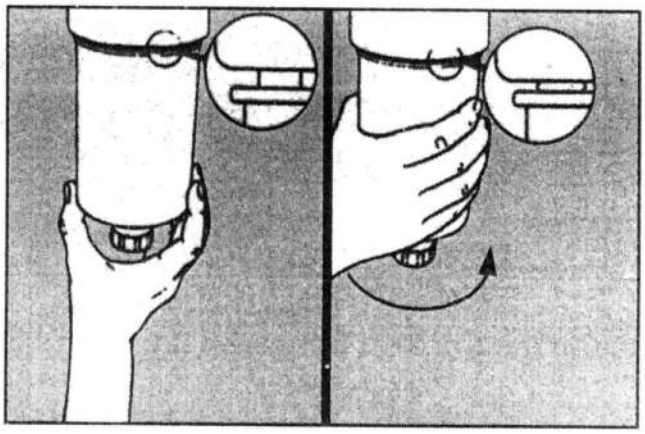
Lubricate the seal with clean lubricating oil.

Install the filters.



**Caution :**

Mechanical overtightening may distort the threads or damage the filter element seal.

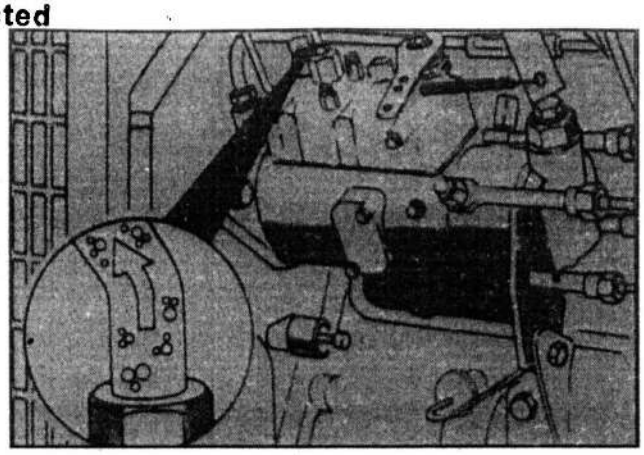


Bleeding the fuel System :

Controlled venting is provided at the injection pump. Small amount of air introduced by changing the filters will be vented automatically.

However, manual bleeding will be required if :

- Fuel filter is not filled properly
- Injection pump is replaced
- high pressure fuel lines are replaced.



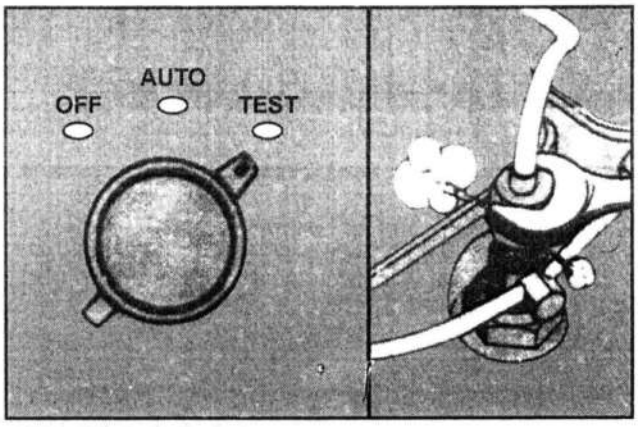
Venting the low pressure lines :

Loosen the fittings at the injectors, and crank the engine to allow entrapped air to bleed from the lines. Tighten the fittings.

**Caution :**

High Pressure could cause penetration of skin.

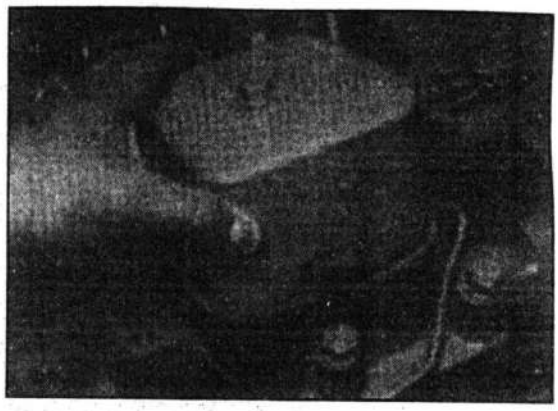
Do not bleed a hot engine as this could cause fuel to spill onto a hot exhaust manifold creating a danger of fire.



**8.4 Every 12 months or 1000 Hours :**

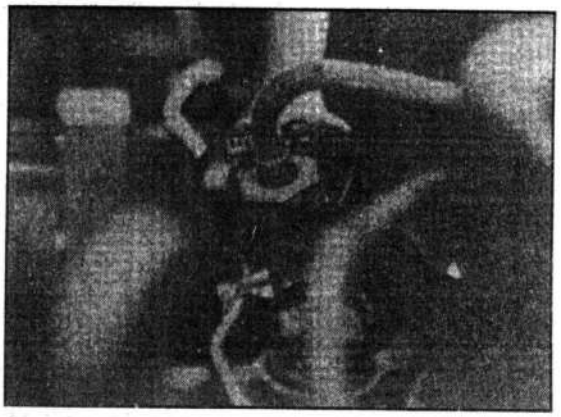
**Adjust Valve Clearance :**

Remove the valve covers.

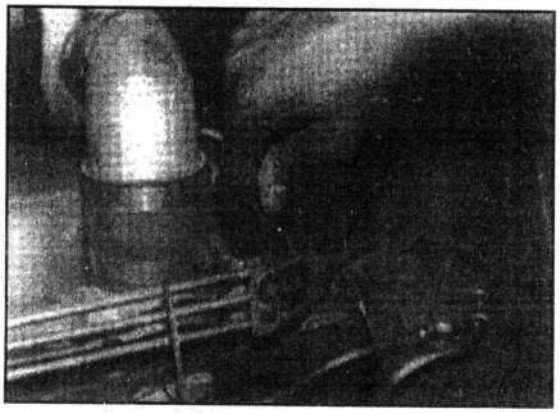


**REPLACING THE HIGH PRESSURE LINES**

Disconnect the high pressure lines from the injectors and complete the following steps.

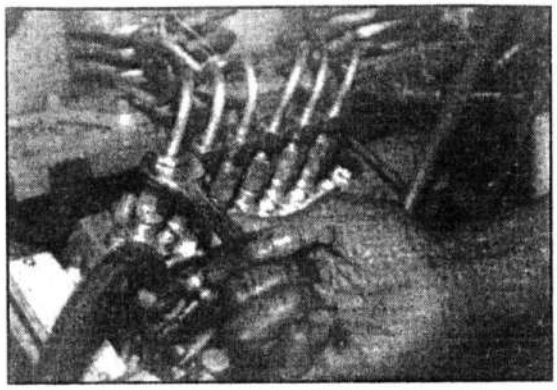


Remove the line clamp capscrews from the intake cover.



Remove the lines from the injection pump.

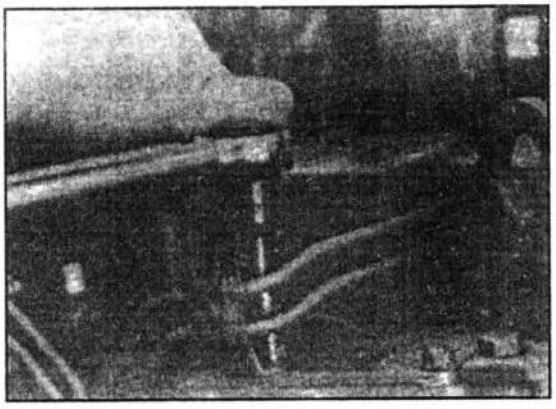
Use two wrenches to prevent the delivery valve holder from turning. Use crowfoot wrench while loosening fuel liner.



Assemble the lines in the reverse order of removal.

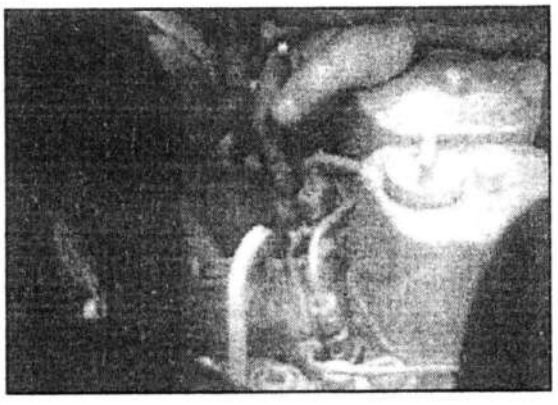
The installation torque on the clamp capscrew is 24 N•m (18ft-lbs)

Bleed the fuel system.



**REPLACING THE FUEL DRAIN MANIFOLD**

Remove the banjo fitting screws and washers.

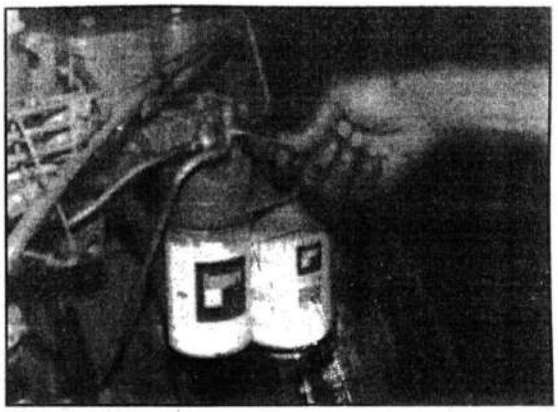


Disconnect the drain line fitting.

USE NEW SEALS FOR THE FITTINGS.

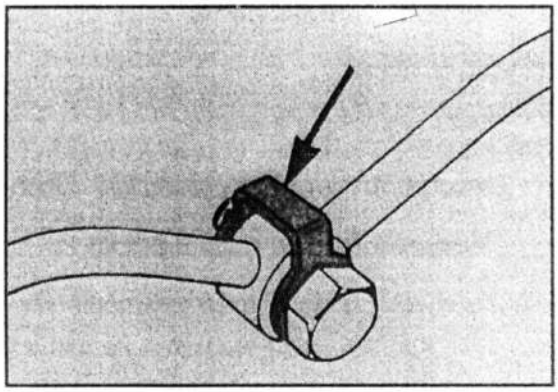
Assemble the drain line and fuel drain manifold in the reverse order of disassembly.

Replace all sealing washers from the drain lines.



USE NEW SEALING WASHERS FOR THE FUEL DRAIN MANIFOLD.

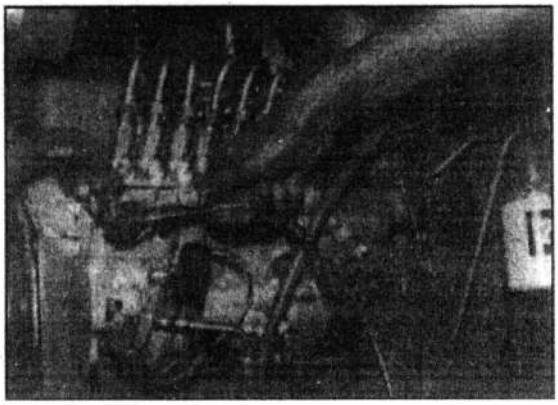
The installation torque for the banjo fitting screw is 9 N•m (6.5 ft-lbs).



REPLACING THE INJECTION PUMP SUPPLY LINE

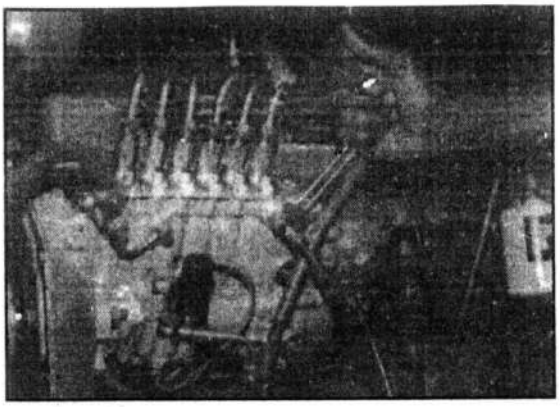
Remove the bleed screw banjo fitting and complete the following steps.

Remove the supply line.



Assemble the supply line in the reverse order of removal.

The installation torque for the bleed screw banjo fitting is 32 N•m (23.5 ft-lbs).

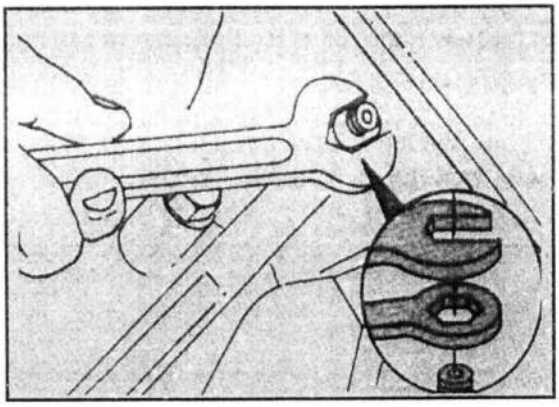


REPLACING THE INJECTORS

Preparatory Steps :

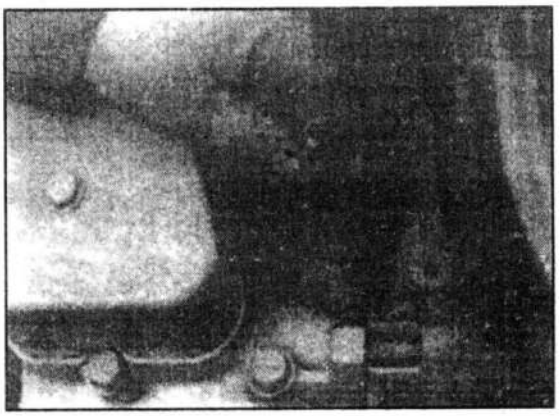
- Clean around the injectors.
- Disconnect the high pressure fuel supply lines.
- Disconnect the fuel drain manifold.

Hold the injector body with an adjustable wrench while you loosen the hold down nut with a 24 mm box wrench.



CAUTION : THE INJECTOR MUST NOT ROTATE IN BORE OF THE CYLINDER HEAD. THIS WILL DAMAGE THE CYLINDER HEAD.

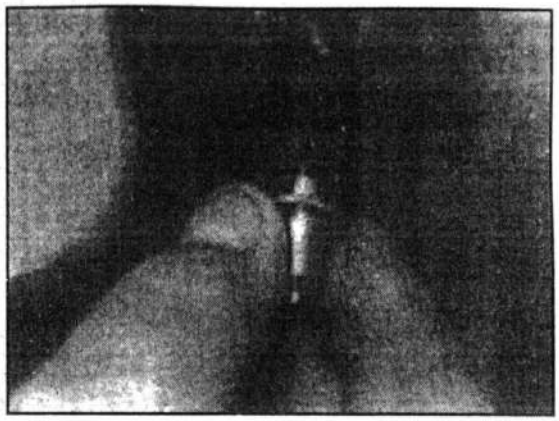
Clean the injector nozzle bore.



Assemble the injector and new copper sealing washer.

ALIGN THE INJECTOR ALIGNMENT BALL WITH THE NOTCH IN THE BORE.

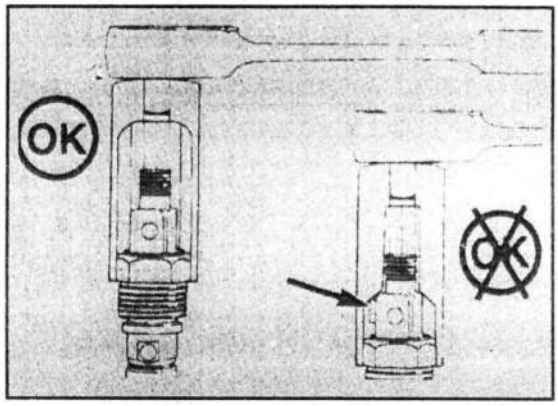
USE ONLY ONE COPPER WASHER.



Install the injector in the reverse order of removal.

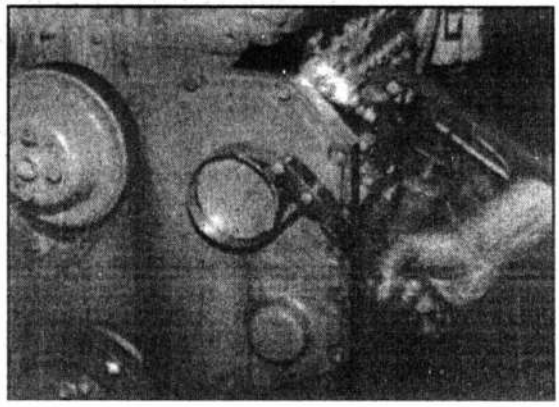
The installation torque on the injector retaining nut is 55 N•m (40 ft-lbs).

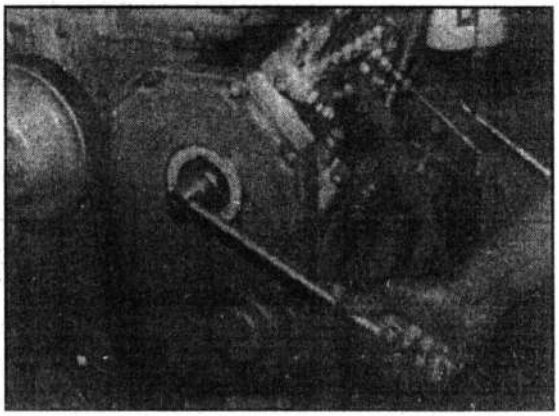
**CAUTION : SOME SOCKETS CAN DAMAGE THE SEALING SURFACE OF THE FUEL DRAIN OUTLET.**



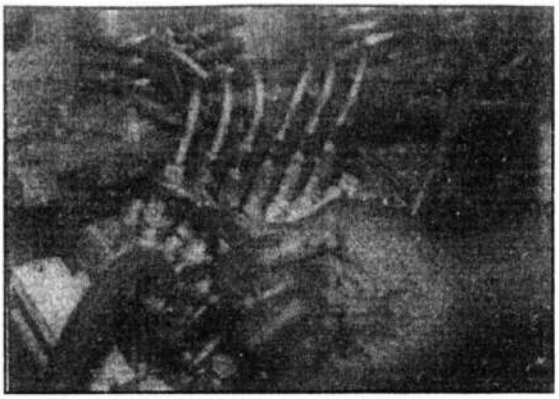

**REPLACING THE FUEL PUMP OF MOTOR POL.**

Remove the access cap and gear retaining nut and washer.



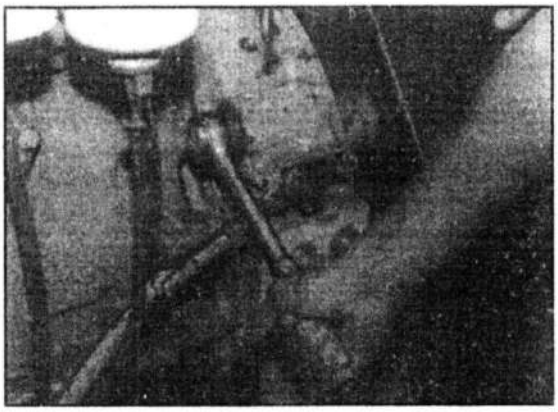


Remove all fuel lines, control linkage support bracket and the solenoid wiring.



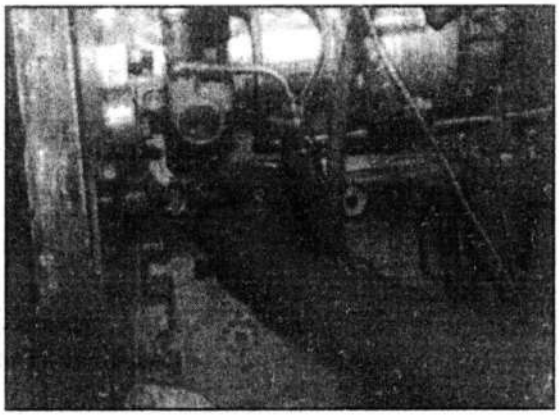
Locate TDC for Cylinder Number 1 by barring engine slowly while pushing in on TDC pin.

