K 系列发动机操作和保养手册

K Series Engine Operation and Maintenance Manual

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重庆康明斯发动机有限公司

CHONGQING CUMMINS ENGINE COMPANY Ltd.

Operation and Maintenance Manual

Cummins Diesel Engines

Agricultural

Construction

Industrial

Industrial Fire Pump

Logging

Mining

Railway

Generator

A BRIEF INTRODUCTION OF CHONQQING CUMMINS ENGINE COMPANY Ltd.

ChongQing Cummins Engine Company Ltd. (CCEC)signed a licence agreement of NT and K series engines with Cummins Engine Company, USA in 1981. manufacturing NT and K series engines , in order to meet the needs for diesels in mine and quarry dump trucks, highway heavy-duly trucks, special purpose trucks, construction and oil field equipments, rail cars and locomotives, marine genset etc. NT and K series engines have adopted unique P fuel system, and big CAM design for NT series engine, available as naturally aspirated, turbocharged, turbocharged-aftercooled and twin turbocharged versions.

They have the advantages of light weight, high power and torque rise, low fuel consumption, easy in maintenance and service. The engines can be run up to 500,000 kilometers before an overhaul is necessary, due to its high reliability and good fuel economy, the engines can fully meet the laws regulations of environmental protection ,and have gained a high reputation international market.

ChongQing Cummins Engine Company Ltd. is one of the national key projects and owns a mass of capable engineering and technical personal, sufficient and advanced manufacturing equipments and measuring instruments, strict quality control system, which ensure to produce the customer satisfied ChongQing-Cummins engines.

CCEC is able to offer customers with revision design application engineering and technical support pare parts and services tools.

CCEC would provide multi-purpose diesels with good economy and reliability for both domestic and foreign customers.

We also accept the business of engine major overhaul service either at CCEC or customer's field.

engine family	power range		No.of cylinders	bore &stroke		total displacement		specific fuel consumption
	kilowatt (horsepower) kW(bhp)	torque N.m(1b.ft)		mm	(in)	liter	(in^3)	g/kW.h(1b/bhp.hr)
K−19	336−1342 (450−1800)	1831−7020 (1350−5177)	inline−6	159×159	($6\frac{1}{4}\times6\frac{1}{4}$)	18.9	(1150)	206(0.340)
K−38			V−12			37.8	(2300)	
K−50			V−16			50.3	(3067)	

Foreword

This is an engine operation and maintenance manual, not a repair manual. The design of Cummins Engines makes it possible to replace worn or damaged parts with new or rebuilt parts with a minimum of down time. Contact the nearest Cummins Distributor for parts replacement as they are equipped and have well informed, trained personnel to perform this service. If your shop is properly equipped to perform either maintenance, unit replacement and/or complete engine rebuild, contact the nearest Cummins Distributors to obtain available repair manuals and arrange for training of personnel.

For model identification of an engine, check the dataplate. The letter and number code indicates breathing (naturally aspirated except when letter "T" for turbocharged is present), cubic inch displacement, application and maximum rated horsepower.

Examples:

KTA-19-C-525
K=Model Identification

T=Turbocharged

A=After-cooled

19=Displacement

M=Industry Application

Cummins Engine Company, Inc.
Columbus, Indiana, U.S.A.

Table of Contents

Operating Instructions

The engine operator must assume the responsibility of engine care while the engine is being operated. There are comparatively few rules which the operator must observe to get the best service from a Cummins Diesel.

General—All Applications

New and Rebuilt Engines Break-In

Cummins engines are run-in on dynamometers before being shipped from the factory and are ready to be put to work in applications such as emergency fire trucks, rail car applications and generator sets.

In other applications, the engine can be put to work, but the operator has an opportunity to establish conditions for optimum service life during initial 100 hours of service by:

1. Operating as much as possible at three-quarter throttle of load range.
2. Avoiding operation for long periods at engine idle speeds, or at the maximum horsepower levels in excess of five minutes.
3. Developing the habit of watching the engine instruments closely during operation and letting up on the throttle if the oil temperature reaches 250°F [121°C] or the coolant temperature exceeds 195°F [91°C].
4. Operating with a power requirement that allows acceleration to governed speed when conditions require more power.
5. Checking the oil level every 8 to 10 hours during the break-in period.

New or Rebuilt Engines Pre-Starting Instructions — First Time

Priming The Fuel System

1. Fill the fuel filter with clean No. 0 diesel fuel oil meeting the specifications outlined in Section 3.
2. Remove the fuel pump suction line and wet the gear pump gears with clean lubricating oil.
3. Check and fill the fuel tanks.
4. If the injector and valve or other adjustments have been disturbed by any maintenance work, check to be sure they have been properly adjusted before starting the engine.

Priming the Lubricating System

Note: On turbocharged engines, remove the oil inlet line from the turbocharger and prelubricate the bearing by adding 2 to 3 oz. [50 to 60 cc] of clean lubricating oil. Reconnect the oil supply line.

1. Fill the crankcase to the "L" (low) mark on the dipstick. See Lubricating Oil Specifications, Section 3.
2. Remove the plug from the front of the oil cooler housing Fig.1-1,1-2,1-3.

Fig. 1-1, (K21902). Lubricating system priming point – KT/KT38 Engine

Caution: Do not prime the engine lubricating system from the by-pass filter.

3. Connect a hand or motor-driven priming pump line from a source of clean lubricating oil to the plug boss in the housing.
4. Prime until a 30 psi [207 kPa] minimum pressure is obtained.
5. Crank the engine at least 15 seconds (with fuel shut-off valve closed or disconnected to prevent starting), while maintaining the external oil pressure at a minimum of 15 psi [103 kPa].
6. Remove the external oil supply and replace the plug. Tighten to proper torque valve.

Fig. 1-2, (OM202). Lubricating system priming point — KTA50

Warning: Clean the area of any lubricating oil spilled while priming or filling the crankcase.

7. Fill the crankcase to the "H" (high) mark on the dipstick with oil meeting specifications, listed in Section 3. No change in oil viscosity or type is needed for new or newly rebuilt engines.

A dipstick oil gauge is located on the side of the engine, Fig. 1-4. The dipstick has an "H" (high) (1) and "L" (low) (2) level mark to indicate lubricating oil supply. The dipstick must be kept with the oil pan, or engine, with which it was originally supplied. Cummins oil pans differ in capacity with different type installations and oil pan part numbers. Check the dipstick calibration. If in doubt, your Cummins Distributor can verify that you have the proper oil pan and dipstick calibration.

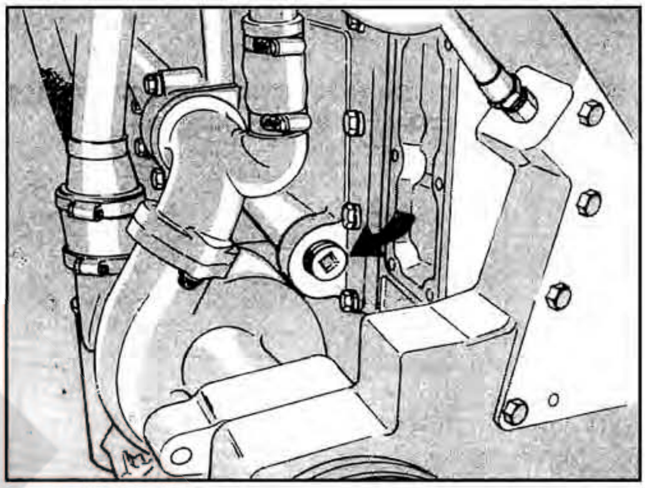


Fig. 1-3, (OM1004L). Lubricating system priming point — KT/KTA19 C.I.D. Engine

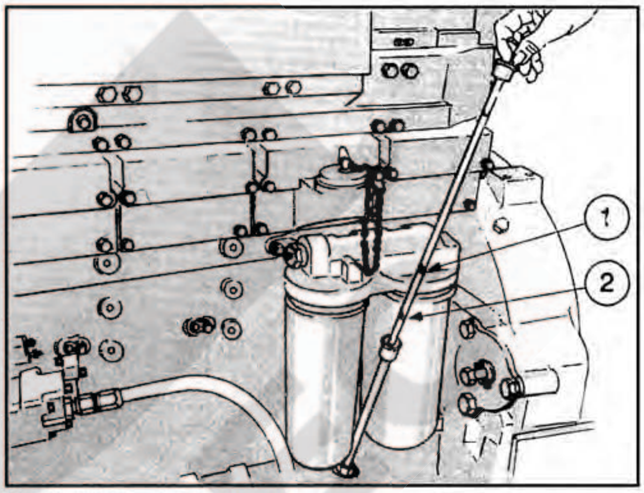


Fig. 1-4, (OM1005L). Checking engine oil level — KT/KTA19

Check Hydraulic Governor

Many engines used in stationary power applications are equipped with hydraulic-governed fuel pumps which use lubricating oil as an energy medium, same weight as used in the engine. Oil level in the governor sump must be at the full mark on the dipstick.

Note: Engine applications in a cold environment should use a lighter weight oil in the governor sump.

Check Air Connections

Check the air connections to the compressor and the air equipment, as used, and to the air cleaners and air crossovers to assure that they all are secure and have no damage.

Check Engine Coolant Supply

1. Remove the radiator or heat exchanger cap and check the engine coolant supply. Add coolant as needed.
2. Make a visual check for leaks and open the water filter shut-off valves.

Starting the Engine

Starting requires that clean air and fuel be supplied to the combustion chambers in the proper quantities at the correct time.

Normal Starting Procedure

Warning: Before starting be sure that everyone is clear of the engine and equipment.

If the fuel system is equipped with an overspeed stop, push the "Reset" button before attempting to start the engine.

1. On units equipped with an air activated prelube device, open the air valve to activate the piston in the prelube device which will lubricate all moving parts in the engine.

Note: On engines equipped with an oil pressure safety switch, hold the fuel by-pass switch in the "start" position until the engine oil pressure reaches 7 to 10 psi [48 to 69 kPa]; then, move it to the "run" position.

2. Set the throttle for idle speed and disengage the driven unit.

Caution: Protect the turbocharger during start-up by not opening the throttle or accelerating above 1000 rpm until the idle speed oil pressure registers on the gauge.

3. Open the manual fuel shut-down valve, if so equipped. Fig. 1-5. Electric shut-down valves operate as the switch is turned on. A manual override knob provided on the forward end of the electric shut-down valve allows the valve to be opened in case of an electric power failure. To use, turn fully clockwise; return it to the run position after an electric repair.
4. Pull the compression release (if so equipped) and press the starter button or turn the switch-key to the "start" position. After three or four seconds of cranking, close the compression release (if so equipped) and continue to crank until the engine fires.

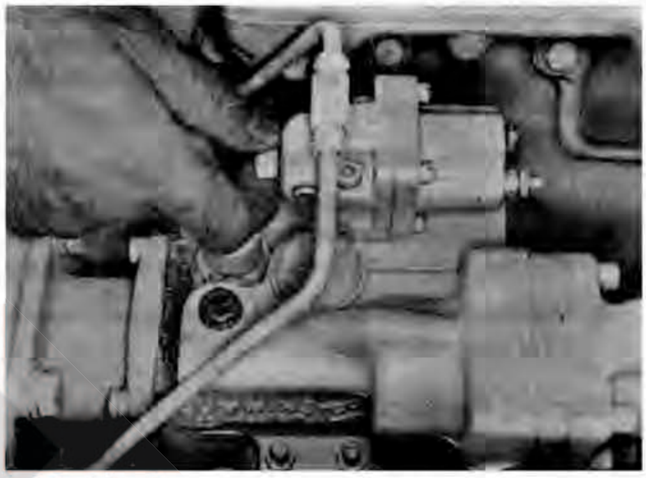


Fig. 1-5, (V21970). Using manual override knob

Caution: To prevent permanent cranking motor damage, do not crank the engine for more than 30 seconds continuously. If the engine does not fire within the first 30 seconds, wait one to two minutes before recranking.

5. At the initial start or after oil or filter changes and after the engine has run for a few minutes, shut it down and wait 15 minutes for the oil to drain back into the pan. Check the engine oil level again; add oil as necessary to bring the oil level to the "H" mark on the dipstick. The drop in oil level is due to absorption by the oil filters. Never operate the engine with the oil level below the low level mark or above the high level mark.

Cold-Weather Starting

Note: A water jacket heater is recommended for stand-by generator set applications installed in a cold climate.

Preheater

The glow plug system supplies heat to the cylinders so that compression temperatures are sufficient to ignite the fuel.

To aid in starting the engine when the temperature is 50°F [10.0°C] or below, an intake air preheater is available.

Preheater equipment consists of a hand-priming pump to pump fuel into the intake manifold, and a switch to turn on the glow plug which is electrically heated by the battery. Fuel burns in the intake manifold and heats the intake air.

Warning: Do not use vapor in conjunction with the preheater. To do so could result in a fire.

To use the preheater for cold starting:

1. Set the throttle in idle position. Turn the glow plug toggle switch to the "ON" position. The red indicator light must be on.
2. After the red light has been on for 20 seconds, start cranking the engine. As soon as the engine begins rotating, operate the preheater priming pump to maintain 80 to 100 psi [552 to 693 kPa] fuel pressure. Use of the primer before the 20-second interval will wet the glow plug and prevent heating.
3. If the engine does not start within 30 seconds, stop cranking. Wait one or two minutes and repeat the cranking operation.
4. After the engine starts, pump the primer slowly to keep the engine idling smoothly. In cold weather this may require 4 to 5 minutes or longer. Do not accelerate the engine.
5. When the engine has warmed up so it does not falter between primer strokes, stop pumping. Close and lock the primer. Turn off the glow plug toggle switch. (The red indicator light will go out.)
6. If the engine gives no indication of starting during the first three full strokes of the preheater pump, touch-check the intake manifold for heat. If there is no heat, check the electrical wiring. If the wiring is all right, remove the 1/8 inch pipe plug (1, Fig. 1- 6) from the manifold near the glow plug and close the glow plug manual switch for 15 seconds and observe the glow plug through the 1/8 inch plug hole. The glow plug should be white hot; if not, connect the wiring to a 6- to 12-volt (as used) source and check the amperage; it should be 30 to 32 (minimum). If the glow plug is all right, check the manual switch and resistor (if used) and replace if necessary.

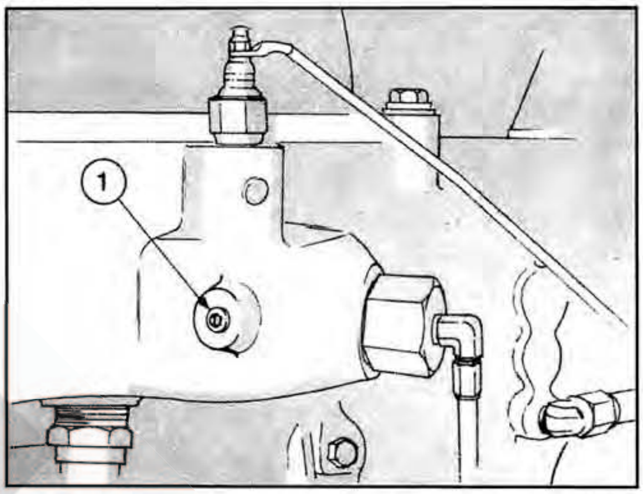


Fig. 1- 6, (OM1006L). Glow plug inspection hole, NT-855 C.I.D. Engine

Note: The preheater priming pump, switches and resistor are located at the instrument panel and are to be checked during engine starting.

The cold starting aid, approved for use in Cummins Engines, has been based upon starting aid capabilities to -25°F [-32°C].

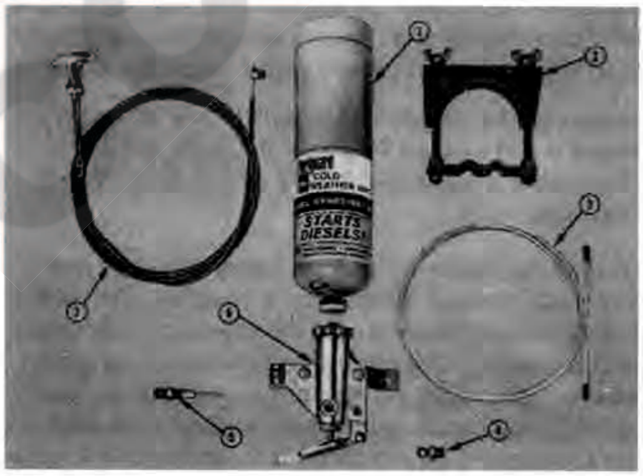


Fig. 1- 7, (OM1007L). Manually operated valve

Caution: Do not attempt to use vapor compound type starting aids near heat, open flame or on engines equipped with a glow plug system.

Manually Operated Valve

The manually operated valve, illustrated in Fig. 1- 7 includes the valve body assembly (6), clamp (2) and nylon tube (3). The fuel cylinder (1), atomizer fitting (5) and pull control (7) must be ordered separately.

Standard pull or throttle control cables may be used, to actuate the manual valve, if desired.

Electrically Operated Valve

The electrically operated valve, Fig. 1-8 , includes the valve body (7), 90 degree elbow (5), clamp (2), push button switch (6), and nylon tube (3). The thermostat is mounted on the engine exhaust manifold and cuts out the valve by sensing manifold heat when the engine is running. See parts catalog for fuel cylinder (1) and fuel atomizer fittings (4). These fittings must be ordered separately, as required.

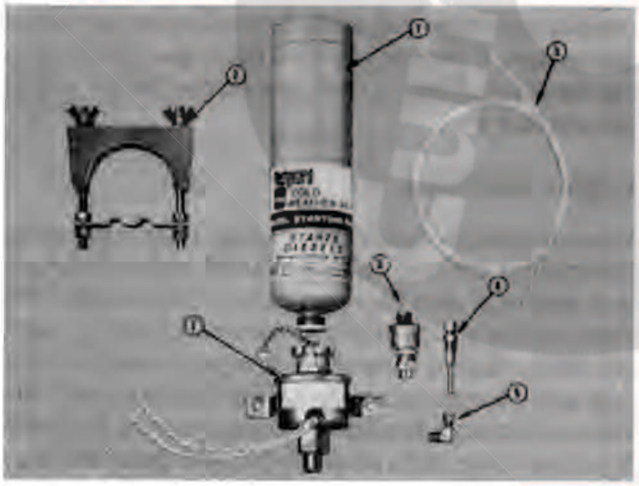


Fig. 1- 8, (OM1008L), Electrically operated valve

Note: The operated valves are designed for V engines. Applied on K engine maybe some different.

Installation Recommendations

The atomizer fittings must be mounted in the engine air intake manifold or inlet connection to provide an equal distribution of starting fuel to each cylinder. The atomizer holes are 180 degrees apart and must be mounted so the spray is injected the "long way" of the manifold. If incorrectly installed, the spray goes crosswise of the manifold.

Recommended Starting Technique Using Fleetguard Starting Aid

1. Set the throttle for idle.
2. Disengage the driven unit or make sure gears are in neutral.
3. Open the manual fuel shut-down valve, or electric shut-down valve, whichever is used.
4. Engage the starter and while cranking, apply metered amounts of starting fluid until the engine idles smoothly.

Use of Starting Fluid Without Metering Equipment

1. Spray starting fluid into the air cleaner intake, while a second man cranks the engine.

Warning: Never handle starting fluid near an open flame. Never use it with a preheater or flame thrower equipment. Do not breathe the fumes. Use of too much will cause excessively high pressures and detonation, or over speed the engine.

2. Starting aid fumes will be drawn into the air intake manifold and the cold engine should start without difficulty.

Warning: Fuel oil or volatile fuel cold starting aids are not to be used in underground mine or tunnel operations. If the engine is so equipped check with the local U.S. Bureau of Mines Inspector for use of the starting aid.

Engine Warm-Up

When the engine is started, it takes a while to get the lubricating oil film re-established between shafts and bearings and between pistons and liners. The most favorable clearances between moving parts are obtained only after all engine parts reach normal operating temperature. Avoid seizing pistons in liners and running dry shafts in dry bearings by bringing the engine up to operating speed gradually as it warms up.

On some emergency equipment (such as fire pump engines) warm-up may not be necessary due to the equipment being housed inside a heated building. For an engine starting with a parasitic load, such as a fire pump, the coolant temperatures must be a minimum of 120°F [49°C].

Engine Speeds

All Cummins engines are equipped with governors to prevent speeds in excess of the minimum or predetermined lower speed rating.

The governor has two functions: First, it provides the fuel needed for idling when the throttle is in the idle position. Second, it overrides the throttle and shuts off the fuel if the engine rpm exceeds the maximum rated speed.

Speeds listed in Table 1-1 are for engines rated at maximum rpm and fuel rate.

Note: Engines in many applications are applied at a lower than maximum rated speed; check the serial dataplate.

Power generator units are pre-set to operate at a specific governed rpm.

Table 1-1: Engine Speeds (RPM)

Engine Model	Maximum Rated
KT19	2100
KTA19	2100
KT38	2100
KTA38	2100
KTA50	2100

Oil Temperature

The oil temperature gauge normally should read between 180°F [82°C] and 225°F [107°C]. Under full load conditions, an oil temperature of 240°F [116°C] for a short period is not cause for alarm.

Caution: Any sudden increase in oil temperature which is not caused by a load increase is a warning of possible mechanical failure and should be investigated at once.

During the warm-up period, apply the load gradually until the oil temperature reaches the 140°F [60°C]. While the oil is cold it does not do a good job of lubricating. Continuous operation or long periods of idle with oil temperatures below 140°F [60°C] may cause crankcase dilution and acids in the lubricating oil which quickly accelerate engine wear.

Water Temperature

A water temperature of 160° to 200°F [71° to 93°C] is the best assurance that the working parts of the engine have expanded evenly to the most favorable oil clearances. Maximum engine coolant temperatures should not exceed 200°F [93°C].

Keep the thermostats in the engine during summer and winter, avoid long periods of idling, and take the necessary steps to keep the water temperature up to a minimum of 160°F [71°C]. If necessary in cold weather, use radiator shutters or cover a part of the radiator to prevent overcooling.

Oil Pressure

Normal engine oil pressures at 225°F [107°C] oil temperature are listed in Table 1-2.

Note: Individual engines may vary from the above normal pressures. Observe and record the pressure when the engine is new to serve as a guide for an indication of progressive engine condition. (High oil pressure during start-up is not cause for alarm.) For record purposes these readings are more accurate and reliable when taken immediately after an oil change.

High Altitude Operation

Some engines, particularly naturally aspirated, lose horsepower when they are operated at high altitude because the air is too thin to burn as much fuel as at sea level. This loss is about 3 percent for each 1000 ft [304.8 m] of altitude above sea level for a naturally aspirated engine. Operate the engine using a lower power requirement at high altitude to prevent smoke and over-fueling.

Table 1-2: Oil Pressure PSI [kPa] @ 225°F [107°C]

Engine Series	Minimum @ Idle Speed	Rated Speed
KT/KTA19	15 [103]	45/70 [310/483]
KT/KTA38 @ 2100 RPM	15 [103]	45/70 [310/483]
KT/KTA38 @ 1500, 1800 or 1950 RPM	15 [103]	40/70 [276/483]
KT/KTA50 @ 2100 RPM	20 [138]	45/70 [310/483]
KT/KTA50 @ 1500 or 1800 RPM	15 [103]	40/70 [276/483]

Power Take-Off Application With PT (type G) VS Fuel Pump

The VS fuel pump governor lever is used to change the standard governed speed of the engine from rated speed to an intermediate power take-off speed.

When changing from the standard speed range to the power take-off speed with the engine idling on standard throttle, operate as follows:

1. Place the VS speed control lever in the operating position.
2. Lock the standard throttle in the full-open position.
3. Engage the power take-off.

To return to standard throttle:

1. Disengage the power take-off.
2. Return the standard throttle to the idle position.
3. Lock the VS speed control lever in the maximum speed position.

Engine Shut-Down

Idle Engine A Few Minutes Before Shut-Down

It is important to idle an engine 3 to 5 minutes before shutting it down to allow the lubricating oil and water to carry heat away from the combustion chamber, bearings, shafts, etc. This is especially important with turbocharged engines.

The turbocharger contains bearings and seals that are subject to the high heat of combustion exhaust gases. While the engine is running, this heat is carried away by oil circulation, but if the engine is stopped suddenly, the turbocharger temperature may rise as much as 100°F [38°C]. The results of the extreme heat may be seized bearings or loose oil seals.

Do Not Idle Engine for Excessively Long Periods

Long periods of idling are not good for an engine because the combustion chamber temperatures drop so low the fuel may not burn completely. This will cause carbon to clog the injector spray holes and piston rings and may result in stuck valves.

If the engine coolant temperature becomes too low, raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil so all moving parts of the engine will suffer from poor lubrication.

If the engine is not being used, shut it down.

Turn Switch to "Off" Position to Shut Down the Engine

The engine can be shut down completely by turning off the switch on installations equipped with an electric shut-down valve, or by turning the manual shut-down valve knob. Turning off the switch which controls the electric shut-down valve stops the engine unless the override button on the shut-down valve has been locked in the open position. If the manual override on the electric shut-down valve is being used, turn the button fully counterclockwise to stop the engine. Refer to "Normal Starting Procedure". The valve cannot be reopened by the switch until after the engine comes to a complete stop, unless a rapid restart valve is installed.

Caution: Never leave the switch key or the override button in the valve open or in the run position when the engine is not running. With overhead tanks this would allow fuel to drain into the cylinders, causing a hydraulic lock.

Stop Engine Immediately If Any Parts Fail

Practically all failures give some warning to the operator before the parts fail and ruin the engine. Many engines are saved because alert operators heed warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine.

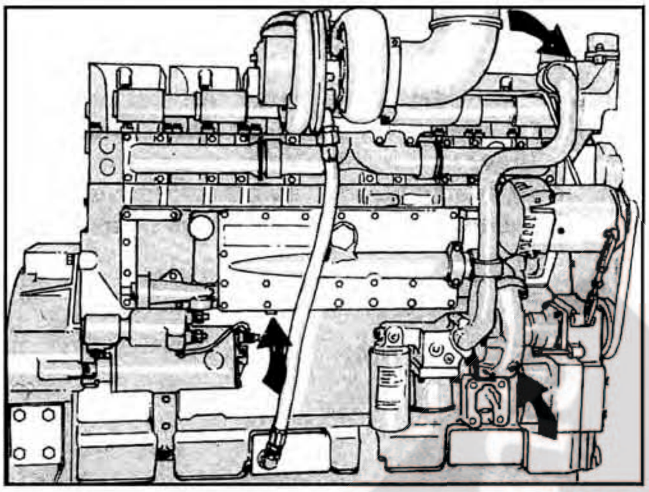


Fig. 1- 9. Cooling system drain points –KT/KTA19 C.I.D. Engine

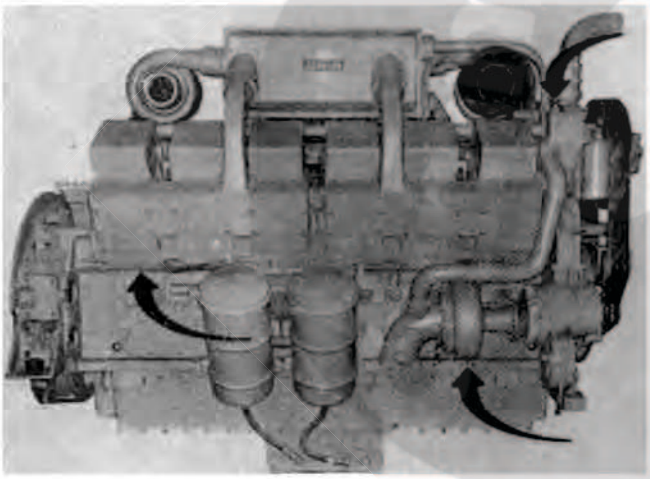


Fig. 1-10. Coolant drain point — KT(A)38 Engine

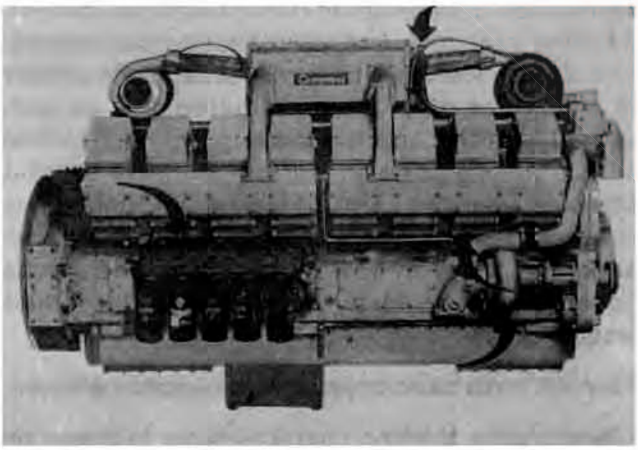


Fig. 1-11. Coolant drain point — KTA50 Engine

Fig. 1-12. Two cylinder air compressor coolant drain

Cold-Weather Protection

1. For cold-weather operation, use of permanent-type antifreeze with rust inhibitor additives is recommended. See Section 3.
2. Drain the cylinder block and heads on all engines by opening the petcocks and removing the drain plugs as shown in Fig.'s 1-13 to 1-11. If an air compressor (Fig. 1-12), heat exchanger or other "water cooled" accessory is used, open the pet-cock and drain. Failure to properly drain the engine and accessories may cause serious damage during freezing weather.
3. Immersion-type water and oil heaters are available for engines used in cold-weather operations and to maintain temperatures to permit the engine to operate at full load at start-up.

Engine Operation in Cold Weather

Satisfactory performance of a diesel engine operating in low ambient temperature conditions requires modification of the engine, surrounding equipment, operating practices and maintenance procedures. The colder the temperatures encountered the greater the amount of modification required and yet with the modifications applied, the engines must still be capable of operation in warmer climates without extensive changes. The following information is provided to engine owners, operators and maintenance personnel on how the modifications can be applied to get satisfactory performance from their diesel engines.

There are three basic objectives to be accomplished:

1. Reasonable starting characteristics followed by practical and dependable warm-up of the engine and equipment.
2. A unit or installation which is as independent as possible from external influences.
3. Modifications which maintain satisfactory operating temperatures with a minimum increase in maintenance of the equipment and accessories.

If satisfactory engine temperature is not maintained, higher maintenance cost will result due to the increased engine wear, poor performance and formation of excessive carbon, varnish and other deposits. Special provisions to overcome low temperatures are definitely necessary, whereas a change to warmer climate normally requires only a minimum of revision. Most of the accessories should be designed in such a way that they can be disconnected so there is little effect on the engine when they are not in use.