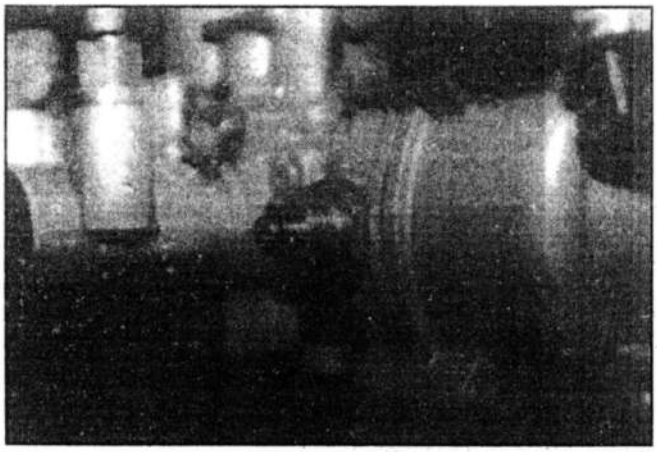
BE SURE TO DISENGAGE THE PIN AFTER LOCATING TDC.

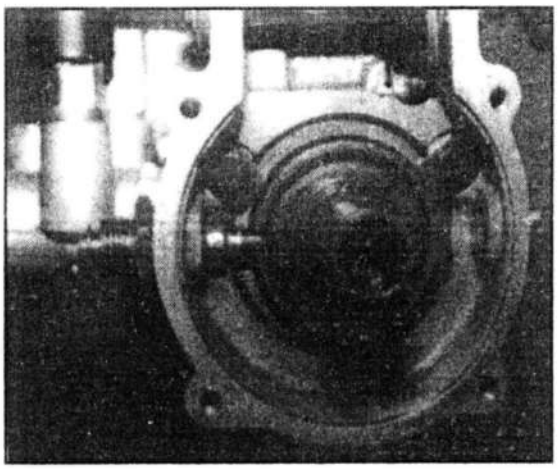


Loosen timing pin cover on fuel pump.

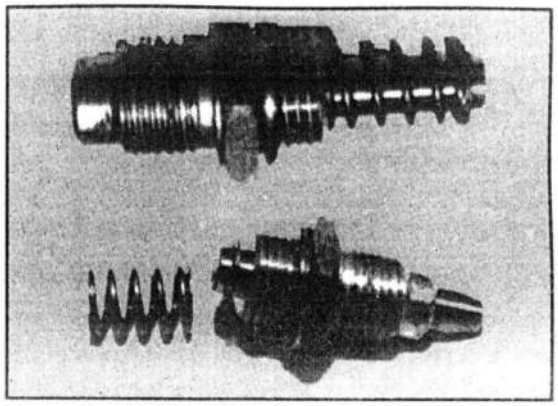
Engage timing pin into fuel pump weight carrier.



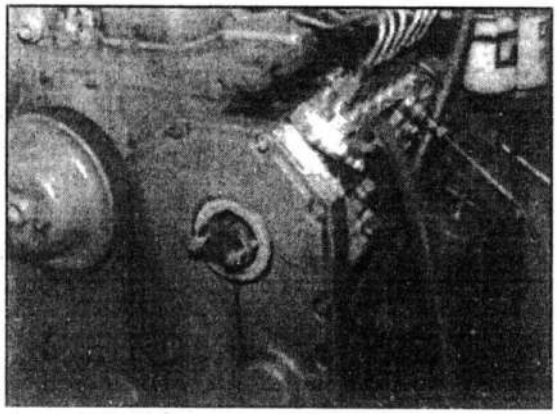


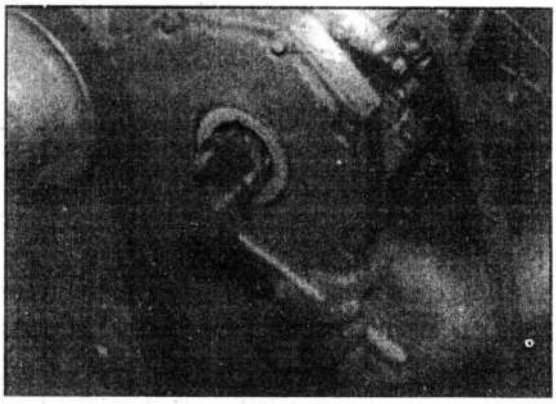


Put the spring behind pin and place the timing pin cover.

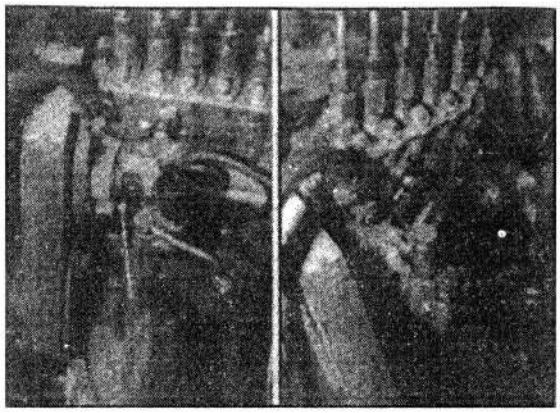


Pull the pump drive gear loose from the drive shaft.

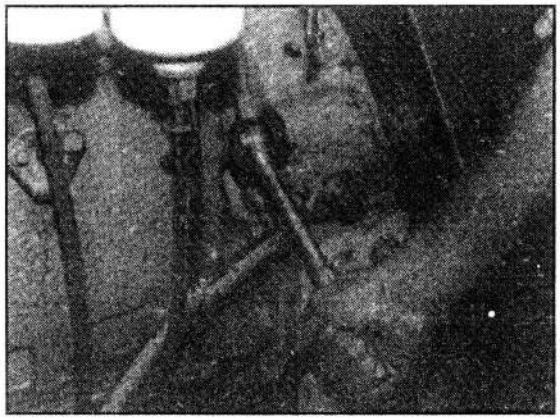




Remove the 4 mounting nuts and take off the injection pump.

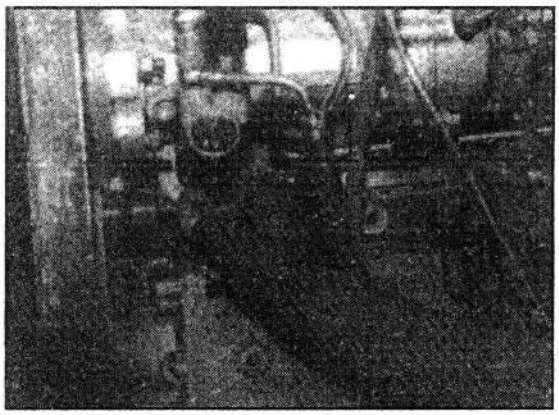


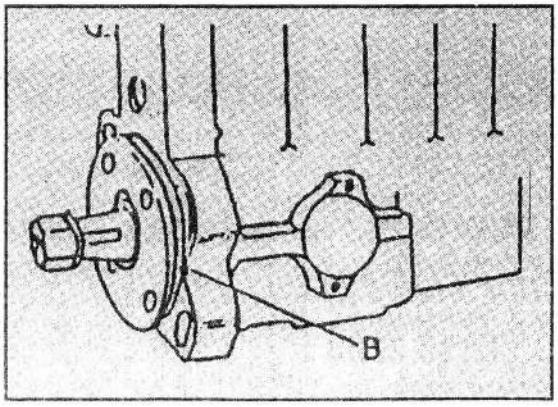
CAUTION : DO NOT DROP DRIVE GEAR KEY WHEN REMOVING PUMP.



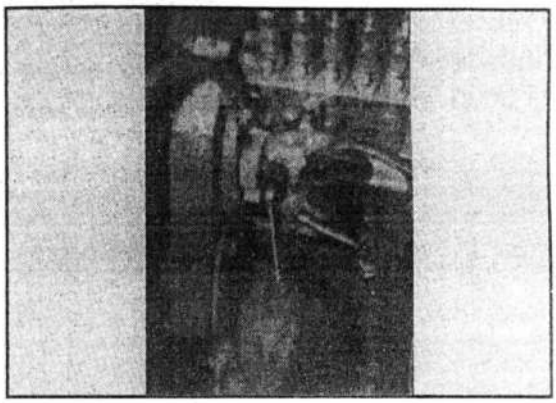
D. Installation of Motorpal fuel pump :

1. Ensure engine is at TDC for Cylinder No. 1, use barring tool to Bar engine.
2. Install new 'O' ring for Pilot bore (B). Please refer Figure 1.
3. Lubricate mounting flange with clear engine oil.
4. Position the pump flange on mounting studs.



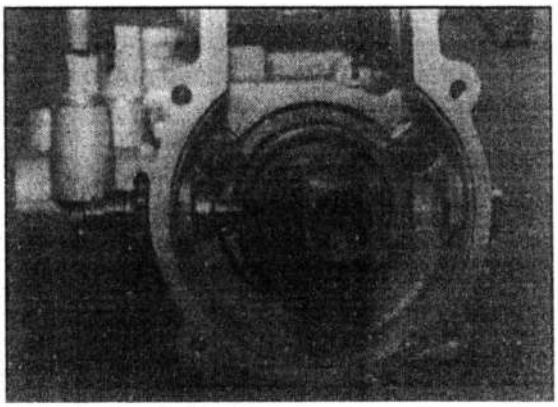


5. Install the mounting nuts (Spanner 15 mm). Torque these nuts to 32 ft lbs.

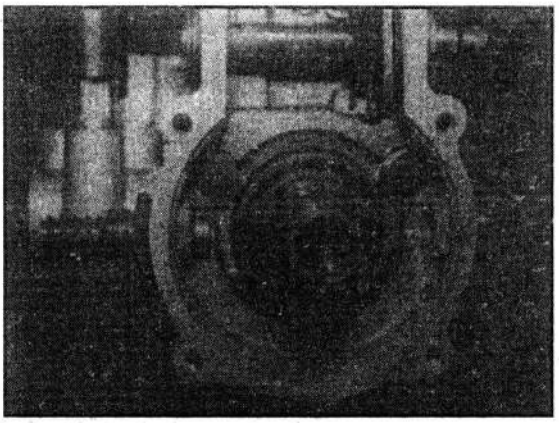


6. Install the fuel pump drive gear and nut with lock washer (Socket 27 mm). Torque this nut to 7-11 ft lbs.

7. Please note that the new Motorpal fuel pump will be in a locked timing condition. (Refer Figure 2).

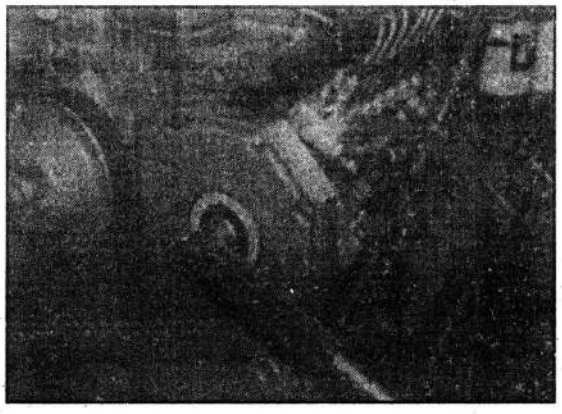


Remove fuel pump timing pin plug. Remove and reverse the position of the pin and install the pin plug and sealing washer. Ensure spring is behind Timing Pin. Torque access plug to 11 ft lbs. (Spanner 27 mm)

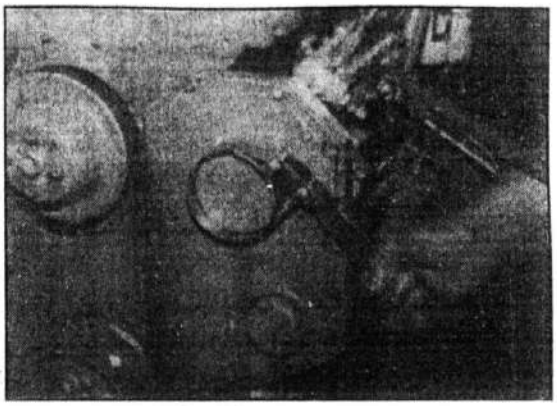


8. Dis-engage the engine timing pin.
9. Tighten the fuel pump drive nut to 126 N•m or 93 lb-ft.

CAUTION : PLEASE DO NOT TIGHTEN THIS NUT WHEN ENGINE TIMING PIN IS ENGAGED.



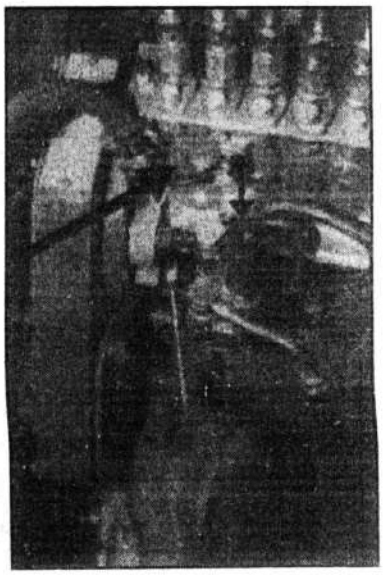
10. Assemble access cover to gear drive nut.



11. Install lube oil supply hose to fuel pump.
12. Install all high pressure pipes / low pressure piping for fuel pump.
13. Install electrical wiring for solenoid fuel pump.

INJECTION PUMP VENTING

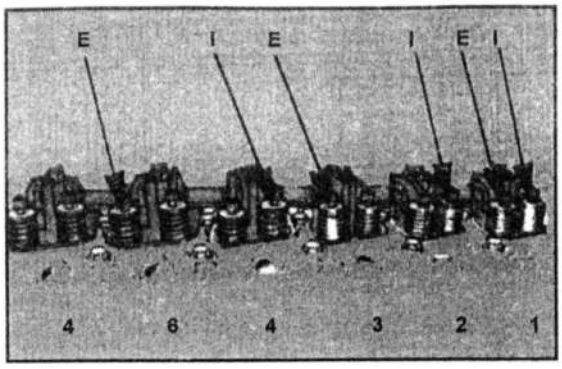
1. Slacken fuel drain adaptor on fuel pump.
2. Press black feed pump handle back and forth (up and down movement) to bleed all air from fuel pump, till clear diesel flow comes out of fuel return passage.
3. Tighten fuel drain adaptor on fuel pump.



**Valve Clearances :**

**Intake Clearance : 0.254 mm (0.010 Inch)**

**Exhaust Clearance : 0.508 mm (0.020 Inch)**




Check/Set valves with engine cold - below 60 deg. C as described in Step 1 & Step 2 below.

**Note :**

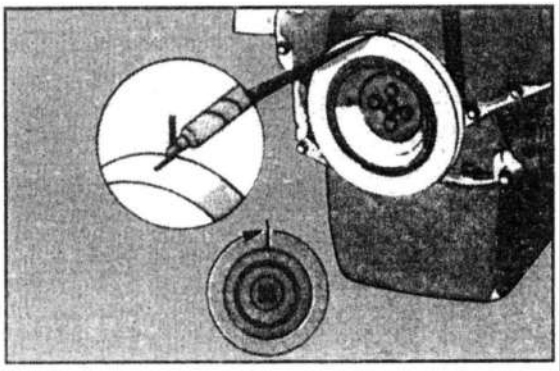
**The clearance is correct when some resistance is 'FELT' when the feeler gauge is slipped between the valve stem & rocker lever.**

Step 1 :

Locate the TDC for cylinder no. 1.

Check/Adjust the valves indicated in the sketch.

Make the pulley & rotate the crankshaft 360 degrees.



**Caution :**

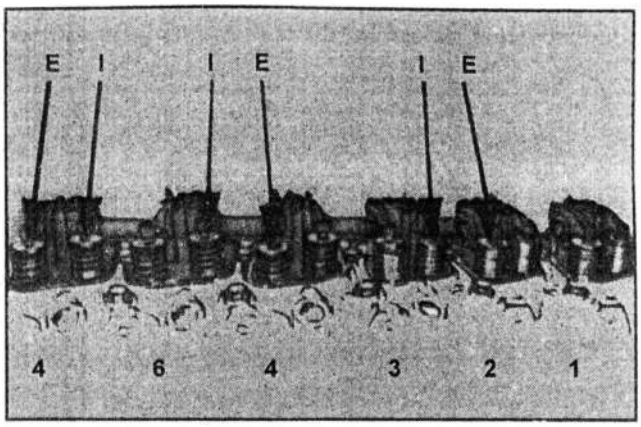
Ensure that the engine timing pin is disengaged.

**Note :** Never rotate engine with the help of fan.

Step 2 :

Set the valves as indicated in the sketch.

Tighten the lock nut to 24 N.m. (18 ft lbs.) and recheck the valve lash.

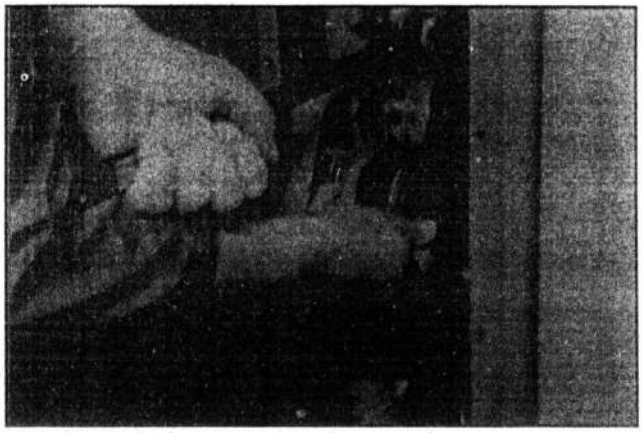



Checking of belt, belt tension, belt tensioner & fan hub :

Measure the belt deflection at the longest span of the belt.

Maximum deflection : 9.5 - 12.7 mm

Check belt tension.

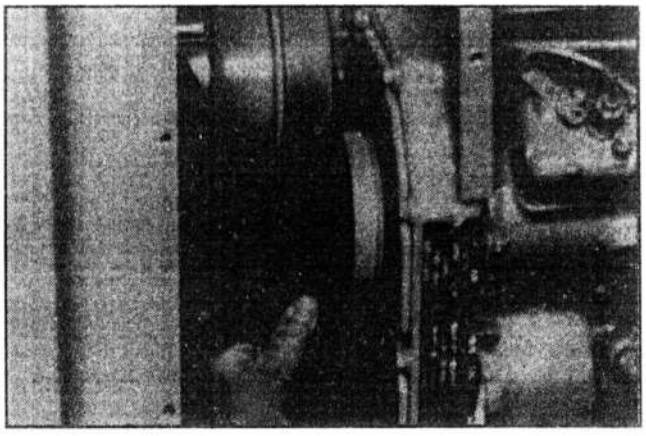


**Note :**

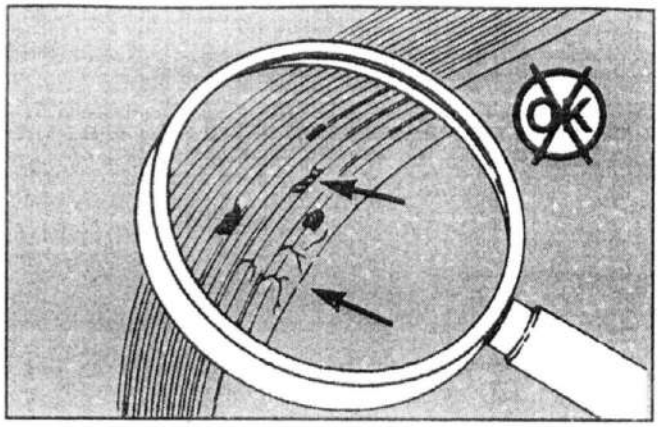
Cummins belt tension gauge ST-1293 should be used. The required gauge value is 80-110 lbs.

Check the drive belt, tensioner bearing & fan hub.

Remove the drive belt.