The two most commonly used terms associated with preparation of equipment for low temperature operation are "Winterization" and "Arctic Specifications"

Winterization of the engine and/or components so starting and operation are possible in the lowest temperature to be encountered requires:

1. Use of correct materials.
2. Proper lubrication, low temperature lubricating oils.
3. Protection from the low temperature air. The metal temperature does not change, but the rate of heat dissipation is affected.
4. Fuel of the proper grade for the lowest temperature.
5. Heating to be provided to increase the engine block and component temperature to a minimum of -25°F [-32°C] for starting in lower temperatures.
6. Proper external heating source available.
7. Electrical equipment capable of operating in the lowest expected temperature.

Arctic specifications refer to the design material and specifications of the components necessary for satisfactory engine operation in extreme low temperatures to -65°F [-54°C]. Contact Cummins Engine Company, Inc., or the equipment manufacturer to obtain the special items required.

For additional information on cold weather operation, obtain Service Bulletin No. 3379009 "Engine Operation in Cold Weather," from the nearest Cummins Distributor or dealer.

Caution: "Anti-leak" antifreezes are not recommended for use in Cummins Engines. Although these antifreezes are chemically compatible with DCA water treatment, the "anti-leak" agents may clog the coolant filters and render them ineffective.

Industrial Fire Pump Engines

Fire pump engines are built and applied under conditions set down by agencies such as Underwriters Laboratory and Factory Mutual Research; therefore, parts originally supplied must not be deviated from without qualifying agency approval. The following instructions are those special items necessary to this application, and should be used in conjunction with those previously stated.

Initial Start-Up

Note: Contact operating personnel responsible for fire protection system before starting. Obtain approval to service or repair. Make sure that the connecting lines to and from the fire pump are open and that there is water to the pump.

1. Close all cooling system drains.
2. Remove the heat exchanger cap, check or fill the engine coolant supply; open the water filter inlet and outlet valves.
3. Prelubricate the engine with oil meeting API Class CD or CC and viscosity of SAE 15W40 or 20W40. This includes removal of the turbocharger oil inlet line on turbocharged engines to prelubricate the housing by adding 2 to 3 oz. [60 cc] of clean engine lubricating oil.
4. Check the crankcase oil level and fill to the high mark on the dipstick.
5. Remove the fuel pump solenoid wire and crank the engine through two cranking cycles using the fire pump controller. Make sure that the fuel pump solenoid wire terminal does not touch the engine.
6. Turn the governor idle adjusting screw **counterclockwise** 6 turns. This will permit the engine to run at or near idle speed at the initial start-up.

   On turbocharged models, removal of the delay cylinder and bracket from the fuel pump will permit operation of the engine at idle speed.
7. Idle speed may be adjusted by turning the governor idle adjustment screw **counterclockwise** to decrease RPM or **clockwise** to increase RPM.
8. Verify that the lube oil system is under pressure.
9. Operate the engine for 8-10 minutes and look for leaks, unusual noises or other indications of improper operation. The engine should be run long enough to open the thermostat(s).
10. Set the overspeed stop switch. Refer to the sections on overspeed switches following this section.
11. Stop the engine and check the engine oil and expansion tank coolant levels. Top off if necessary. Clean the raw water strainer.
12. Start the engine and bring it to the fire pump required operating speed.
13. Adjust the raw water pressure regulator to obtain the required pressure.
14. Readjust the engine speed if necessary.
15. Once engine speed and water pressure are set, lock the governor lever in position on naturally aspirated models, and the max speed screw on turbocharged models.
16. Shut off the engine. Contact operating personnel responsible for fire protection system that engine is ready for service. Obtain authorized signature of acceptance.

Normal Operation

The engine should be exercised at least once a month unless the insurers or owners require more frequent running. The engine should be run for at least the period of time prescribed by the insuring agency, or for 5 minutes after stabilization of the coolant temperature before stopping. The engine is started and stopped under load on some installations. On engines wired to wiring diagram 3031644, the high water temperature alarm may activate after stopping due to afterboiling. Wiring diagram 3031644 has been superceded by wiring diagram 3036570 to eliminate this condition. Refer to the "Engine Wiring Diagrams" section for information on wiring diagram 3036570.

In addition to engine operation, routine examination of the engine should be made to see that oil and water levels are maintained, and that the battery specific gravity remains within the battery manufacturer's specifications.

Stopping the Engine

The engine can be stopped completely by turning off the switch on the controller. Turning off the switch stops the engine unless the override knob (1, Fig. 1-13) on the fuel pump shutoff valve has been locked in the open position. If the manual override knob on the shutoff valve is being used, turn the knob fully **counterclockwise** to stop the engine. Turn the controller switch to "auto" before leaving the engine so that it will be ready to start automatically if there should be a demand.

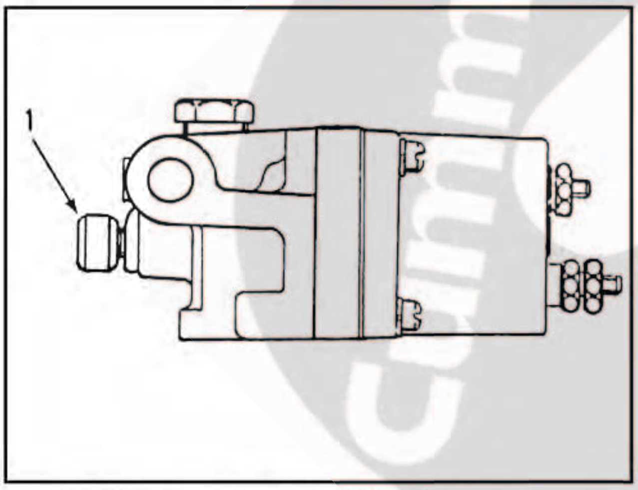


Fig. 1-13, (OM21000). Fuel pump shutoff valve knob

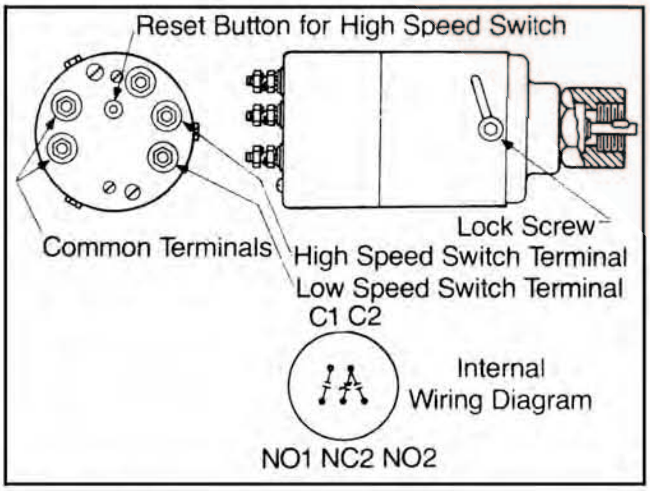


Fig. 1-14, (CGS27). Mechanical overspeed switch

Mechanical Overspeed Switch

Some fire pump engines are equipped with a mechanical overspeed switch, Fig. 1-14.

An ST-1224 tachometer drive adapter with 2:1 ratio, in speed switch drive only, (Fig. 1-15) is available to drive the speed switch at twice the engine speed. This tool when installed in place of the existing adapter permits adjustment to be made to the speed switch at slightly over 1/2 engine and pump speed. This maintains a pump speed well within its safe speed range while the adjustments are being made.

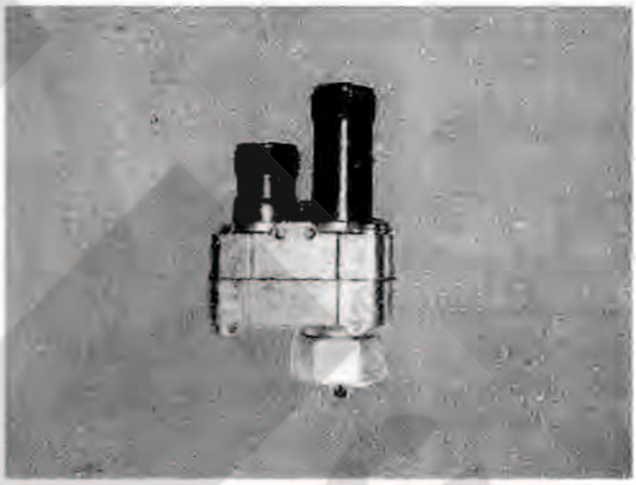


Fig. 1-15 (ST-1224). ST-1224 Tachometer drive adapter

Table 1-3 lists commonly used fire pump required speeds and the corresponding engine overspeed switch set when using the ST-1224. The overspeed switch **must** be set to shut off the engine at a speed 20 percent above the required speed of the fire pump that it is driving. To calculate the overspeed switch set speed for a fire pump required speed not listed in the table, use the following equation when using the ST-1224:

$$\text{OVERSPEED SWITCH SET SPEED} = \frac{\text{FIRE PUMP REQUIRED SPEED} \times 120\%}{2}$$

Example: To calculate the overspeed switch set speed for a fire pump required speed of 2100 RPM when using the ST-1224 (2:1 ratio).

$$\text{OVERSPEED SWITCH SET SPEED} = \frac{2100 \times 120\%}{2} = \frac{2520}{2} = 1260 \text{ RPM}$$

Table 1-3: Engine Overspeed Settings (RPM)
Mechanical Overspeed Switch

Fire Pump Required Speed	Overspeed Switch Set Speed *	Fire Pump Required Speed	Overspeed Switch Set Speed *
1460	875	2300	1380
1750	1050	2400	1440
1900	1140	2600	1560
2000	1200	2800	1680
2100	1260	3000	1800
2200	1320	3300	1980

* Using ST-1224

Adjustment Procedure

Engines equipped with mechanical speed switches should be adjusted in accordance with this procedure:

1. Remove the tachometer drive adapter.
2. Install the ST-1224, in position of the standard drive adapter. Connect the tachometer and overspeed stop switch to the ST-1224.

Note: The overspeed stop switch cable must be connected to the short adapter connection (1, Fig. 1-26).

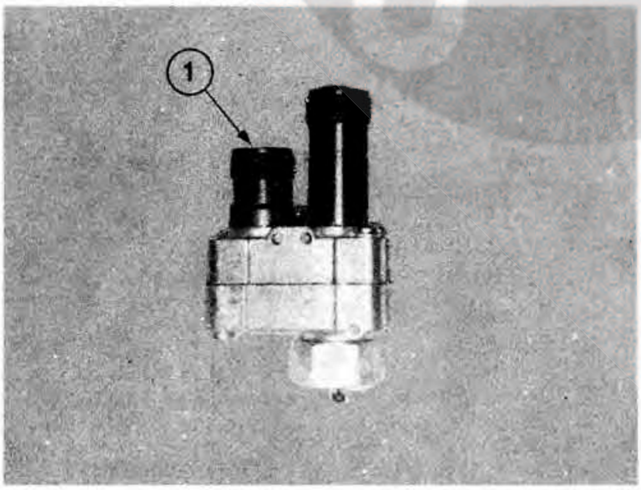


Fig. 1-26 (ST-1224). ST-1224 Adapter

3. Start the engine and warm to operating temperature.
4. Set the engine speed to the appropriate overspeed switch set speed in Table 1-3 as indicated by the tachometer.

   a. On engines without a throttle delay cylinder, the speed adjustment **must** be made by adjusting the governor idle and maximum speed screws. The idle screw (1) is housed in the back of the governors. The maximum speed screw (2) is at right angles to the idle speed screw. See Figures 1-17 and 1-18. Engine slow down is accomplished by turning the idle screw **counterclockwise** and turning the maximum speed screw in a **clockwise** direction. To increase the engine speed reverse the procedure.

Fig. 1-17 (OM21001). PT (type G) Fuel pump with VS governor

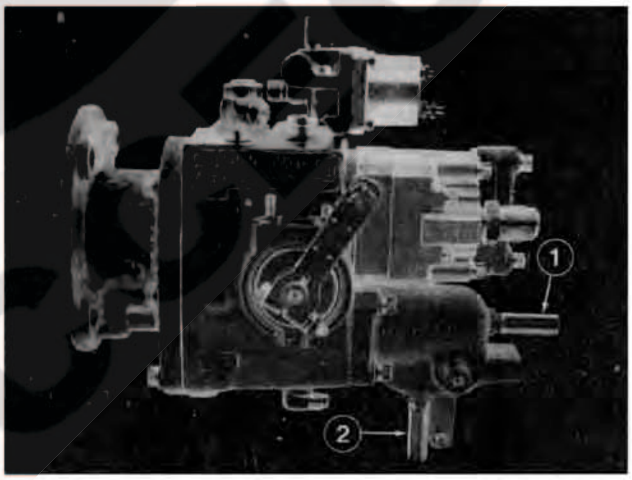


Fig. 1-18 (OM21002). PT (type R) fuel pump with MVS governor

   b. On engines with a throttle delay cylinder, remove the delay cylinder bracket so that the throttle can be advanced manually to the desired speed.

5. Set the overspeed switch by the following procedure:

Caution: Do not break or remove the lockwire.

a. Remove the round head dust cover screw marked 2 from the top of the switch, Figure 1-19.

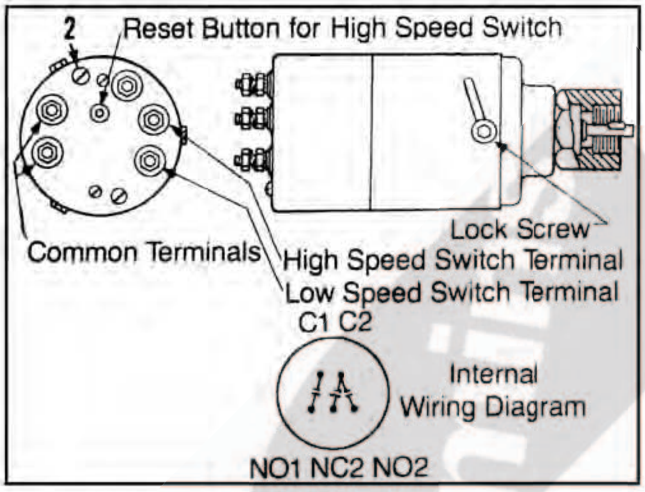


Fig. 1-19 (OM21003). Double speed switch

b. Insert a 1/16 inch hex allen wrench into the adjusting screw located just below the surface of the cover.

c. Turn the adjusting screw **counterclockwise** to lower the engine shut off speed. Turn the screw **clockwise** to raise the engine shut off speed.

Caution: Do not turn the adjusting screw more than three (3) revolutions in either direction from the factory setting.

d. Replace the dust cover screw removed in "Step a" above.

e. All fire pump overspeed switches **must** be manually reset; reactivate the switch by pushing the reset button on top of the switch.

6. Replace the ST-1224, with the original drive adapter and reconnect the cables.

Note: If the stop crank adjustment is required, do not use the ST-1224. Use the standard tachometer drive adapter when making the adjustment.

Table 1-4: Electronic Overspeed Switches

Manufacturer	Dynalco	Barber-Colman	Synchro-Start
Color	Green	Blue	Black
Overspeed Switch	3011357	3011357	3011574
Magnetic Pickup	3034572	3034572	—
Signal Generator	—	—	3011575
Tachometer	3031734	3031734	3019895
Test Method	Test Button	Test Button	Jumper Wire "C" to "L"
Trips at (Test)	60% of Rated Overspeed	60% of Rated Overspeed	66% of Rated Overspeed

Industrial Fire Pump Engine Maintenance Schedule

EQUIPMENT NO. ____________ ENGINE SERIAL NO. ____________
MECHANIC ____________ HOURS, CALENDAR ____________
TIME SPENT ____________ CHECK PERFORMED ____________
PARTS ORDER NO. ____________ DATE ____________

CUMMINS DIESEL FIRE PUMP ENGINES

Check each operation as performed.

A—CHECK	B—CHECK	C—CHECK	D—CHECK	SEASONAL	OTHER
Daily ☐ Check engine operating log ☐ Check engine: • oil level • coolant level ☐ Check engine lubricating oil and coolant heaters * • oil bath cleaner oil level ☐ Visually inspect engine for damage, leaks, loose or frayed belts **Weekly** ☐ Repeat Daily "A" Check ☐ Check air cleaner • clean precleaner dust pan • check restriction indicator • clean/change air cleaner element * • change oil bath cleaner oil ☐ Drain water/sediment from fuel tanks & fuel filters ☐ Check raw water strainer ☐ Check starter battery ☐ Start engine & check for unusual noise	**Repeat "A" (Daily/Weekly)** ☐ Change engine oil ☐ Change filters • oil full flow • fuel filter ☐ Check coolant • check engine coolant DCA concentration level. Add make-up DCA and change element ☐ Clean/change • crankcase breather * Clean oil bath air cleaner tray/screen	**Repeat "A" & "B"** ☐ Adjust valves & injectors * Clean oil bath air cleaner	**Repeat "A", "B" & "C"** ☐ Clean & calibrate injectors, fuel pump ☐ Check and/or rebuild and/or replace the following assemblies: • turbocharger • vibration damper ☐ Rebuild or replace the following assemblies: • water pump ☐ Clean & flush cooling system	**Fall** ☐ Replace hose as required ☐ Check cold start & thermal aids ☐ Clean electrical connections and check batteries ☐ Clean engine water heater **Spring** ☐ Steam clean engine ☐ Tighten mounting bolts ☐ Check crankshaft end clearance ☐ Check heat exchanger zinc plugs annually or as required ☐ Check overspeed switch	**Electrical Components** ☐ + Starter ☐ + Alternator ☐ + Batteries ☐ + Voltage regulator ☐ + Switches ☐ + Gauges ☐ + Tachometer ☐ + On these components follow the manufacturer's procedure
Engine Series **Interval**	B	C	D		
All Hours Calendar	250 6 mos.	1500 1 year	4500 2 years		

Note: Under circumstances where hours of operation are not accumulated at a fast rate, use calendar time. In other words, use hours, or calendar time, whichever comes first.

***Cummins Engine Company, Inc., recommends the use of dry type air cleaners.**

Maintenance

Maintenance is the key to lower operating costs. A diesel engine requires regularly scheduled maintenance to keep it running efficiently.

Maintenance Schedule

Preventive maintenance is the easiest and least expensive type of maintenance. It permits the Maintenance Department to do the work at a convenient time.

A Good Maintenance Schedule Depends On Engine Application

Actual operating environment of the engine governs the maintenance schedule. The suggested check sheet on the following page indicates some checks have to be performed more often under heavy dust or other special conditions.

Using the Suggested Schedule Check Sheet

The maintenance schedule check sheet is designed as a guide until adequate experience is obtained to establish a schedule to meet a specific operation.

A detailed list of component checks is provided through several check periods; also a suggested schedule basis is given for hours of operation, or calendar of time.

A maintenance schedule should be established using the check sheet as a guide; the result will be a maintenance program to fit a specific operation.

The check sheet shown can be reproduced by any printer. The person making each check can then indicate directly on the sheet that the operation has been completed. When a complete column (Under A, B, C, etc.) of checks is indicated, the engine will be ready for additional service until the next check is due.

Storage for Engines Out of Service

If an engine remains out of service and its use is not immediately forthcoming, special precautions should be taken to prevent rust. Contact the nearest Cummins Distributor or consult applicable Shop Manual for information concerning engine storage procedure.

Maintenance Performance Record

Engine Serial No. ____________________ Engine Model ____________________

Owner Name ____________________ Equipment Name/Number ____________________

Interval Basis Mileage	[Kilometres]	Check	Mileage	[Kilometres]	Check	Other	Date	Actual Mileage	Distributor/Dealer Location/Shop	Authorized Signature
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B, C								
		A, B			A, B, C					
		A, B			A, B					
		A, B			A, B					
		A, B			A, B					
		A, B, C			A, B					
		A, B								
		A, B			A, B, C					
		A, B			A, B					
		A, B			A, B					
		A,B,C,D			A, B					
		A, B			A, B					
		A, B			A,B,C,D					

To prove that the Engine has been properly maintained retain records, such as work orders and receipts, showing that scheduled maintenance has been performed. The maintenance record form on this page is for that purpose.

Scheduled Maintenance

Schedule I, Schedule II

The following maintenance schedules should be used to establish maintenance practices for Cummins standby (GS) or continuous duty (GC) generator sets.

Schedule I is used with standby applications. Many of these installations are regulated by NFPA and/or local codes (reference NFPA No. 76A).

Standby rated generator sets are for supplying electric power in the event of normal utility power failure. No overload capability is available for this rating. This rating may be used for continuous service for as long as the emergency may last. This rating conforms with the BS 649:1958 overload rating and DIN "B" 6270.

Schedule II is used with continuous duty applications.

Continuous duty rated generator sets are for supplying electric power in lieu of commercially purchased power. Intermittent overloads up to the standby rating are allowable. This rating may be used for continuous service in commercial applications and it conforms with BS 649:1958 and DIN "A" 6270 for generator set applications.

Using The Suggested Schedule Check Sheet

Actual operating environment of the engine governs the maintenance schedule. The suggested check sheet on the following page indicates some checks have to be performed more often under heavy dust or other special conditions.

The maintenance schedule check sheet is designed as a guide until adequate experience is obtained to establish a schedule to meet a specific operation.

A detailed list of component checks is provided through several check periods; also a suggested schedule basis is given for hours of operation, or calendar of time.

A maintenance schedule should be established using the check sheet as a guide; the result will be a maintenance program to fit a specific operation.

Cummins Standby Generator Sets

Cummins standby generator sets may be required to start and come on line in 10 seconds or less.

These engines must be equipped with engine coolant heaters capable of maintaining coolant temperature at a minimum of 100°F [38°C].

Engines subject to ambient temperatures less than 70°F [21°C] must also be equipped with a lubricating oil heater. When using a lubricating oil heater immersed in oil, the maximum surface of heater in contact with oil, should be less than 300°F [149°C] to minimize formation of hard carbon on the heating element.

Recommended wattage for the heaters when the unit is in a protected area or in an enclosure are shown in Bulletin No. 3379009, in Section 7 Miscellaneous.

Standby units should be operated once a week under a minimum of 25% of rated KW load for at least thirty minutes. During this test, the engine must reach normal operating temperature.

Cummins Continuous Duty Generator Sets

Continuous duty generator sets may be equipped with a cold starting aid. Maintenance procedures for these devices can be found in the seasonal maintenance section.

Stand-By Generator Set Maintenance

Engine Systems

		Checks	A			B	
			Daily	Weekly	Monthly	6 Mos./ 250Hrs	Annual
Lubricating	Check:	— For Leaks	•	•	•	•	•
		— Operation of Oil Heater	•	•	•	•	•
		— Engine Oil Level		•	•	•	•
		— Hydraulic Governor Oil Level		•	•	•	•
	Change:	— Full Flow Filter				•	•
		— By-Pass Filter				•	•
		— Engine Oil				•	•
		— Hydraulic Governor Oil				•	•
Cooling	Check:	— For Leaks	•	•	•	•	•
		— For Radiator Air Restriction			•	•	•
		— Operation of Coolant Heater	•	•	•	•	•
		— Hose and Connections			•	•	•
		— Coolant Level		•	•	•	•
		— Anti-Freeze and DCA Concentration			•	•	•
		— Belt Condition and Tension			•	•	•
		— Fan Hub, Drive Pulley and Water Pump					•
		— Heat Exchanger Zinc Anode Plugs				•	•
		— Motor Operated Louvers			•	•	•
	Change:	— DCA Water Filter				•	•
	Clean:	— Cooling System					•
Air Intake	Check:	— For Leaks			•	•	•
		— Air Cleaner Restriction		•	•	•	•
		— Piping and Connections				•	•
	Clean:	— Crankcase Breather				•	•
		— Or Change Air Cleaner Element				•	•
Fuel	Check:	— For Leaks	•	•	•	•	•
		— Fuel Level			•	•	•
		— Governor Linkage				•	•
		— Fuel Lines and Connections				•	•
		— Fuel Transfer Pump			•	•	•
	Drain:	— Sediment from Tanks				•	•
	Change:	— Fuel Filters				•	•
		— Float Tank Breather					•
Exhaust	Check:	— For Leaks			•	•	•
		— For Exhasut Restriction			•	•	•
	Drain:	— Condensate Trap			•	•	•
	Torque:	— Exhaust Manifold and Turbocharger Capscrews					•
Electrical	Check:	— Battery Charging System		•	•	•	•
		— Battery Electrolyte Level and Specific Gravity			•	•	•
		— Safety Controls and Alarms				•	•
Engine Related	Check:	— For Unusual Vibration		•	•	•	•
		Tighten Mounting Hardware					•
	Clean:	— Engine					•
Main Generator	Check:	— Air Inlet and Outlet for Restriction			•	•	•
		— Windings and Electrical Connections					•
		— Operation of Generator Heater Strips					•
	Grease:	— Bearing					•
		Measure and Record Generator Winding Resistance					•
	Check/Clean:	— Generator				•	•
Switchgear	Check:	— Start Switch in Automatic	•	•	•	•	•
		— Instrumentation					•
		— Power Distribution Wiring and Connections				•	•
		— Power Circuit Breaker				•	•
		— Transfer Switch				•	•
Operational Procedures	Perform:	— Operational Load Test		•	•	•	•
		— Generator Load Bank Test					•
	Check:	— Service Tool Availability			•	•	•

Continuous Duty Generator Set Maintenance

Engine Systems

System	Action	Item	A Daily	B 6 Mos./ 250Hrs	C 1 Year 1500Hrs	D 2 Year 4500Hrs	Annual
Lubricating	Check:	— For Leaks	●	●	●	●	●
		— Operation of Oil Heater					●
		— Engine Oil Level	●	●	●	●	●
		— Hydraulic Governor Oil Level	●	●	●	●	●
	Change:	— Full Flow Filter		●	●	●	●
		— By-Pass Filter		●	●	●	●
		— Engine Oil		●	●	●	●
		— Hydraulic Governor Oil		●	●	●	●
Cooling	Check:	— For Leaks	●	●	●	●	●
		— For Radiator Air Restriction	●	●	●	●	●
		— Operation of Coolant Heater					●
		— Hose and Connections	●	●	●	●	●
		— Coolant Level	●	●	●	●	●
		— Anti-Freeze and DCA Concentration		●	●	●	●
		— Belt Condition and Tension	●	●	●	●	●
		— Fan Hub, Drive Pulley, and Water Pump		●	●	●	●
		— Heat Exchanger Zinc Anode Plugs					●
	Change:	— DCA Water Filter		●	●	●	●
	Clean:	— Cooling System					●
Air Intake	Check:	— For Leaks	●	●	●	●	●
		— Air Cleaner Restriction	●	●	●	●	●
		— Piping and Connections		●	●	●	●
	Clean:	— Crankcae Breather		●	●	●	●
		— Or Change Air Cleaner Element		●	●	●	●
Fuel	Check:	— For Leaks	●	●	●	●	●
		— Governor Linkage		●	●	●	●
		— Fuel Lines and Connections		●	●	●	●
	Drain:	— Sediment from Tanks	●	●	●	●	●
	Change:	— Fuel Filters		●	●	●	●
	Clean:	— Float Tank Breather		●	●	●	●
		— and Calibrate Injectors				●	
		— and/or Calibrate Fuel Pump				●	
		Adjust Injectors and Valves			●	●	
Exhaust	Check:	— For Leaks	●	●	●	●	●
		— For Exhaust Restriction			●	●	
	Clean:	— Turbocharger Comp. Wheel and Diffuser				●	
	Check:	— Turbocharger Bearing Clearances				●	
		— Torque Exhaust Monifold and Turbocharger Capscrews			●	●	
Engine Related	Check:	— For Unusual Vibration	●	●	●	●	●
		— Vibration Damper				●	
		— Crankshaft End Play				●	
		Tighten Mounting Hardware				●	
	Clean:	— Engine					●
	Grease:	— Fan Pillow Block Bearings		●	●	●	●
Electrical	Check:	— Battery Charging System					●
		— Battery Electrolyte Level					
		Specific Gravity		●	●	●	●
		— Glow Plug					●
		- And Clean Magnetic Pickup Unit			●	●	
		— Safety Control and Alarms			●	●	
Main Generator	Check:	— Air Inlet and Outlet for					
		Restriction	●	●	●	●	●
		— Windings and Electrical Connections	●	●	●	●	●
		— Operation of Generator Heater Strips					●
	Grease:	— Bearing			●	●	
	Clean:	— Generator					●
Switchgear	Check:	— Power Distribution Wiring					
		and Connections	●	●	●	●	●
		— Power Circuit Breaker			●	●	
		— Transfer Switch			●	●	
Operational Procedures	Perform:	Generator Load Bank Test					●

"A" Maintenance Checks—Daily

Make a Daily Report of Engine Operation to the Maintenance Department

The engine must be maintained in top mechanical condition if the operator is to get optimum satisfaction from its use. The maintenance department needs daily running reports from the operator to make necessary adjustments in the time allotted and to make provisions for more extensive maintenance work as the reports indicate the necessity.

Comparison and intelligent interpretation of the daily report along with a practical follow-up action will eliminate most failures and emergency repairs.

Report to the Maintenance Department any of the following conditions:

1. Low lubricating oil pressure.
2. Low power.
3. Abnormal water or oil temperature.
4. Unusual engine noise.
5. Excessive smoke.
6. Excessive use of coolant, fuel or lubricating oil.
7. Any fuel, coolant or lubricating oil leaks.

Check Engine

Check Engine Oil Level

Note: Some dipsticks have dual markings, with high- and low-level marks: static oil marks on one side, engine running at low idle speed marks on opposite side. Be sure to use the proper scale.

1. Check the oil level with the dipstick oil gauge located on the engine. Fig. 2-1. For accurate readings, the oil level should not be checked for approximately 15 minutes after the engine is shut-down. Keep the dipstick with the oil pan with which it was originally shipped. Keep the oil level as near the "H" (high) mark as possible.

Caution: Never operate the engine with the oil level below the "L" (low) mark or above the "H" (high) mark.

2. If necessary, add oil of the same quality and brand as already in the engine. See Section 3.

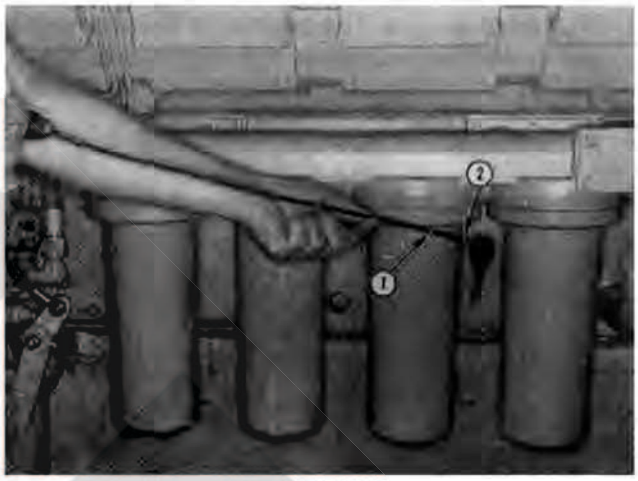


Fig. 2-1. Checking engine oil level

Check Engine Coolant Level

Keep the cooling system filled to the operating level. Check the coolant level daily or at each fuel fill point. Investigate for causes of coolant loss. Check the coolant level only when the system is cool.

Check Belts

Visually check belts for looseness. If there is evidence of belt slippage adjust as follows:

Using the appropriate gauge, Fig's. **2-2** and **2-3**, check and/or adjust belts to the tension as indicated in Table **2-1**.

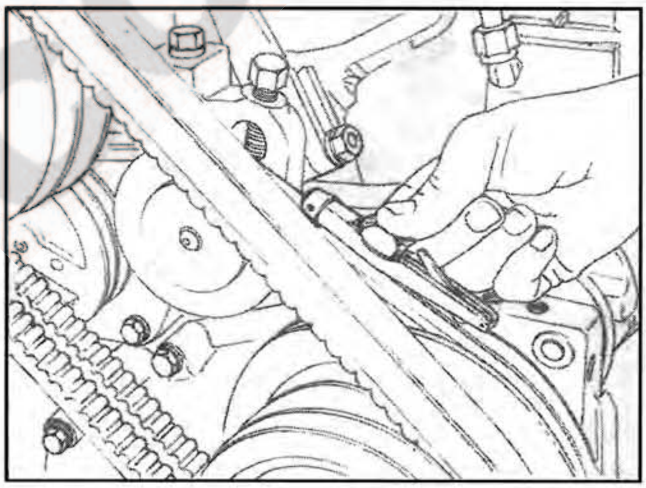


Fig. **2-2**, (OM1014L). Checking belt tension with a Krikit gauge

Table 2-1: Belt Tension (Lbs.)

Belt Width Inches	Belt Gauge	New Belt Tension Minimum-Maximum	• Used Belt Installation Tension* • If Below Min. Tension, Retension to Maximum Tension Minimum-Maximum
.380	ST-1274	140-150	60 - 100
.440	CAN-292	140-150	60 - 100
1/2		140-150	60 - 100
11/16		160-170	60 - 100
3/4	ST-1138	160-170	60 - 100
7/8		160-170	60 - 100
K-Sect. 5 Rib V-Ribbed	ST-1293	125-135	60 - 100
K-Sect. 6 Rib V-Ribbed	ST-1293	150-160	70 - 120
K-Sect. 10 Rib V-Ribbed	N/A	250-260	140 - 200
L-Sect. 16 Rib V-Ribbed	3376344	450-500	300 - 400

* Used belts should be retensioned to values listed in this column.

Note: A belt is considered used if it has been in operation for at least 10 minutes.

Note: Belts with self tensioning idlers require no adjustment or tension check.

Note: When using the "Krikit" gauge the correct belt tension reading for the belt tested must be read at the point where the **top** of the black indicator arm crosses the bottom numbered scale. Position the gauge in the center of the belt between two pulleys. The flange at the side of the gauge should be flat against the edge of the belt.

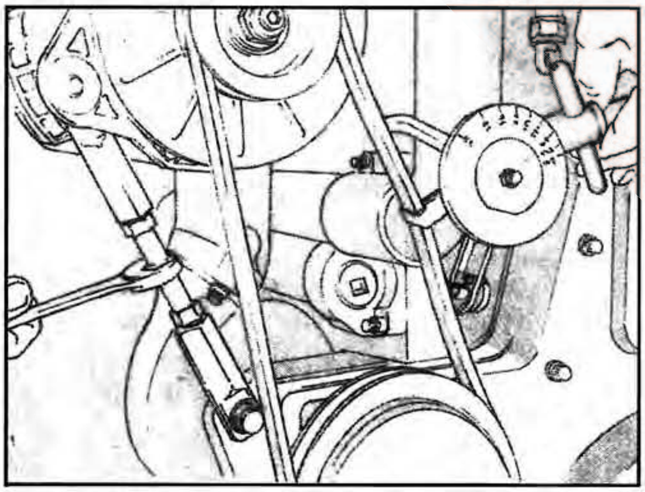


Fig.2-3,(OM1015L). Adiusting belt tension with ST-1293

Inline Engine Water Pump Belts (No Idler)

1. Eccentric water pump adjustment.
   a. Loosen the water pump clamp ring to allow the pump body to turn.
   b. Loosen the pump body by pulling up on the belts. A sharp jerk may be required.
   c. Insert a bar in the water pump body slots and rotate the pump body counterclockwise to tighten the belts.

Note: Do not adjust to final tension at this time.

   d. Snug the clamp ring capscrew farthest from the belts, on the exhaust side to 5 ft-lbs [7 N•m].
   e. Snug the two capscrews above and below the first one to 5 ft-lbs [7 N•m].
   f. Finish tightening by alternating from side to side in 5 ft-lbs [7 N•m] increments to a final torque of 12 to 15 ft-lbs [16 to 20 N•m].
   g. Check the belt tension.

Final belt tension was not obtained by adjustment alone. The water pump body was pulled straight by snugging the capscrews in the order described, thus increasing the belt tension to the final value.

Fan Drive Belts

1. Loosen the large locking nut on the fan hub shaft or the capscrews securing the fan hub shaft to the mounting bracket. The fan hub will fall out of line when this is done.
2. Turn the adjusting screw to increase the belt tension.
3. Tighten the locknut or capscrews until the fan hub is straight. Snug the nut to maintain the hub in proper alignment with the fan hub bracket.

Caution: Do not adjust to full tension with the adjusting screw, as this would result in overtightening.

4. Belt tension should read as indicated in Table 2-1 on applicable gauge.

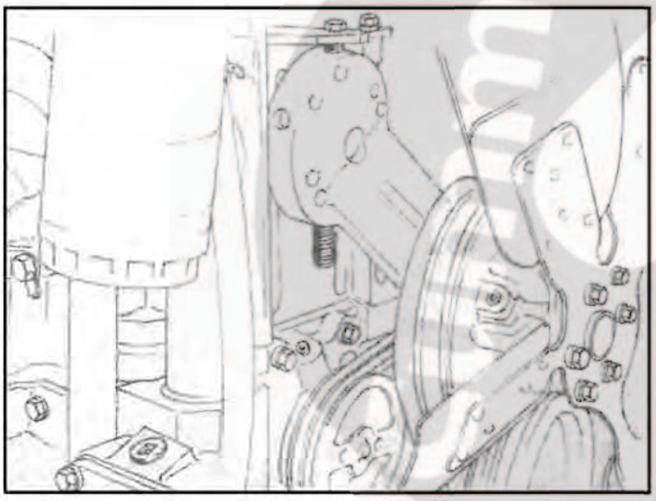


Fig. 2-4, (OM1016I). Fan hub installation, NTC-350 FFC

5. Recheck the belt tension.
6. Back out the adjusting screw one-half turn to prevent breakage.

Note: The self tensioning backside idler on KT/KTA38 and KTA50 belt driven fan requires no belt tension check.

Generator/Alternator Belts

Belt tension should be as indicated in Table 2-1 when measured with the applicable gauge.

Belt Installation

If the belts show wear or fraying, replace as follows:

1. Always shorten the distance between the pulley centers so the belt can be installed without force. Never roll a belt over the pulley and never pry it on with a tool such as a screwdriver. Either of these methods will damage the belts and cause early failure.
2. Always replace the belts in complete sets. Belts riding depth should not vary over 1/16 in. [1.6 mm] on matched belt sets.
3. Pulley misalignment must not exceed 1/16 in [1.6 mm] for each ft [0.3 m] of distance between the pulley centers.
4. Belts should not bottom on the pulley grooves nor should they protrude over 3/32 in [2.4 mm] above the top edge of the groove, or 1/32 in [0.8] below the top edge of the groove.
5. Do not allow belts to rub any adjacent parts.
6. Adjust belts to the proper tension.

Readjusting New Belts

All new belts will loosen after running for 10 minutes and must be retensioned if necessary. Ref. Table 2-1.

Check for Damage

Visually check the fuel system, etc., for misadjustment or tampering; check all connections for leaks or damage. Check the engine for damage; correct as necessary.

"A" Maintenance Checks—Weekly

Repeat Daily Checks

Check Air Cleaner

Clean Pre-Cleaner and Dust Pan

Under extremely dirty conditions an air pre-cleaner may be used. Clean the pre-cleaner jar and dry-type air cleaner dust pans daily or more often, as necessary, depending on operating conditions.

Check Inlet Air Restriction

Mechanical Indicator

A mechanical restriction indicator is available to indicate excessive air restriction through a dry-type air cleaner. This instrument can be mounted in the air cleaner outlet or on the vehicle instrument panel. The red flag (1, Fig. 2-5) in the window gradually rises as the cartridge loads with dirt. After changing or replacing the cartridge, reset the indicator by pushing the reset button (2).

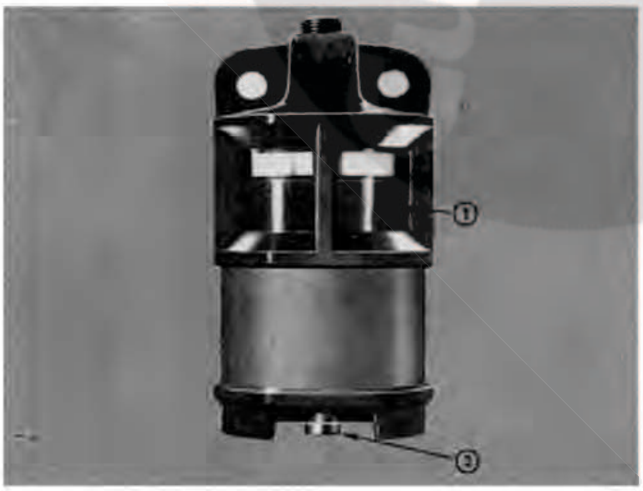
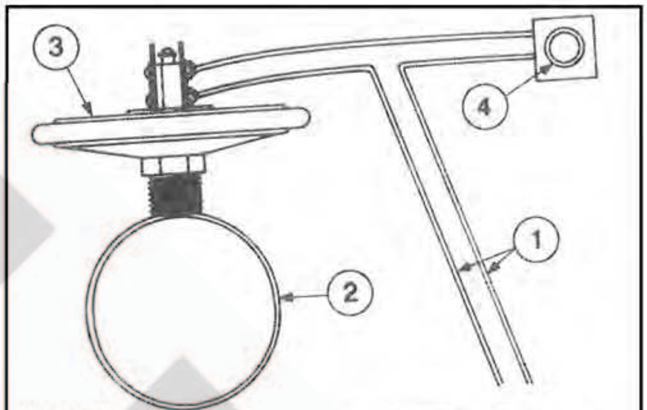


Fig. 2-5, (CGS-20). Air inlet restriction indicator

Note: Never remove the felt washer from the indicator. It is necessary to absorb moisture.

Vacuum Indicator

Vacuum switches, Fig. 2-6, are available which actuate a warning light on the instrument panel when the air restriction becomes excessive.



1. Wiring
2. Piping
3. Vacuum Switch
4. Warning Light

Fig. 2-6, (N21905). Vacuum switch to check air inlet

1. Air restriction on turbocharged engines must not exceed 25 inches [635 mm] of water or 1.8 inches [46 mm] of mercury under full power conditions.
2. Naturally aspirated engine air restriction must not exceed 20 inches [508 mm] of water or 1.5 inches [38 mm] of mercury at air intake manifold at rated speed.

Clean or Replace Air Cleaner Elements

The paper element in a dry-type air cleaner, Fig's. 2-7, 2-8, 2-9 and 2-10, may be cleaned several times by using compressed air to blow off dirt, approximately 30 psi [207 kPa]. Do not hold the air jet too close to the paper element.

Elements that have been cleaned several times will finally clog and air flow to the engine will be restricted. After cleaning, check the restriction as previously described and replace the element if necessary.

Caution: Holes, loose end seals, dented sealing surfaces and other forms of damage render the cleaner inoperative and require immediate element replacement.

To change the element:

1. Loosen the wing nut (1, Fig. 2-7) securing the bottom cover (2) to the cleaner housing (3). Remove the cover.

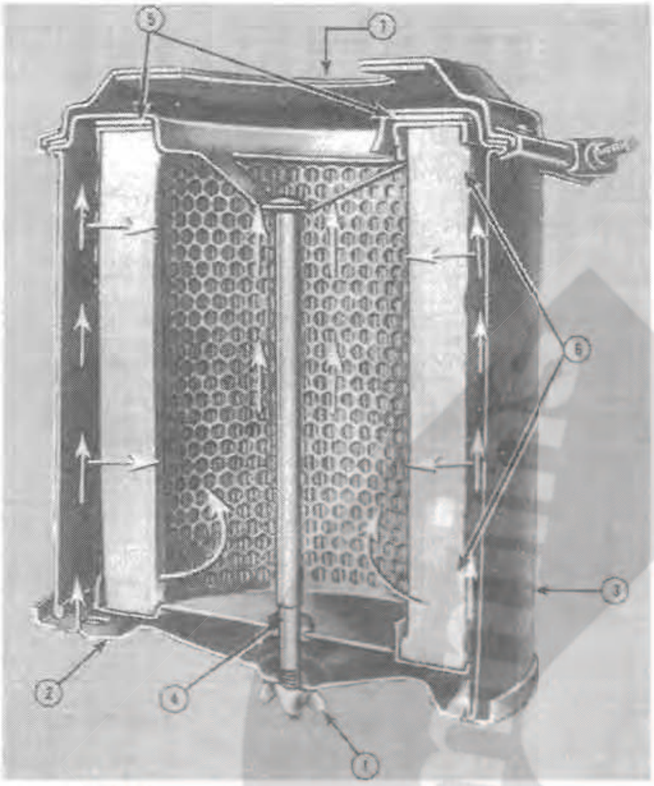


Fig. 2-7, (OM1028L). Air cleaner—dry type

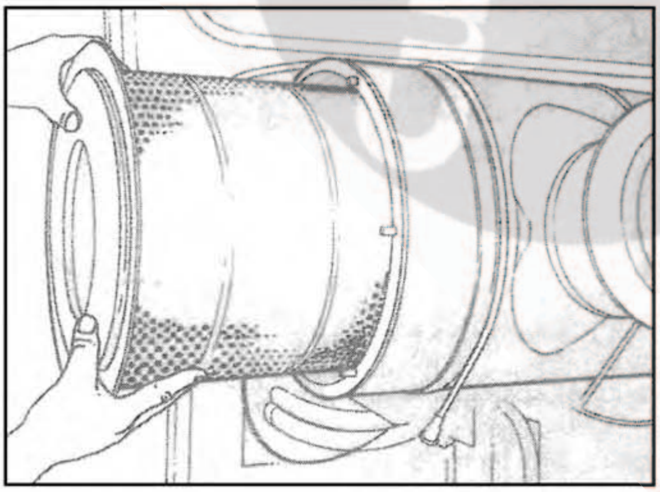


Fig. 2-8 , (OM1031L). Changing air cleaner element

2. Pull the element (6) down from the center bolt (4).

Caution: Pull the cover and the element straight out when removing them from the housing, Fig. 2-10, to avoid damage to the element.

3. Remove the gasket (5) from the outlet end (7) of the housing.

When installing the element, make sure it seats on the gasket at the air cleaner outlet end.

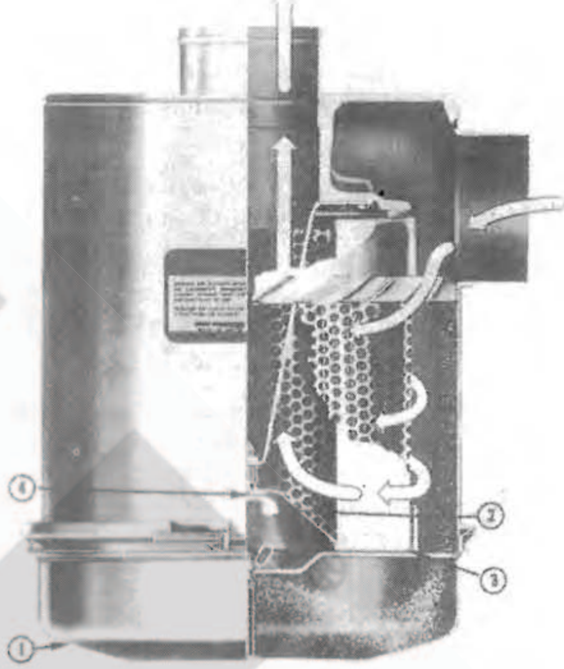


Fig. 2-9 , (OM1029L). Air cleaner—heavy duty

Fig. 2-10, (OM1030L). Air cleaner—heavy duty dual element

Heavy Duty Dry-Type Air Cleaners

Heavy duty air cleaners (single and dual types) combine centrifugal cleaning with element filtering, Fig's. **2-9** and **2-10**, before air enters the engines.

Before disassembly, wipe dirt from the cover and the upper portion of the air cleaner. To clean single or dual types:

1. Loosen the wing bolt, remove the band securing the dust pan (1, Fig. **2-9**), (2, Fig. **2-10**).
2. Loosen the wing nut (2, Fig. **2-9** and 3, Fig. **2-10**), remove the dust shield (3, Fig. 2- **9**), (4, Fig. 2- **9**), from the dust pan (1, Fig. 2- **9**), (2, Fig. 2-**10**). Clean the dust pan and shield.
3. Remove the wing nut (2, Fig. 2- **9**), (5, Fig. 2-**10**) securing the air cleaner primary element (6, Fig. 2-**10**) in the air cleaner housing, inspect the rubber sealing washer on the wing nut (4, Fig. 2- **9**), (5, Fig. 2-**10**).
4. Blow out the element from the clean air side with compressed air not exceeding 30 psi [207 kPa].
5. Inspect the element after cleaning.
6. Install a new or the cleaned primary element.
7. Be sure the gasket washer is in place under the wing nut before tightening.
8. Reassemble the dust shield and dust pan, position them to the air cleaner housing and secure with the band.
9. On the dual element type Cyclopac cleaner:
   a. Check the air restriction indicator. If the air restriction is excessive, disassemble the air cleaner, remove the wing nut (8, Fig. **2-10**), and replace the safety element (9).
   b. Reassemble the air cleaner as described in "Steps 8 and 9" above.

Cartridge Type Air Cleaner Element

1. Loosen the wing nuts (4, Fig. 2-**11** or 2-**12**) on the air cleaner housing (5) to remove the pre-cleaner panel with the dust bin (1). To remove the pre-cleaner panel (2) equipped with an exhaust aspirator loosen the "U" bolt clamp securing the pre-cleaner to the aspirator tubing.
2. Remove the dirty Pamic cartridge (3), by inserting your fingers in the cartridge opening (loosen all four corners of the cartridge, one at a time) and pulling it straight out.

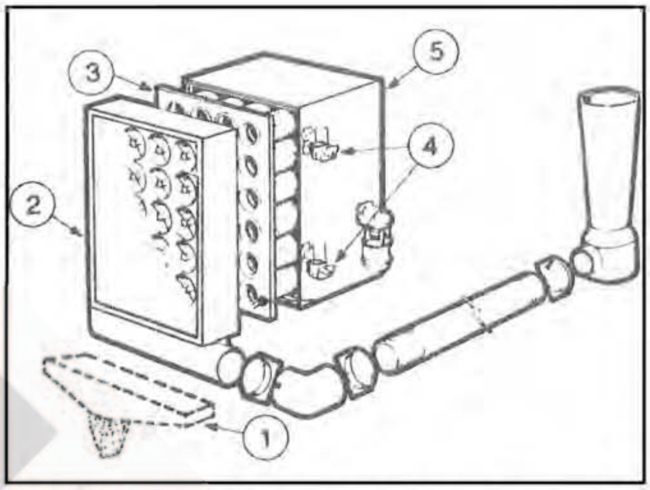


Fig. **2-11**, (N21026). Air cleaner — cartridge type (two stage)

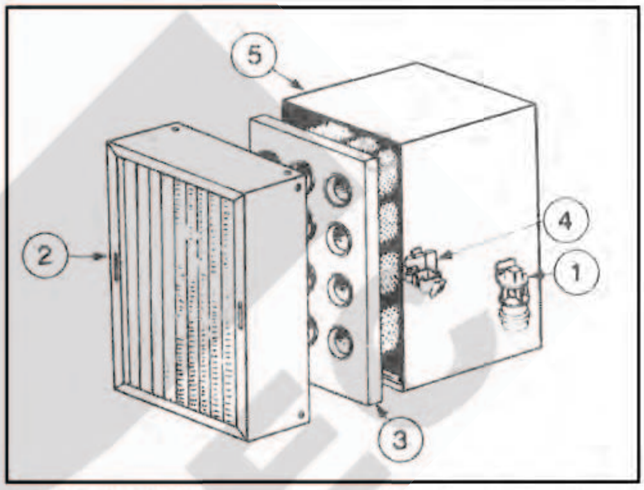


Fig. **2-12**, (V11009). Air cleaner — cartridge type (single stage)

With the larger cartridge, it may be necessary to break the seal along the edges of the cartridge. After the seal has been broken, pull the cartridge straight out and slightly up so the cartridge will clear the sealing frame and edges of the air cleaner housing.

Cleaning and Inspection

1. Clean the pre-cleaner openings (2) of all soot, oil film and any other objects that may have become lodged in the openings. Remove any dust or dirt in the lower portion of the pre-cleaner and aspirator tubing. Inspect the inside of the air cleaner housing for foreign material.
2. Inspect the dirty cartridge for soot or oil. If there is soot inside the Pamic tubes, check for leaks in the engine exhaust system, exhaust "blow-back" into the air intake and exhaust from other equip-

ment. If the cartridge appears "oily", check for fumes escaping from the crankcase breather. Excessive oil mist shortens the life of any dry-type cartridge. Troubleshooting at this point can appreciably lengthen new cartridge life.

3. It is not recommended to clean and reuse the cartridge. When returned to service, life expectancy of a paper cartridge will be only a fraction of the original service life.
4. Inspect clamps and flexible hose or tubing to be sure all fittings are air tight on cleaners with exhaust aspirators.
5. The pre-cleaner dust bin is self-cleaning.

Assembly

1. Inspect the new filter cartridge for shipping damage before installing.
2. To install a new cartridge, hold the cartridge (3, Fig. 2-11 and 2-12) in the same manner as when removing it from the housing. Insert the clean cartridge into the housing; avoid hitting the cartridge tubes against the sealing flange on the edges of the air cleaner housing.
3. The cleaner requires no separate gaskets for seals; therefore, care must be taken inserting cartridge to insure a proper seat within the cleaner housing. Firmly press all edges and corners of the cartridge with your fingers to effect a positive air seal against the sealing flange of the housing. Under no circumstances should the cartridge be pounded or pressed in the center to effect a seal.
4. Replace the pre-cleaner panel (2) and tighten the wing nuts (4) by hand, for final tightness turn 1-1/2 to 2 turns with a small adjustable wrench. Do not overtighten. On a pre-cleaner with an exhaust aspirator, assemble the aspirator tube to the pre-cleaner panel and tighten the "U" bolt.
5. Care should be taken to keep the cleaner face unobstructed.

Change Oil Bath Air Cleaner Oil

Before dirt build-up reaches 1/2 inch [12.7 mm], remove the oil cup from the cleaner. Discard the oil and wash the cup in cleaning solvent or fuel oil.

Note: During wet weather and in winter months, changing of the oil is equally as important as during dusty weather since the air cleaner inlet may be located in an air stream which carries moisture into the cleaner.

Fill the oil cup to the level indicated by the bead on the side with clean, fresh oil of the same grade as that in the crankcase and assemble it to the cleaner. In extremely cold weather a lighter grade may be necessary. A straight mineral, non-foaming detergent, or non-foaming additive oil may be used in oil bath air cleaners.

Caution: Never use dirty oil or used oil.

Drain Air Tanks

In cold weather, condensed moisture in the air tanks and lines may freeze and make controls useless.

Drain the air tanks to keep all water out of the compressed air system.

Engine Front Trunnion

If used, the engine front trunnion mount should be lubricated with grease meeting specifications as outlined in Section 3.

"B" Maintenance Checks

B-Check

At each "B" Maintenance Check, perform all the "A" Checks in addition to the following.

Lubricating Oil Change Intervals

1. Divide the engines into groups by engine model (engines with the same lube system capacity).

2a. Determine the average fuel consumption for all the engines in each group.

b. Select a group fuel consumption, for entering the chart, that is halfway between the average fuel consumption and the highest fuel consumption in the group.

3a. Determine the average lube oil consumption for all the engines in the group.

b. Select a group lube oil consumption for entering the chart that is halfway between the average lube oil consumption and the lowest oil consumption in the group.

4. Read the appropriate chart for each group using the fuel consumption determined in 2b and the lube oil consumption determined in 3b. The oil change interval determined in this manner should be applied to the entire group.

5. Since some will have more than one group of engine models, a change interval should be determined for each group. In some cases it may be wise to divide some groups into sub-groups (such as older NTC-290's and newer Formula 290's) for which a change interval is determined.

6. Practically, now, a manager must review the oil change intervals determined for each group or subgroup; consider the other items in his preventative maintenance schedule; consider his own past practice; and select an oil change interval which he feels is the best compromise.

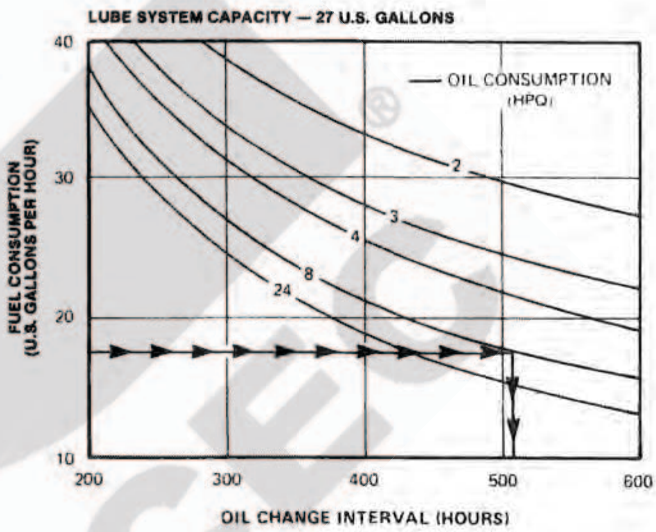
Note: Cummins Engine Co., Inc., does not recommend exceeding 25,000 miles and/or 600 hours on oil change intervals. Therefore, the charts are limited to 25,000 miles or 600 hours and must not be extended.

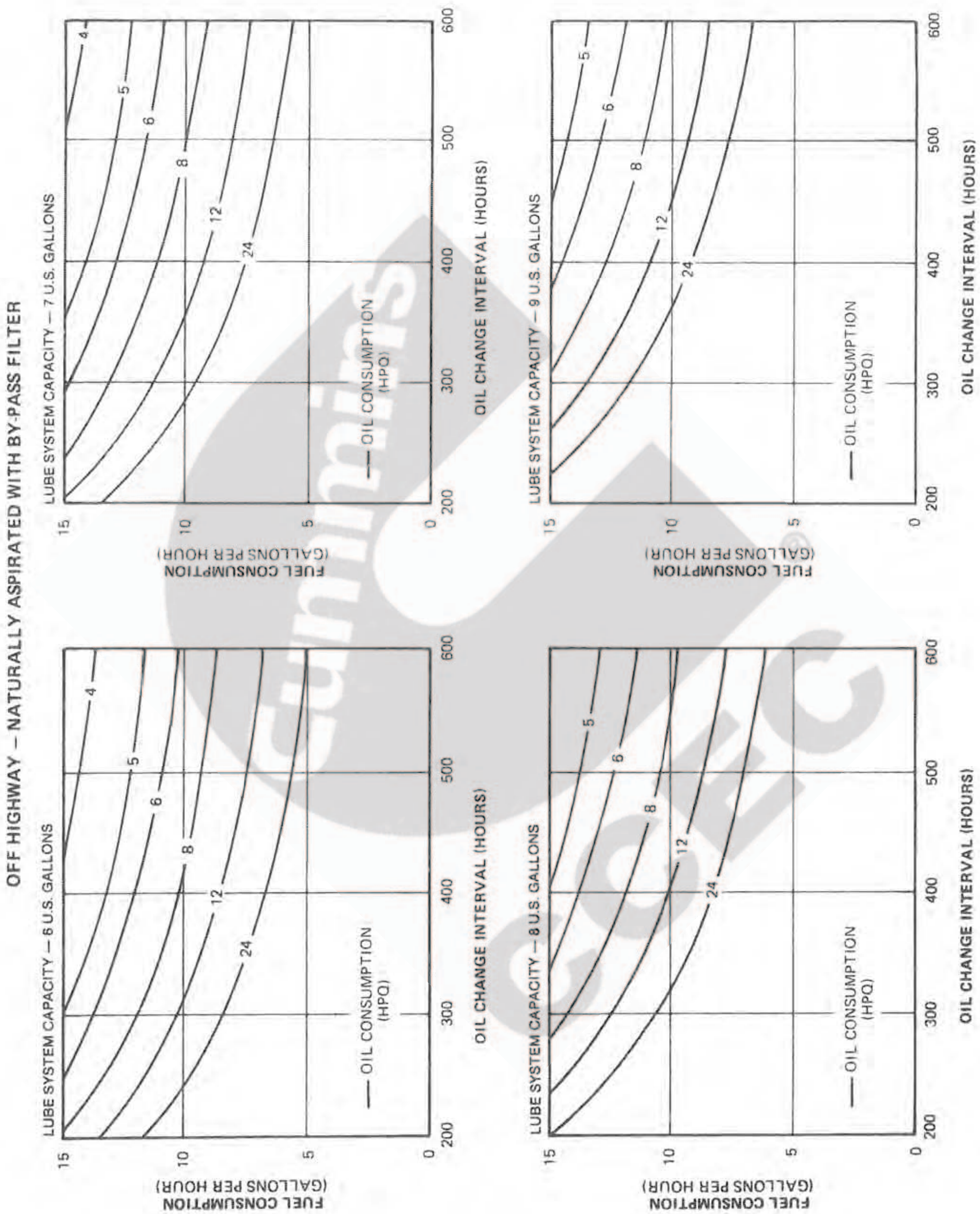
The charts for determining the recommended oil change intervals are included in the following pages.