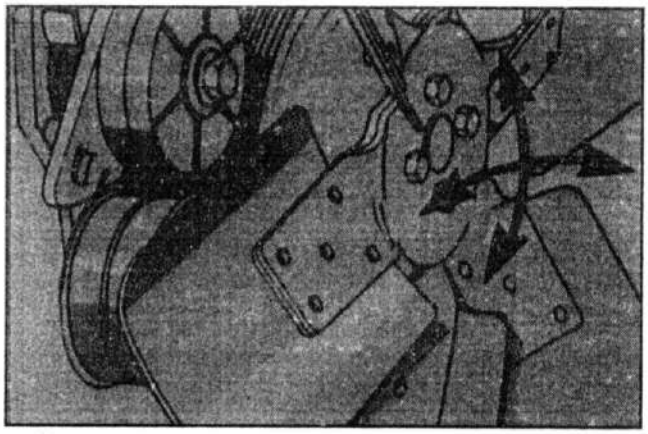
Inspect the belt for damage




Check the tensioner bearing.

**Note :**

The tensioner pulley should spin freely with no rough spots detected under hand pressure.

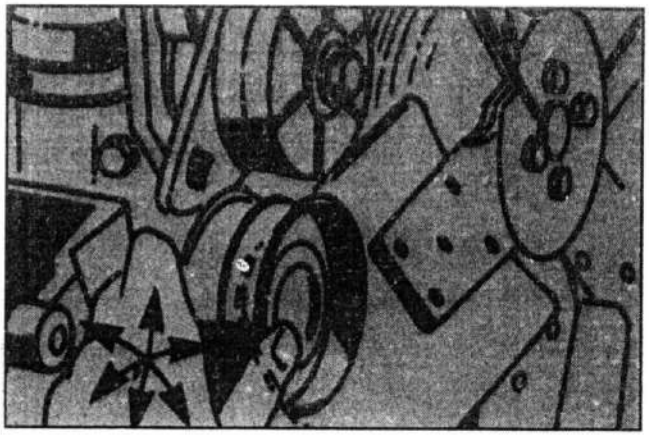


Check the fan hub bearing.

**Note :**

The fan hub should spin freely without excessive end play.

Install the drive belt.



# MICO PUMP ADJUSTMENT, REPLACEMENT, REPAIR ON B SERIES

Section A - **Adjustment, Replacement and Repair B series**

## Injection Pump Replacement

**Preparatory Steps :**

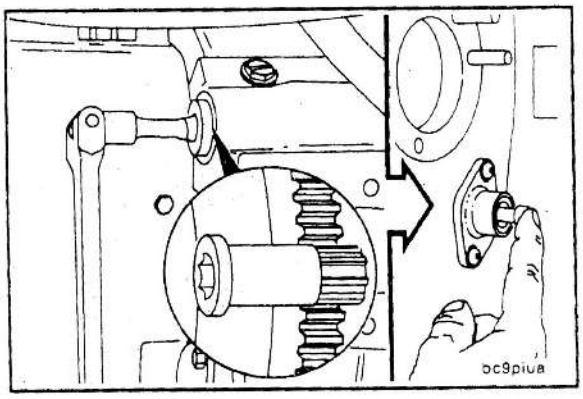
- Clean debris.
- Remove all fuel lines.
- Remove control linkage.
- Remove fuel shutoff solenoid.

**Removing**

Engine Barring Gear

Locate TDC for cylinder number 1. Push the TDC pin into the hole in the camshaft gear while slowly rotating the crankshaft.

**Caution : Be sure to disengage the pin after locating TDC to prevent damage to the pin.**

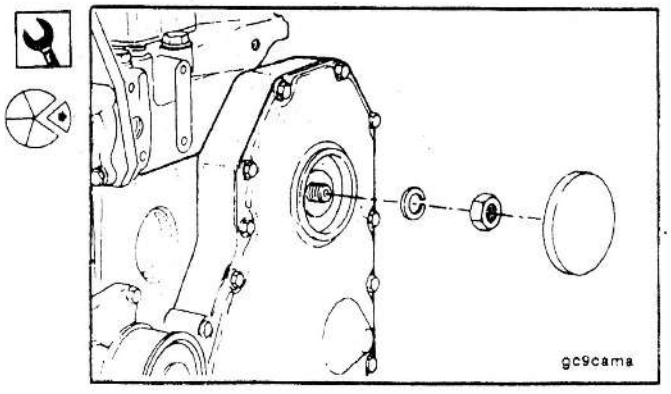



Injection Pump

**22 mm (PES.A Pump), 27 mm (PES. MW Pump), 30 mm (PES.P Pump)**

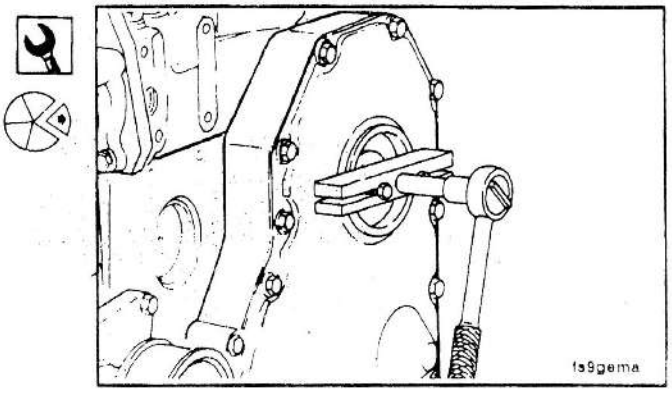
Remove the gear cover access cap.

Remove the nut and washer from the fuel pump shaft.




**75 mm T-Bar Puller**

Pull the fuel pump drive gear loose from the shaft.

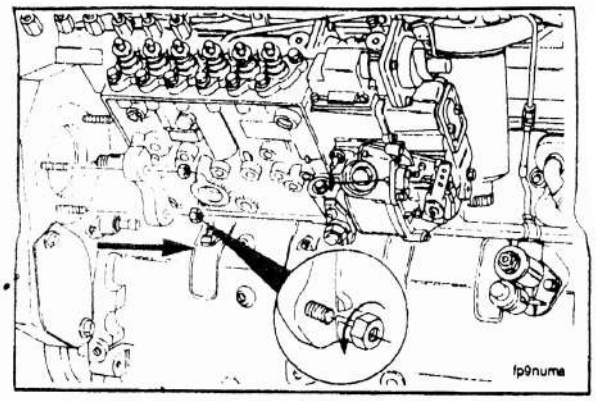


**Section A - Adjustment, Replacement and Repair B Series**

**10mm, 15 mm**

Remove the four mounting nuts and the capscrews that fasten the pump support to the cylinder block.

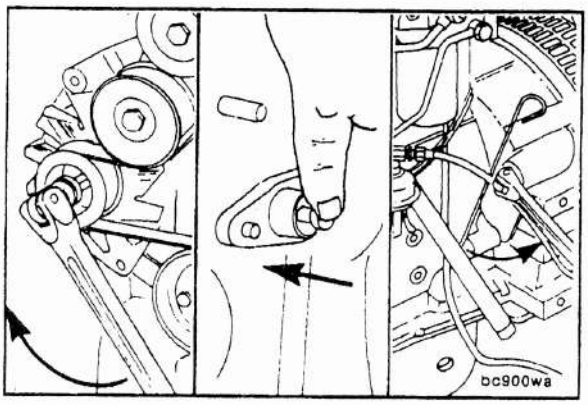
Remove the fuel pump.




Installing

Engine Barring Gear

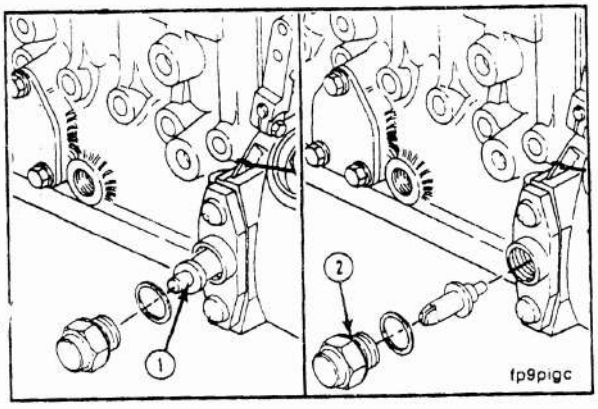
Make sure the engine has cylinder number 1 at TDC.




Injection Pump - Timing

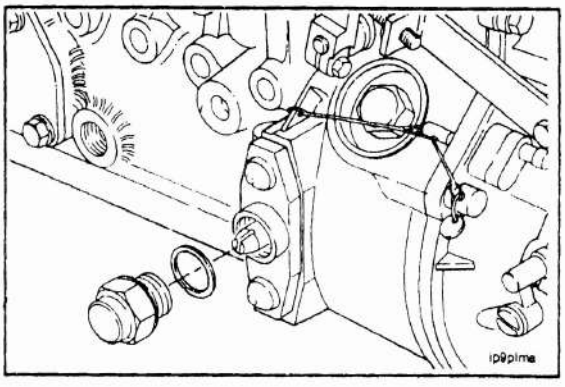
The injection pump also has a timing pin (1), located in the governor housing, to position the pump shaft to correspond with TDC for cylinder number 1. After the pump is installed the pin is to be reversed and stored in the housing (2).

Note : The industrial governor is shown in the illustration. The procedure is the same for automotive governors.

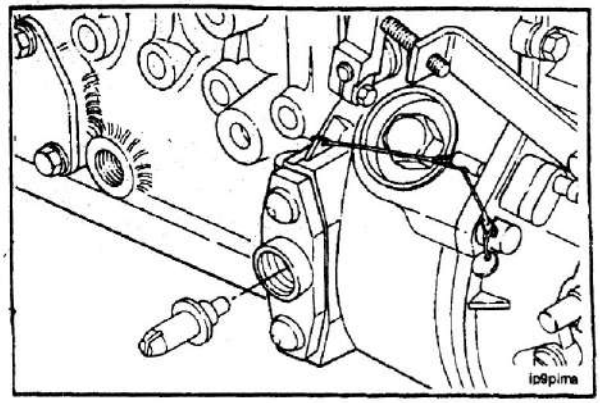



24 mm

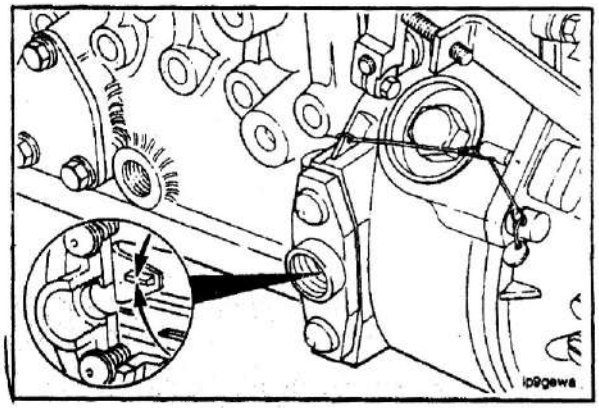
Remove the access plug.



Remove the timing pin.

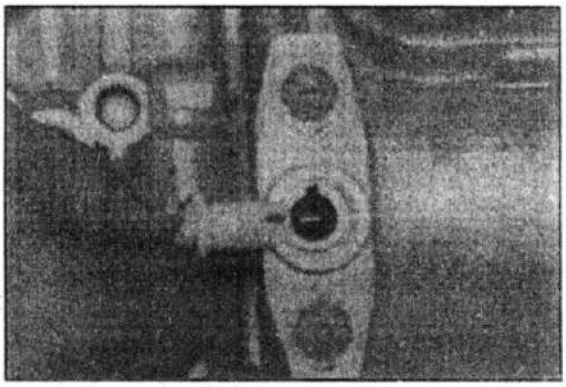



**If the timing tooth is not aligned with the timing pin hole. Rotate the pump shaft until the timing tooth aligns.**



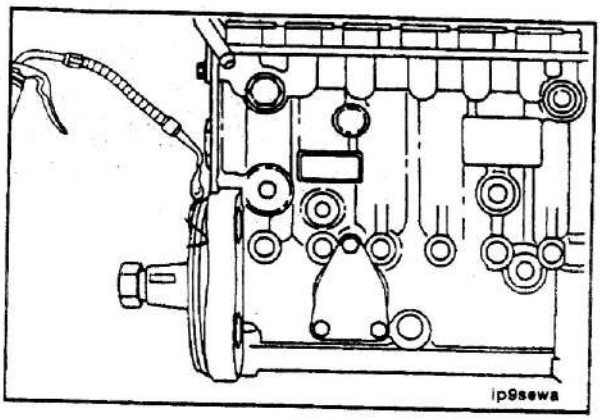

Reverse the position of the pin so the slot of the pin will fit over the timing tooth in the pump.

Install and secure the pin with the access plug.

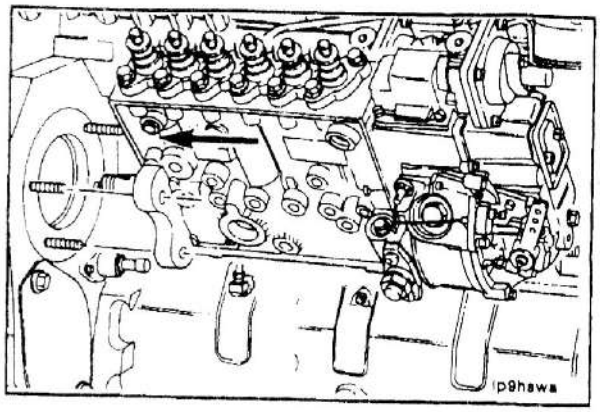


Make sure the o-ring seals for the fill orifice and pilot are correctly installed and are not damaged.

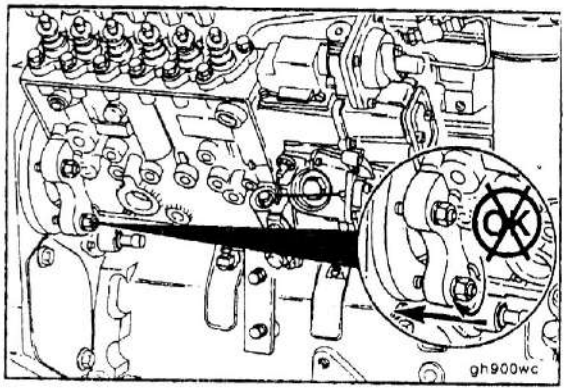
Lubricate the mounting flange with clean engine oil.



Slide the pump shaft through the drive gear and position the pump flange onto the mounting studs. If the pump is equipped with a support bracket, use your fingers to tighten the mounting nuts.



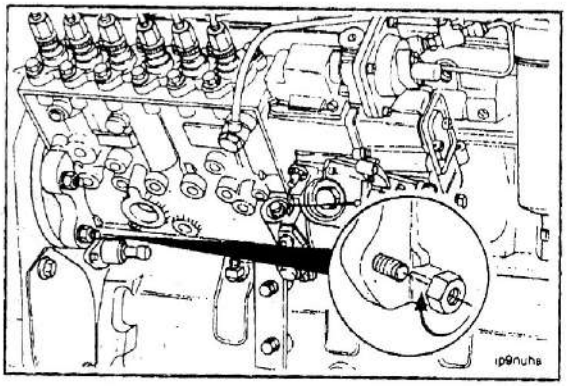

Use your fingers to tighten the capscrews for the support bracket, if so equipped.




**15 mm**

Tighten the mounting nuts.

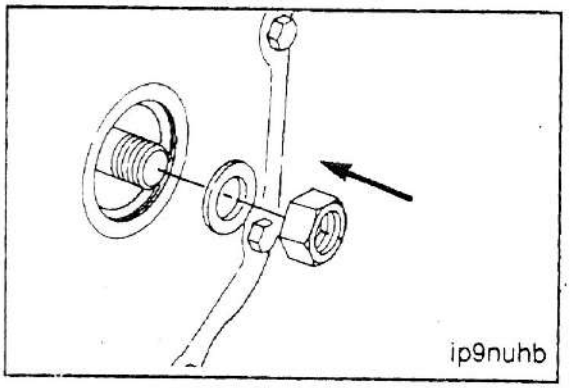
**Torque Value : 43 Nm (32 ft-lb)**




**10 mm**

Tighten the capscrews for the rear support bracket.

**Torque Value : 24 Nm (18 ft-lb)**



# ENDPLAY AND BACK LASH VALUES

| | | |
|---|---|---|
| 1. | Crankshaft Endplay | 0.102 mm - 0.432 mm (0.004" - 0.017") |
| 2. | Cam Shaft Endplay | 0.12 mm - 0.34 mm (0.005" - 0.013") |
| 3. | Turbocharger Endplay - Axial | 0.03 mm - 0.08 mm (0.001" - 0.003") |
| 4. | Turbocharger Endplay - Radial | 0.30 mm - 0.46 mm (0.012" - 0.018") |
| 5. | F.P. Drive Gear Backlash | 0.076 mm - 0.330 mm (0.003" - 0.013") |
| 6. | Camshaft Gear Backlash | 0.076 mm - 0.330 mm (0.003" - 0.013") |

# ENGINE COMPONENT TORQUE VALUES

| Socket or Wrench Size MM (Inch) | | Torque Nom | (Ft-lb) |
|---|---|---|---|
| 10 | Aftercooler Mounting | 24 | (18) |
| (5/16) | Aftercooler Water Hose Clamp | 5 | (41) |
| (15/16) | Alternator Pulley | 80 | (59) |
| 13 or (3/4) | Alternator Link (Delco 15-20-27 SI) | 43 | (32) |
| 16 | Alternator Mounting Bolt 15 SI | 43 | (32) |
| 18 | Alternator Mounting Bolt and Nut 20-27 SI | 77 | (57) |
| 13 | Alternator Support (Upper) | 24 | (18) |
| Allen 5 mm | Belt Tensioner Flat Bracket | 24 | (18) |
| 15 | Belt Tensioner Mounting | 43 | (32) |
| | Camshaft Bolt ... Step 1 | 27 | (20) |
| | ... Step 2 Rotate 180 Degrees | | |
| 13 | Cam Thrust Plate | 24 | (18) |
| (3/8) | Coolant Heater | 12 | (91) |
| 12 | Connecting Rod Bolt ... Step 1 | 35 | (261) |
| | (Alternately Tighten ... Step 2 | 70 | (51) |
| | in Three Steps) ... Step 3 | 100 | (73) |
| 15 | Crankshaft Damper & Pulley | 125 | (92) |
| 18 | Cylinder Head Mounting ... Step 1 (All) | 90 | (66) |
| | ... Step 2 (All Recheck to | 90 | (66) |
| | ... Step 3 (Long Capscrews) | 120 | (90) |
| | ... Step 4 Recheck (Long Capscrews Only) | 120 | (90) |
| | ... Step 5 (All) Rotate 90° | | |

| Socket or Wrench Size MM (Inch) | | Torque Nom | (Ft-lb) |
|---|---|---|---|
| (5/16) | Crossover Clamp | 5 | (4) |
| 13 | Exhaust Manifold | 43 | (32) |
| 13 | Exhaust Outlet Pipe Brkt. Mounting | 43 | (32) |
| 13 | Exhaust Outlet Pipe, Flanged | 24 | (18) |
| (7/16) | Exhaust Outlet Pipe, V Band Clamp | 8 | (6) |
| 10 | Fan Bracket Mounting | 24 | (18) |
| 13 | Fan Pulley | 24 | (18) |
| 19 | Flywheel | 137 | (101) |
| 15 | Flywheel Housing | 77 | (57) |
| 13 | Flywheel Housing Access Cover | 24 | (18) |
| (1/2) | Flywheel Housing Plug | 36 | (25) |
| - | Front Cover Cap | Hand Tighten | |
| 18 | Front Engine Support Mounting | 77 | (57) |
| (1 1/8) | Front Engine Support (Barrel) | 350 | (257) |
| 17 | Fuel Banjo Screw (In Fuel Pump) | 32 | (24) |
| 17 | Fuel Banjo Screw (In Head) | 24 | (181) |
| 10 | Fuel Banjo Screw (In Injector) | 9 | 71 |
| 10 | Fuel Vent Screw (In Banjo) | 9 | (7) |
| 80-95 | Fuel Filter | 3/4 Turn After Contact | |
| 14 | Fuel Low Pressure Supply (Lift Pump Outlet) | 24 | (18) |
| 24 | Fuel Filter Adapter | Nut 32 | (24) |
| 17 | Fuel Line Fitting (High Press) | 24 | (18) |
| 22 | Fuel Pump Drive Gear (With Pump Unlocked) | | |
| | Bosch (Rotary), Lucas CAV, Stanadyne DB4 | 65 | (48) |
| | Nippondenso | 123 | (92) |
| | Bosch (P3000, P7100) | 165 | (122) |
| 10 | Fuel Pump Lock (Bosch) | 30 | (22) |
| | Fuel Pump Unlock (Bosch) | 13 | (10) |
| - | Fuel Pump Mtg. Nut (Bosch In-Line) | 43 | (32) |
| - | Fuel Pump Solenoid | | |
| 24 | (Bosch VE) | 43 | (32) |
| 22 | (CAV) | 15 | (11) |
| 10 | Fuel Pump Support Bracket | 24 | (18) |
| 10 | Gear Cover | 24 | (18) |
| 10 | Gear Housing - to- Block | 24 | (18) |
| 24 | Injector Retaining Nut | 60 | (44) |
| 10 | Intake Manifold Cover | 24 | (18) |