Chart Method Alternative

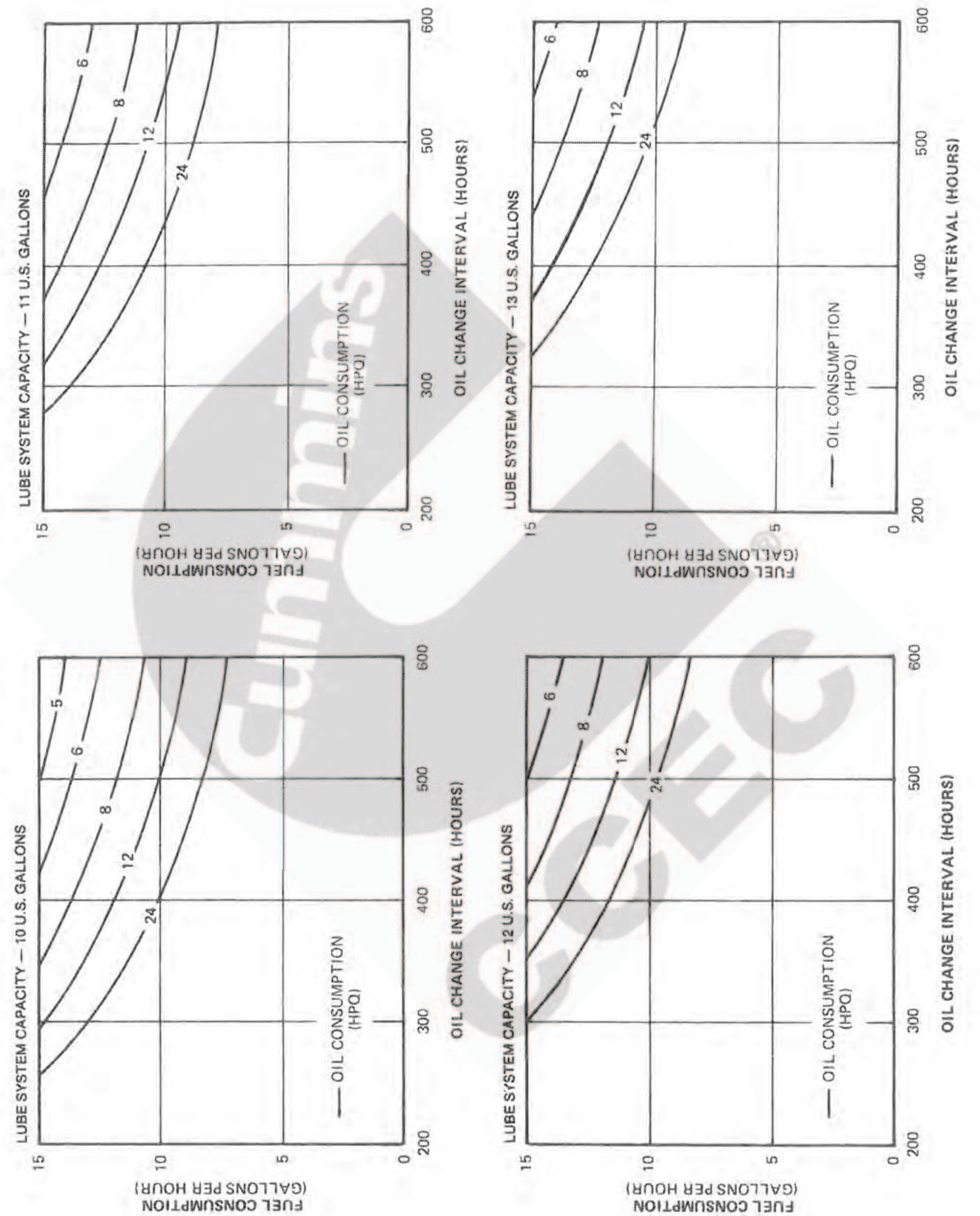
As an alternative to the Chart Method for determining the "B" maintenance check interval, Cummins Engine Co., Inc., recommends that the "B" check be performed every 10,000 miles, 250 hours or 6 months.

Note: Perform the "B" check in 6 month intervals for engines in emergency or standby operations and any other operation where less than the recommmended miles or hours have been accumulated in a 6 month interval.

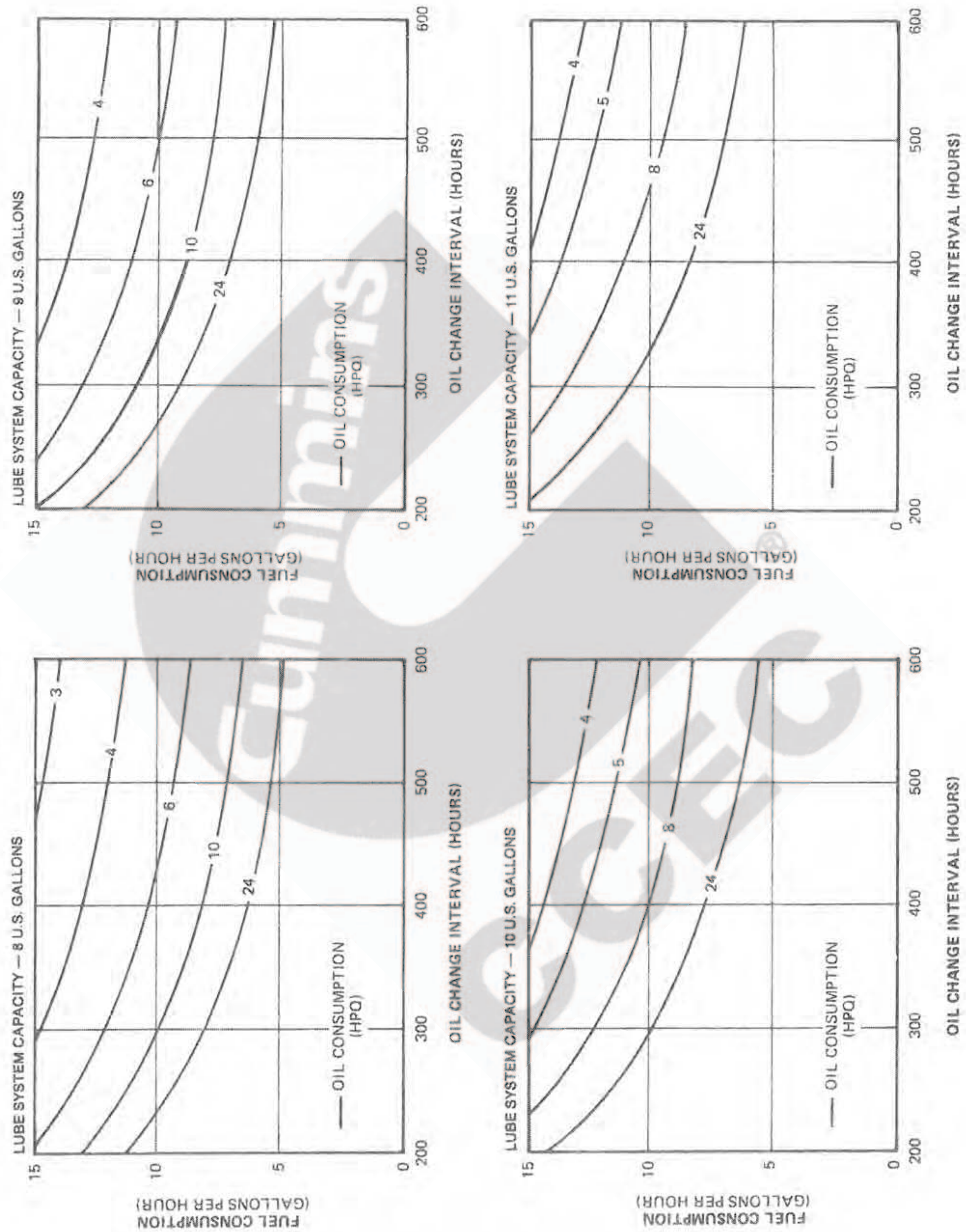


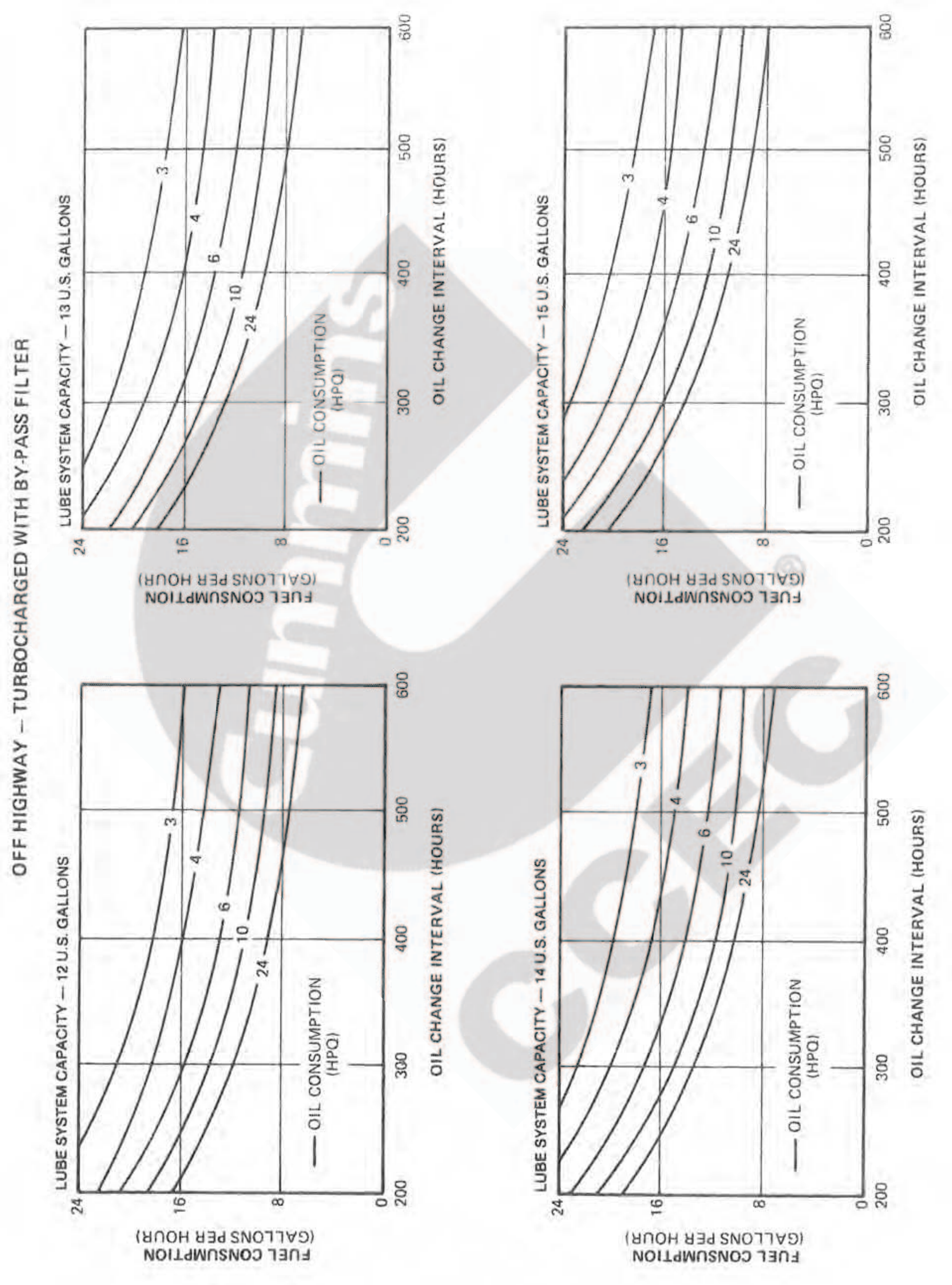

OFF HIGHWAY – NATURALLY ASPIRATED WITH BY-PASS FILTER
LUBE SYSTEM CAPACITY – 6 U.S. GALLONS
LUBE SYSTEM CAPACITY – 7 U.S. GALLONS
LUBE SYSTEM CAPACITY – 8 U.S. GALLONS
LUBE SYSTEM CAPACITY – 9 U.S. GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
OIL CHANGE INTERVAL (HOURS)
OIL CONSUMPTION (HPQ)

OFF HIGHWAY — NATURALLY ASPIRATED WITH BY-PASS FILTER

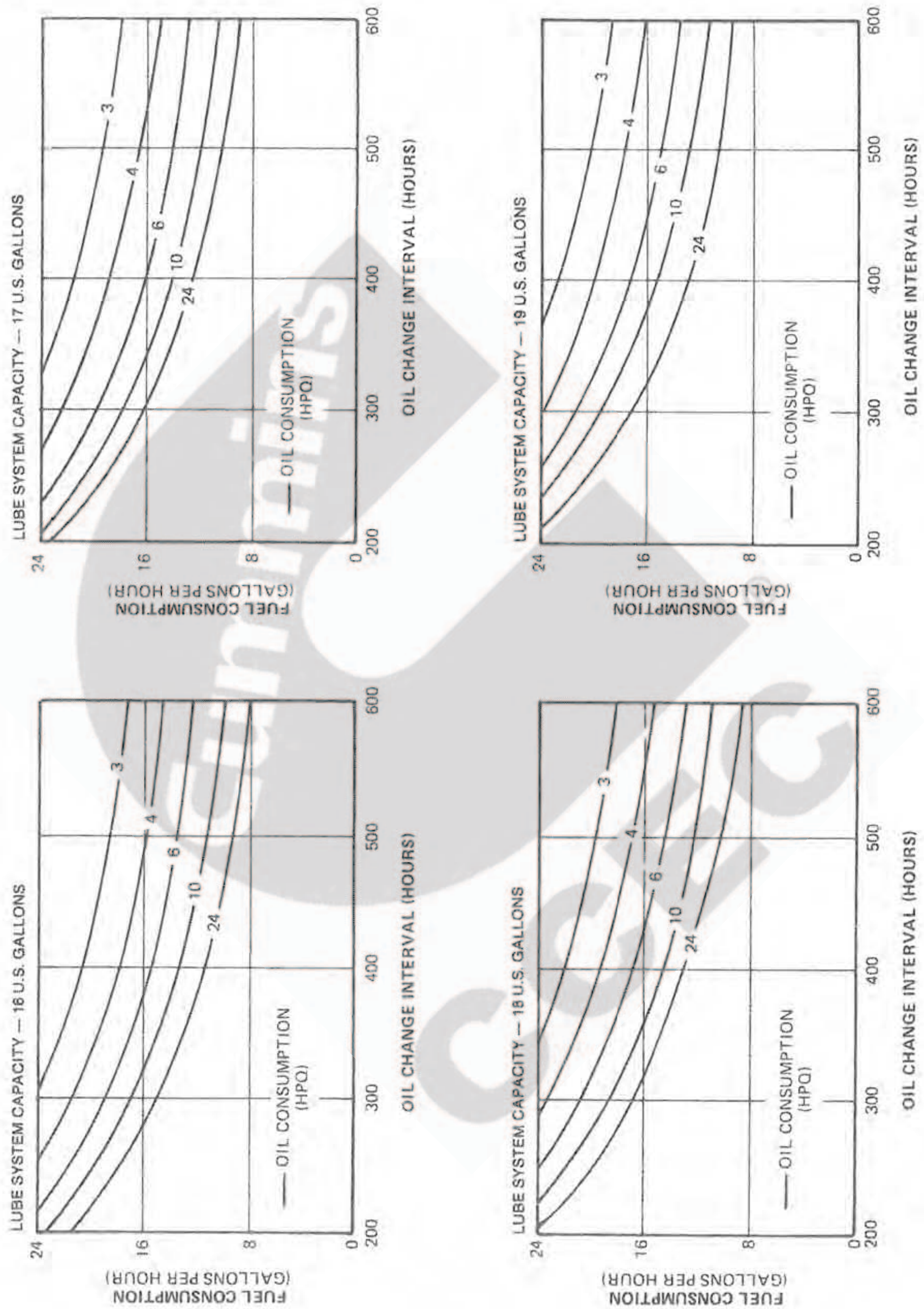


OFF HIGHWAY — TURBOCHARGED WITH BY-PASS FILTER

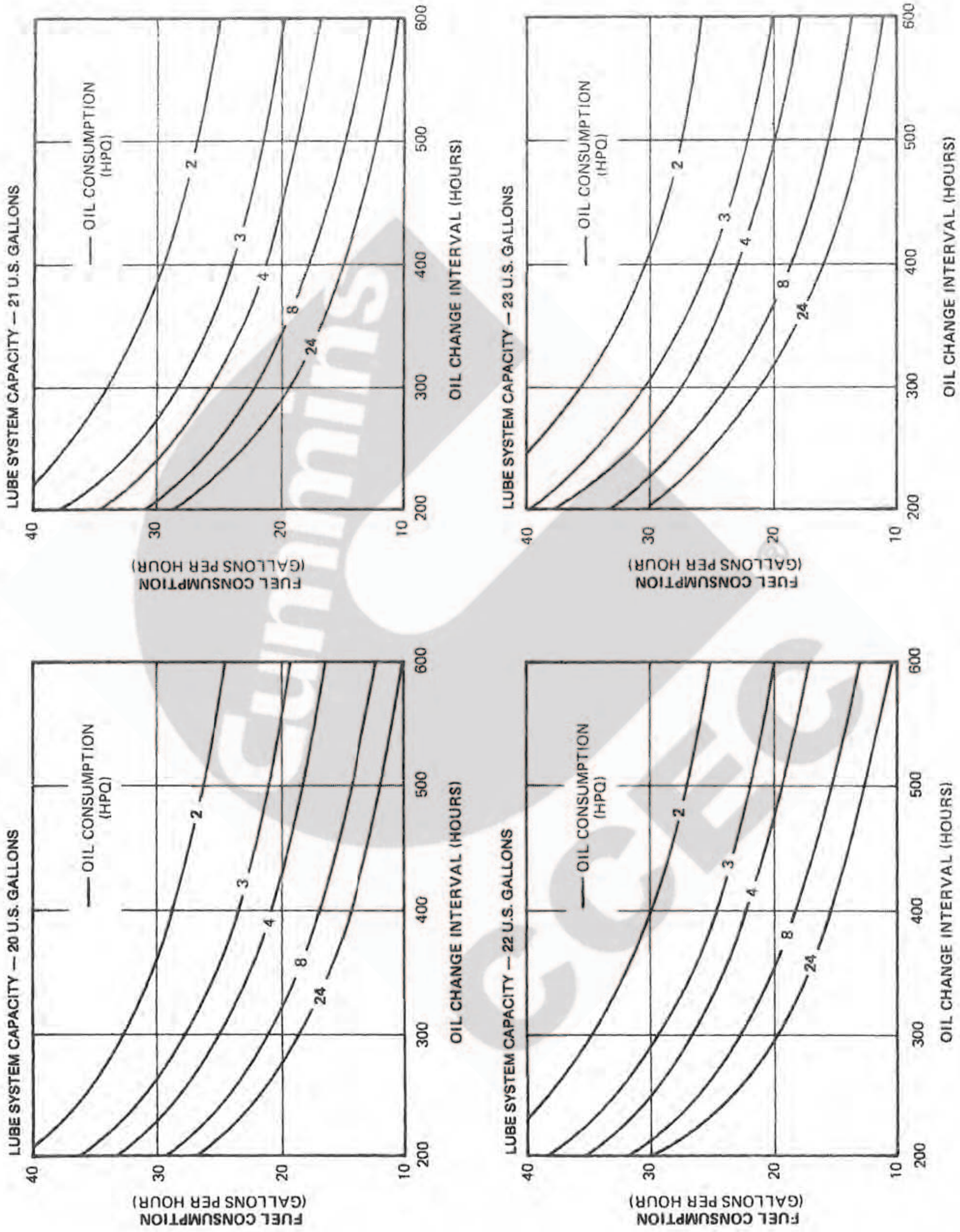



OFF HIGHWAY — TURBOCHARGED WITH BY-PASS FILTER
LUBE SYSTEM CAPACITY — 12 U.S. GALLONS
LUBE SYSTEM CAPACITY — 13 U.S. GALLONS
LUBE SYSTEM CAPACITY — 14 U.S. GALLONS
LUBE SYSTEM CAPACITY — 15 U.S. GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
OIL CHANGE INTERVAL (HOURS)
OIL CONSUMPTION (HPQ)
3
4
6
10
24

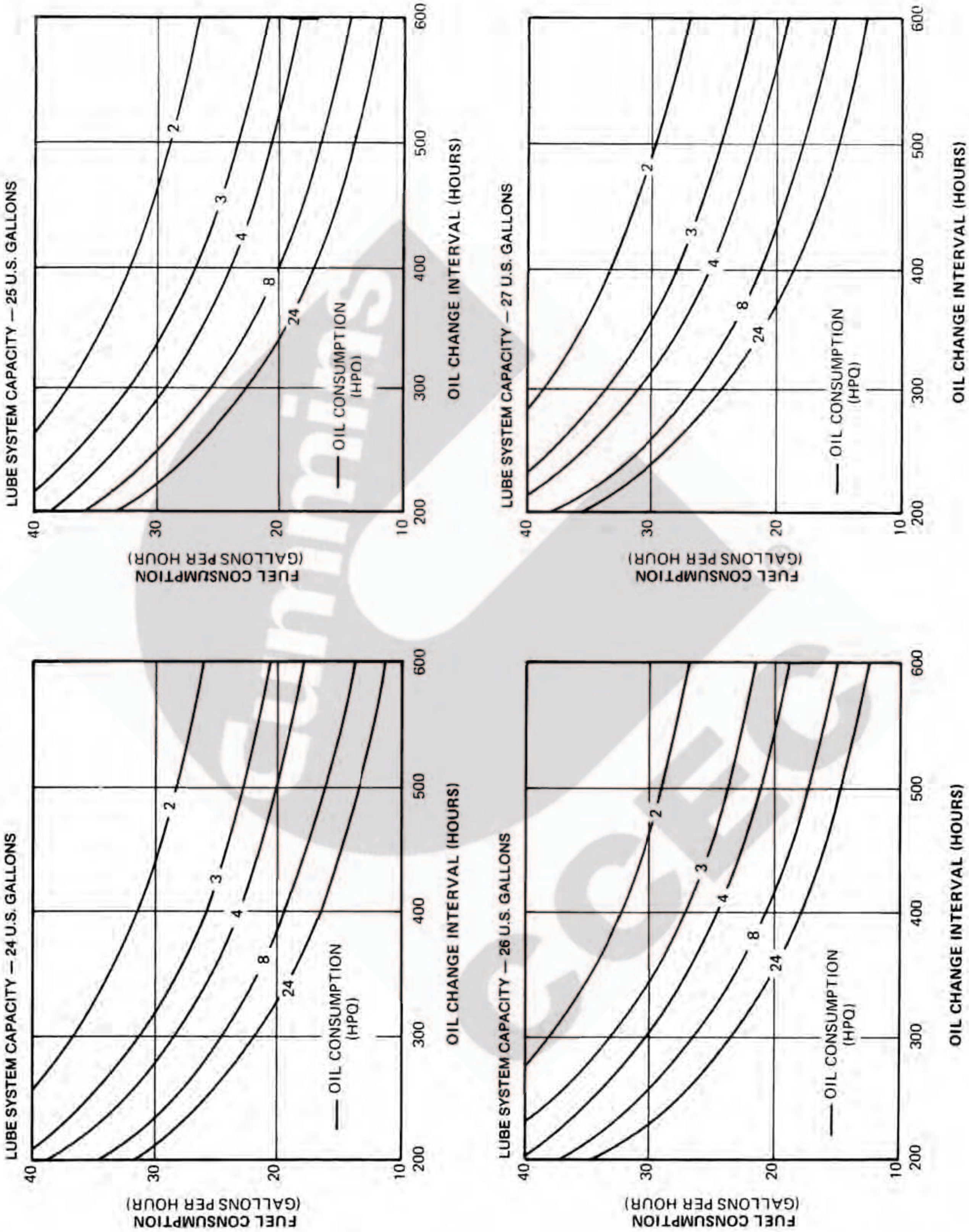
OFF HIGHWAY — TURBOCHARGED WITH BY-PASS FILTER

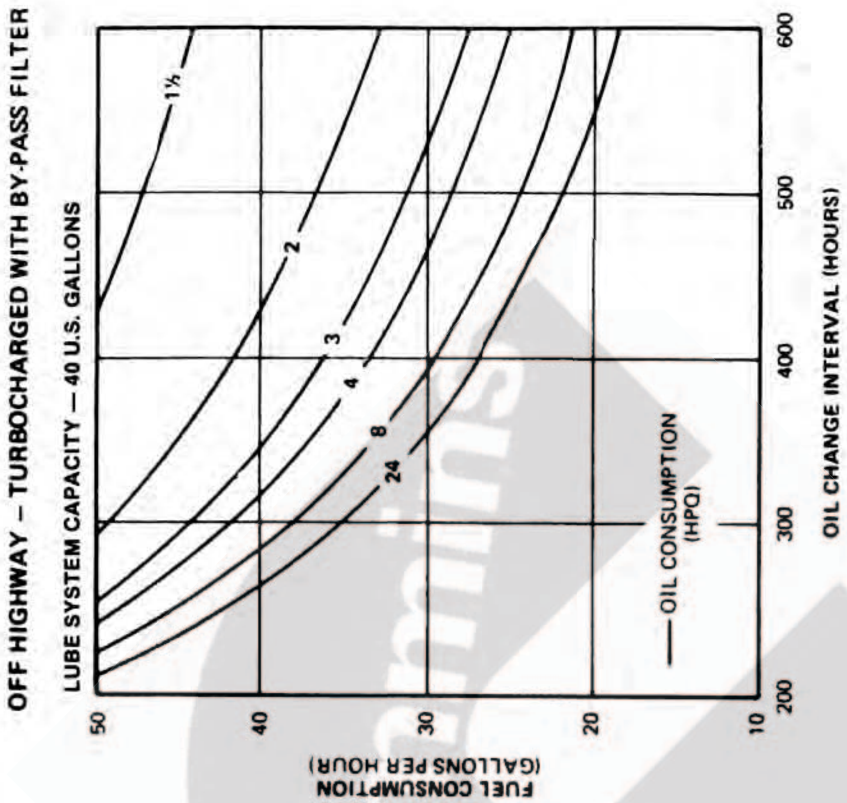


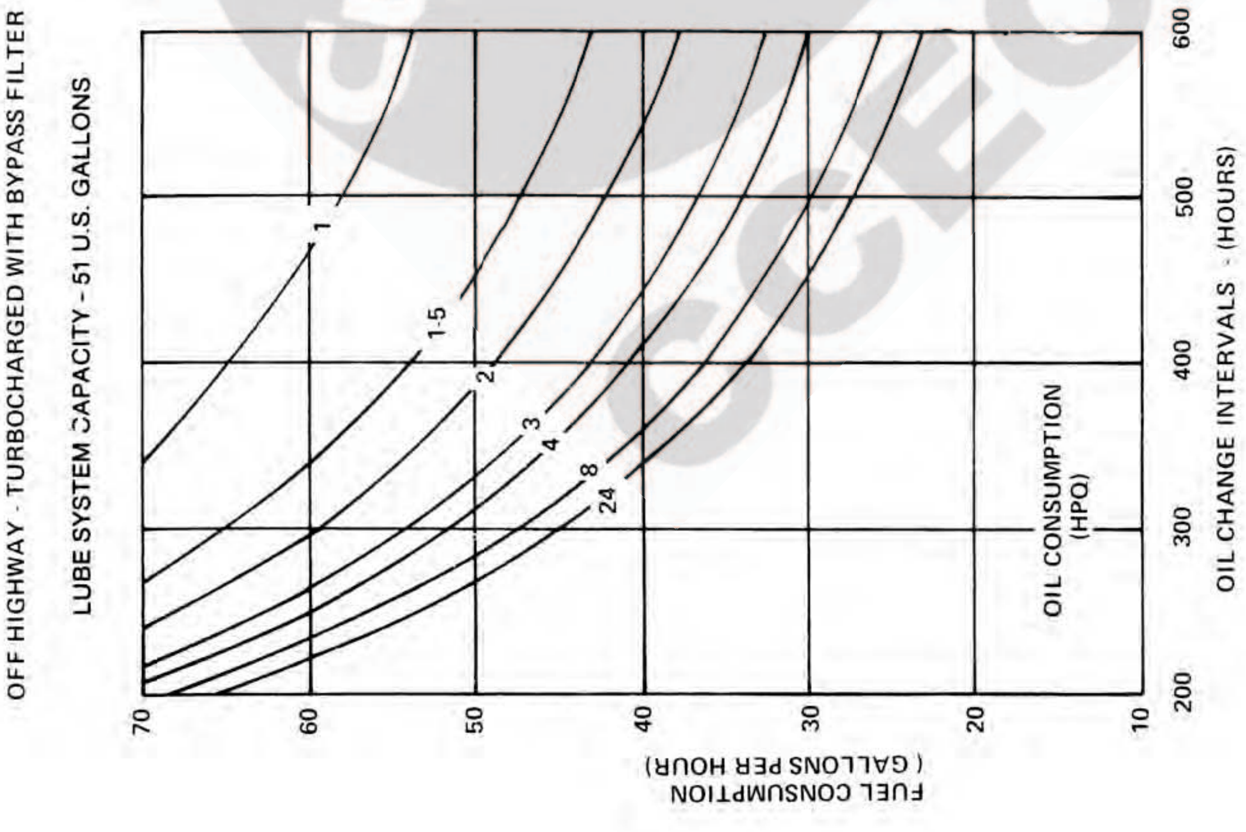
OFF HIGHWAY – TURBOCHARGED WITH BY-PASS FILTER



OFF HIGHWAY — TURBOCHARGED WITH BY-PASS FILTER




OFF HIGHWAY — TURBOCHARGED WITH BY-PASS FILTER
LUBE SYSTEM CAPACITY — 40 U.S. GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
OIL CHANGE INTERVAL (HOURS)
OIL CONSUMPTION (HPQ)
1½
2
3
4
8
24
10
20
30
40
50
200
300
400
500
600


OFF HIGHWAY - TURBOCHARGED WITH BYPASS FILTER
LUBE SYSTEM CAPACITY - 51 U.S. GALLONS
FUEL CONSUMPTION (GALLONS PER HOUR)
OIL CHANGE INTERVALS - (HOURS)
OIL CONSUMPTION (HPQ)
1
1·5
2
3
4
8
24
10
20
30
40
50
60
70
200
300
400
500
600

Lubricating Oil Analysis

An alternate method for determining when to change lubricating oil and filters is by used oil analysis using laboratory tests. The analyses used are for the purpose of determining the amount of contamination in the oil; not for predicting potential engine failures. It is recommended that new engines be operated through at least one oil change interval determined by the chart method prior to initiating a used oil analysis program.

In order to initiate a used oil analysis program for a large number of engines they should be grouped by basic model, rated horsepower and type of service. The horsepower range of a group should not exceed 25; K models should be in separate groups. After the engines have been grouped, a sub-group consisting of 10 percent of the total engines in each group should be selected for the used oil analysis program. If a group consists of less than 50 engines but more than 25 engines the sub-group size should be 5 engines. For groups of less than 25 engines the sub-group size should be 8 engines. The selecting of the engines for each sub-group should be completely random.

Each group of engines should be set up on oil change intervals as described under the "Chart Method". When the engines reach the end of the second chart method oil change interval, an oil change should be performed on all units in the group except those engines selected for the sub-group. The engines in the sub-groups should only have an oil sample taken. Additional oil samples should be taken from each of the engines in the sub-groups at every 48-operating-hour interval after the first sample. This sampling frequency may be varied somewhat as dictated by the operation. The sampling frequency should not be extended beyond 60 hours for equipment safety reason or reduced below 40 hours because of the added analytical costs.

This sampling process should continue until the results of the analyses of the samples indicate that any one of the condemnation limits listed in Table 2-2 has been reached or exceeded until the desired oil change interval extension is reached. This process should be continued cautiously since the engines in the sub-groups are subject to permanent damage because of the over-extended oil change interval. The analytical work on the samples and the examination of the analytical results should be done as quickly and carefully as possible to prevent serious engine damage.

Table 2-2: Lubricating Oil Condemnation Limits

Property (ASTM Method*)	Condemnation Limit
Viscosity @ 100° C (D-445)	± SAE Viscosity grade** from the new oil
Insolubles, pentane, noncoagulated (D-893)	1.0% maximum
Insolubles, toluene, noncoagulated (D-893)	1.0% maximum
Total acid number (D-664)	3.5 number increase from the new oil value, maximum
Total base number (D-664)	2.0 minimum
Water content (D-95)	0.2% maximum
Additive metal content (AES or AAS**)	75% of new oil level, minimum

*ASTM (The American Society for Testing and Materials) publishes these methods in their Annual Book of Standards, Part 23. Other methods should not be used without consulting Cummins.

**SAE Viscosity grades are published by the Society of Automotive Engineers in their annual SAE Handbook as SAE Recommended Practice J300d, and are shown in Table 1 of this bulletin.

***AES (Atomic Emission Spectroscopy) and AAS (Atomic Absorption Spectroscopy) are not standard ASTM methods, however most used oil analysis laboratories are capable of determining additive metal concentration by one of these methods and sample results determined by the same laboratory using the same method can be safely compared.

To determine whether the maximum oil change interval has been reached the properties in Table 2-2 should be determined by the laboratory methods specified. This table also specifies condemnation limits to be used for determining the lubricating oils' useful life. This group of analyses and the methods are not generally part of the oil analyses offered by most commercial used oil analysis laboratories. These analyses are not low cost, generally costing between $50 and $135 per sample.

When any one of the condemnation limits is exceeded on any one sample an oil change should be performed on all engines in the sub-group. The hours at which the sample for which a condemnation limit was exceeded is the oil change interval at which 10% or more (depending on sub-group size) of the group are using lubricating oil which has exceeded its useful life. This sampling and analysis process should be repeated once to confirm the oil change interval. When this process is complete the entire group of engines can be placed on the new oil change interval.

This method of establishing an oil change interval will determine a different interval for each group of engines. It is not possible to provide maintenance on several different schedules or if one desires to schedule the oil change to coincide with other maintenance, the more conservative (or shorter) maintenance schedule should be used.

Please contact your Cummins Service Representative if you need assistance or have any questions about utilizing this method of determining an oil change interval.

Change Engine Oil

Factors to be checked and limits for oil analysis are listed below. Oil change at "B" Check, as shown in the maintenance chart on Page 2-2, is for average conditions.

1. Bring engine to operating temperature, shut down engine, remove drain plug from bottom oil pan, and drain oil.
2. Install drain plug in oil pan. KT/KTA19, KT/KTA38 and KTA50 Engines torque to 60 to 70 ft-lbs [81 to 95 N•m].
3. Fill the crankcase to "H" (high level) mark on the dipstick.
4. Start engine and visually check for oil leaks.
5. Shut down the engine; allow 15 minutes for oil to drain back into the pan; recheck the oil level with the dipstick. Add oil, as required.

Note: Use lubricating oil meeting specifications listed in Section 3, and genuine Cummins filters on equipment.

Change Spin-On Lubricating Oil Filter Elements

1. Unscrew combination case and elements, Fig. 2-13, discard elements.

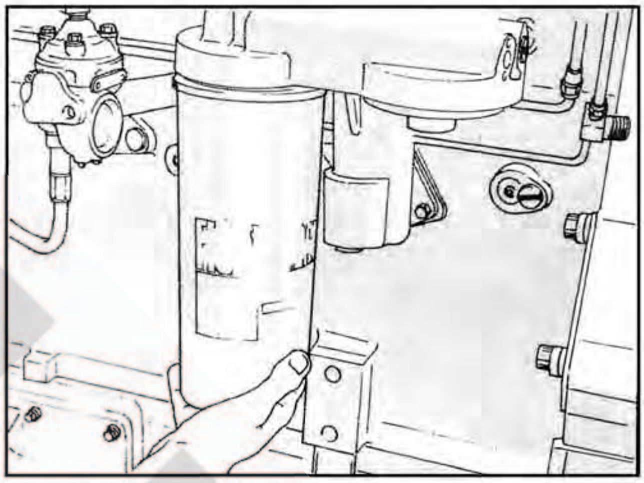


Fig. 2-13. Installing lubricating oil filter cartridge

Note: At each filter change check torque on adapter or insert; it should be 25 to 35 ft.lbs [34 to 47 N•m]. If they are not within torque range, they may rotate when the spin-on filter is removed. Replace the adapter or insert to the filter head gasket at each "C" maintenance check.

2. Fill the filter with lubricating oil. Apply a light even coat of lubricating oil to the gasket sealing surface prior to installing the filter.

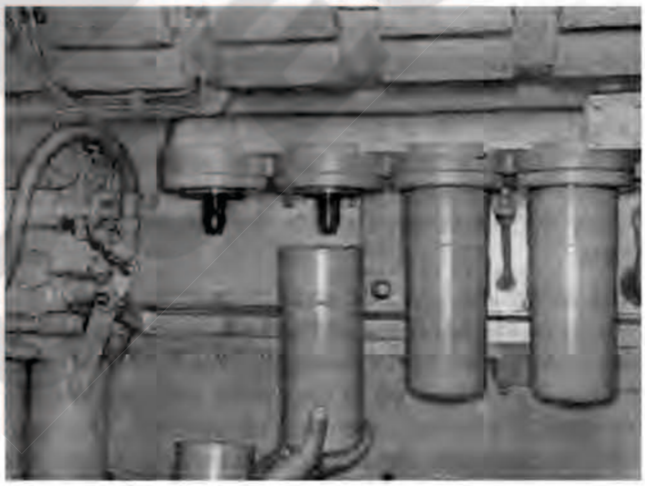


Fig.2-14. Installing "spin-on" lubricating oil filter-KT/KTA38 Engine

3. Position element to the filter head, Fig. 2-14. Tighten by hand until the seal touches the filter head, tighten an additional one-half to three-fourths turn.
4. Run the engine, check for leaks, recheck engine oil level; add oil as necessary to bring the oil level to "H" mark on the dipstick.

Note: Always allow oil to drain back to the oil pan before checking the level. This may require 15 minutes.

Change the Lubricating Oil Spin-On By-pass Filter

1. Unscrew the spin-on filter from the filter head; discard the filter.
2. Apply a light even coat of lubricating oil to the gasket sealing surface, prior to installing the filter.
3. Position the filter to the filter head. Tighten by hand until the seal touches the filter head; tighten an additional one turn.
4. Run the engine, check for leaks, shut-down the engine. Add oil as necessary to bring the oil level to the "H" mark on the dipstick.

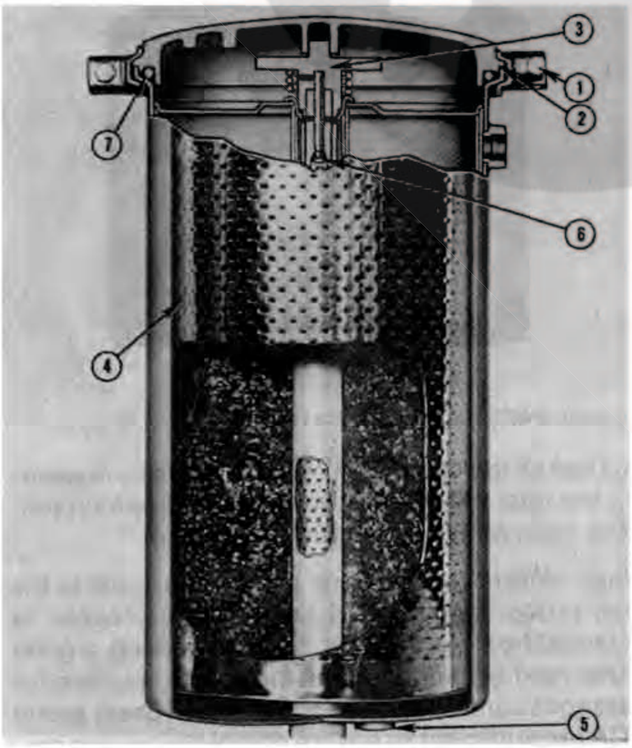


Fig. 2-15. By-pass filter cross section

Caution: Never use a by-pass filter in place of a full-flow filter.

Change Fuel Filter Element

Spin-On Type Filter

1. Unscrew and discard the spin-on type fuel filter. Fig. 2-16.
2. Fill the new filter with clean fuel and apply a light even coat of lubricating oil to the gasket sealing surface prior to installing the filter.
3. Install the filter; tighten by hand until the seal touches the filter head. Tighten an additional one-half to three-fourths turn.

Caution: Mechanical tightening will distort or crack the filter head.

Fig. 2-16, (OM21008). Fuel superfilter

Check Engine Coolant

Periodic tests of the engine coolant should be made to ensure that the frequency of water filter servicing or concentration of DCA inhibitor is adequate to control corrosion for any specific condition of operation. In cases where "make-up" water must be added frequently, we suggest that a supply of water be treated and added as necessary.

The concentration of effective inhibitor dissolved in the coolant can be measured by a Fleetguard DCA Coolant Checking Kit Part No. 3300846-S or Cummins 3375208 which is available from Cummins Distributors for this check. Fig. 2-17.

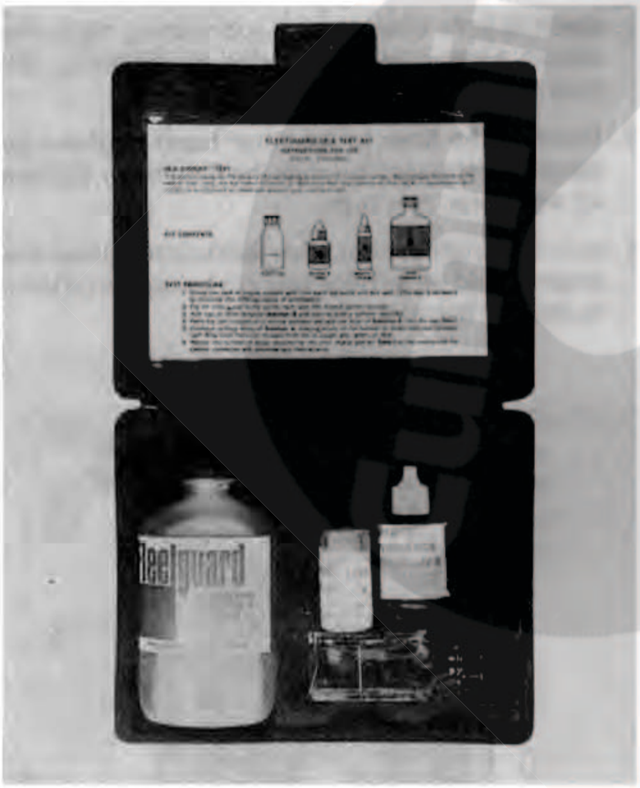


Fig. 2-17. (N12021). DCA coolant test kit

The test kit indicates DCA concentration by measuring the total nitrite of a coolant sample, which provides cylinder liner cavitation protection.

When antifreeze is present, it may contribute to the total nitrite, but most of the nitrite protection is obtained from the DCA inhibitor. In general, a good nitrite reading indicates that the combined inhibitor packages contained in the antifreeze (if used) and in DCA are sufficient to ensure complete cooling system protection.

Concentration Test Procedure

1. Rinse the plastic dropper pipet several times with the engine coolant. Fill the dropper exactly to the 1.0 ml. mark. Discharge into the empty vial. Fig. 2-18.
2. Fill the vial to the 10 ml. scribe mark with tap water and mix well. (This dilution step is necessary to minimize the differing colors of antifreeze.)
3. Add two or three drops of Solution B and swirl to form a uniform red color.
4. Add one drop of Solution A to the vial, being careful to hold the dispenser provided in a vertical position. Swirl.
5. Continue adding drops of solution A, keeping count of the number of drops and swirl between each drop until the color changes from red to a pale grey, green, or blue.
6. Record the number of drops required for the color change and consult Table 2-3 for coolant condition and recommended maintenance.

Fig. 2-18. (V12022). Mixing bottle

Table 2-3: Number of Drops of Test Solution "A"

Number of Drops of SOLUTION A necessary to cause color change	Coolant Conditions	Maintenance Required
0-10 drops	**DANGEROUS** (less than 0.4 DCA Units per gallon)	Initial charge system to a minimum of one DCA Unit per gallon of coolant.
11-16 drops	**BORDERLINE** (0.45 to 0.8 DCA Units per gallon)	Add DCA Liquid units to maintain one Unit per gallon minimum or change DCA filter
17-25 drops	**ACCEPTABLE** (.85 to 1.3 DCA Units per gallon)	None
26-35 drops	**HIGH ACCEPTANCE** (1.35 to 2.0 DCA Units per gallon)	None
36-55 drops	**OVERCONCENTRATED** (2.1 to 3.3 DCA Units per gallon)	Review maintenance practice
over 56 drops	**DANGEROUSLY OVERCONCENTRATED**	Drain 50% of coolant and replace with water/antifreeze. Retest for proper DCA Unit concentration.

Maintain a minimum of one DCA Unit per gallon of coolant in your system. **Less** than ½ (.5) Unit per gallon indicates an **Under**concentrated coolant solution. **More** than two units per gallon indicates an **Over**concentrated coolant solution.

Adding Make-Up Coolant and DCA to Cooling System

1. Test the coolant for DCA according to the nitrite test procedure "With or Without Antifreeze" depending on the presence or absence of antifreeze in the cooling system.
2. Estimate the make-up DCA. For example, if a fifteen gallon cooling system contains only 0.5 oz/gal. [4 ml per l] DCA, and 1.5 oz/gal. [12 ml per l] is required, 15 ounces [426 g] of DCA should be added to the make-up coolant.

Note: A one pint bottle of DCA-4L liquid (P/N 3300858) contains six dry ounces of DCA chemical in Step 2, concentrations are in dry ounces of chemical per gallon of coolant.

3. Estimate the total amount of make-up coolant required (gallons), and calculate the proportions of water and antifreeze, if used, required. For example, one gallon of 50-50 antifreeze/water solution will require two quarts of antifreeze and two quarts of water.
4. Add the required amount of water to a mixing container and dissolve the number of ounces of DCA obtained in Step 2 in the water. If negative or zero results were obtained in Step 2, do not add DCA. (For DCA to dissolve, water should be above 50°F [10°C].)
5. Add the required amount of antifreeze, if used, to the water solution and mix thoroughly.
6. Add the make-up coolant to the cooling system.

Note: If the DCA concentration is low, and the coolant level high, DCA may be added directly to the radiator in the amount indicated in Step 2. The engine should be running and warm enough to permit coolant circulation throughout the entire system.

Bulk Storage of Make-Up Coolant

If make-up coolant is stored in bulk, the following recommendations are provided for mixing and storing the coolant.

1. Drain and clean the bulk storage tank to remove any possible contaminants.
2. Knowing the total capacity of the holding tank, calculate the proportions of water and antifreeze, if used, required. For example, a 500 gallon [1892 l] tank will hold 250 gallons [946 l] of water and 250 gallons [946 l] of antifreeze for a 50-50 mixture.
3. Multiply the desired DCA concentration by the total capacity of the holding tank in gallons. In the example above, 1.5 oz. DCA per gallon [12 ml per l] of coolant can be used in the 50-50 mixture. Multiplying 1.5 oz. DCA per gallon [12 ml per l] times 500 gallons [1892 l] yields a total DCA requirement of 750 oz. [46 lb 14 oz.) [21.3 kg].
4. Add the water to the holding tank. Agitating continuously, add the DCA to the water in small amounts until all of the chemical has dissolved. The water should be above 50°F [10°C].
5. Add the antifreeze last, if used, maintaining agitation to bring and keep the finished coolant in solution. Both antifreeze and DCA will settle to the bottom of the tank unless constant mixing or circulation is provided. An example of recirculation is the use of a small pump operating continuously to draw DCA and antifreeze off the bottom of the tank and discharging the solution at the top. Samples of coolant can be drawn off the top, middle and bottom of the storage tank and tested for antifreeze and/or DCA concentration if inadequate mixing is suspected.

Change DCA Water Filter

Change the filter or element at each "B" Check; selection of element to be used should be based upon the size of the system. See "Coolant Specifications", Section 3.

Note: Whenever the coolant supply is changed the system must be drained, flushed, and precharged. See "Coolant Specifications", Section 3 for DCA compatibility with different brands of antifreeze.

Spin-On Element

1. Close the shut-off valves on the inlet and drain lines.
2. Unscrew the element and discard.
3. Apply a light even coat of lubricating oil to the gasket sealing surface prior to installing the filter.
4. Install a new element, tighten until the seal touches the filter head. Tighten an additional one-half to three-fourths turn. Fig. 2-19. Open the shut-off valves.

Caution: Mechanical tightening will distort or crack the filter head.

Fig. 2-19 (OM 10236). Installing DCA water filter cartridge

Check Oil Levels

Check Aneroid Oil

1. Remove the pipe plug from the hole marked "Lub Oil".
2. Fill with engine lubricating oil to the level of the pipe plug hole. Reinstall the pipe plug.

Check Hydraulic Governor Oil Level

Keep the level half-way up on the inspection glass or to the high-level mark on the dipstick. Use the same grade oil as used in the engine.

Clean/Change Crankcase Breather

Mesh Element Breather

1. Remove the wing nut (6, Fig. 2-20), flatwasher and rubber washer securing the cover (1), to the breather body (5).
2. Lift off the cover and lift out the breather element (2), vapor element (3), and gasket (4).
3. Clean all metal and rubber parts in an approved cleaning solvent. Dry thoroughly with compressed air.
4. Inspect the rubber gasket; replace it if necessary. Inspect the body and cover for cracks, dents or breaks; discard all unserviceable parts.
5. Install a cleaned or new breather element (2, Fig. 2-24) and cleaned vapor element (3) to the breather body (5).
6. Install the rubber gasket (4) in the cover (1); position the cover assembly to the body (5).
7. Install the rubber washer, flatwasher and wing

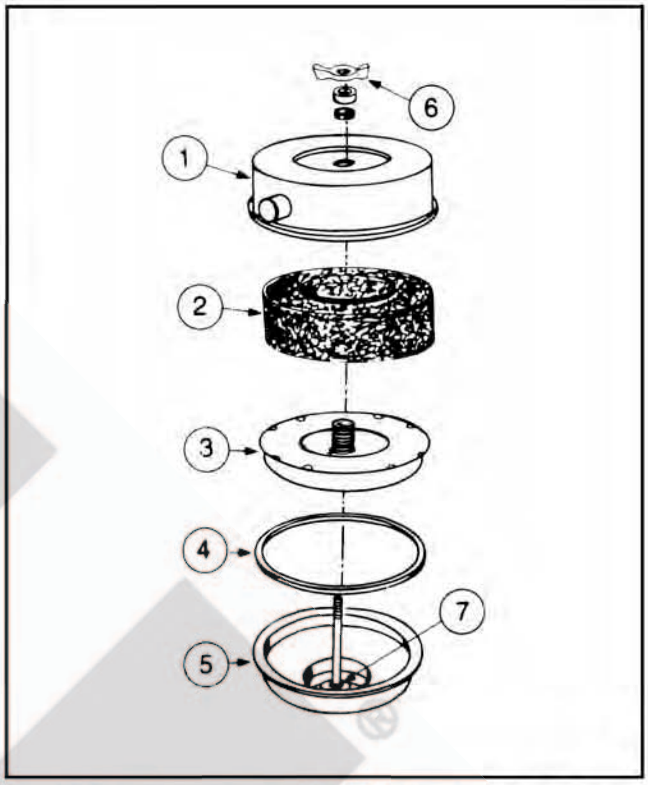


Fig. 2-20. Crankcase breather - mesh element with vapor barrier

nut (6); tighten securely.

Screen Element Breather — Cleaning and Inspection

1. Remove the vent tube if not previously removed.
2. Remove capscrews, washers, cover, screens and baffle if used, from the breather body. Fig. 2-25.

Fig. 2-21. Crankcase breather — screen type

3. Clean the vent tube, screens and baffle in an approved cleaning solvent. Dry with compressed air. Wipe out the breather housing.

4. Assemble the baffle and screens, if used, and a new gasket in the body.
5. Replace the cover with the cover boss resting securely on the point of the screen, if used; secure with washers and capscrews.
6. Replace the vent tube.

Clean Air Compressor Breather

When used, service breathers regularly as follows:

Bendix-Westinghouse Paper Element

Remove the breather cover and element, Fig. 2-22. Clean by reverse flushing with compressed air; reassemble on the compressor. Discard the element if it is damaged or unsuitable for cleaning.

Fig. 2-22, (V41420). Bendix-Westinghouse air compressor breather.

Bendix-Westinghouse Sponge

Remove the breather from the air compressor. Disassemble the breather, wash all metal parts in solvent and blow dry with compressed air. Wash the element in solvent; remove all solvent from the element; dip it in clean engine oil and squeeze excess oil from the element.

Cummins Paper

Clean the element at each "D" maintenance check. Remove the wing nut securing the front cover to the body. Lift off the front cover and element. Inspect the paper element before cleaning by reverse flow of compressed air; discard the element if it is damaged or unsuitable for cleaning. Fig. 2-23.

Caution: Do not rupture the filter element.

Fig. 2-23, (V414209). Cummins air compressor breather — paper element

Clean the body and front cover with a clean cloth. With the rubber gasket on center bolt, place the element in the front cover and assemble over the center bolt; secure with the wing nut.

Note: At any time the three-prong unloader hat is used, it will set up air pulsations across the compressor intake which can destroy the paper element. Pipe intake air for Cummins compressors from the engine air manifold when the three-prong unloader hat is applied; current factory-installed compressors are so equipped. This same procedure may be used for any Cummins Compressor in the Field.

Clean Tray Screen

Clean the tray screen in kerosene or cleaning solvent. Dry with compressed air, reassemble to the cleaner.

Note: If the tray screen is extremely dirty, it may be necessary to singe the screen with a flame. Do not melt the tin plate on the screen.

"C" Maintenance Checks

At each "C" Maintenance Check, first perform all "A", and "B" Checks in addition to those following:

Adjust Injectors and Valves

It is essential that the injectors and valves be in correct adjustment at all times for the engine to operate properly. One controls engine breathing; the other controls fuel delivery to the cylinders.

Final operating adjustments must be made using correct values as stated.

Caution: Be sure the injector and valve set markings, wherever located, are in proper alignment with the indicator mark.

Engine Temperatures

The following temperature conditions provide the necessary stabilization of engine components to allow for an accurate valve and injector adjustment.

Cummins Engine Company, Inc. recommends that valve and injector plunger adjustments be made when the engine is cold. The engine must be at any stabilized temperature of 140°F [60°C] or below.

A second setting or resetting after the engine is warm is not recommended.

Injector and Valve Adjustment Using 3375004 Dial Indicator Kit KT/KTA19 Engines

This method involves adjusting the injector plunger travel with an accurate dial indicator. A check can be made of the adjustment without disturbing the locknut or screw setting. The valves can also be checked or set while adjusting the injectors by this method. See Table 2-4.

3375004 Injector Adjustment Kit is used to adjust the injectors with or without Jacobs Brake units installed.

It is essential that the injectors and valves be in correct adjustment at all times for the engine to operate properly.

Table 2- 4 : Injector and Valve Set Position KT/KTA19

Bar In Direction	Pulley Position	Set Cylinder Injector	Valve
Start	A	3	5
Adv. To	B	6	3
Adv. To	C	2	6
Adv. To	A	4	2
Adv. To	B	1	4
Adv. To	C	5	1

Firing Order 1-5-3-6-2-4

One controls engine breathing; the other controls fuel delivery to the cylinders.

Operating adjustments must be made using the correct values as stated.

Injector and Valve Adjustment

Note: Do not use the fan to rotate the engine. Remove the shaft retainer clip. Fig. 2-24, and press the shaft inward until the barring gear engages the drive gear; then advance. After the adjustments are complete retract the shaft and install the retainer clip into the safety lock groove.

Fig. 2-24, (K11919). Engine barring arrangement — KT/KTA19

Caution: The barring mechanism gear must be completely engaged when barring the engine to avoid damage to the teeth of the gear.

1. Bar the engine in the direction of rotation until "B" mark on the pulley, Fig. 2-25, is aligned with pointer on the gear case cover. In this position, both valve rocker levers for cylinder No. 3 must be free (valves closed). The injector plunger for cylinder No. 6 must be at top of travel; if not, bar the engine 360 degrees, realign the marks with the pointer.

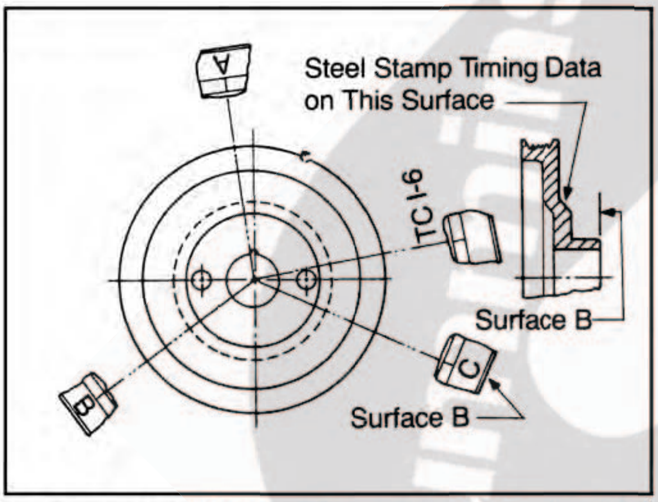


Fig. 2-25, (K11920). Accessory drive pulley marking — KT/KTA19

Note: The injector and valves on any one (1) cylinder can not be set at the same valve set position. Example: If the rocker levers on No. 3 cylinder are free (valves closed) the injector plunger travel on No. 6 cylinder is a starting point. See Table 2-4.

2. Install 3375004 Dial Indicator Assembly to the rocker housing, (3375005) extension must go through the opening in the Jacobs Brake housing and contact the injector plunger top, Fig. 2-26.

3. Screw the injector lever adjusting screw down until the plunger is bottomed in the cup, back off approximately 1/2 turn then bottom again, set the dial indicator at zero (0).

Note: Care must be taken to assure the injector plunger is correctly bottomed in the cup, without overtightening the adjusting screw, before setting the dial indicator.

4. Back the adjusting screw out until a reading of 0.304 inch [7.72 mm], reference Table 2-5, is obtained on the dial indicator. Snug tighten the locknut.

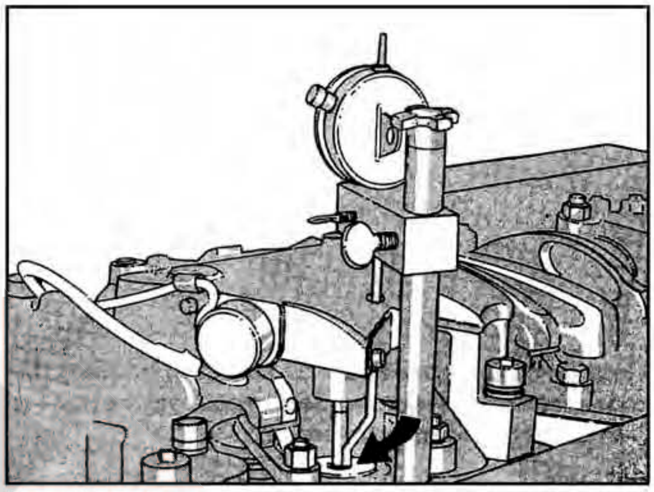


Fig. 2-26, (OM1061L). Dial indicator in place — extension in contact with plunger

5. Using 3375009 Rocker Lever Actuator Assembly and (3375007) Support Plate, bottom the injector plunger, check the zero (0) setting. Fig. 2-27. Allow the plunger to rise slowly; the indicator must show the plunger travel to be within the range indicated in Table 2-5.

Table 2-5: Adjustment Limits Using Dial Indicator Method Inch [mm] KT/KTA19 Engines

Injector Plunger Travel	Valve Clearance Intake	Exhaust
0.304 ± 0.001 [7.72 ± 0.03]	0.014 [0.36]	0.027 [0.69]

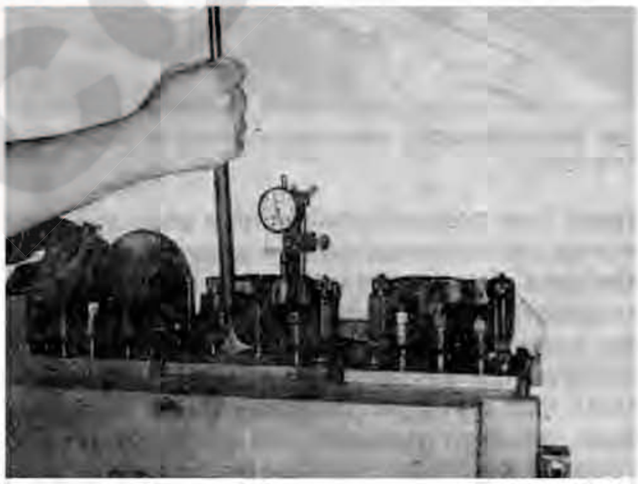


Fig. 2-27, (K114104). Actuating rocker lever

6. Using ST-669 Torque Wrench Adapter to hold the adjusting screw in position, torque the locknut to 30 to 35 ft-lbs [41 to 47 N•m]. If the torque wrench adapter is not used, hold the adjusting screw with a screwdriver, torque the locknuts to 40 to 45 ft-lbs [54 to 61 N•m].
7. Actuate the injector plunger several times as a check of the adjustment. Remove the dial indicator assembly.

Caution: If Jacobs Brake is not used, be sure the crossheads are adjusted before setting the valves. See Crosshead Adjustment following.