| Socket or Wrench Size MM (Inch) | | Torque Nom | (Ft-lb) |
|---|---|---|---|
| (5/8) | Intake Heater Plug | 125 | (90) |
| 10 | Lift Pump Mounting / Cover Plate | 24 | (18) |
| 23 | Main Bearing Cap ..... Step 1 | 60 | (44) |
| | ..... Step 2 | 119 | (88) |
| | ..... Step 3 | 176 | (129) |
| 15 | Oil Fill Tube Mounting | 43 | (32) |
| 75-85 | Oil Filter | 3/4 Turn After Contact | |
| 10 | Oil Cooler Assembly | 24 | (18) |
| 17 | Oil Pan Drain Plug | 80 | (60) |
| 17 | Oil Pan Heating Plug | 80 | (60) |
| 10 | Oil Pan Mounting | 24 | (18) |
| 19 | Oil Pressure Regulator Plug | 80 | (60) |
| 13 | Oil Pump Mounting | 24 | (18) |
| 13 | Oil Suction Tube (Flange) | 24 | (18) |
| 10 | Oil Suction Tube Brace | 24 | (18) |
| 8 | Rear Seal Mounting | 9 | (7) |
| 13 | Rocker Support | 24 | (18) |
| (14) | Rocker Lever Nut | 34 | (25) |
| 10 | Starter Mounting | 43 | (32) |
| 10 | Tach Drive Retainer | 3 | (2) |
| 10 | Tappet Cover / Fuel Drain Line Supports | 24 | (18) |
| 10 | Thermostat Housing | 24 | (18) |
| T-25 Torx | Timing Pin Flange Mounting | 5 | (4) |
| 10 | Turbocharger Compressor Housing V-Band | 8.5 | (6) |
| 15 | Turbocharger Mounting Nut | 43 | (32) |
| 13 | Turbocharger Oil Drain Tube | 24 | (18) |
| (5/81) | Turbocharger Oil Supply (Both Ends) | 35 | (26) |
| 13 | Turbocharger Turbine Housing | 20 | (15) |
| | Water Hose Clamps | 4-5 | (4) |
| 13 | Water Inlet Connection | 43 | (32) |
| (3/8) | Water Inlet Plugs | 24 | (18) |
| 13 | Water Pump Mounting | 24 | (18) |
| 15 | Valve Cover | 24 | (18) |
| - | Valve Cover Oil Fill | Hand Tighten | |

# TROUBLESHOOTING

## Troubleshooting Procedures and Techniques

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems. Unless noted otherwise, the problems listed are those which an operator can diagnose and repair. See a Cummins Authorized Repair Location for diagnosis and repair of problems **not** listed.

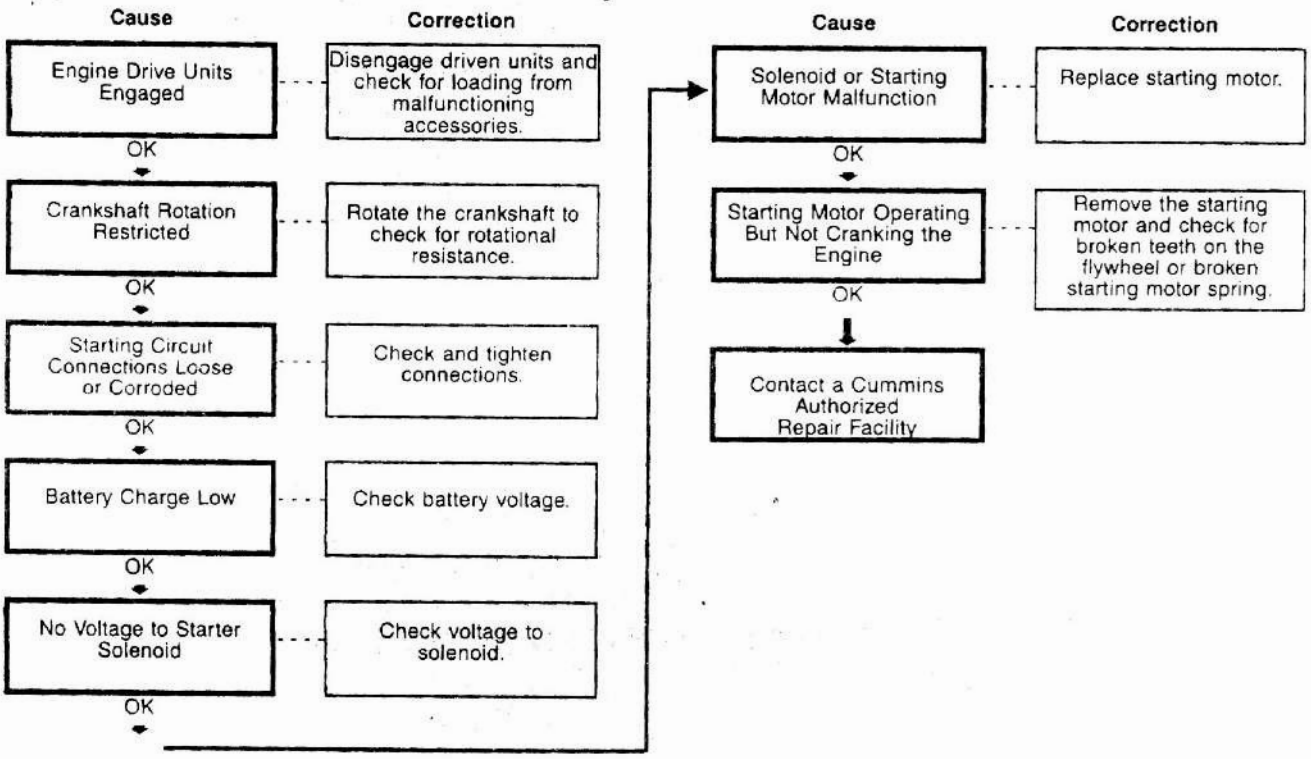
Follow the suggestions below to develop good troubleshooting procedures:

- Study the problem thoroughly before acting.
- Do the easiest and obvious things first.
- Find and correct the basic cause of the problem.

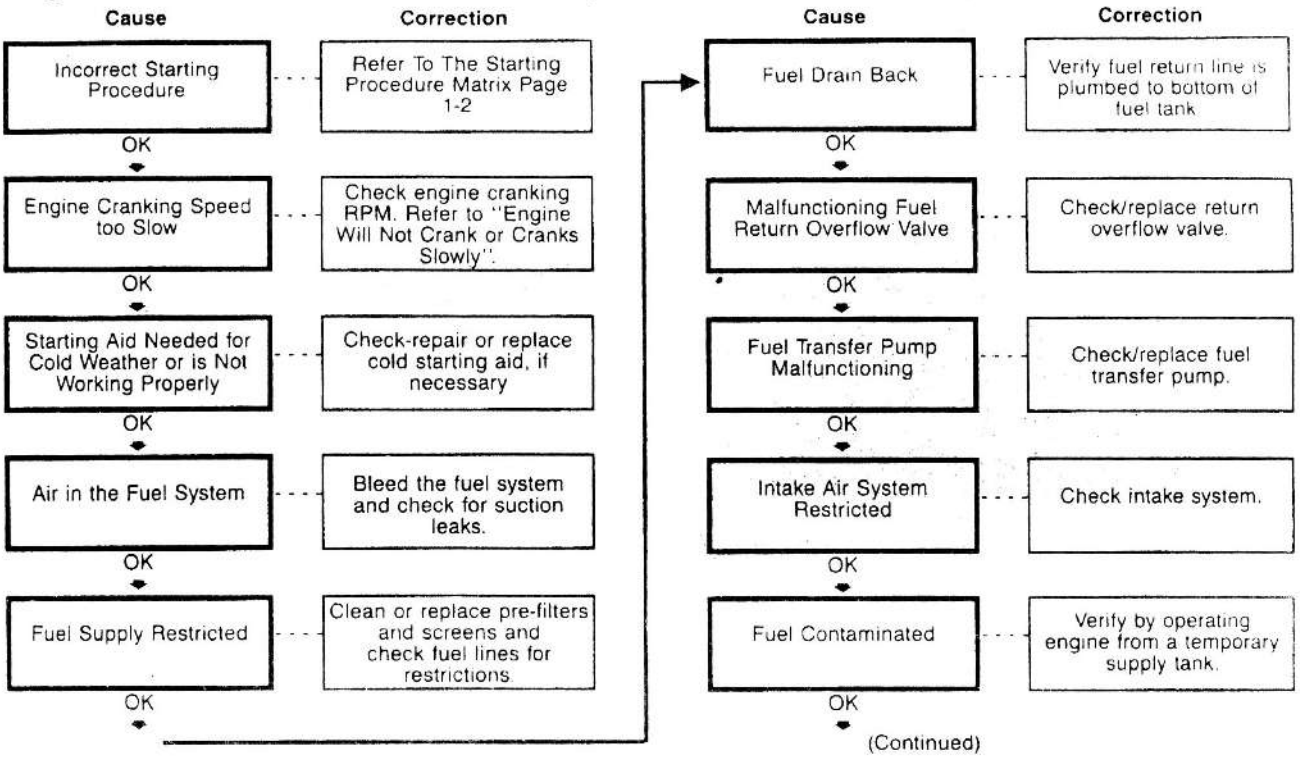
## Troubleshooting Symptoms

Use the charts given on the following pages to help find the cause and correction of a malfunction. Read each row of blocks from top to bottom. Follow the arrows through the chart to identify corrective action.

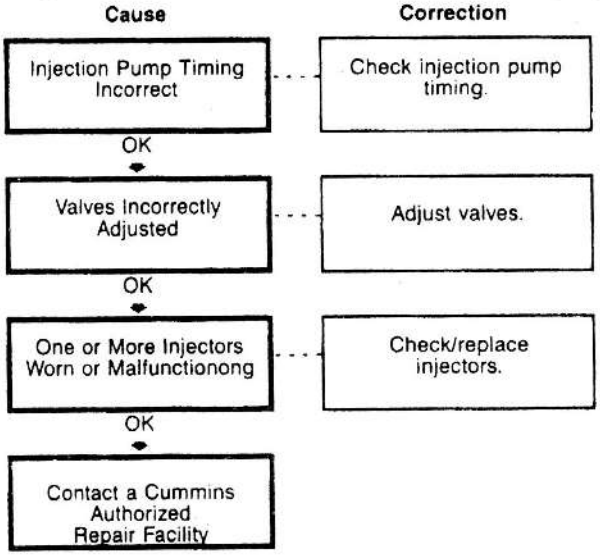
### Engine Will Not Crank or Cranks Slowly



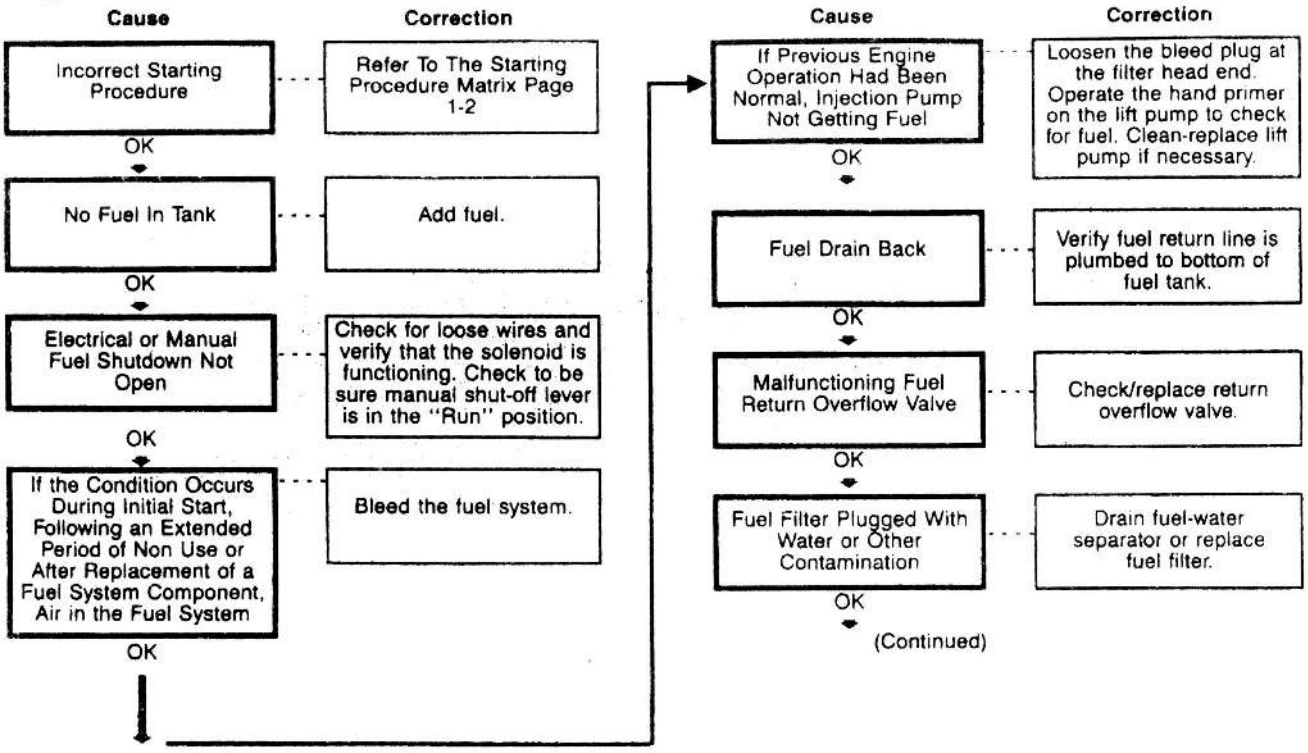
## Engine Hard to Start or Will Not Start (Exhaust Smoke Present)



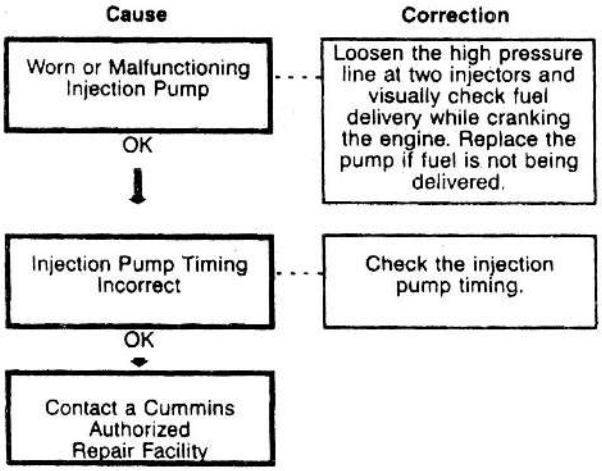

## Engine Hard to Start or Will Not Start (Exhaust Smoke Present) (Continued)



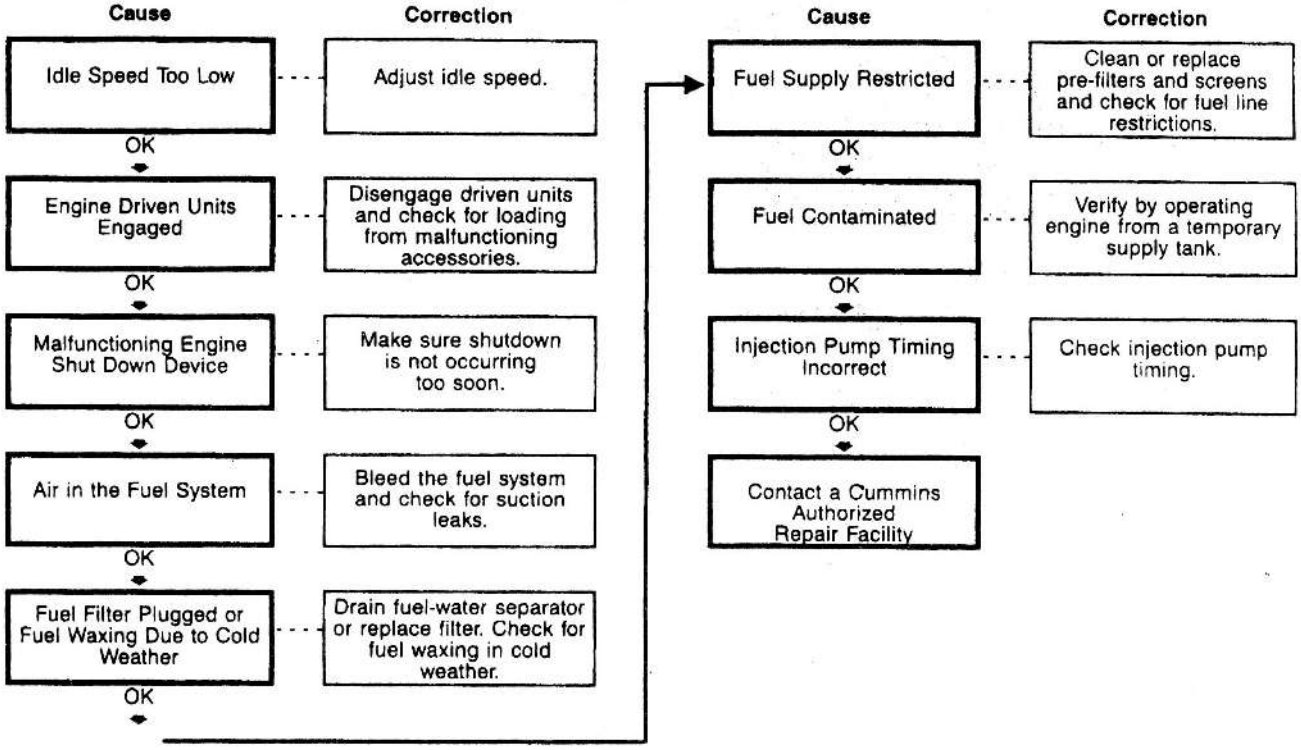
## Engine Cranks But Will Not Start (No Smoke From Exhaust)