8. Adjust the valves on the appropriate cylinder as determined in Step 1 and Table 2-5. Tighten the locknuts the same as the injector locknut.
9. If Jacobs Brake is used, use 3375012 (0.018 inch [0.46 mm] thick) Feeler Gauge and 3375008 Torque Wrench Extension, set the exhaust valve crosshead to Jacobs Brake slave piston clearance, Fig. 2-28.

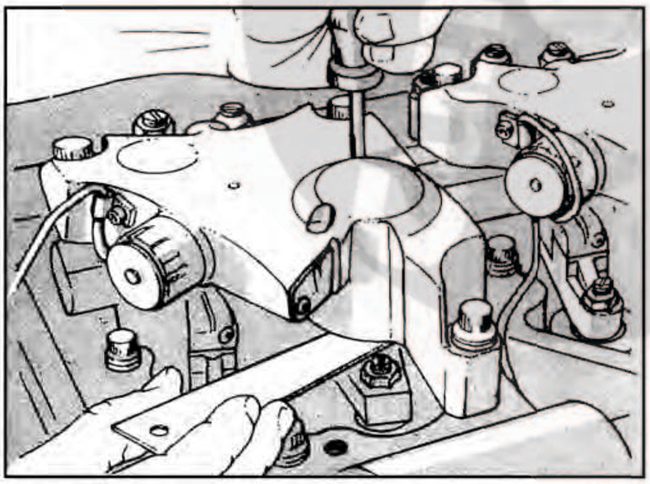


Fig. 2-28, (OM1063L). Adjusting crosshead to slave piston clearance

Note: Turn both adjusting screws alternately and evenly until the crosshead and feeler gauge contact the slave piston and the adjusting screws are bottomed on the valve stem. Back the adjusting screws out one-fourth (1/4) to one-half (1/2) turn. Starting with the outer adjusting screw (next to water manifold), then moving to the screw under the rocker lever, retighten gradually until the crosshead and feeler gauge contact the slave piston. Snug tighten the locknuts.

10. Hold the crosshead adjusting screws with a screwdriver, torque the locknuts 22 to 26 ft-lbs [30 to 35 N•m] using 3375008 Extension and torque wrench.
11. See Table 2-19 for valve clearance values.
12. Repeat the adjustment procedure for each cylinder. See Table 2-18 for firing order and injector and valve set positions.

Crosshead Adjustment

Note: The engine produced after 2006, needn`t adjust the crosshead.

Crossheads are used to operate two valves with one rocker lever. The crosshead adjustment is provided to assure equal operation of each pair of valves and prevent strain from misalignment.

1. Loosen the valve crosshead adjusting screw locknut and back off the screw (4, Fig. 2-29) one turn.

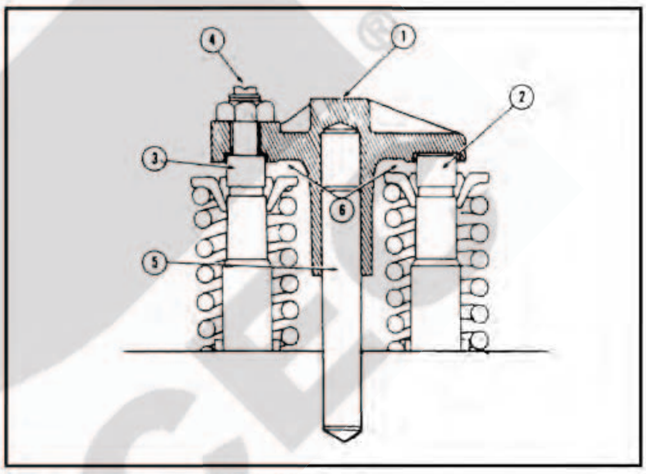


Fig. 2-29, (K21924). Valve crosshead

2. Use light finger pressure at the rocker lever contact surface (1) to hold the crosshead in contact with the valve stem (2) (without adjusting screw).
3. Turn down the crosshead adjusting screw until it touches the valve stem (3).
4. Using ST-669 Torque Wrench Adapter, tighten the locknuts to 22 to 26 ft-lbs [30 to 35 N•m]. If ST-669 is not available, hold the screws with a screwdriver and tighten the locknuts to 25 to 30 ft-lbs [34 to 41 N•m].
5. Check the clearance (6) between the crosshead and valve spring retainer with a wire gauge. There must be a minimum of 0.025 inch [0.64 mm] clearance at this point.

Injector and Valve Adjusting Using 3375004 Dial Indicator Kit (KT/KTA38 and KTA50 Engines)

Valve Set Mark Alignment

Note: KT/KTA38 and KTA50 injectors, crossheads and valves are adjusted to the same values. Refer to Fig's. 2-30 and 2-31 for specific cylinder arrangement and engine firing order.

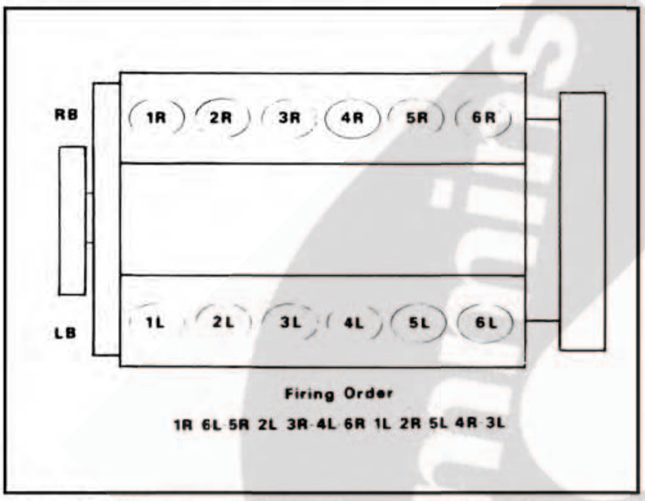


Fig. 2-30, (K21916). Cylinder arrangement and firing order — KT/KTA38

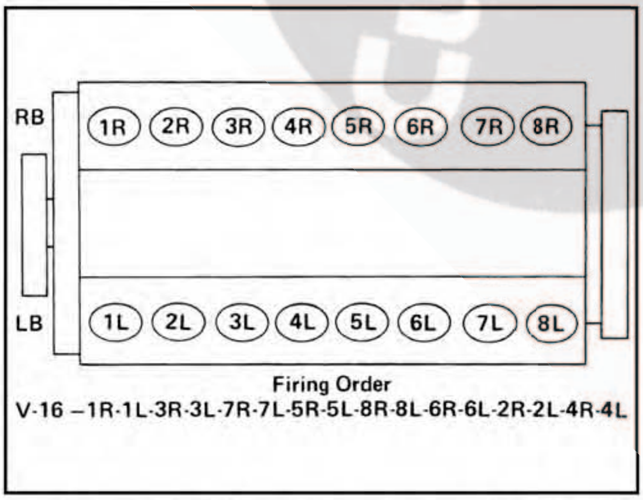


Fig. 2-31, (OM204). Cylinder arrangement and firing order — KTA50

Three locations are provided where valve and injector alignment marks may be viewed. Injector plunger travel and valves both may be set on one cylinder at the same valve set location. The crankshaft must be turned through two (2) complete revolutions to properly set all injector plunger travel and valves.

Note: The barring mechanism may be located on either the left bank or right bank at the flywheel housing. The cover plate on opening "A" or "C" directly above the barring mechanism must be removed when viewing the timing marks at the flywheel housing.

1. When viewing the engine at the vibration damper, Fig. 2-32, align the timing marks on the damper with the pointer on the gear case cover.

Fig. 2-32, (K21917). Valve set marks on vibration damper — KT/KTA38

2. When barring the engine from the right bank at the flywheel housing "A" VS timing marks on the flywheel (1, Fig. 2-33) must align with the scribe mark (2) when viewed through the opening marked "A" on the flywheel housing.

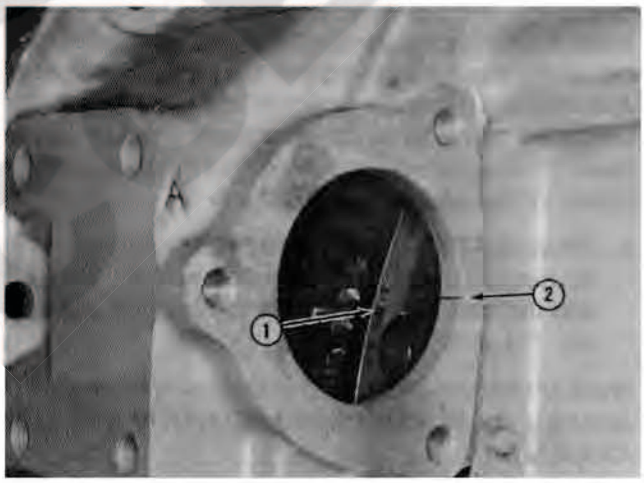


Fig. 2-33, (K21918). Valve set marks on right bank flywheel and housing — KT/KTA38

3. When barring the engine from the left bank at the flywheel housing "C" VS timing marks on the flywheel (1, Fig. 2-34) must align with the scribe

mark (2) when viewed through the opening marked "C" on the flywheel housing.

Caution: When aligning valve set marks at either flywheel housing location, care must be taken to assure that "A" or "C" valve set marks on the flywheel match "A" or "C" marks on the flywheel housing opening.

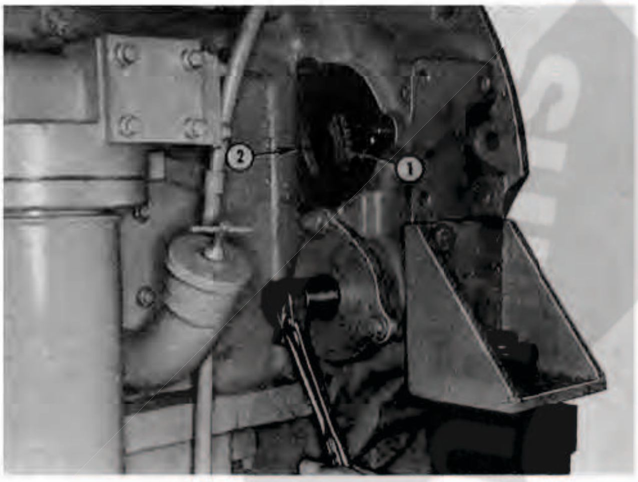


Fig. 2-34, (K21919). Engine barring device

Injector Plunger Adjustment

1. Bar the engine in the direction of rotation until the appropriate valve set mark is aligned with the scribe mark on the flywheel housing or until a valve set mark on the vibration damper is aligned with the pointer on the gear case cover.

Note: Any valve set position may be used as a starting point when adjusting the injectors, crossheads and valves. Determine which of the two (2) cylinder indicated have both valves closed (rocker levers free). This cylinder is in position for injector plunger travel, crosshead and valve adjustment.

2. Set up 3375007 Support Block on the rocker lever housing, of the cylinder selected, with the 3375005 dial indicator extension on the injector plunger top. Fig. 2-35.

Note: Make sure 3375008 Dial Indicator extension is secure in the indicator stem and is not touching the rocker lever.

3. Using the rocker lever actuator, Fig. 2-36, depress the lever toward the injector until the plunger is bottomed in the cup to squeeze the oil film from the cup. Allow the injector plunger to rise, bottom again, hold in the bottom position and set the indicator zero (0). Check the extension contact with the plunger top.

4. Allow the plunger to rise then bottom the plunger again, release the lever, the indicator must show travel as indicated in Table 2-6. Adjust as necessary.

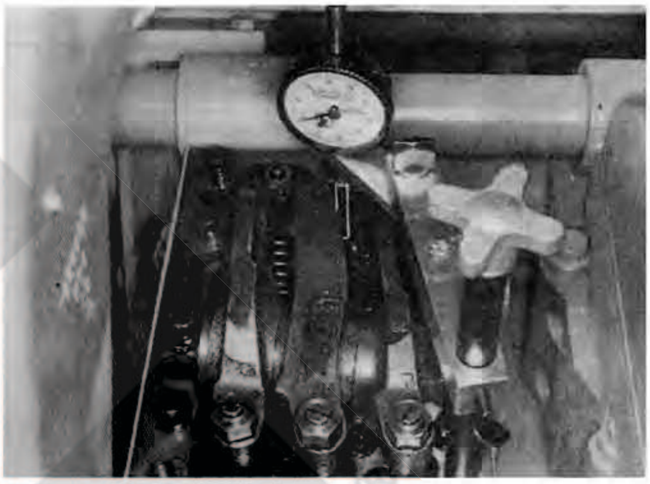


Fig. 2-35, (K21920). Dial indicator in place — extension in contact with plunger

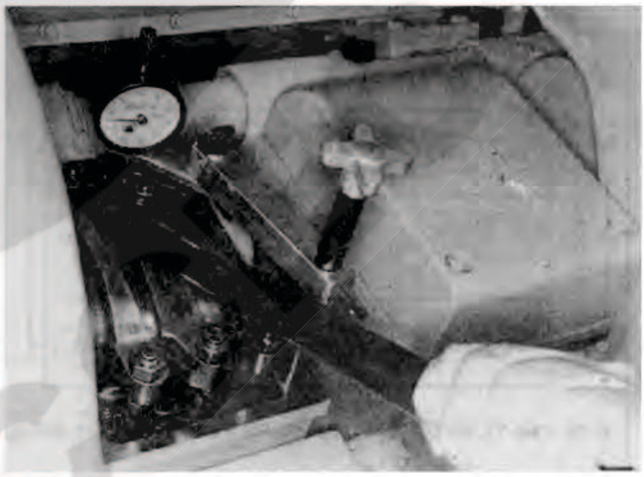


Fig. 2-36, (K21921). Bottoming injector plunger in cup

Table 2-6: Adjustment Limits Using Dial Indicator Method Inch [mm] KT/KTA38 and KTA50 Engines

Injector Plunger Travel	Valve Clearance Intake	Exhaust
0.308 ± 0.001 [7.82 ± 0.03]	0.014 [0.36]	0.027 [0.69]

5. If the adjusting screw locknuts were loosened for adjustment, tighten to 40 to 45 ft-lbs [54 to 61 N•m] torque and actuate the plunger several times as a check of the adjustment. Tighten the locknuts to 30 to 35 ft-lbs [41 to 47 N•m] torque when using ST-669 Torque Wrench Adapter.
6. Remove 3375004 Kit.

Note: The engine produced after 2006, needn't adjust crosshead.

Crosshead Adjustment

Crossheads are used to operate two valves with one rocker lever, an adjusting screw is provided to assure equal operation of each pair of valves and prevent strain from misalignment. Crosshead adjustment changes as a result of valve and seat wear during engine operation.

1. Loosen the adjusting screw locknut, back off the screw (4, Fig. 2-29) one turn.
2. Use light finger pressure at the rocker lever contact surface (1) to hold the crosshead in contact with the valve stem (2). The adjusting screw should not touch the valve stem (3) at this point.
3. Turn down the adjusting screw until it touches the valve stem (3).
4. Using 3375008 Torque Wrench Extension to hold the adjusting screw in position, tighten the locknut to 22 to 26 ft-lb [30 to 35 N•m] torque. If the torque wrench adapter is not used, hold the adjusting screw with a screwdriver, tighten the locknut to 25 to 30 ft-lb [34 to 41 N•m] torque.
5. Check the clearance (6) between the crosshead and the valve spring retainer with a gauge. There must be a minimum of 0.025 inch [0.64 mm] clearance at this point.

Valve Adjustment

1. Insert the correct thickness feeler gauge between the rocker lever and the crosshead for the valves being adjusted. See Table 2-20 for valve clearance.

Note: Exhaust valves are toward the front of the engine in each cylinder head on the LB side and are toward the rear of the engine in each cylinder head on the RB side.

2. If adjustment is required, loosen the locknut and turn the adjusting screw down until the rocker lever just touches the feeler gauge; lock the adjusting screw in this position with the locknut.
3. Tighten the locknut to 40 to 45 ft-lb [54 to 61 N•m] torque. When using ST-669 Torque Wrench Adapter tighten the locknuts to 30 to 35 ft-lb [41 to 47 N•m] torque.

After completing the injector plunger travel, crosshead and valve adjustment on this cylinder bar the engine in the direction of rotation until the next valve set mark is aligned with the scribe mark at the flywheel housing or the pointer on the gear case cover; repeat the procedure. See Fig's. 2-30 and 2-31 for cylinder arrangement and engine firing order.

Change Oil

Change Aneroid Oil

1. Remove fill plug (1, Fig. 2-36) from the hole marked "Lub oil".

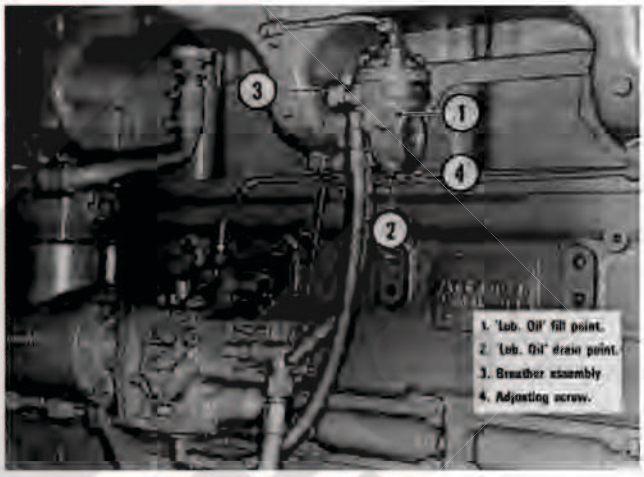


Fig. 2-36, (N10503). Aneroid

2. Remove the drain plug (2) from the bottom of the aneroid.
3. Replace the drain plug (2), fill the aneroid with clean engine lubricating oil. Replace the fill plug (1).

Replace Aneroid Breather

Remove and replace the aneroid breather (3, Fig. 2-36).

Change Hydraulic Governor Oil

Change oil in the hydraulic governor sump at each "C" Check.

Use the same grade of oil as used in the engine. See "Lubricating Oil Specifications"

Note: When temperature is extremely low, it may be necessary to dilute the lubricating oil with enough fuel oil or other special fluid to ensure free flow for satisfactory governor action.

Backside Idler Fan Drive

Inspect the idler assembly to be sure the pivot arm is not binding. Use the following procedure.

1. Check the idler arm for freedom of movement.
   a. Grasp the pulley and move the pulley and arm away from the fan belt until the arm is nearly vertical.
   b. Release the arm and pulley and allow them to move back to their original position against the belts.
   c. The motion of the arm and pulley assembly should be free with no binding.
2. If the arm appears to be binding or tight, release the spring tension by placing a box end wrench over the square knob on the end of the pivot arm cap and while holding up on the box end wrench, remove the capscrew which holds the cap in place and allow the spring to unwind by allowing the box end wrench to rotate counterclockwise.
   a. With the spring unloaded, rotate the cap until the slots inside the cap align with the roll pins in the pivot arm, and remove the cap by pulling away from the engine.
   b. With the torsion spring unloaded, the pivot arm should rotate freely. If it does not appear free, then the bushings require replacement or repacking with lubricant.
3. To inspect the bushings, loosen and remove the large hex head capscrew in the center of the pivot arm and remove the pivot arm from the pivot arm support.
   a. Inspect the shaft for corrosion and clean it as necessary with fine grade emery cloth.
   b. Inspect the bushings and thrust washers, clean and repack them with a good grade of lubricant such as:
      — lubriplate
      — moly-disulfide grease
   c. Inspect the O-ring on the pivot arm and replace it as necessary. Lubricate the O-ring prior to installation.
   d. Reassemble the pivot arm assembly cap using a new spring.
   e. Retension the new spring and lock the cap in place. Install a new fan belt and test the unit.

Clean Complete Oil Bath Air Cleaner

Steam

Steam clean the oil bath cleaner main body screens. Direct the stream jet from the air outlet side of the cleaner to wash dirt out in the opposite direction of air flow.

Solvent-Air Cleaning

1. Steam clean the exterior of the cleaner.
2. Remove the air cleaner oil cup.
3. Clamp the hose with the air line adapter to the air cleaner outlet.
4. Submerge the air cleaner in solvent.
5. Introduce air into the unit at 3 to 5 psi [21 to 34 kpa] and leave it in the washer 10 to 20 minutes.
6. Remove the cleaner from solvent and steam clean thoroughly to remove all traces of solvent. Dry with compressed air.

Caution: Failure to remove solvent may cause engine to overspeed until all solvent is sucked from the cleaner.

7. If the air cleaner is to be stored, dip it in lubricating oil to prevent rusting of the screens.

Note: If screens cannot be thoroughly cleaned by either method, or if the body is pierced or otherwise damaged, replace with a new air cleaner.

"D" Maintenance Checks

At each "D" Maintenance Check, perform all "A", "B" and "C" checks in addition to those following. Most of these checks should be performed by a Cummins Distributor or Dealer and where Cummins Shop Manuals are available for complete instructions.

Clean and Calibrate Injectors

Clean and calibrate the injectors regularly to prevent restriction of fuel delivery to the combustion chambers. Because of the special tools required for calibration, most owners and fleets find it more economical to let a Cummins Distributor do the cleaning and calibration operations.

To clean and calibrate the injectors, refer to Bulletin No. 3379071 and revisions thereto.

After removing the injectors from KT/KTA19, KT/KTA38 or KTA50 Engines for cleaning the seal seat should be removed from the injector (1, Fig. 2-37) or injector "well" for cleaning, examination and/or replacement as necessary.

Fig. 2-37, (K11918). Injector seal seat — all KT Engines

Caution: There must be only one (1) seal seat used in each injector "well". Use of more than one seal seat per injector will change the injector protrusion and cause combustion inefficiency.

Clean and Calibrate Fuel Pump

Check the fuel pump calibration on the engine if required. See the nearest Cummins Distributor or Dealer for values.

Clean and Calibrate Aneroid

1. Remove the flexible hose or tube from the aneroid cover to the intake manifold.
2. Remove the lead seal (if used), screws and aneroid cover.
3. Remove the bellows, piston, upper portion of the two piece shaft and the spring from the aneroid body.

Note: Count and record the amount of thread turns required to remove the upper shaft, piston and bellows from the lower shaft.

4. Place the hex portion of the shaft in a vise, snug tighten the vise, remove the self-locking nut, retaining washer and bellows.
5. Clean the parts in an appoved cleaning solvent.
6. Position the new bellows over the shaft to the piston, secure with retaining washer and self-locking nut. Tighten the self-locking nut to 20 to 25 ft-lb [27 to 34 N•m] torque.
7. Install the spring, shaft, piston and bellows assembly into the aneroid body. As the two piece shaft is re-assembled, turn the upper portion of the shaft the same amount of thread turns as recorded during disassembly.

Caution: The amount of thread turns during installation must correspond with turns during removal to avoid changing the aneroid setting.

8. Align the holes in the bellows with the corresponding capscrew holes in the aneroid body.
9. Position the cover to the body; secure with flatwashers, lockwashers and fillister head screws.
10. Install a new seal. Refer to Bulletin No. 3379084 for sealing instructions and calibration procedure. Calibration, if required, must be performed by a Cummins Distributor on a fuel pump test stand.

11. Reinstall the flexible hose or tube from the aneroid cover to the intake manifold.

Clean Cooling System

The cooling system must be clean to do its work properly. Scale in the system slows down heat absorption from water jackets and heat rejection from the radiator. Use clean water that will not clog any of the hundreds of small passages in the radiator or water passages in the block. Clean the radiator cores, heater cores, oil cooler and block passages that have become clogged with scale and sediment by chemical cleaning, neutralizing and flushing.

Chemical Cleaning

If rust and scale have collected, the system must be chemically cleaned. Use a good cooling system cleaner and follow the manufacturer's instructions.

Pressure Flushing

When pressure flushing the radiator, open the upper and lower hose connections and screw the radiator cap on tight. Use the hose connection on both the upper and lower connections to make the operation easier. Attach a flushing gun nozzle to the lower hose connection and let water run until the radiator is full. When full, apply air pressure gradually to avoid damage to the core. Shut off the air and allow the radiator to refill; then apply air pressure. Repeat until the water coming from the radiator is clean.

Caution: Do not use excessive air pressure while starting the water flow. This could split or damage the radiator core.

Sediment and dirt settle into pockets in the block as well as the radiator core. Remove the thermostats from the housing and flush the block with water. Partially restrict the lower opening until the block fills. Apply air pressure and force water from the lower opening. Repeat the process until the stream of water coming from the block is clean.

Inspect Water Pump, Fan Hub and Idler Pulley

Inspect the water pump shaft, fan hub and idler for wobble and evidence of grease leakage. Refer to the engine shop manual for rebuild and lubricating procedure for these assemblies.

Rebuilt prelubricated water pumps, fan hubs and idler assemblies are available from Diesel ReCon, Incorporated.

Inspect Turbocharger

Check Turbocharger Bearing Clearance

Check bearing clearances. This can be done without removing the turbocharger from the engine, by using a dial indicator to indicate the end-play of the rotor shaft and a feeler gauge to indicate the radial clearance. Fig. 2-38.

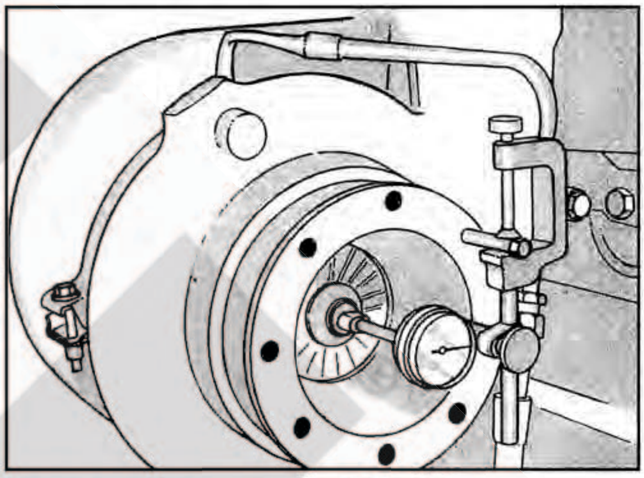


Fig. 2-38. Check turbocharger bearing end clearance.

Checking Procedure

1. Remove the exhaust and intake piping from the turbocharger to expose the ends of the rotor assembly.
2. Remove one capscrew from the front plate (compressor wheel end) and replace it with a long capscrew. Attach an indicator to the long capscrew and register the indicator point on the end of the rotor shaft. Push the shaft from end-to-end making note of the total indicator reading. Fig. 2-66. On T-50, ST-50 and VT-50 the end clearance should be 0.006 to 0.018 inch [0.15 to 0.46 mm].
3. If end clearances exceed the limits, remove the turbocharger from the engine and replace it with a new or rebuilt unit.
4. Check the radial clearance on the compressor wheel only.
   a. Push the wheel toward the side of the bore.
   b. Using a feeler gauge, check the distance between the tip of the wheel vanes and the bore. On T-50, ST-50 and VT-50 the clearance

should be 0.003 to 0.033 inch [0.08 to 0.84 mm].

Check T-18A turbochargers as follows:

a. For checking procedures refer to Service Manual Bulletin No. 3379091.

b. End clearance should be 0.004 to 0.009 inch [0.10 to 0.23 mm], radial clearance should be 0.003 to 0.007 inch [0.08 to 0.18 mm]. If the clearances exceed these limits, remove the turbocharger(s) from the engine and replace them with new or rebuilt units.

6. Install the exhaust and intake piping to the turbocharger(s).

Inspect Vibration Damper

Rubber Damper

The damper hub (1, Fig. 2-39) and the inertia member (2) are stamped with an index mark (3) to permit the detection of movement between the two components.

There should be no relative rotation between the hub and the inertia member resulting from engine operation.

Check for extrusion or rubber particles between the hub and the inertia member.

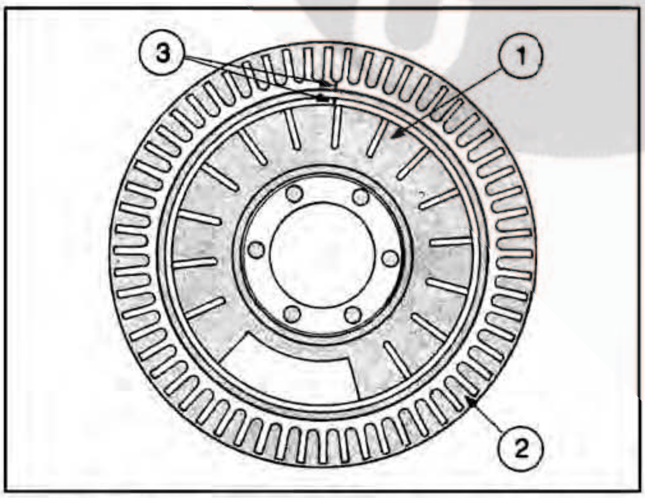


Fig. 2-39, (OM1066L). Vibration damper alignment marks

If there is evidence of inertia member movement and rubber extrusion, replace the damper.

Viscous Dampers

Check the damper for evidence of fluid loss, dents and wobble. Visually inspect the vibration damper's thickness for any deformation or raising of the damper's front cover plate.

1. If a lack of space around the damper will not permit a visual inspection, run a finger around the inside and the outside of the front cover plate. If any variations or deformations are detected, remove the vibration damper and check as follows.
2. Remove paint, dirt and grime from the front and rear surface of the damper in four (4) equal spaced areas. Clean the surface with paint solvent and fine emery cloth.
3. Using a micrometer measure and record the thickness of the dampers at the four (4) areas cleaned in Step 3. Take the reading approximately 0.125 inch [3.18 mm] from the outside edge of the front cover plate.
4. Replace the damper if the variation of the four (4) readings exceed 0.010 inch [0.25 mm].

Air Compressor

All air compressors have a small amount of oil carryover which lubricates the piston rings and moving parts. When this oil is exposed to normal air compressor operating temperatures over a long period of time, it will form varnish or carbon deposits. Cummins Engine Company recommends air compressor inspections every 180,000 miles or 4500 hours. If the following inspections are ignored, the air compressor piston rings will be affected by high operating temperatures, and will not seal properly.

Backside Idler Fan Drive

Remove the pivot arm assembly, disassemble and clean. Replace the Teflon bushings. Inspect the thrust washers and replace as necessary. Pack Teflon bushings with Aeroshell No. 5 Lubriplate (type 130AA) or Moly-disulfide grease, reassemble and install the idler assembly.

Clean Crankcase Breathers (KT/KTA38 and KTA50 Engines)

Remove the crankcase breathers from the right bank front and left bank rear of the cylinder block. Clean in an approved cleaning solvent, dry with compressed air, install the breather.

Seasonal Maintenance Checks

There are some maintenance checks which may or may not fall exactly into suggested maintenance schedule due to miles or hours operation but are performed once or twice each year.