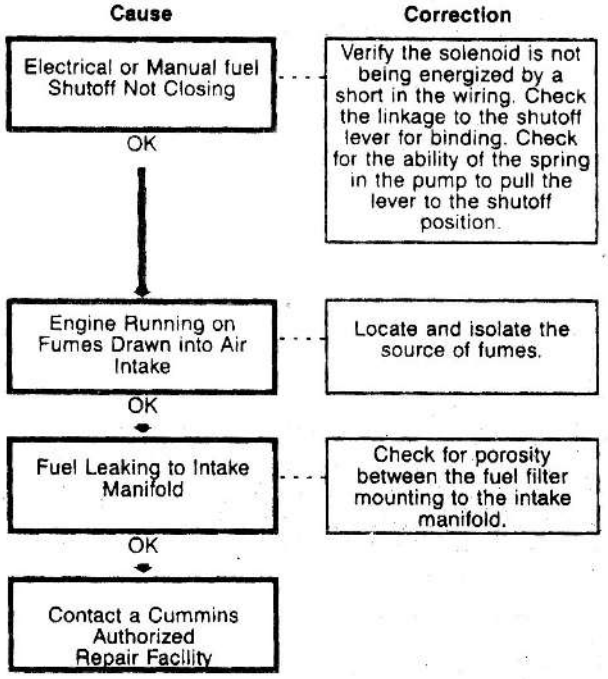

## Engine Cranks But Will Not Start (No Smoke From Exhaust) (Continued)



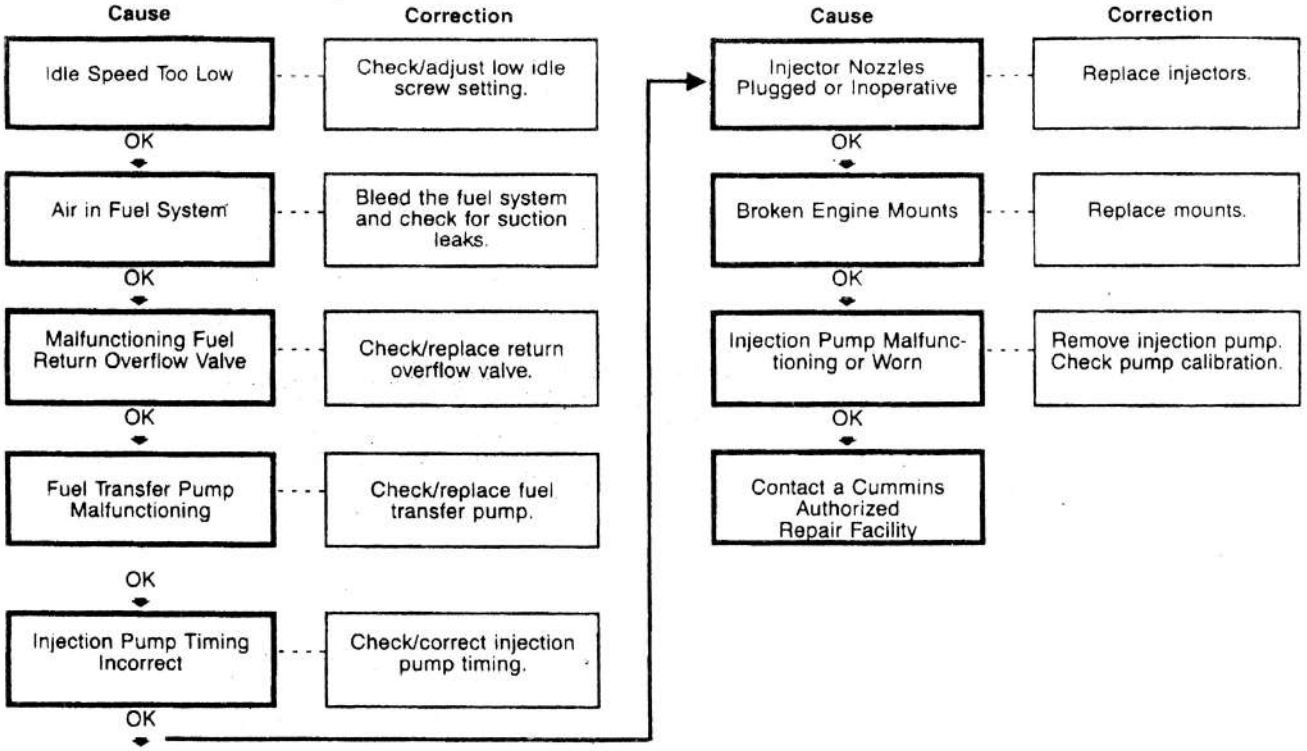
## Engine Starts But Will Not Keep Running



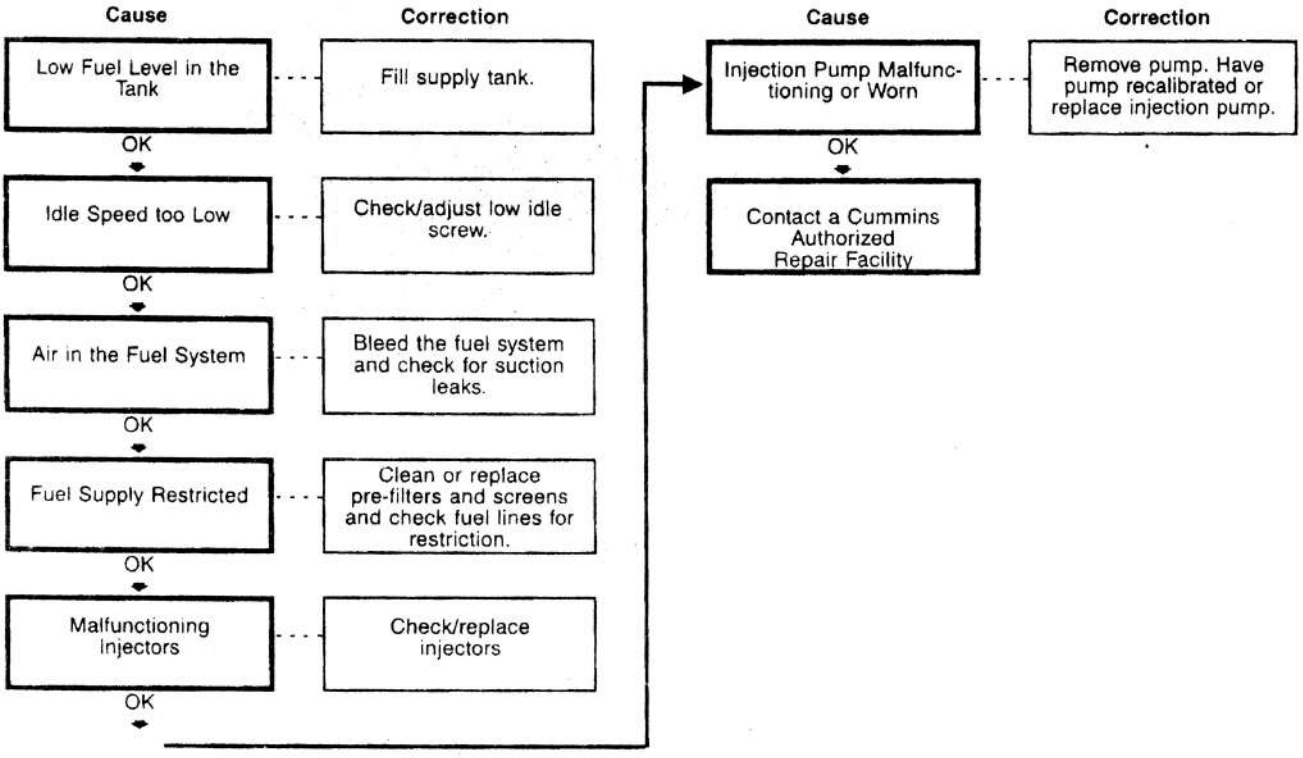

## Engine Will Not Shut Off



## Rough Idle, Warm Engine

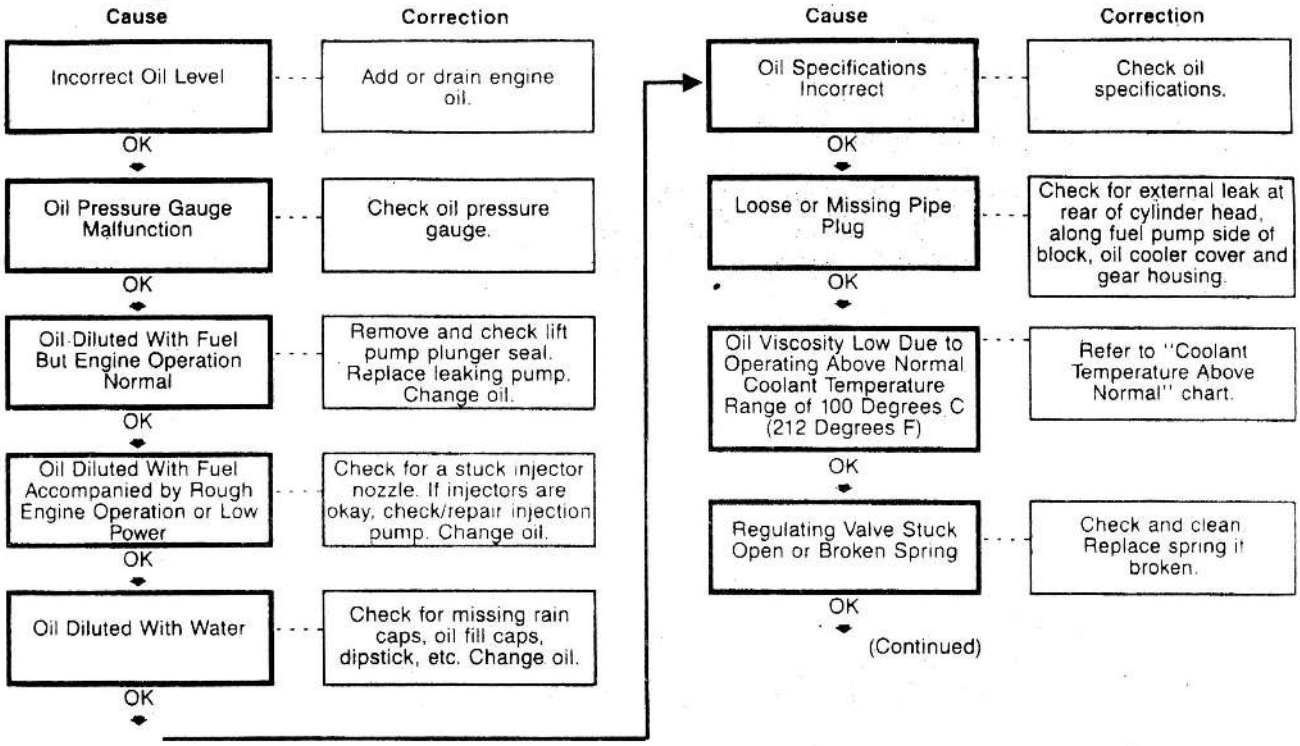



## Engine Surges at Idle

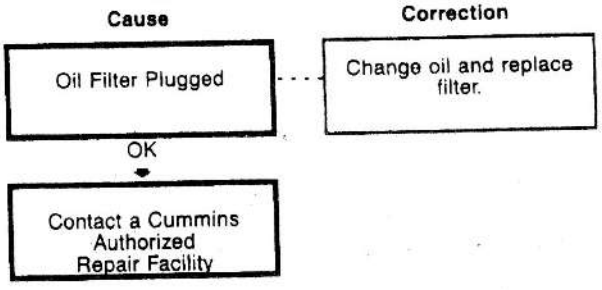


## Lubricating Oil Pressure Low

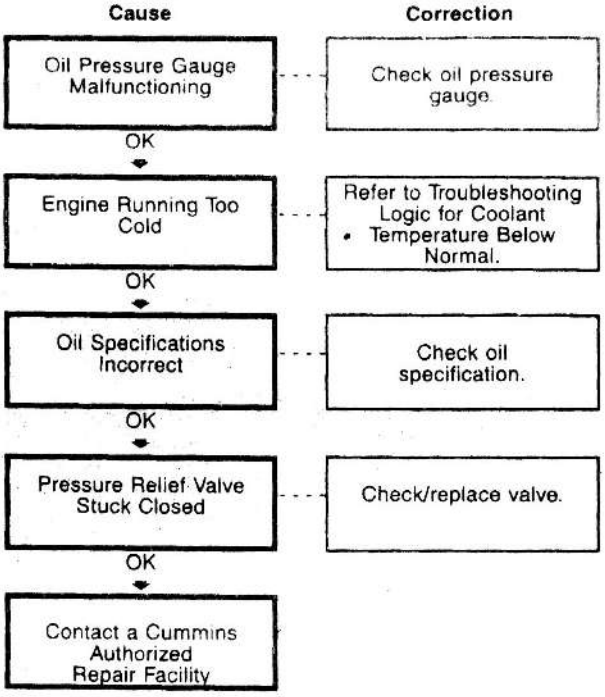
Restricted



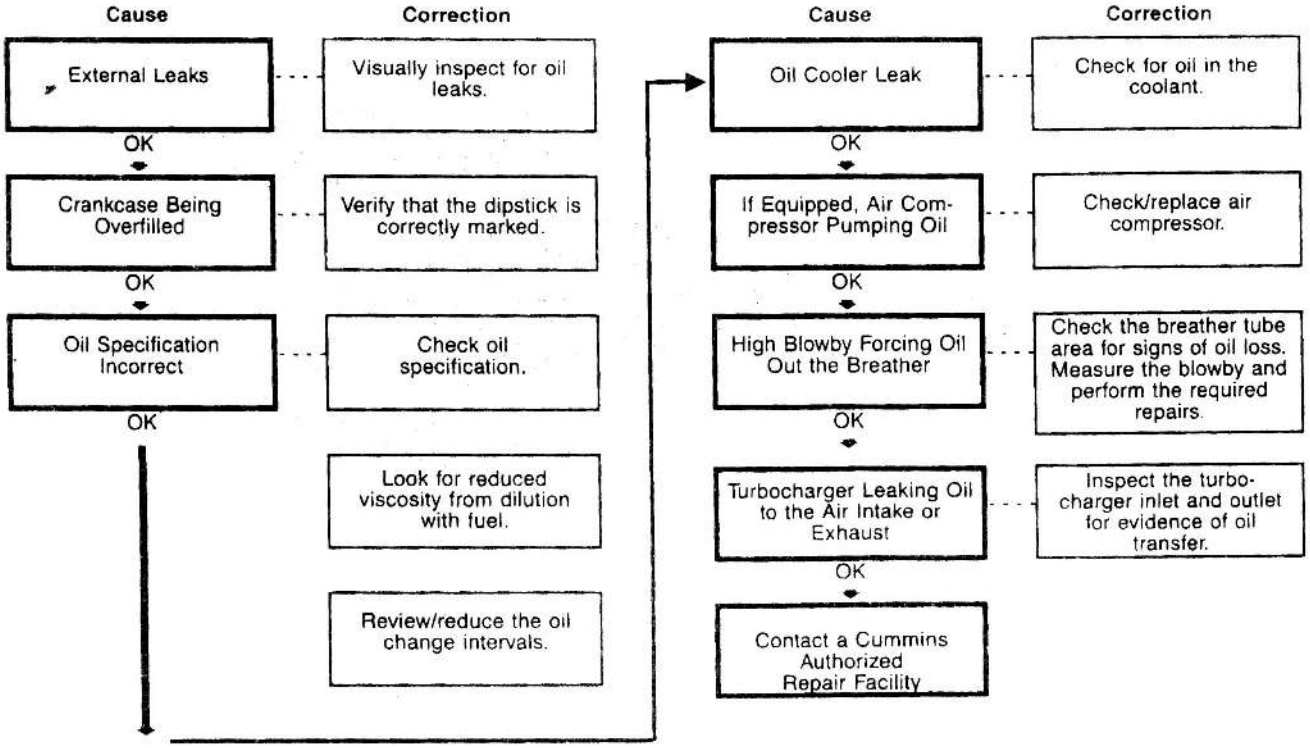

## Lubricating Oil Pressure Low (Continued)



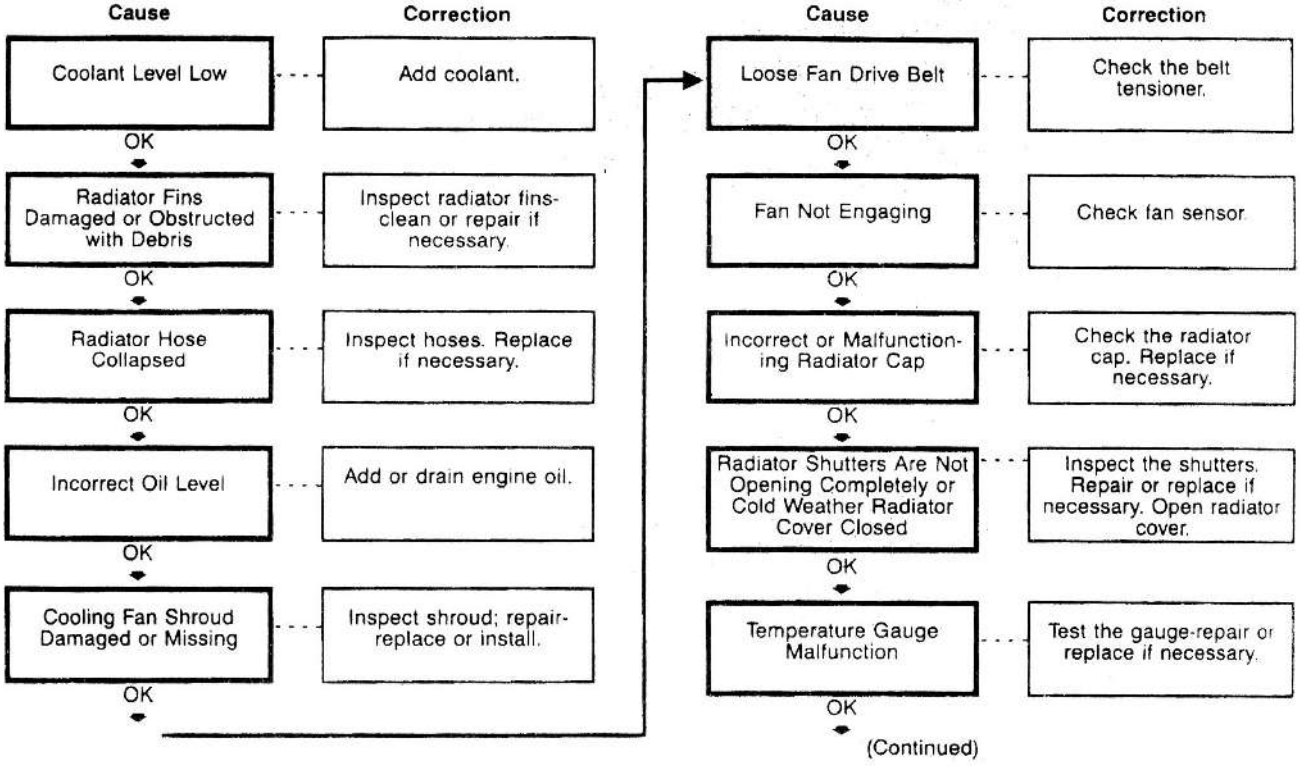
## Lubricating Oil Pressure Too High




## Lubricating Oil Loss

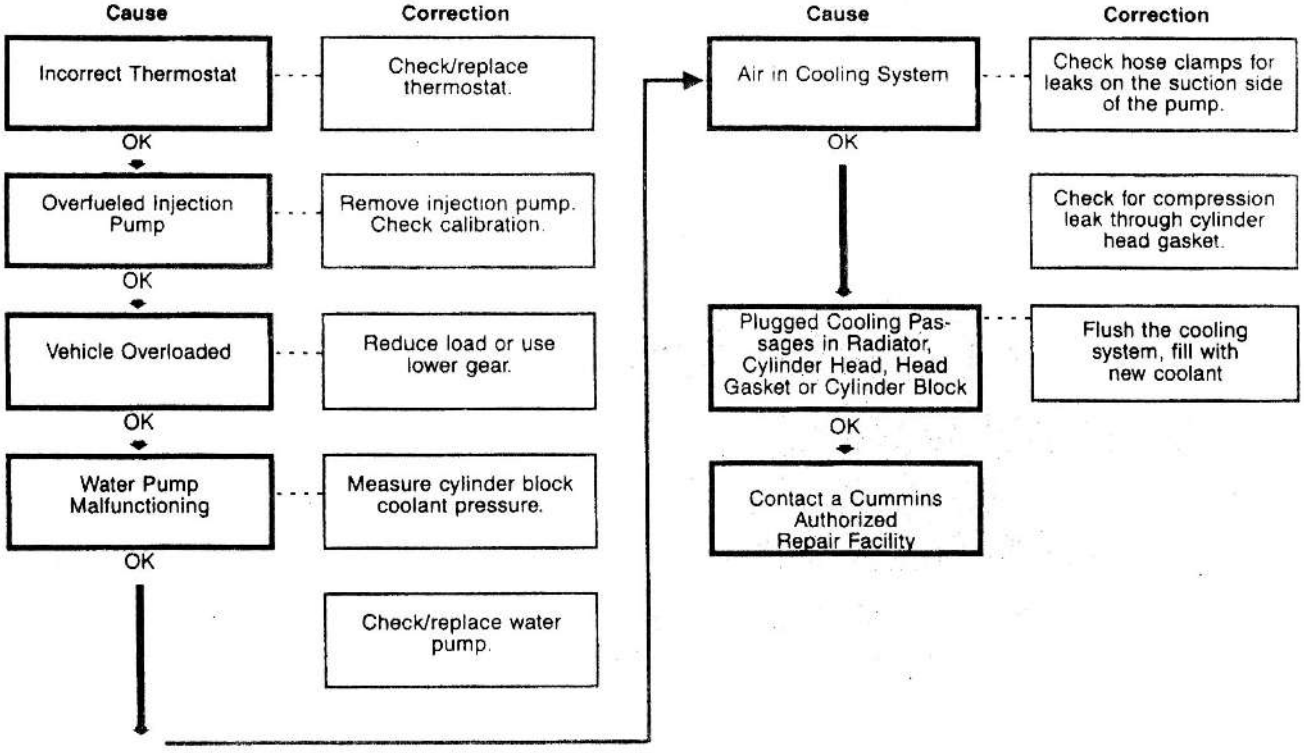


## Coolant Temperature Above Normal

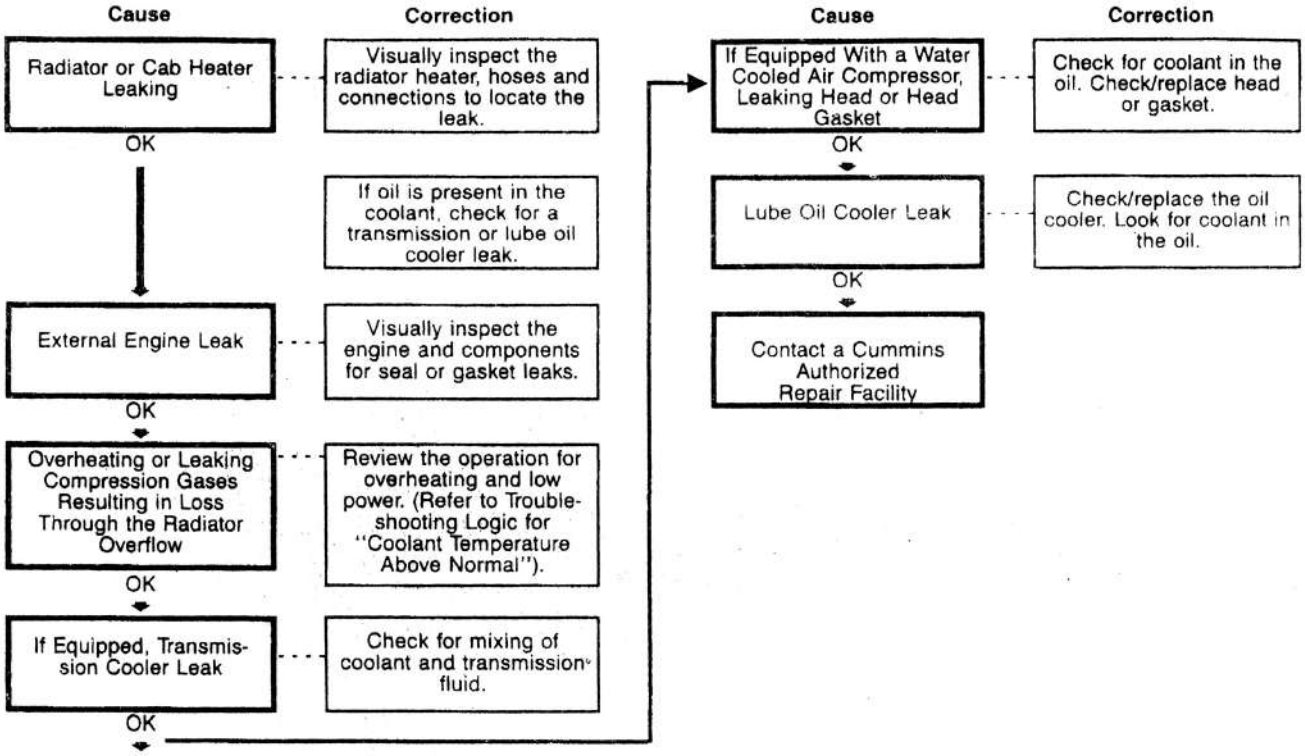



(Continued)

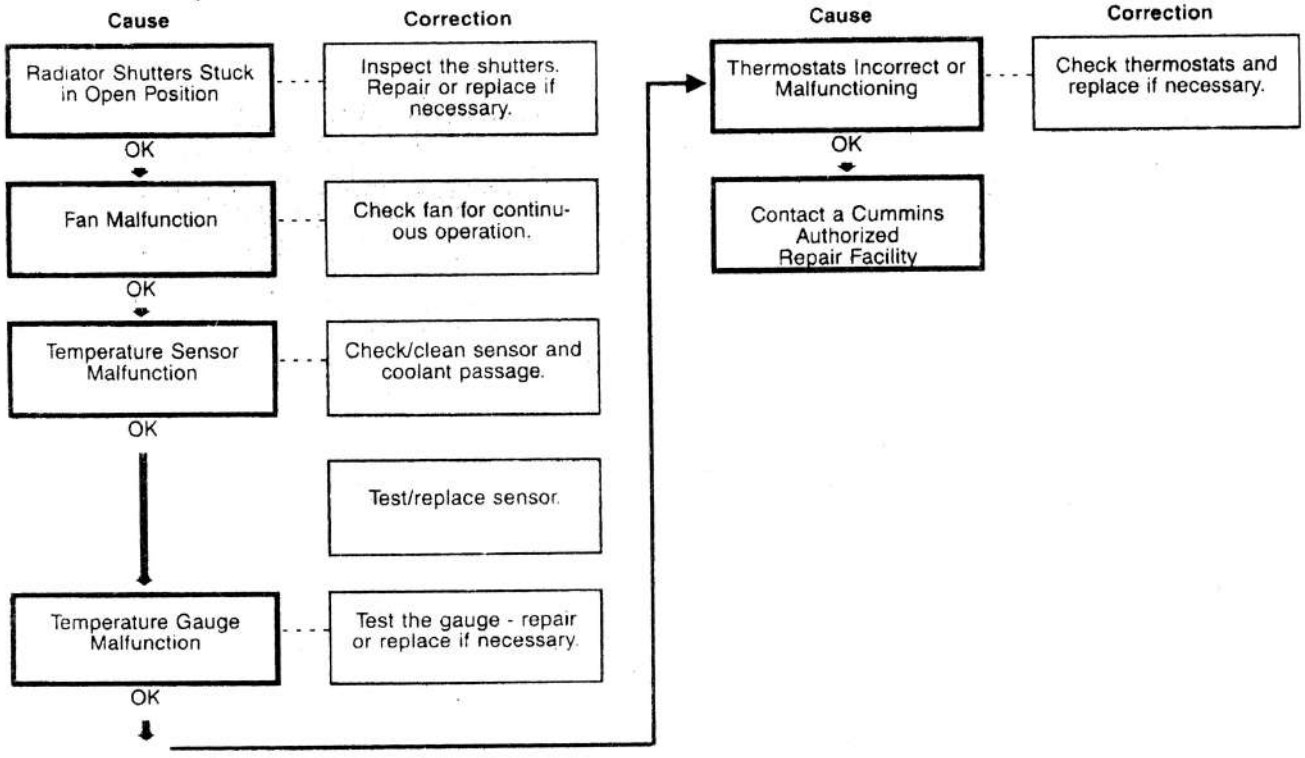
## Coolant Temperature Above Normal (Continued)



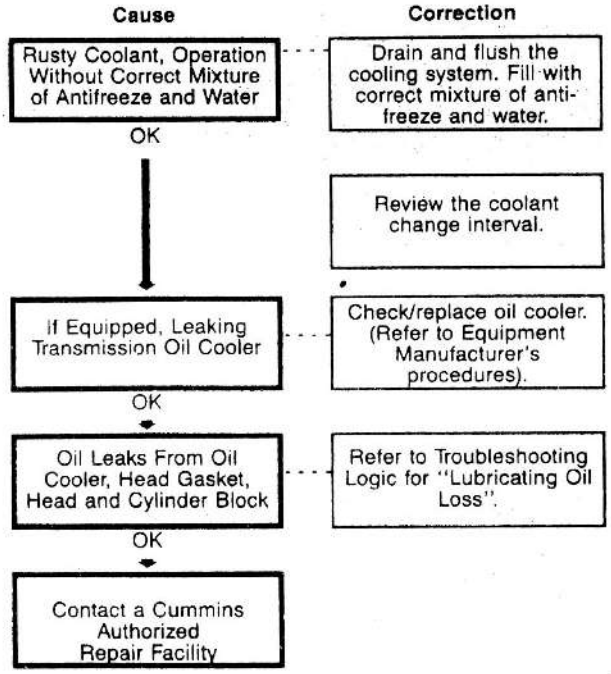
## Coolant Loss



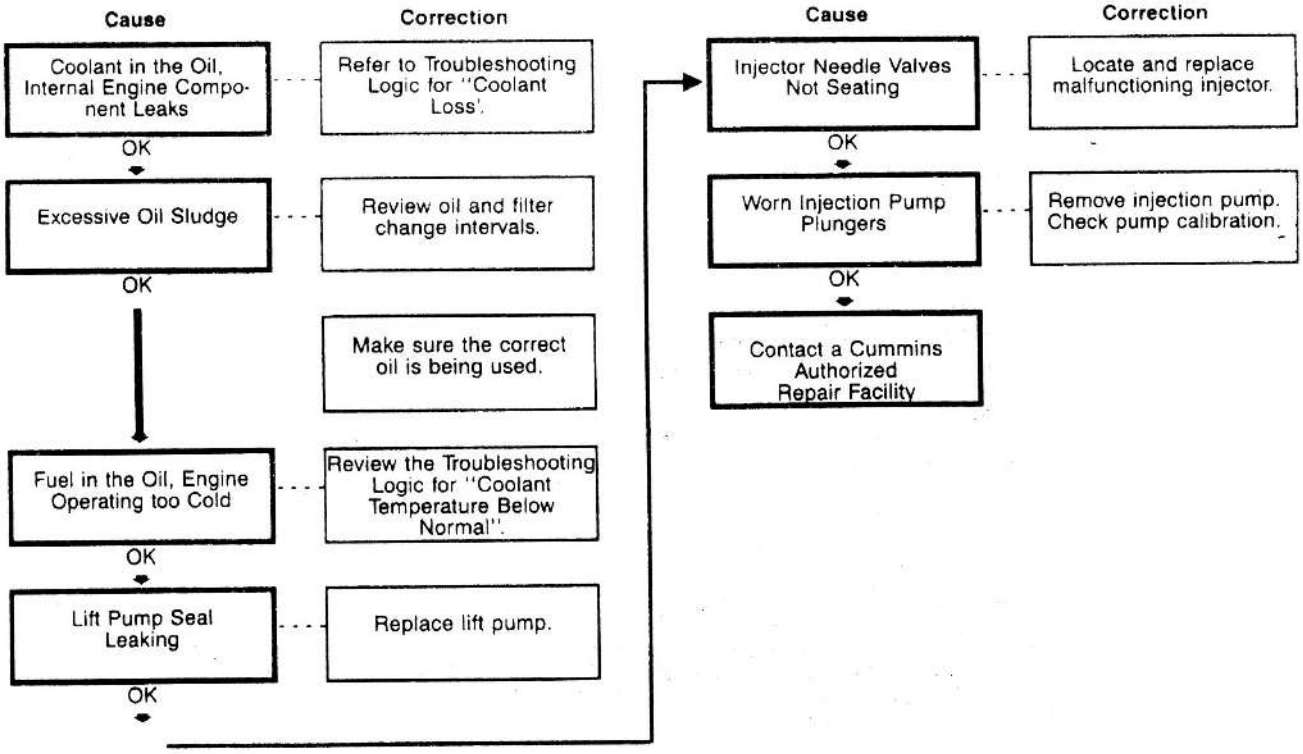

## Coolant Temperature Below Normal



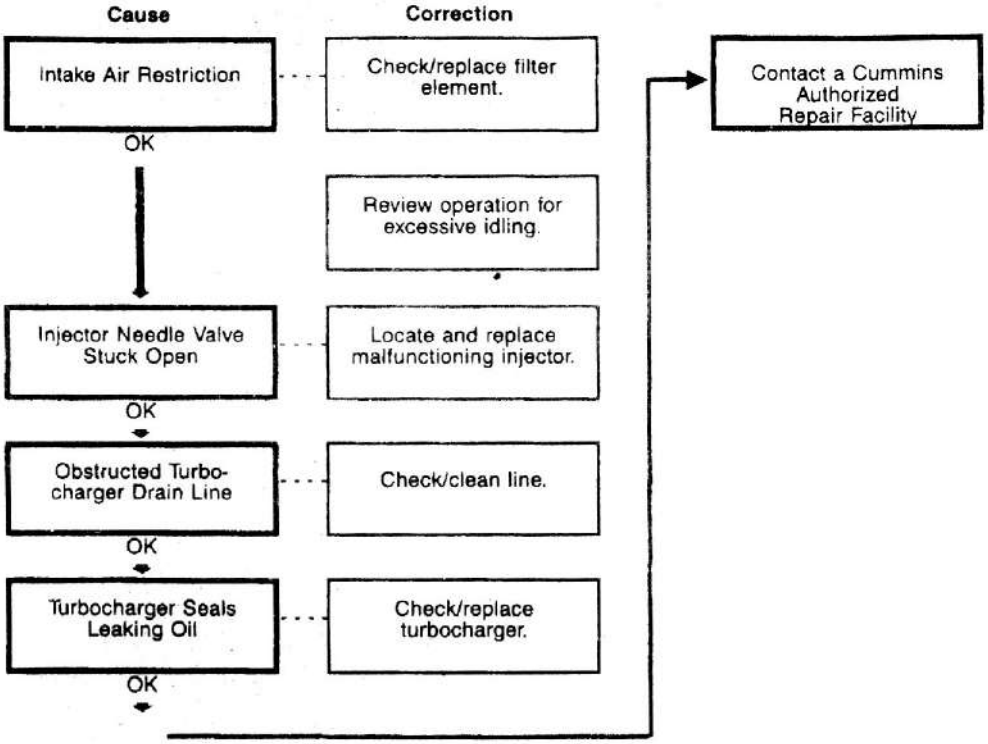
## Coolant Contaminated



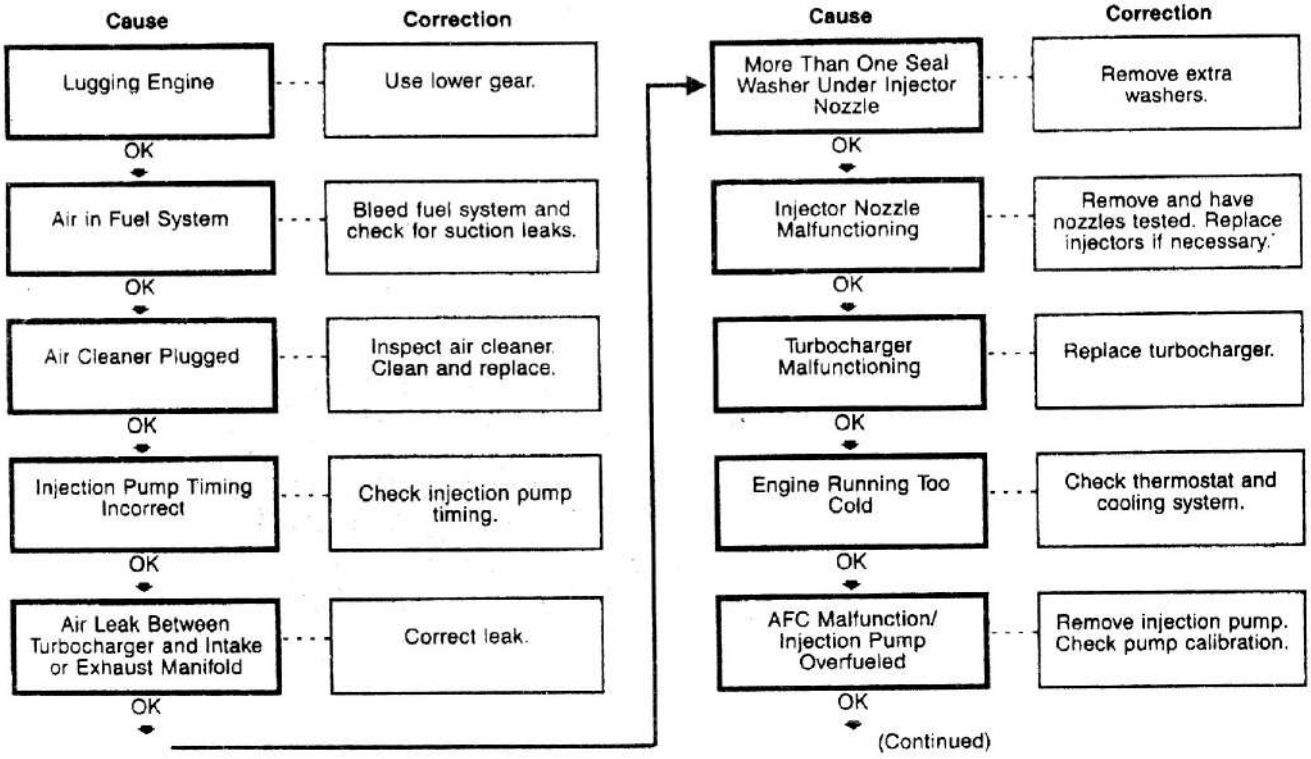

## Lubricating Oil Contaminated



## Fuel or Oil Leaking from Exhaust Manifold




## Exhaust Smoke Excessive Under Load

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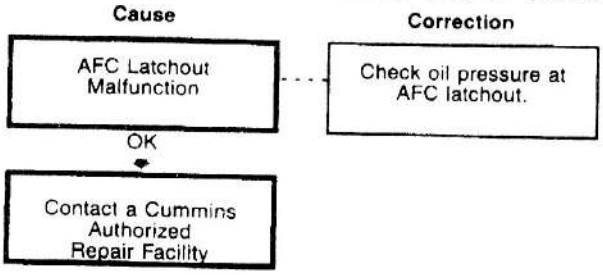
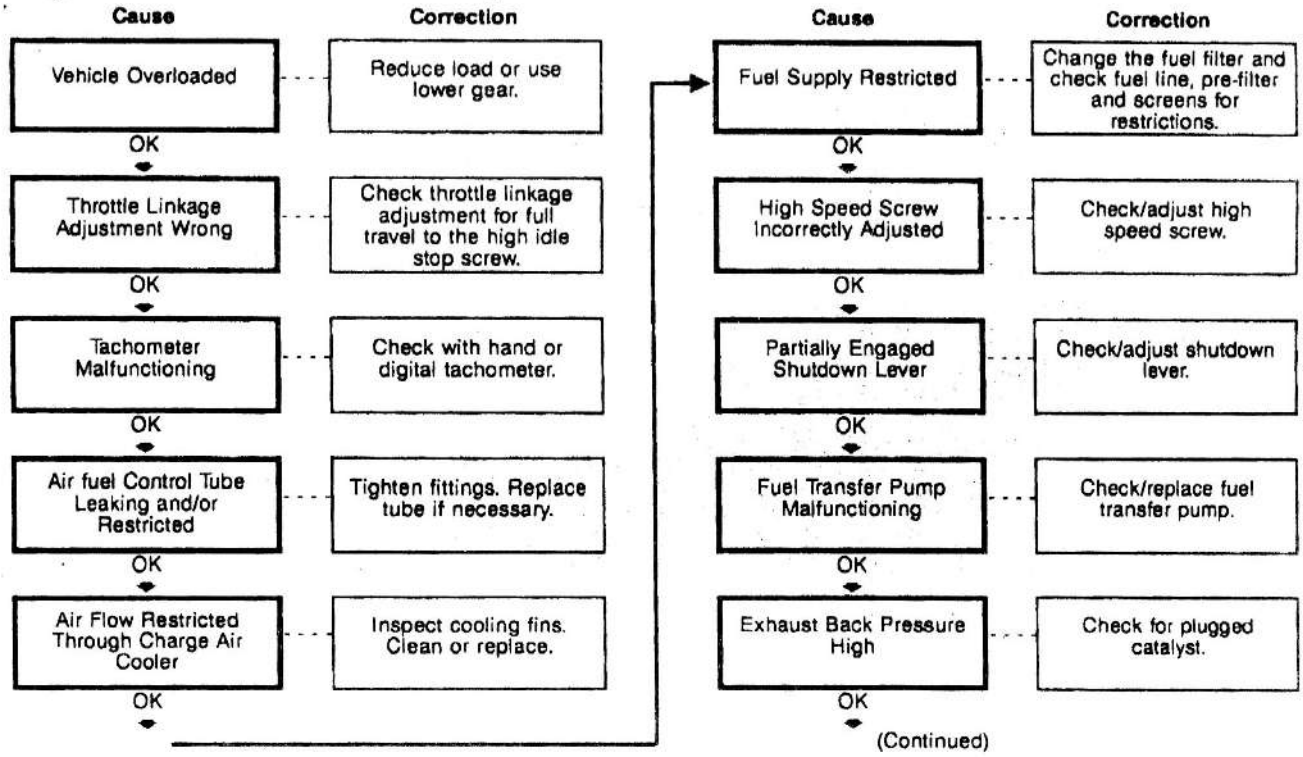
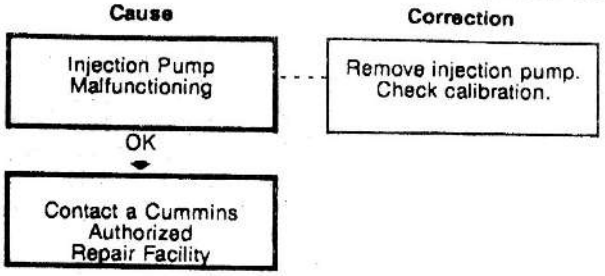
## Exhaust Smoke Excessive Under Load (Continued)