Replace Hose (As Required)

Inspect the oil filter and cooling system hose and hose connections for leaks and/or deterioration. Particles of deteriorated hose can be carried through the cooling system or lubricating system and restrict or clog small passages, especially radiator core, and lubricating oil cooler, and partially stop circulation. Replace as necessary.

Check Preheater Cold-Starting Aid (Fall)

Remove the 1/8 inch pipe plug from the manifold, near the glow plug, and check the operation of the preheater as described in Section 1.

Check Shutterstats and Thermatic Fans (Fall)

Shutterstats and thermatic fans must be set to operate in the same range as the thermostat with which they are used. Table 2-7 gives the settings for shutterstats and thermatic fans as normally used. The 180 to 195°F [82 to 91°C] thermostats are used only with shutterstats that are set to close at 187°F [86°C] and open at 195°F [91°C].

Check Thermostats and Seals (Fall)

Remove the thermostats from the thermostat housings and check for proper opening and closing temperature.

Most Cummins Engines are equipped with either medium 170 to 185°F [77 to 85°C] or low 160 to 175°F [71 to 79°C] and in a few cases high-range 180 to 195° [82 to 91°C] thermostats, depending on engine application.

Steam Clean Engine (Spring)

Steam is the most satisfactory method of cleaning a dirty engine or piece of equipment. If steam is not available, use an approved solvent to wash the engine.

All electrical components and wiring should be protected from the full force of the cleaner spray nozzle.

Checking Mountings (Spring)

Tighten Mounting Bolts and Nuts (As Required)

Engine mounting bolts will occasionally work loose and cause the engine supports and brackets to wear rapidly. Tighten all mounting bolts or nuts and replace any broken or lost bolts or capscrews.

Torque Turbocharger Mounting Nuts (As Required)

Torque all turbocharger mounting capscrews and nuts to be sure that they are holding securely. Torque the mounting bolts and supports so that vibration will be at a minimum. Fig. 2-40.

Fig. 2-40, (N11953). Tightening turbocharger mounting nuts

Check Fan and Drive Pulley Mounting (Spring)

Check the fan to be sure it is securely mounted; tighten the capscrews as necessary. Check the fan for wobble or bent blades.

Check the fan hub and crankshaft drive pulley to be sure they are securely mounted. Check the fan hub pulley for looseness or wobble; if necessary, remove

Table 2-7: Thermal Control Settings

Control	Setting With 160 to 175°F [71 to 79°C]		Setting With 170 to 185°F [77 to 85°C]		Setting With 180 to 195°F [82 to 91°C]	
	Open	Close	Open	Close	Open	Close
Thermatic Fan	185°F [85°C]	170°F [77°C]	190°F [88°C]	182° [82°C]		
Shutterstat	180°F [82°C]	172°F [78°C]	185°F [85°C]	177°F [81°C]	195°F [91°C]	187°F [86°C]
Modulating Shutters Open	175°F [79°C]		185°F [85°C]		[91°C]	

the fan pilot hub and tighten the shaft nut. Tighten the fan bracket capscrews.

Check Crankshaft End Clearance (Spring)

The crankshaft of a new or newly rebuilt engine must have end clearance as listed in Table 2-8. A worn engine must not be operated with more than the worn limit end clearance shown in the same table. If the engine is disassembled for repair, install new thrust rings.

Table 2-8: Crankshaft End Clearance — Inch [mm]

Engine Series	New Minimum	New Maximum	Worn Limit
KT/KTA19	0.007 [0.18]	0.017 [0.43]	0.022 [0.56]
KT/KTA38 KTA50	0.005 [0.13]	0.015 [0.38]	0.022 [0.56]

Caution: Do not pry against the outer damper ring.

The check can be made by attaching an indicator to rest against the damper or pulley, while prying against the front cover and inner part of the pulley or damper. End clearance must be present with the engine mounted in the unit and assembled to the transmission or converter.

Check Heat Exchanger Zinc Plugs (Spring)

Check the zinc plugs in the heat exchanger and change if they are badly eroded. Frequency of change depends upon the chemical reaction of raw water circulated through the heat exchanger.

Specifications and Torque

Providing and maintaining an adequate supply of clean, high-quality fuel, lubricating oil, grease and coolant in an engine is one way of insuring long life and satisfactory performance.

Lubricant, Fuel and Coolant

The Functions of Lubricating Oil

The lubricating oil used in a Chongqing-Cummins engine must be multifunctional. It must perform the primary functions of:

Lubrication by providing a film between the moving parts to reduce wear and friction.

Cooling by serving as a heart transfer media to carry heat away from critical areas.

Sealing by filling in the uneven surfaces in the cylinder wall, valve stems and turbocharger oil seals.

Cleaning by holding contaminants in suspension to prevent a build up of deposits on the engine surfaces.
In addition, it must also provide:

Dampening and cushioning of components that operate under high stress, such as gears and push tubes.

Protection from oxidation and corrosion.
Engine lubricating oil must be changed when it can no longer perform its functions within an engine. Oil does not wear out, but it becomes contaminated to the point that it can no longer satisfactorily protect the engine. Contamination of the oil is a normal result of engine operation. During engine operation a wide variety of contaminants are introduced into the oil. Some of theses are:

Byproducts of Engine Combustion ----
aspartames, soot and acids from partially burned fuel.

Acids, varnish and sludge which are formed as a result of the oxidation of the oil as it breaks down or decomposes.

Dirt entering the engine through the combustion air, fuel, while adding or changing lubricating oil.
The oil must have an additive package to combat theses contaminates. The package generally consists of:

Detergents/Dispersants which keep insoluble matter in suspension until they are filtered from the oil or are removed with the oil change. This prevents sludge and carbon deposits from forming in the engine.

Inhibitors to maintain the stability of the oil, prevent acids from attacking metal surfaces and prevent rust during the periods the engine is not operating.

Other Additives that enable the oil to lubricate highly loaded areas, prevent scuffing and seizing, control foaming and prevent air retention in the oil.

Oil Performance Classification System
The performance of oil which has been used in Chongqing-Cummins to see another document 3165408.

Break-In Oils
Special “break-in” lubricating oils are not recommend-ded for new or rebuilt Chongqing-Cummins engines. Use the same lubricating oils used in normal engine operation.

Viscosity Recommendations
The viscosity of an oil is a measure of its resistance to flow. The Society of Automotive Engineers has classified engine oils in viscosity grades; Table 3-1 shows the viscosity range for these grades. Oil that meet the low temperature (0 ℉[-18℃]) requirement carry a grade designation with a “W” suffix. Oils that meet both the low and high temperature requirements are referred to as multigrade or multiviscosity grad oils. Multigrade oils are generally produced by adding viscosity index improver additives to retard the thinning effects low viscosity base oil will experience at engine operating temperatures. Multigrade oils that meet the requirements of the API classifications are recommended for use in Chongqing-Cummins engines.

Caution: If engine oils are used in transmissions or gear boxes the respective manufacturers

should be contracted regarding the required oil viscosity and content for these components.

Cummins and CQAEP recommend the use of multigrade lubricating oil with the viscosity grades shown in Table 3-2. Table 3-2 shows Cummins viscosity grade recommendations at various ambient temperatures. The only viscosity grades recommended are those shown in this table.

Cummins has found that the fuse of multigrade lubricating oil improve oil consumption control, improved engine cranking in cold conditions while maintaining lubrication at high operating temperatures and may contribute to improved fuel consumption. Cummins and CQAEP do not recommend the use of single grade lubricating oils. In the event that the recommended multigrade oil is not available, single grade oils may be substituted.

Caution: When single grade oil is used, be sure that the oil will be operating within the temperature ranges shown in Table 3-3.

The primary criterion for selecting an oil viscosity grade is the lowest temperature the oil will experience while in the engine oil sump. Bearing problems can be caused by the lack of lubrication during the cranking and start up of a cold engine when the oil being used is too viscous to flow properly. Change to a lower viscosity grade if oil as the temperature of the oil in the engine oil sump reaches the lower end of the ranges shown in Table 3-2.

Synthetic Lubricating Oil

Synthetic oils for use in diesel engines are primarily blended from synthesized hydrocarbons and esters. These base oils are manufactured by chemically reacting lower molecular weight materials to produce a lubricant that has planned predictable properties.

Synthetic oil was developed for use in an extreme environment where the ambient temperature may be as low as -50 ℉ [-45℃] and extremely high engine temperatures at up to 400 ℉ [205℃]. Under these extreme conditions petroleum base stock lubricates (mineral oil) do not perform satisfactorily.

Cummins Engine Co., Inc. and CQAEP recommends synthetic lubricating oil for use in Cummins engines operating in areas where the ambient temperature is consistently lower than -13 ℉ [-25℃]. Synthetic lubricating oils may be used at higher ambient temperatures provided they meet the appropriate API Service categories and viscosity grades.

Cummins Engine Co., Inc. and CQAEP recommend the same oil change interval be followed for synthetic lubricating oil as that for petroleum based lubricating oil.

Artic Operations

For engine operation in areas where the ambient temperature is consistently below -13 ℉ [-25℃] and where there is no provision to keep the engine warm when it is not operating, the lubricating oil should meet the requirements in Table 3-4. Oil meeting these requirements usually has synthetic base stocks. SAE 5 W viscosity grade synthetic oils may be used provided they meet the minimum viscosity requirement at 212 ℉ [100℃].

Grease

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

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

Fuel Oil

Chongqing-Cummins Diesel Engines have been developed to take advantage of the high energy content and generally lower cost of No. 2 Diesel Fuels. Experience has shown that a Chongqing-Cummins Diesel Engine will also operate satisfactorily on No.1 fuels or other fuels within the following specifications Table 3-5.

Coolant

Water should be clean and free of any corrosive chemicals such as chloride, sulphates and acids. It should be kept slightly alkaline with pH value in range of 8.5 to 10.5. Any water which is suitable for drinking can be treated as described in the following paragraphs for use in an engine.

Maintain the Fleetguard DCA Water Filter on the engine. The filter by-passed a small amount of coolant from the system via a filtering and treating element which must be replaced periodically.

1. In summer, with no antifreeze, fill system with water.
2. In winter, select an antifreeze except anti-freeze with anti-leak additive and use with water as required by temperature.

Note: Some antifreeze also contains anti-leak additives such as inert inorganic fibers, polymer particles or ginger root. These antifreeze should not be used in conjunction with the water filter. The filter element will filter out the additives and/or become clogged and ineffective.

3. Install or replace DCA Water Filter as follows and as recommended in Section 2.

New Engines Going Into Service Equipped With DCA Water Filters

1. New engines shipped from the factory are equipped with water filters containing a DCA pre-charge element. This element is compatible with plain water or all permanentype anti-freezes except Methoxy Pro-panel. See Table 3-6 for Methoxy Pro-panel pre-charge instructions.
2. At the first “B” check (oil change period) the DCA pre-charge element be changed to DCA Service Element. See Table 3-6.
3. Replace the DCA Service Element at each succeeding “B” check.
   a. If make-up coolant must be added between element changes, use coolant from a pretreated supply, see “Make-Up Coolant Specifications”, Section 2.
   b. Each time system is drained, pre-charge according to Table 3-6.
4. Service element may be changed at “C” check if 3300858 (DCA-4L) direct chemical additive is added to the cooling system at each “B” check between service element changes. One bottle of direct additive should be used for every 10 gallon of cooling system capacity. Add one bottle for every 15 gallon capacity if methoxy pro-panel antifreeze is used in the cooling system.
5. To insure adequate protection have the coolant checked at each third element change or more often. See “Check Engine Coolant”, Section

Table: 3-1: SAE Viscosity Numbers for Lubricating Oils

SAE Viscosity Grade	Viscosity Range: Mill Pascal-second, mPa.s (centipoise,cP) @ 0℉[-18℃]	Millimetre²/second, mm²/s (centistokes, cSt) @ 212℉[100℃]	
	Maximum	Minimum	Maximum
5W	1250	3.8	----
10W	2500	4.1	----
15W	5000	5.6	----
20W	10000	5.6	----
20	----	5.6	Less than 9.3
30	----	9.3	Less than 12.5
40	----	12.5	Less than 16.3
50	----	16.3	Less than 21.9

1. SAE Recommended Practice J300d
2. 1mPa.s=1 cP
3. 1mm^2/s=cSt

Table 3-2: Cummins Recommendations for Viscosity Grade vs. Ambient Temperature

SAE Viscosity Grade*	Ambient Temperature**
Recommended	
10W-30	-13℉ to 95℉ [-25℃ to 35℃]
15W-40	14℉ and above [-10℃ and above]
20W-40	32℉ and above [0℃ and above]

* SAE-5W mineral oils should not be used.
** For temperature consistently below -13℉[-25℃] See Table 3-4.

Table 3-3: Alternate Oil Grades

10W	-13℉ to 32℉ [-25℃ to 0℃]
20W	23℉ to 68℉ [-5℃ to 20℃]
20W-20*	23℉ to 68℉ [-5℃ to 20℃]
20	23℉ to 68℉ [-5℃ to 20℃]
30	39℉ and above [4℃ and above]
40	50℉ and above [10℃ and above]

*20w-20 is not considered a multigrade even though it meets two grades.

Table 3-4: Arctic Oil Recommendations	
Parameter (Test Method)	Specifications
Performance Quality Level	API Classification CC/SC API Classification CC/SC
Viscosity	10,000 mPa.s Max. at -31℉[-35℃] 4.1mm²/s Min. at 212℉[100℃]
Pour Point (ASTM D-97)	Min. of 9℉[5℃] Below the Lowest Expected Ambient Temperature
Sulfated Ash Content	1.85% by Weigh Maximum

Table 3-5: Recommended Fuel Oil Properties:	
Viscosity (ASTM D-445)	1.3 to 5.8 centistokes [1.3 to 5.8 mm^2 per second] at 104℉[40℃]
Cetane Number (ASTM D-613)	40 minimum except in cold weather or in service with prolonged low loads, a higher cetane number
Sulfur Content (ASTM D-129 or 1552)	Not to exceed 1% by weight.
Water and Sediment (ASTM D1796)	Not to exceed 0.1% by weight.
Carbon Residue (Ransbottom ASTM D-524 or D-189)	Not to exceed 0.25% by weight on 10% residue.
Flash Point (ASTM D-93)	125℉ [52℃] minimum. Certain marine registries require higher flash points.
Density (ASTM D-287)	30℉ to 40℉ [-1℃ to 6℃] A.P.I. at 60℉ [16℃] (0.816 to 0.876 Sp. Gr.).
Cloud Point (ASTM D-97)	10℉ [-12℃] below lowest temperature expected to operate at.
Active Sulfur-Copper Strip-Corrosion (ASTM D-130)	Not to exceed No. 2 rating after 3 hours at 122℉ [50℃].
Ash (ASTM D-482)	Not to exceed 0.02%by weight.
Distillation (ASTM D-86)	The distillation curve should be smooth an continuous. At least 90% of the fuel should evaporate at less than 680℉ [360℃]. All of the fuel should evaporate at less than 725℉ [385℃]

Table 3-6: Spin-On Type DCA Water Filter

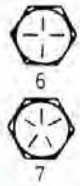
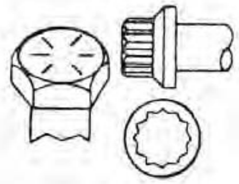
Ethylene Glycol Base Antifreeze

Cooling System Capacity (U.S. Gallons)	DCA-4L Precharge (P/N 3300858)	Service Element(s)	[New Part No.]
0-8	1	WF-2010 (P/N 299080)	[2051]
9-15	2	WF-2010	[2051]
16-30	5	WF-2010	[2051]
31-60	10	(2)WF-2010	[2051]
35-90	12	(2)WF-2016 (P/N 299086	[2053]
70-90 (KT38)	16	(4)WF-2010	[2051]

Notes: A "DCA Unit"=1.5dry ounces(42.5 grams) or 4 liquid ounces (0.12 liters).

Methoxy Propanol Base Antifreeze

DCA-4L Precharge Service			DCA Units
DCA Units	(P/N 3300858)	Elemtnt(s) [New Part No.]	
4	1	WF-2011[2050] (P/N 3300721)	2
4	2	WF-2011[2050]	2
4	4	WF-2011[2050]	2
4	8	WF-2011[2050]	2
8	8	WF-2017[2052] (P/N 300724)	6
4	16	WF-2011[2050]	2

Capscrew Markings and Torque Values				
Current	**Much Used**	**Much Used**	**Used at Times**	**Used at Times**
Minimum Tensile Strength PSI MPa	To 1/2~69,000[476] To 3/4~64,000[441] To 1~55,000[379]	To 3/4~120,00[827] To 1~115,000[793]	To 5/8~140,000[965] To 3/4~133,000[917]	150,000[1034]
Quality of Material	Indeterminate	Minimum Commercial	Medium Commercial	Best Commercial
SAE Grade Number	1 or 2	5	6 or 7	8
Capscrew Head Markings **Manufacturer's marks may vary** **These are all SAE Grade 5（3 line）** 				
Capscrew Body Size (Inch)-(Thread)	**Torque Ft-Lb[N.m]**	**Torque Ft-Lb[N.m]**	**Torque Ft-Lb[N.m]**	**Torque Ft-Lb[N.m]**
1/4 -20 -28	5[7] 6[8]	8[11] 10[14]	10[14]	12[16] 14[19]
5/6 -18 -24	11[15] 13[18]	17[23] 19[26]	19[26]	24[33] 27[37]
3/8 -16 -24	18[24] 20[27]	31[42] 35[47]	34[46]	44[60] 49[66]
7/16 -14 -20	28[38] 30[41]	49[66] 55[75]	55[75]	70[95] 78[106]
1/2 -13 -20	39[53] 41[56]	75[102] 85[115]	85[115]	105[142] 120[163]
9/16 -12 -18	51[69] 55[75]	110[149] 120[163]	120[163]	155[210] 170[231]
5/8 -11 -18	83[113] 95[129]	150[203] 170[231]	167[226]	210[285] 240[325]
3/4 -10 -16	105[142] 115[153]	270[366] 295[400]	280[380]	375[508] 420[569]
7/8 -9 -14	160[217] 175[237]	395[563] 435[590]	440[597]	605[820] 675[915]
1 -8 -14	235[319] 250[339]	590[800] 660[895]	660[895]	910[1234] 990[1342]

Note:

1. Always use the torque values listed above when specific torque values are not available.
2. Do not use above values in place of those specified in other sections of this manual; special attention should be observed when using SAE Grade 6,7 and 8 capscrews.
3. The above is based on use of clean, dry threads.
4. Reduce torque by 10% when engine oil is used as a lubricant.
5. Reduce torque by 20% if new plated capscrews are used.
6. Capscrews threaded into aluminum may require reductions in torque of 30% or more of Grade 5 capscrews torque and must attain two capscrew diameters of thread engagement.

Caution: If replacement capscrews are of a higher grade than originally supplied, adhere to torque specifications for that placement.

Troubleshooting

Troubleshooting is an organized study of the problem and a planned method of procedure for investigation and correction of the difficulty. The chart on the following page includes some of the problems that an operator may encounter during the service life of a Cummins diesel engine.

Cummins Diesel Engines

The chart does not give all the answers for correction of the problems listed, but it is meant to stimulate a train of thought and indicate a work procedure directed toward the source of trouble. To use the troubleshooting chart, find the complaint at the top of the chart; then follow down that column until you come to a black dot. Refer to the left of the dot for the possible cause.

Think Before Acting

Study the problem thoroughly. Ask these questions:

1. What were the warning signs preceding the trouble?
2. What previous repair and maintenance work has been done?
3. Has similar trouble occurred before?
4. If the engine still runs, is it safe to continue running it to make further checks?

Do Easiest Things First

Most troubles are simple and easily corrected; examples are "low-power" complaints caused by loose throttle linkage or dirty fuel filters, "excessive lube oil consumption" caused by leaking gaskets or connections, etc.

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

Double-Check Before Beginning Disassembly Operations

The source of most engine troubles can be traced not to one part alone but to the relationship of one part with another. For instance, excessive fuel consumption may not be due to an incorrectly adjusted fuel pump, but instead to a clogged air cleaner or possibly a restricted exhaust passage, causing excessive back pressure. Too often, engines are completely disassembled in search of the cause of a certain complaint and all evidence is destroyed during diassembly operations. Check again to be sure an easy solution to the problem has not been overlooked.

Find And Correct Basic Cause of Trouble

After a mechanical failure has been corrected, be sure to locate and correct the cause of the trouble so the same failure will not be repeated. A complaint of "sticking injector plungers" is corrected by replacing the faulty injectors, but something caused the plungers to stick. The cause may be improper injector adjustment or more often, water in the fuel.

Tools and Procedures To Correct A Complaint

Tools and procedures to correct the complaints found in this Troubleshooting section are available from Cummins distributors and dealers. A list of publications, by bulletin numbers, is included in the back of this manual in the form of a purchase order. This list includes all engine model shop and engine repair and rebuild manuals.

AFC Fuel Pump Adjustments

All AFC fuel pump adjustments are specified for calibration on a fuel pump test stand and not to be made on the engine. Contact your nearest authorized Cummins distributor to perform maintenance, if required.

Trouble Shooting
Cummins Engines

CAUSES		COMPLAINTS: Hard Starting or Failure to Start	Engine Misses	Excessive Black Smoke at Idle	Excessive White Smoke at Idle	Excessive Smoke Under Load	Excessive Acceleration Smoke	Low Power or Loss of Power	Cannot Reach Governed RPM	Low Air Output	Sluggish Engine Acceleration	Excessive Fuel Consumption	Poor Deceleration	Erratic Idle Speed	Engine Dies	Surging at Governed RPM	Excessive Oil Consumption	Crankcase Sludge	Dilution	Low Oil Pressure	Coolant Temperature too Low	Coolant Temperature Too High	Oil Temperature Too High	Piston, Liner and Ring Wear	Wear of Bearings and Journals	Worn Valves and Guides	Fuel Knocks (Combustion Noise)	Mechanical Knocks	Gear Train Whine	ve Engine Vibration	Excessive Noise	Excessive Crankcase Pressure
Air System	Restricted Air Intake					●	●	●		●		●																				
	High Exhaust Back Pressure					●	●	●				●																				
	Thin Air in Hot Weather or High Altitude					●	●	●		●																						
	Air Leaks Between Cleaner and Engine						●	●		●														●	●	●						
	Dirty Turbocharger Compressor					●	●	●		●		●																				
	Improper Use of Starter Aid/Air Temp.	●			●																			●	●		●					
Fuel System	Stuck Drain Valve			●		●	●					●	●																		●	
	Out of Fuel or Fuel Shut Off Closed	●													●																	
	Poor Quality Fuel/Grade Fuel	●	●		●	●		●				●		●	●			●									●					
	Air Leaks in Suction Lines	●	●					●			●		●	●	●	●											●					
	Restricted Fuel Lines	●	●	●		●	●	●			●	●	●																			
	External or Internal Fuel Leaks							●				●			●				●													
	Plugged Injector Spray Holes		●	●		●	●	●				●																				
	Broken Fuel Pump Drive Shaft	●													●																	
	Scored Gear Pump or Worn Gears	●						●																								
	Wrong Injector Cups			●	●	●	●	●				●																				
	Cracked Injector Body or Cup	●	●	●	●	●	●	●				●							●								●					
	Damaged Injector O-Ring		●					●				●	●						●													
	Excessive Injector Check Ball Leakage												●																			
	Throttle Linkage or Adjustment							●	●				●	●	●	●																
	Incorrectly Assembled Idle Springs												●	●	●																	
	Incorrectly Assembled Governor Weights													●	●	●																
	High-Speed Governor Set Too Low							●	●																							
	Water in Fuel and/or Waxing	●	●						●		●			●	●																	
	AFC Calibration Incorrect	●					●	●			●																				●	
	Damaged/Worn AFC Plunger Seal/Barrel										●																					
	Fuel Pump Calibration Incorrect					●	●	●	●		●	●	●	●	●																●	
	Injector Flow Incorrect		●			●	●	●	●		●	●																				
	Plugged ASA							●			●																					
	ASA/AFC Air Leak, Bellows							●			●																					
	ASA Reverse Flow Valve Stuck Open						●																								●	
Lubricating System	External and Internal Oil Leaks																●			●												
	Dirty Oil Filter																	●		●					●	●						
	Faulty Cylinder Oil Control			●													●		●					●								
	Clogged Oil Drillings																			●				●	●	●						
	Oil Suction Line Restriction																			●				●	●	●						
	Faulty Oil Pressure Regulator																			●												
	Crankcase Low or Out of Oil																			●		●	●	●	●	●						
	Wrong Grade Oil for Weather Conditions																●			●				●	●							
	Oil Level Too High							●				●					●						●									
Cooling System	Insufficient Coolant/Worn Pump																			●		●	●									
	Faulty Thermostats																	●		●	●	●	●									
	Damaged Hose/Loose Belts																			●		●	●									
	Radiator Shutters Stuck Open				●													●			●											
	Internal Water Leaks																	●	●													
	Clogged Oil Cooler or Water Passages																			●			●									
	Exterior Leaks/Air in System																			●		●	●									
	Low Coolant Capacity/Dirty Radiator																			●		●	●									
	Coolant Temperature Low				●													●	●		●						●					
Operation and Maintenance Practices	Dirty Filters/Screens/Breather							●	●										●					●	●	●						
	Long Idle Periods	●	●	●	●	●		●										●	●		●											
	Engine Overloaded							●	●			●												●	●		●					
	Oil Needs Changing																	●						●	●	●						
	Engine Exterior Dirty																					●	●									
Mechanical Adjustments or Repair	Gasket Blow-By or Leakage	●	●	●		●	●	●	●		●	●	●	●	●	●	●		●	●												
	Faulty Damper/Flywheel Balance																											●		●	●	
	Valve Leakage/Adjustment Bad	●	●			●	●	●																		●					●	
	Broken or Worn Piston Rings	●	●	●		●		●									●							●				●				●
	Incorrect Bearing Clearances							●				●								●					●			●	●			
	Excessive Crankshaft End Clearance																								●			●	●			
	Broken Cam Lobes						●																									
	Main Bearing Bore Out of Alignment																								●			●		●		
	Engine Due for Overhaul	●		●		●		●				●					●			●				●	●	●		●	●	●		●
	Damaged Main or Rod Bearings																			●					●			●				
	Geartrain Backlash/Broken Tooth																											●	●		●	
	Misalignment-Engine to Driven Unit											●													●				●	●		
	Loose Mounting Bolts/Head Capscrew																											●		●		
	Incorrect Valve and Injection Timing	●			●	●	●	●				●															●				●	
	Worn or Scored Liners or Pistons			●			●	●									●							●				●			●	●
	Injectors Need Adjustment		●	●	●	●	●	●	●		●	●															●					
	Broken/Bent Push Rod or Cam Box						●																					●			●	
Mechanical Variable Timing System	Faulty Rail Pressure Switch (Open)			●	●		●																									
	Faulty Rail Pressure Switch (Closed)							●																							●	
	Faulty Solenoid			●	●		●																									
	Damaged Piston and Rack Seals			●	●		●																									●
	Insufficient Torque on Actuator Capscrew			●	●		●																									
	Solenoid Orifice Plugged							●																								
	System Stick in Retard			●	●		●																									
	Broken or Disconnected MVT Wire				●																											
	Loose Cam Follower Shaft Eccentric		●		●																											
	System Stuck in Advance							●																			●				●	
Maintenance	Plugged Airline to MVT Activator			●	●		●																									
	Plugged Exhaust From MVT Activato·							●																								

Operating Principles

Dependable service can be expected from a Chongqing-Cummins Diesel Engine when the operating procedures are based up in a clear understanding of the engine working principles. Each part of the engine affects the operation of every other working part and of the engine as a whole. Chongqing-Cummins Diesel Engines treated in this manual are four-stroke-cycle, high-speed, full-diesel engines.

Chongqing-Cummins Diesel Engines

Chongqing-Cummins Diesel Cycle

Chongqing-Cummins Diesel Engines differ from spark ignited engines in a number of ways. Compression ratios are higher; the charge taken into combustion chamber during the intake stroke consists of air only with no fuel mixture. Cummins Injectors receive low-pressure fuel from the fuel pump and deliver it into individual combustion cha-mbers at the proper time, in equal quantity and atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber.

It is easier to understand the function of engine parts if it is known what happens in the combustion chamber during each of the four pistons strokes of the cycle. The four strokes and order in which they occur are: Intake Stroke, Compression Stroke, Power Stroke and Exhaust Stroke.

In order for the four strokes to function properly, valves and injectors must act in direct relation to each of the four strokes of the piston. The intake valves, exhaust valves and injectors are camshaft actuated, linked by tappets or cam followers, push rods, rocker levers and valve crossheads. The camshaft is gear driven by the crankshaft gear, thus rotation of the crankshaft directs the action of the camshaft which in turn controls the opening and closing sequence of the valves and the injection timing (fuel delivery).

Intake Stocks

During intake stroke, the piston travels downward; intake valves are open, and exhaust valves are closed. The down ward travel of the piston allows air from the atmosphere to enter the cylinder. On turbocharged engines the intake manifold is pressurized as the turbocharger forces more air into the cylinder through the intake manifold. The intake charge consists of air only with no fuel mixture.

Compression Stroke

At the end of the intake stroke, intake vales close and piston starts upward on compression stroke. The exhaust valves remain closed.

At end of compression stroke, air in combustion chamber has been forced by piston to occupy a smaller space (depending upon engine model and one-fourteenth to one-sixteenth as great in volume) than it occupied at beginning of stroke. Thus, a compression ratio is the direct proportion in the amount of air in the combustion chamber before and after being compressed.

Compressing air into a small space causes temperature of the air to rise to a point high enough for ignition of fuel.

During last part of compression stroke and early part of power stroke, a small metered charge of fuel is injected into combustion chamber.

Almost immediately after fuel charge is injected into combustion chamber, fuel is ignited by the existing hot compressed air.

Power Stroke

During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases; both intake and exhaust valves are closed. As more fuel is added and burns, gases get hotter and expand more to further force piston down ward and thus add driving force to crankshaft rotation.

Exhaust Stroke

During exhaust stroke, intake valves are closed, exhaust valves are open, and piston on upstroke.

Upward travel of piston forces burned gases out of combustion chamber through open exhaust valve ports and into the exhaust manifold.

Proper engine operation depends upon two things----first, compression for ignition; and second, that fuel be measured and injected into cylinders im-proper quantity at proper time.

Fuel System

The PT fuel system is used exclusively on Cummins Diesels. The identifying letters, "PT", are an abbreviation for "pressure-time".