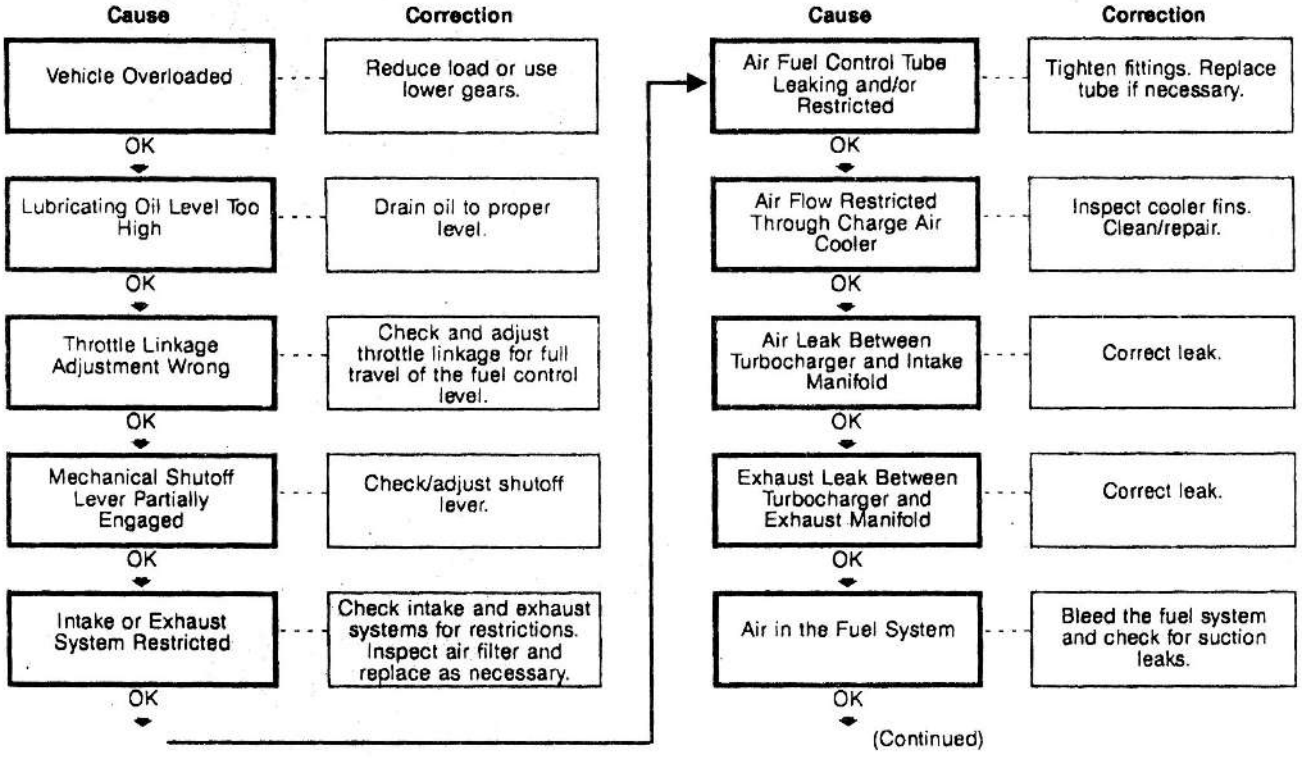

## Engine Will Not Reach Rated Speed When Loaded



## Engine Will Not Reach Rated Speed When Loaded (Continued)




## Power Output Low

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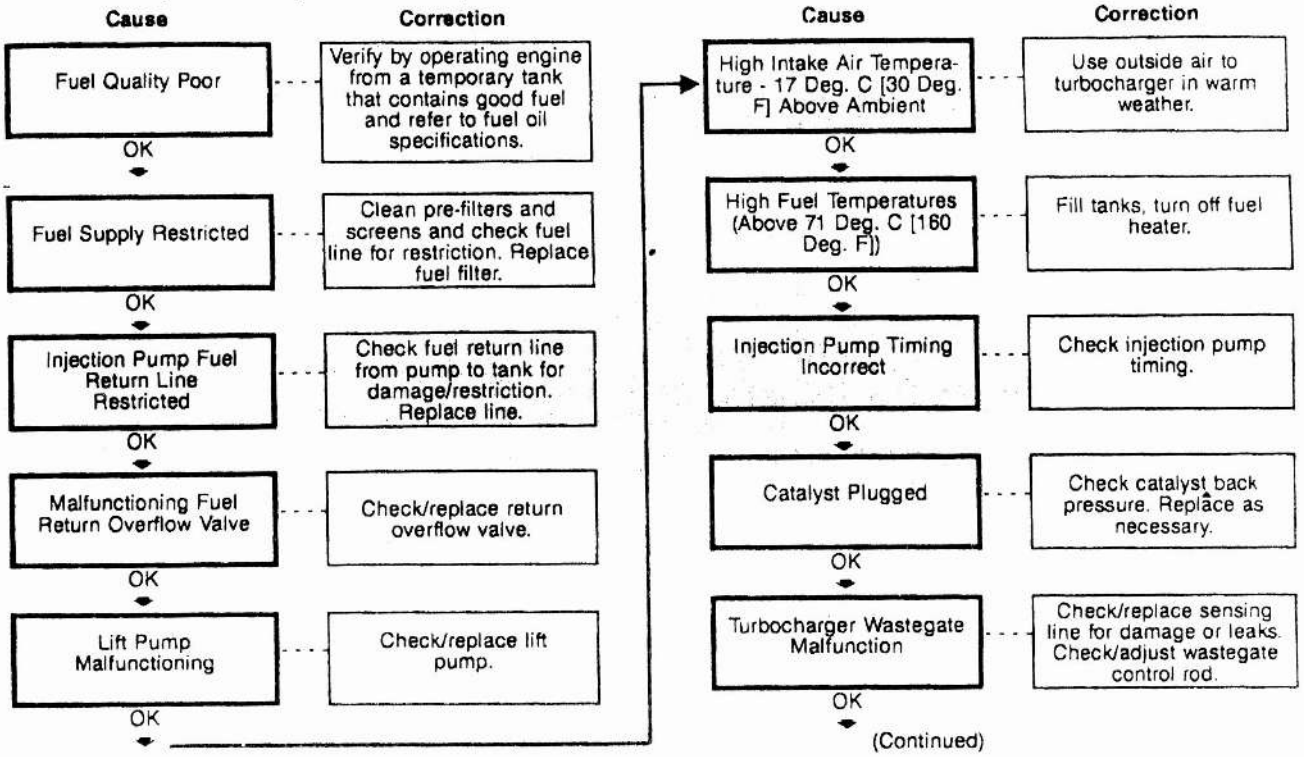
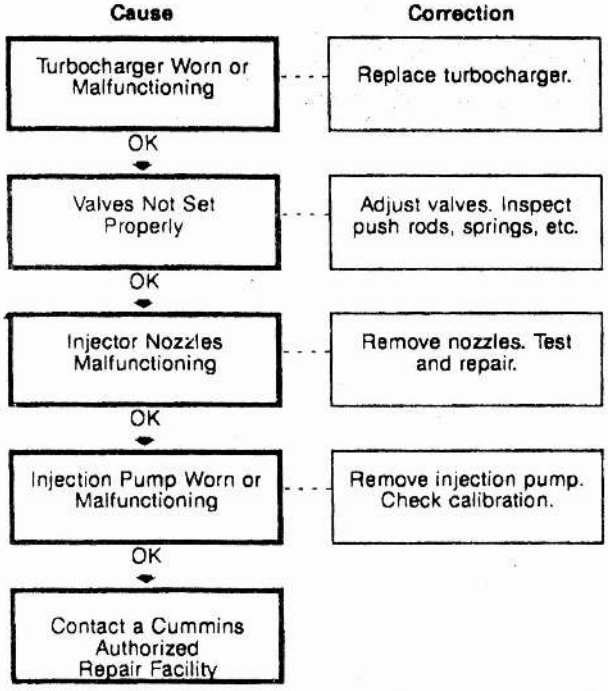
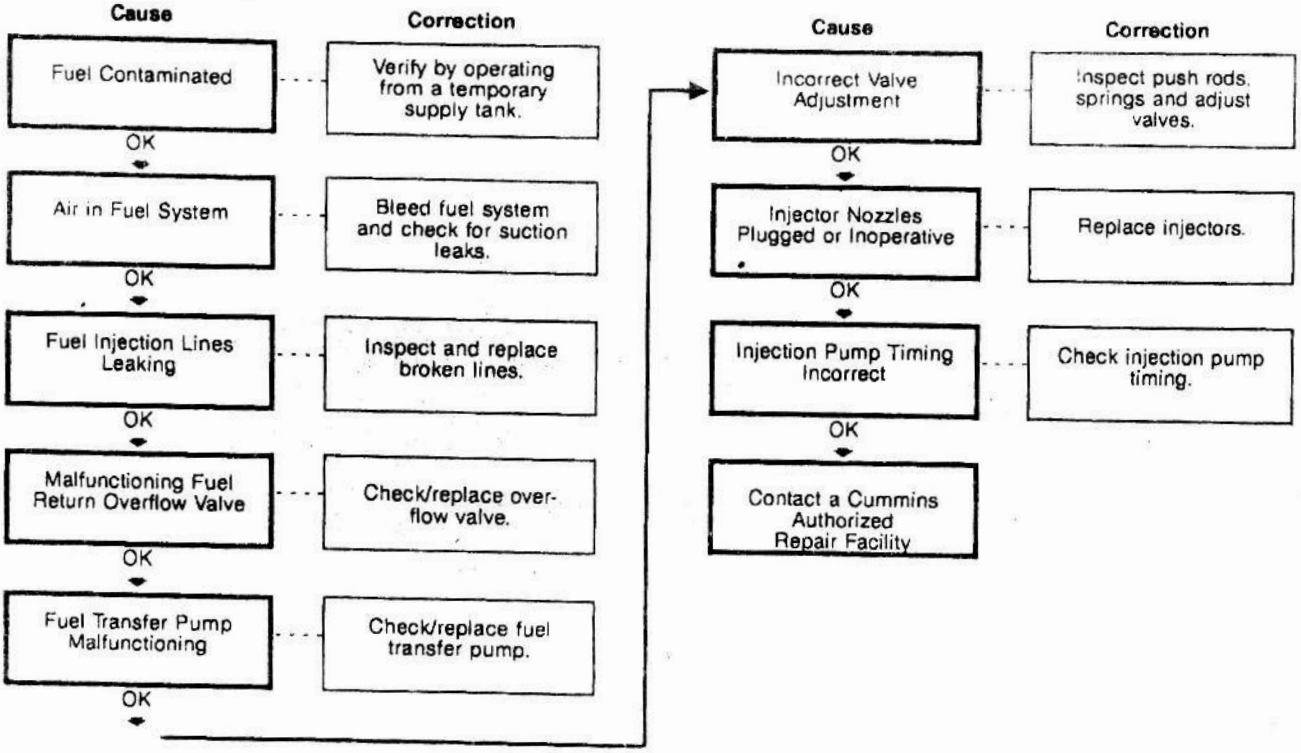
## Power Output Low (Continued)



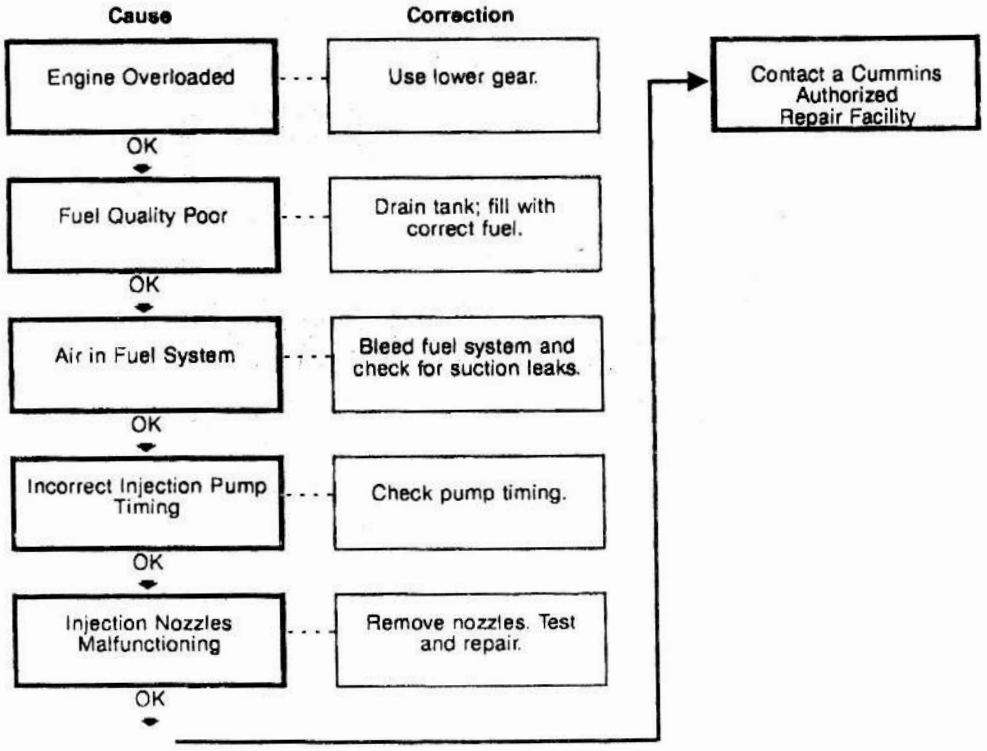

## Power Output Low (Continued)



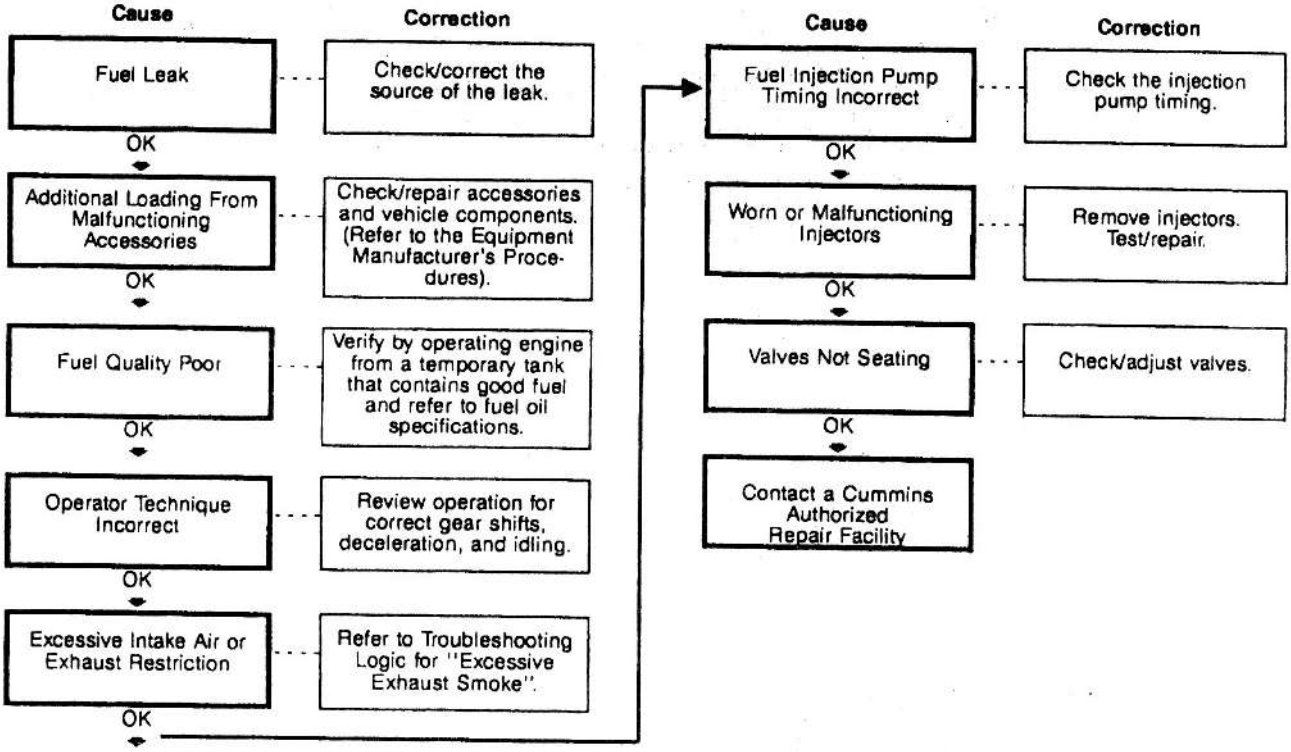
## Engine Misfiring



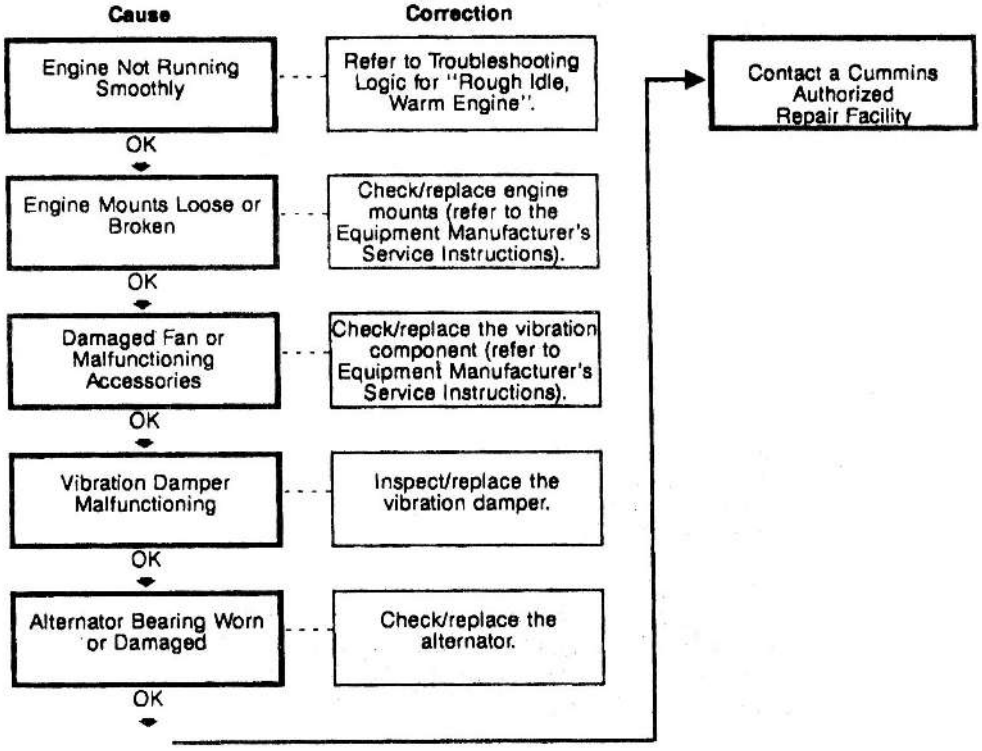

## Fuel Knock



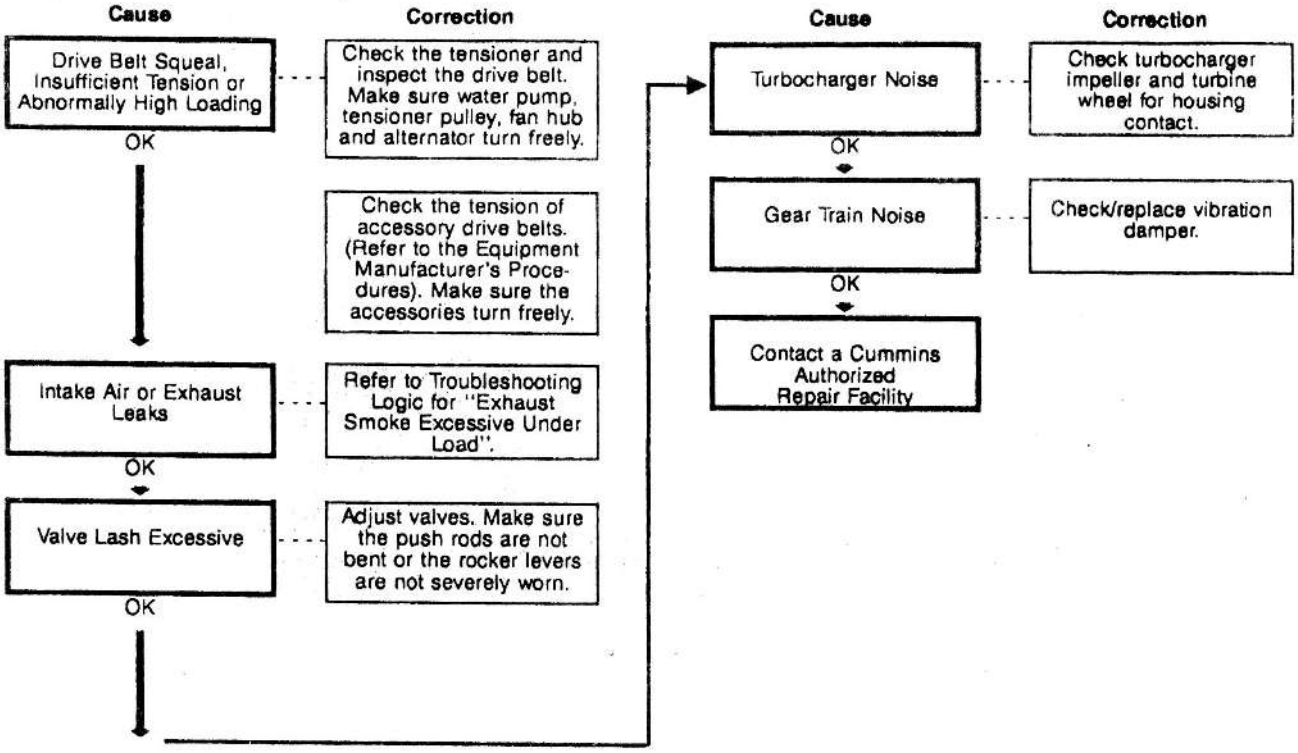
## Fuel Consumption Excessive



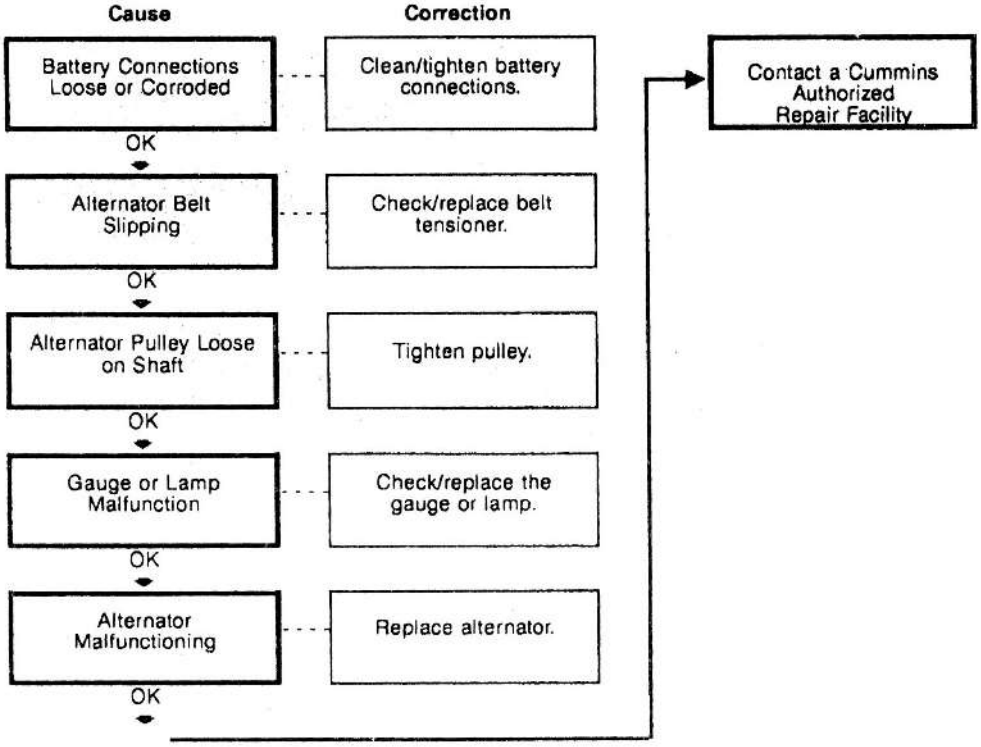

## Vibration Excessive



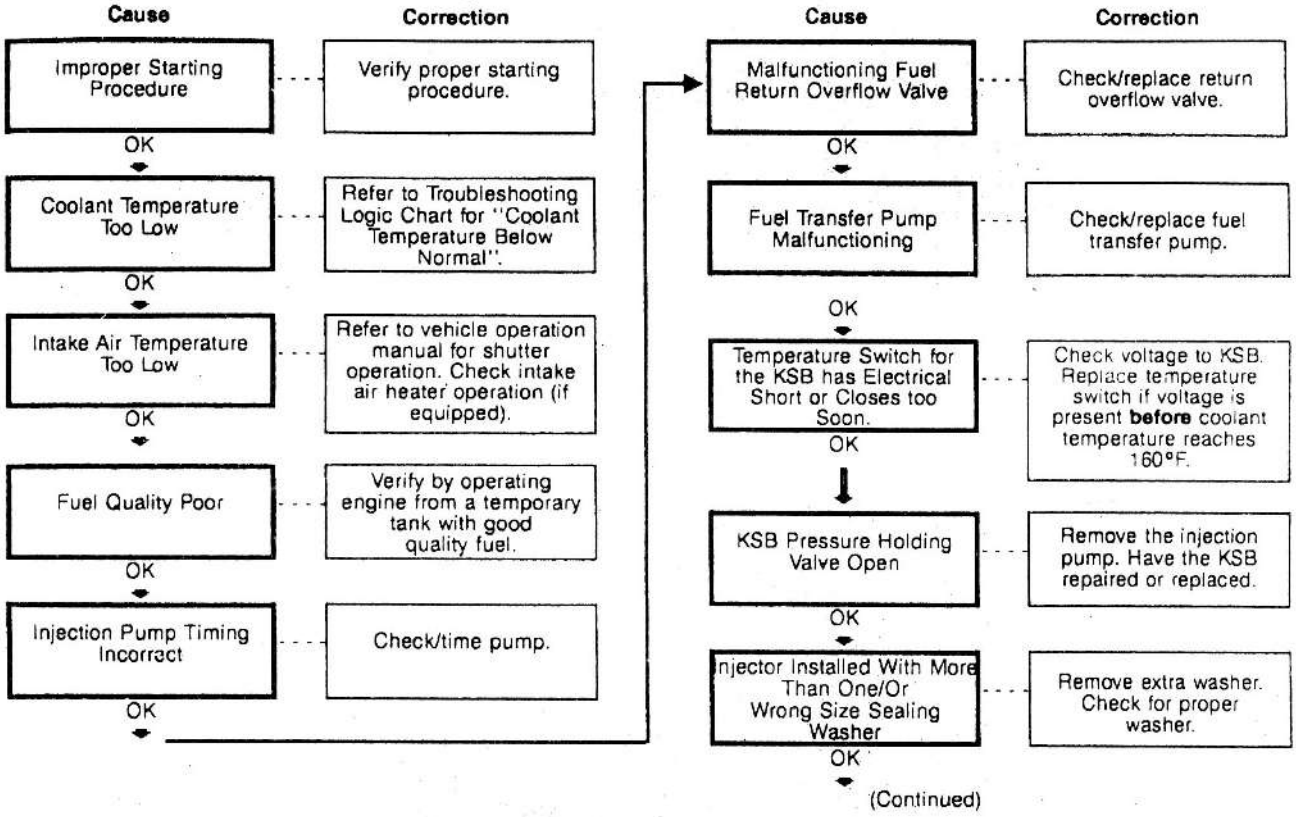
## Engine Noises Excessive




## Alternator Not Charging or Insufficient Charging



## White Smoke Excessive During Cold Start

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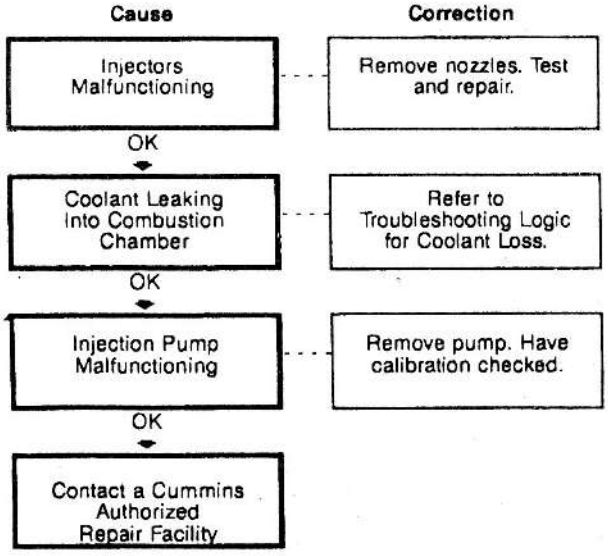
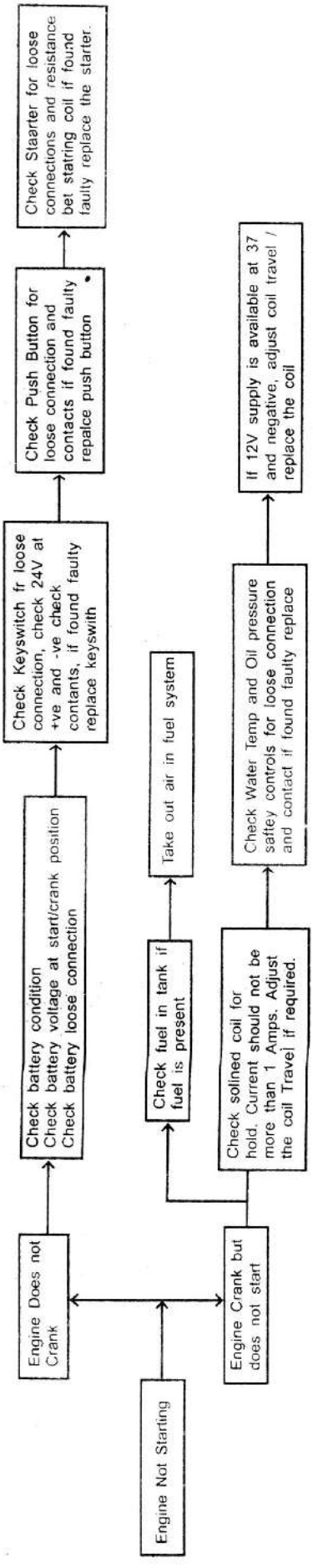
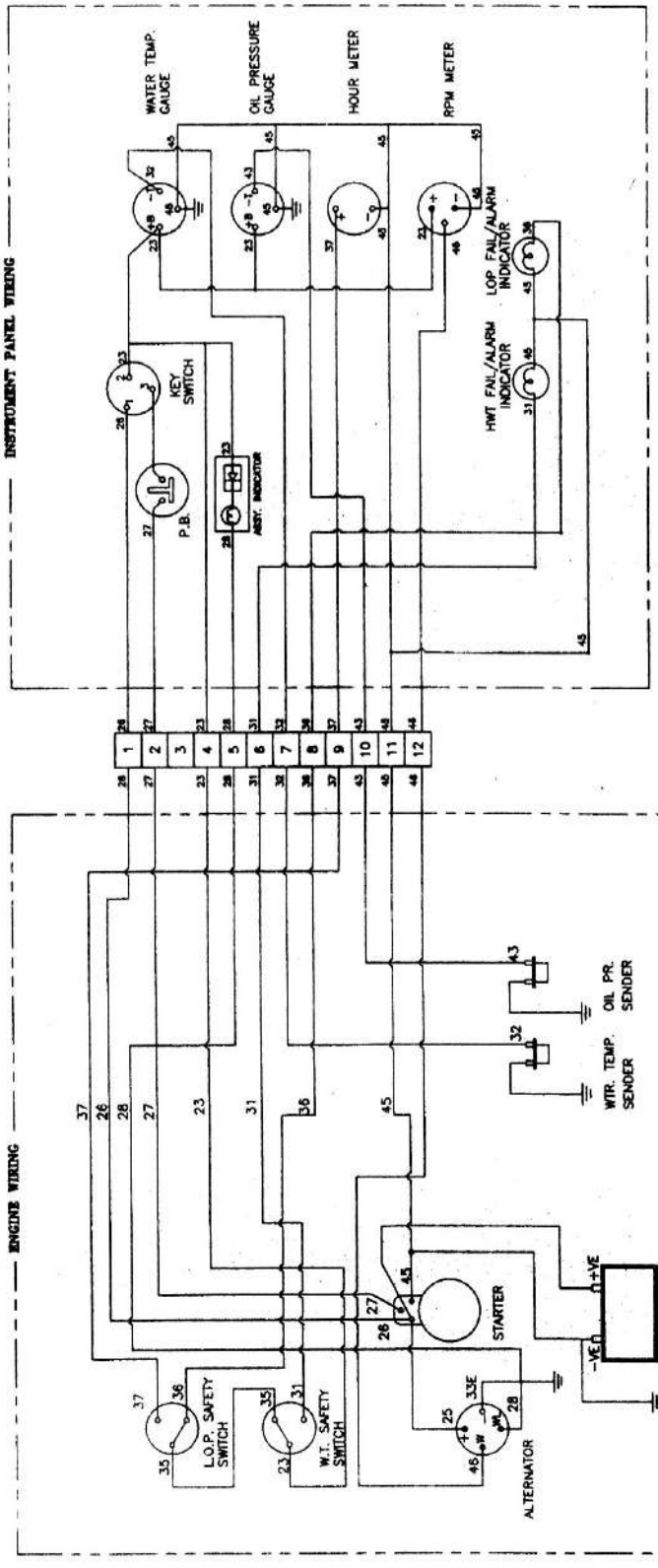
## White Smoke Excessive During Cold Start (Continued)




Engine Not Starting
Engine Does not Crank
Engine Crank but does not start
Check battery condition
Check battery voltage at start/crank position
Check battery loose connection
Check Keyswitch fr loose connection, check 24V at +ve and -ve check contants, if found faulty replace keyswith
Check Push Button for loose connection and contacts if found faulty repalce push button
Check Staarter for loose connections and resistance bet statring coil if found faulty replace the starter.
Check fuel in tank if fuel is present
Take out air in fuel system
Check solined coil for hold. Current should not be more than 1 Amps. Adjust the coil Travel if required.
Check Water Temp and Oil pressure saftey controls for loose connection and contact if found faulty replace
If 12V supply is available at 37 and negative, adjust coil travel / replace the coil

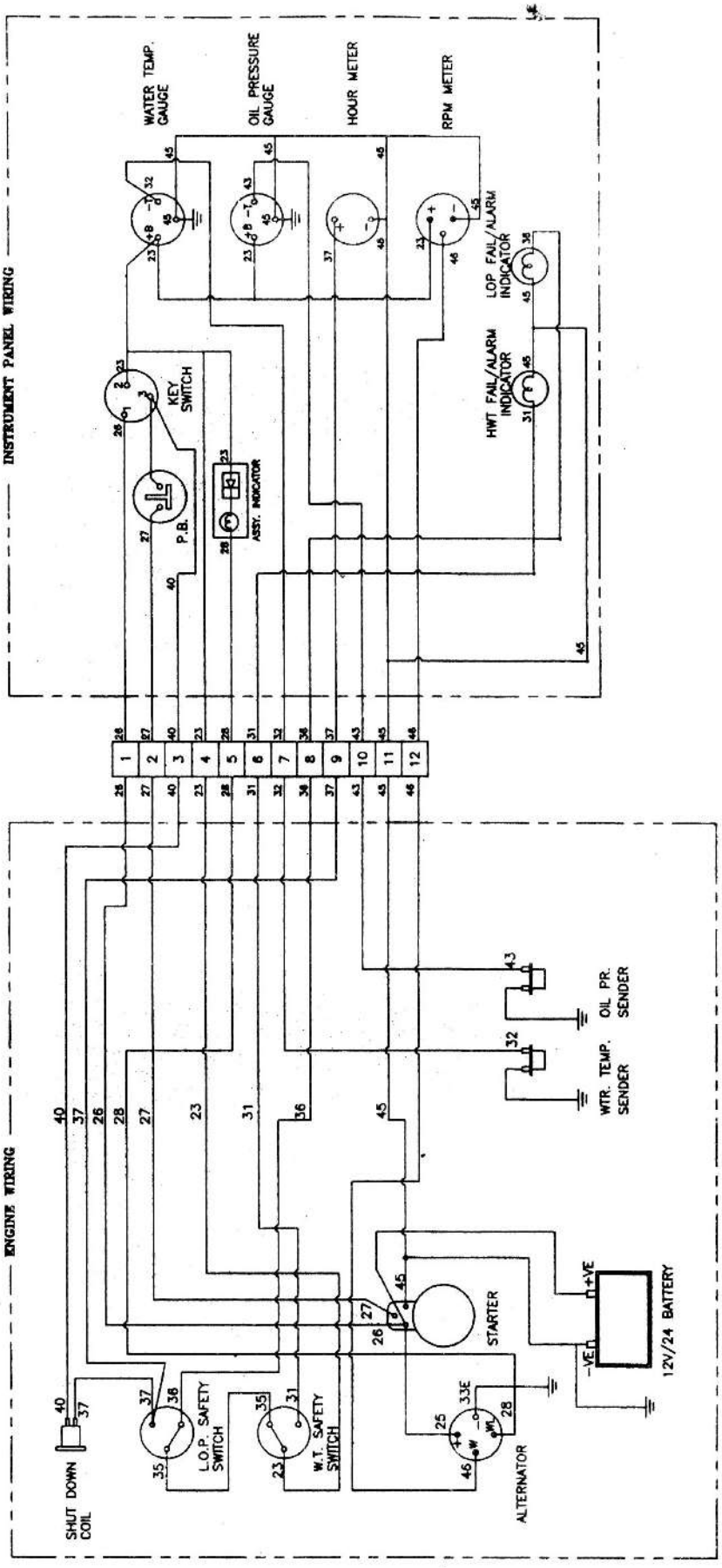
# ENGINE WIRING DIAGRAM

FOR B SERIES INDUSTRIAL APPLICATIONS (WITHOUT SD. COIL)




GAUGES AND INDICATING LAMPS TO BE USED AS PER 12V OR 24V

FOR B SERIES INDUSTRIAL APPLICATIONS (WITH SD. COIL)




GAUGES AND INDICATING LAMPS TO BE USED AS PER 12V OR 24V