The operation of the Cummins PT fuel System is based on the principle that the volume of liquid follow is proportionate to the fluid pressure, the time allowed to flow and the passage size through which the liquid flows. To apply this simple principle to the Cummins PT Fuel System, it is necessary to provide:

1. A fuel pump.
2. A means of controlling pressure of the fuel being delivered by the fuel pump to the injectors so individual cylinders will receive the right amount of fuel for the power required of the engine.
3. Fuel passages of the proper size and type so fuel will be distributed to all injectors and cylinders with each pressure under all speed and load conditions.
4. Injectors to receive low-pressure from the fuel pump and deliver it into the individual combustion chambers at the right time, in equal quantities and proper condition to burn.

The PT fuel system consists of the fuel pump, supply lines, drain lines, fuel passages and injectors. See Fig. 5-1 and the PT (type G) Fig. 5-2, VS (Variable Speed) fuel pump is shown in Fig. 5-3.

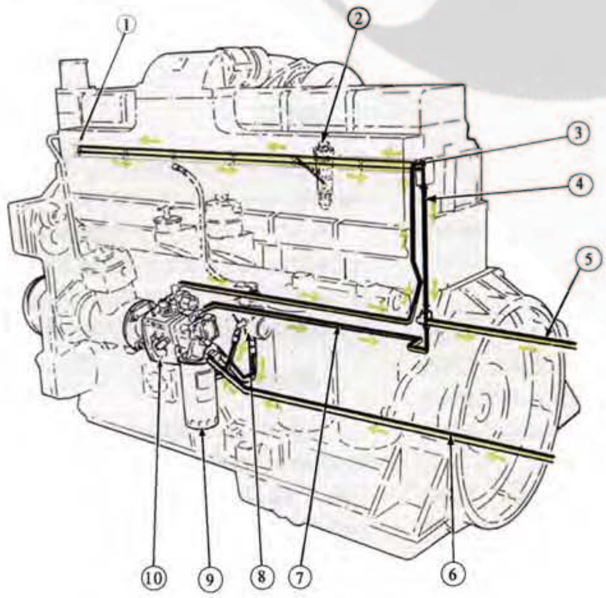


Fig. 5-1 Fuel flow schematic - KT(A)19

1. Fuel Manifold
2. Injector
3. Fuel Supply
4. Fuel Drain
5. Fuel Return to Tanks
6. Fuel Supply From Tanks
7. Fuel Pump Coolant Line
8. Aneroid
9. Fuel Filter
10. Fuel Pump

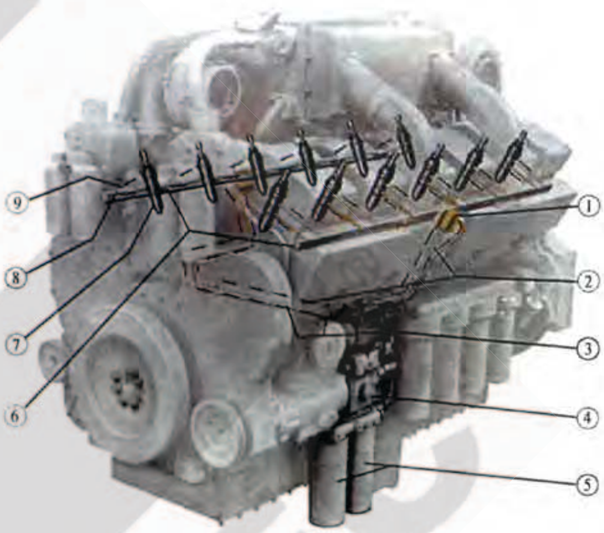


Fig. 5-2 Fuel flow schematic - KT(A)38

1. Junction Block
2. Drain Lines
3. Supply Lines
4. Fuel Pump
5. Fuel Filter
6. Fuel Manifolds
7. Injector
8. Fuel Supply Passage
9. Fuel Drain Passage

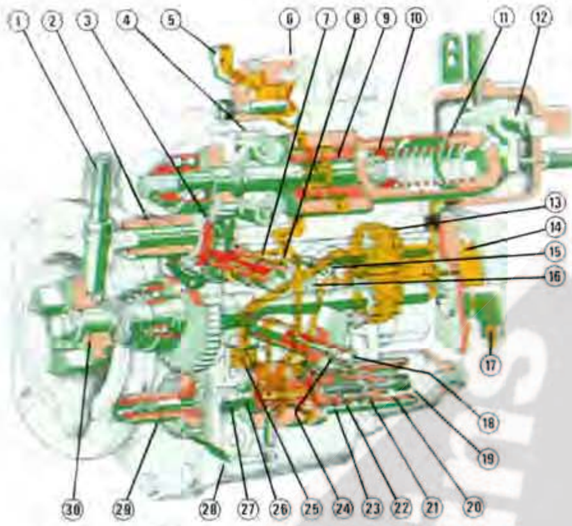


Fig. 5-3 PT(Type G) VS(variable speed) AFC fuel pump and fuel flow

1. Tachometer Drive
2. Idler Gear and Shaft
3. AFC Piston
4. VS Governor Weights
5. Fuel to Injector
6. Shutdown Valve
7. AFC Control Plunger
8. AFC Fuel Barrel
9. Vs Governor Plunger
10. VS Idle Spring
11. VS High Speed Spring
12. VS Throttle Shaft
13. Gear Pump
14. Pulsation Damper
15. AFC Needle Valve
16. Pressure Regulator Valve
17. Fuel from Filter
18. Throttle Shaft
19. Idle Adjusting Screw
20. Spring Spacer
21. High Speed Spring
22. Idle Spring
23. Idle Spring Plunger
24. Fuel Adjusting Screw
25. Filter Screen
26. Governor Plunger
27. Torque Spring
28. Governor Weights
29. Governor Assist Plunger
30. Main Shaft

Fuel Pump

The fuel pump is coupled to the fuel pump drive which is driven from the engine gear train. Fuel pump main shaft in turn drives the gear pump, governor and tachometer shaft assemblies.

Gear Pump and Pulsation Damper

The gear pump is driven by the pump main shaft and contains a singles set of gears to pick up a deliver fuel throughout the fuel system. Inlet is at the rear of the gear pump. A pulsation damper mounted to the gear pump contains a steel diaphragm which absorbs pulsations and smoothes fuel flow through the fuel system. From gear pump, fuel flows through the filter screen and to the governor assemblies as shown in Fig. 5-4

Throttle

The throttle provides a means for the operator to manually control engine speed above idle as required by varying operating conditions of speed and load.

In the fuel pump, fuel flows through the governor to the throttle shaft. At idle speed, fuel flows through the idle port in the governor barrel, past the throttle shaft. To operate above idle speed, fuel flows through the main governor barrel port to the throttling hole in the shaft.

PT (type G) VS Fuel Pump

The PT (type G) VS fuel pump is made up of four main units: the gear pump, standard governor, throttle and a VS (Variable Speed) governor.

Governors

The "standard" governor is actuated by a system of springs and weights, and has two functions:

1. The governor maintains sufficient fuel for idling with the throttle control in idle position.
2. It cuts off fuel to the injectors above maximum rated rpm.

During operation between idle and maximum speeds, fuel flows through the governor to the injectors. This fuel is controlled by the throttle and limited by the size of the idle spring plunger counter bore. When the engine reaches governor speed, the governor weights move the governor plunger, and fuel passages to the injectors are shut off. At the same time another passage opens and dumps the fuel back into the main pump body.

In this manner, engine speed is controlled and limited by the governor regardless of throttle position.

The VS governor, in the upper portion of the fuel pump housing, operates in series with the standard governor to permit operation at any desired (near constant) speed setting within the range of the standard governor. Speed can be varied with the VS speed control lever, located at top of pump.

This pump gives surge free governing throughout the engine speed range with a speed droop smaller than the standard governor and is suited to the varying speed requirements of power takeoff etc.

When operating the PT (type G) VS fuel pump at any desired constant speed, the VS governor lever should be placed in operating position and the throttle locked in full open position to allow a full flow of fuel through the standard governor.

PT (type D) Injectors

The injector provides a means of introducing fuel into each combustion chamber. It combines the acts of metering, timing and injection. Principles of operation are the same for Inline and V-engines but injector size and internal design differs slightly. Fig's 5-4 and 5-5.

Fuel supply and drain flow are accomplished through internal drillings in the cylinder heads. A radial groove around each injector mates with the drilled passages in the cylinder head and admits fuel through an adjustable (adjustable by burnishing to size at test stand) orifice plug in the injector body. A fine mesh screen at each inlet groove pro-vides final fuel filtration.

The fuel grooves around the injectors are separated by o-rings which seal against the cylinder head injector bore. This forms a leak-proof passage between the injectors and the cylinder head injector bore surface.

Fuel flows from a connection atop the fuel pump shut-down valve through a supply line into the lower drilled passage in the cylinder head. A second drilling in the head is aligned with the upper injector radial groove to drain away excess fuel. A fuel drain allows return of the unused fuel to the fuel tank.

The injector contains a ball check valve. As the injector plunger moves down ward to cover the feed opening , an impulse pressure wave seats the ball and at the same time traps a positive amount of fuel in the injector cup for injection. As the continuing downward plunger movement injects fuel into the combustion chamber, it also uncovers the drain opening and the ball rose from its seat. This allows free flow through the injector and out the drain for cooling purposes and purging gases from the cup.

Fuel Lines, Connections and Valves

Supply and Drain Lines

Fuel is supplied through lines to cylinder heads. A common drain line returns fuel not injected, to supply tank.

Connections

Fuel connectors are used between the Inline engine cylinder heads to bridge the gap between each supply and drain passage.

Shut-Down Valve

Either a manual or an electric shut-down valve is used on Cummins Fuel pumps (Fig. 5-9).

With a manual valve, the control lever must be fully clockwise or open to permit fuel flow through the valve.

With the electric valve, the manual control knob must be fully counterclockwise to permit the solenoid to open the valve when the "switch key" is turned on. For emergency operation in case of electrical failure, turn manual knob clockwise to permit fuel to flow through the valve.

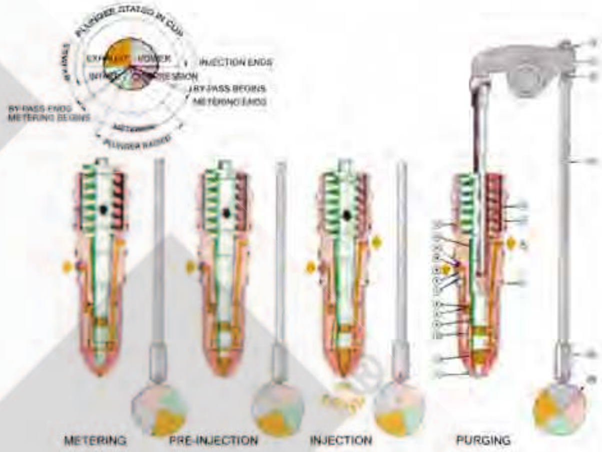


Fig. 5-4 (FWC-29). Fuel injection cycle -PT (Type D) injector 5/16 inch diameter plunger

1. CUP
2. CUP RETAINER
3. BARREL
4. PLUNGER
5. GASKET
6. CLIP
7. SCREEN
8. FUEL IN
9. ORIFICE
10. ORIFICE GASKET
11. COUPLING
12. ADAPTER
13. SPRING
14. LINK
15. FUEL OUT
16. "O" RING
17. NUT
18. ROCKER LEVER
19. ADJUSTING SCREW
20. PUS ROD
21. TAPPET
22. CAMSHAFT LOBE

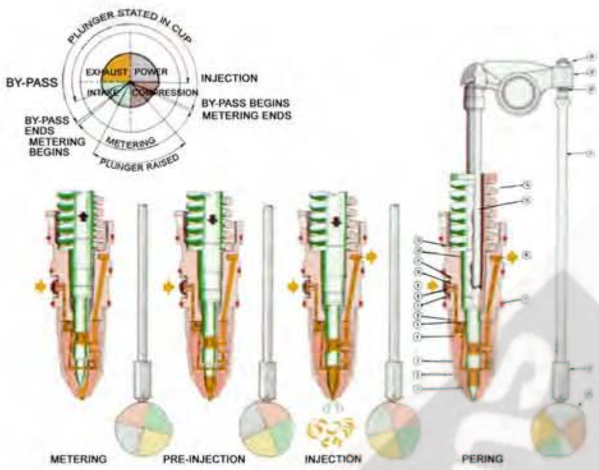


Fig. 5-5 (FWC-28). Fuel injection cycle - PT (Type D) injector 3/8 inch diameter plunger

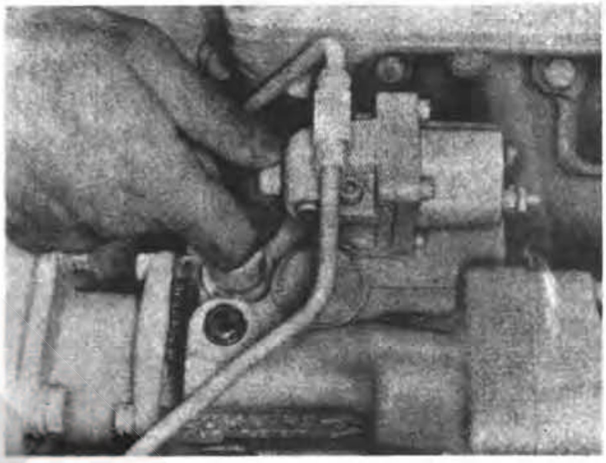


Fig. 5-6 Fuel pump manual override knob

1. CUP
2. CUP RETAINER
3. BARREL
4. PLUNGER
5. GASKET
6. CLIP
7. SCREEN
8. FUEL IN
9. ORIFICE
10. ORIFICE GASKET
11. COUPLING
12. ADAPTER
13. SPRING
14. LINK
15. FUEL OUT
16. “O” RING
17. NUT
18. ROCKER LEVER
19. ADJUSTING SCREW
20. PUS ROD
21. TAPPET
22. CAMSHAFT LOBE

Lubricating System

Chongqing-Cummins engines are pressure lubricated; pressure is supplied by a gear-type lubricating oil pump located in oil pan or on side of the engine.
A pressure regulator is mounted in the lubricating oil pump to control lubricating oil pressure.
Filters and screens are provided in lubricating oil system to remove foreign material from circulation and prevent damage to bearings or mating surfaces.
A by-pass valve is provided in full-flow oil filter head as insurance against interruption of oil flow by a dirty or clogged element.
Maximum cleansing and filtration is achieved through use of both by-pass and full-flow, lubricating oil filters.
Full-flow filters are standard on all engines; by-pass filters are used on all turbocharged models and optionally on all other engines.
Some engines are equipped with special oil pans and filters for some applications, and others with auxiliary oil coolers to maintain closer oil temperature regulation.
Turbochargers are lubricated and cooled by same lubricating oil used for engine lubrication.
Fuel pumps and injectors are lubricated by fuel oil.

KT/KTA 19 Engines

The KT-19 engines are pressure lubricated by a gear-type lubricating oil pump located on the exhaust manifold side of the engine directly below the water pump inside the gear case cover.
Lubricating oil is drawn from the pan through a suction tube, by the lubricating oil pump then transferred from the suction cavity by the pump gears into the pressure cavity. A pressure regulator valve dumps excess oil directly into the pump intake rather than back into the pan. From the lubricating oil pump, oil flows to lubricating oil cooler, through the cooler, then across the block. On air intake side of block it flows to filter head. A by-pass valve is provided in the oil inlet cavity to assure against interruption of oil flow if filter elements become clogged.
From the filter head oil enters the shells and passed through the elements then up, splitting into two passages. One flows to the main engine oil pass-age and the other to the piston-cooling passage. A second pressure control valve, located in the base of the filter head, limits the flow of lubricating oil to nozzles depending on pump supplied pressure.

Main bearings are lubricated through intersecting drillings, directly from the main oil passage. Oil flows from the main passage into camshaft bushings; from these, by constant flow, it goes to cam follower shafts and up through the cylinder heads. The cam followers are individually drilled to supply lubricating oil to rollers and push tube seats. The rocker lever bushings are also shaft lubricated.
Adjusting screws are lubricated through drillings in levers and bushings.
The connecting rod bearings get lubrication from cross drillings in the crankshaft, oil then flows through angle drillings in the connecting rods to lubricate piston pins and bushings. It is then routed from the main passage through drillings in the gear housing and cover to the camshaft and water pump idler gears. It then moves across to the gear cover and is routed by drillings to the rest of the gears and bushings.
Filtered and cooled lubricating oil is routed to the turbocharger though an external drilling in the gear housing. Turbocharger drain oil is dumped directly into the crankcase.

KT/KTA 38 and KTA 50 Engines

The KT/KTA38 engines are pressure lubricated by a gear-type lubricating oil pump located in the oil pan at the rear of the engine. The pump is mounted to block directly below crankshaft and is driven from rear crankshaft gear.
Lubricating oil is drawn from the pan, through a suction tube, by the pump then transferred from suction cavity by pump gears into pressure cavity. A pressure regulator valve dumps excess oil back into the oil pan.
From lubricating oil pump, oil flows through block drillings to lubricating oil cooler located in block “V”, through cooler, then to filters which may be mounted on either side of block. A by-pass valve is pro-vided in filter head oil inlet cavity to assure against interruption of oil flow if filter elements become clogged.
From filter head, oil enters and passes through filter elements; it then flows to the main oil pass-age located in block “V”. This passage feeds two (2) camshafts and two (2) piston cooling drillings in the block. Pressure control valves limit the flow of lubricating oil to piston cooling nozzles, depending on lubricating oil pump pressure.
Main bearings are lubricated through intersecting drillings, directly from the main oil passage. Oil flows from main passages into camshaft bushing; from there by constant flow, it goes to cam follower shafts and up through cylinder heads. The cam followers are lubricated from their shaft; cam followers are

individually drilled to supply lubricating oil to rollers and push tube seats. Rocker lever bushings are also shaft lubricated. Adjusting screws and valve guides are lubricated through drillings in rocker levers and bushings.
Connecting rod bearings are lubricated from cross drillings in the crankshaft; oil then flows through angle drillings in connecting rods to lubricate piston pins and bushings. Lubricating oil is routed from main oil passage through passages in gear housing and cover to lubricate front gear train gears, bushings and idler shafts. The rear gear train receives lubrication through an intersecting drilling from the right bank camshaft passage.
Filtered and cooled lubricating oil is routed from camshaft passages to each turbocharger th-rough external lines from drillings in cylinder block. Turbocharger drain oil is dumped back into oil pan through drilling in cylinder block.

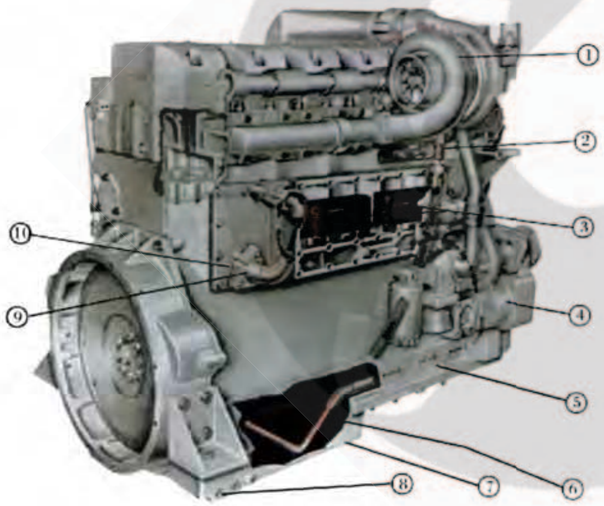


Fig. 5-7 Lubricating oil flow (exhaust side) KT38 Engines

1. TURBOCHARGER SUPPLY
2. TURBOCHARGER DRAIN
3. OIL COOLER ELEMENTS
4. OIL PUMP
5. OIL PAN ADAPTER
6. SUCTION TUBE
7. OIL PAN
8. OIL PAN DRAIN PLUG
9. TRANSFER TUBE
10. TO LUBRICATING OIL FILTER

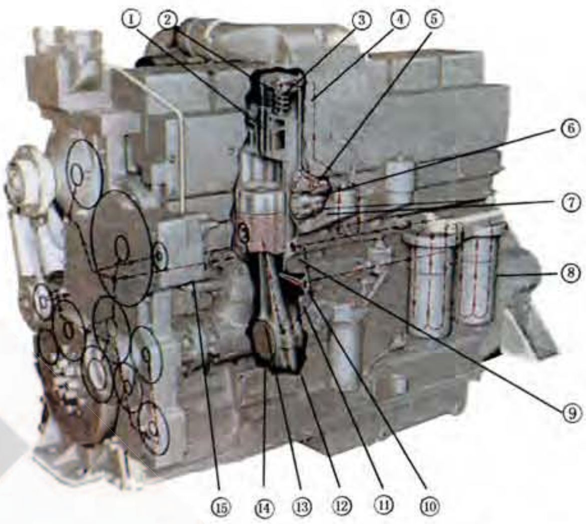


Fig. 5-8 Lubricating oil flow (intake side) KT-38 engines

1. INJECTION
2. ROCKER LEVER
3. ROCKER LEVER SHAFT
4. PUSH TUBE
5. CAM FOLLOWER
6. CAM FOLLOWER SHAFT
7. CAMSHAFT
8. LUBRICATING OIL FILTERS
9. MAIN OIL PASSAGE
10. PISTON COOLING OIL PASSANGE
11. PISTON COOLING NOZZLE
12. CONNECTION ROD
13. PISTON PIN
14. PISTON PIN
15. CANKSHAFT
16. OIL FLOW TO GEAR TRAIN

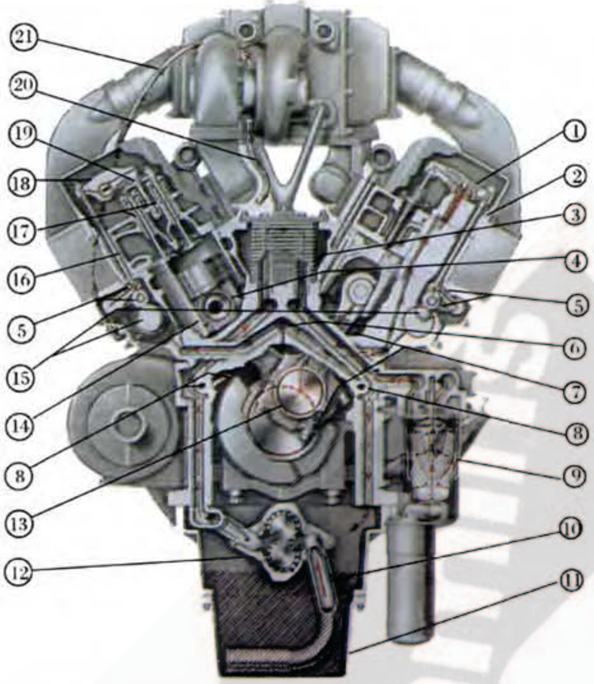


Fig. 5-9 lubricating oil flow (front view) KTA-38 Engine

1. INJECTOR ROCKER LEVER
2. INJECOR PUSH TUBE
3. OIL COOLER ELEMENT
4. PISTON PIN
5. CAM FOLLOWER
6. MAIN OIL RIFLE
7. CONNECTING ROD
8. PISTON COOLING RIFLE
9. FULL FLOW OIL FILTER
10. OIL FUCTION TUBE
11. OIL PAN
12. OIL PUMP
13. CRANKSHAFT
14. CYLINDER LINER
15. CAMSHAFT
16. VALVE PUSHROD
17. VALVE GUIDE
18. VALVE ROCKER ARM
19. VALVE CROSS HEAD
20. TURBO DRAIN LINE
21. TURBO SUPPLY HOSE

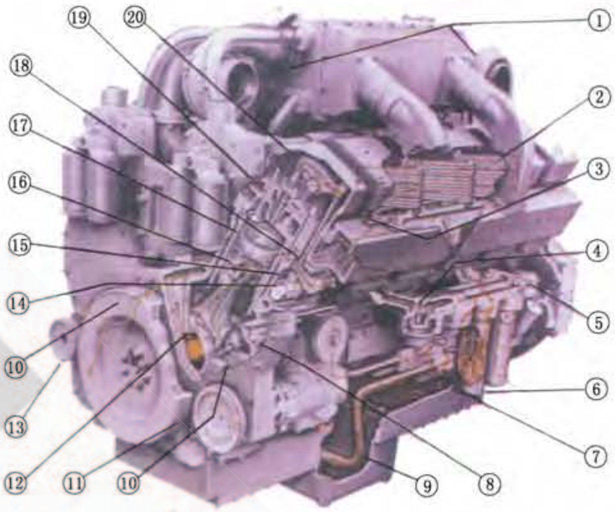


Fig. 5-10 Lubricating oil flow (3/4 front view KTA-38)

1. TURBOCHARGER
2. OIL COOLER ELEMENTS
3. OIL SUPPLY TO COOLER
4. OIL TO ENGINE FROM FILTERS
5. PRESSURE REGUALTOR
6. FULL FLOW OIL FILTERS
7. LUBRICATING OIL PUMP
8. PISTON COOLING NOZZLE
9. OIL SUCTION TUBE
10. OIL FLOW AT CAM BUSHINGS
11. ACCESSORY DRIVE
12. MAIN BEARING
13. WATER PUMP DRIVER
14. CAMSHAFT
15. CAM FOLLOWER
16. PISTON PIN
17. PISTON
18. PUSH TUBE
19. VALVE GUIDE
20. INJECTOR ROCKER LEVER

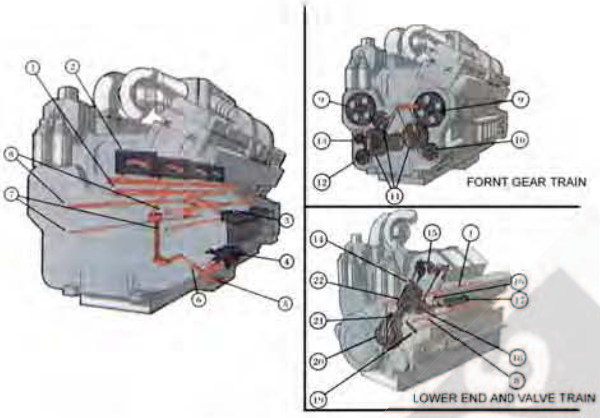


Fig. 5-11 Lubricating oil flow schematic - KTA50 Engine

1. MAIN OIL RIFLE
2. OIL COOLER
3. FILTER HEAD
4. LUBRICATING OIL PUMP
5. SUCTION TUBE
6. DISCHARGE TUBE
7. PISTON COOLING OIL RIFLES
8. CAMSHAFT OIL RIFLES
9. CAMSHAFT DRIVE GEAR
10. ACCESSORY DRIVE GEAR
11. IDLER GEARS
12. HYDRAULIC PUMP DRIVE GEAR
13. WATER PUMP DRIVE GEAR
14. EXHAUST VALVES
15. ROCKER LEVER
16. OIL CONTROL ORIFICE
17. CAMSHAFT
18. CONNECTING ROD
19. PISTON

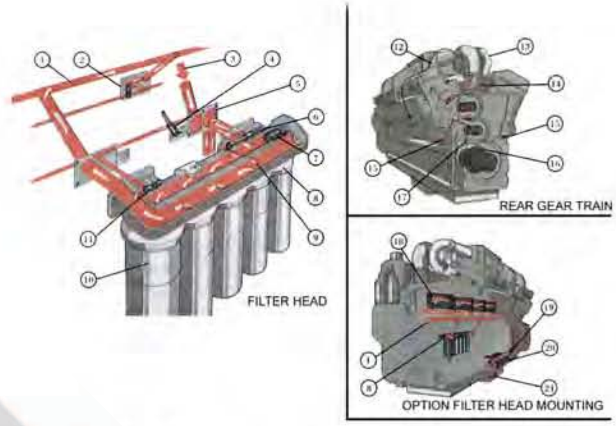


Fig. 5-12 Option lubricating oil flow schematic – KTA50 Engine

1. MAIN OIL RIFLE
2. PISTON COOLING REGULATOR R.B.
3. FLOW FROM OIL COOLERS
4. PISTON COOLING NOZZLE
5. BYPASS TO OIL PAN
6. PRESSURE REGULATOR
7. BYPASS VALVE
8. FILTER HEAD
9. REQULATOR CONTROL RIFLE
10. FILTERS
11. PISTON COOLING REGULATOR L.B.
12. TURBOCHARGER OIL SUPPLY LINE
13. TURBOCHARGER
14. TURBOCHARGER OIL DRAIN LINE
15. CAMSHAFT OIL RIFLE
16. THRUST BEARINGS
17. FROM MAIN OIL RIFLE
18. OIL COOLINGS
19. DISCHARGE TUBE
20. LUBRICATINGOIL PUMP
21. SUCTION TUBE

Cooling System

Water is circulated by a centrifugal water pump mounted either in or on the front of the engine belt driven from the accessory drive or crankshaft. Water circulates around wet-type cylinder liners, through the cylinder heads and around the injector sleeves. Fig. 5-11 through Fig. 5-13. The injector sleeves, in which the injectors are mounted, are designed for fast dissipation of heat. The engine has a thermostat or thermostats to control the engine operating temperature. The engine coolant is cooled in a heat exchanger or keel coder. Sea water is circulated through heat exchanger by the raw water pump, mounted on front of engine, and discharge through connections on the heat ex-changer.

The Fleetguard Water Filter is standard on Chong-qing-Cummins Engines. The filter by-pass a small amount of coolant from the system via a filtering and treating element which must be replaced periodically.

KT/KTA 19 Engines

Water is circulated by a centrifugal water pump. Mounted on the exhaust side of the block. The pump is driven by an idler gear from the crankshaft.

Coolant flows from the water pump volute into the oil cooler housing, through the cooler housing (serving as a water distribution manifold) into the block, maintaining an equal flow around all cylinder liners. From the liner area coolant flows into individual cylinder heads through holes drilled between the valves and around the injector "wells". From the cylinder heads water flows to the rocker housing (water outlet manifold) then to the thermo-stat housing. At the thermostat housing water is re-turned to the water pump via a by-pass tube until the engine coolant temperature activates dual thermostats. Coolant flow is then directed through a heat exchanger or Keel cooler.

KT/KTA 38 and 50 Engines

Water is circulated by a centrifugal water pump mounted on the right bank side of the block. The pump is driven by an idler gear from the crankshaft.

Coolant flows from the water pump volute into the center of the "V" of the cylinder block, around the lubricating oil cooler elements. The center of the "V" serves as a water distribution manifold to supply a flow of coolant through the aftercooler elements and around the cylinder liners.

From the liner area coolant flows into individual cylinder heads through passages between the valves and around the injector "wells". From the cylinder heads coolant flows to the rocker housing (water outlet manifold) then to the thermostat housings. At the thermostat housings coolant is re-turned to the water pump via a by-pass tube until the engine coolant temperature activates the thermostats. Coolant flow is then directed through a heat exchanger or Keel cooler. Coolant circulated through the aftercooler is also returned into the thermostat housings.

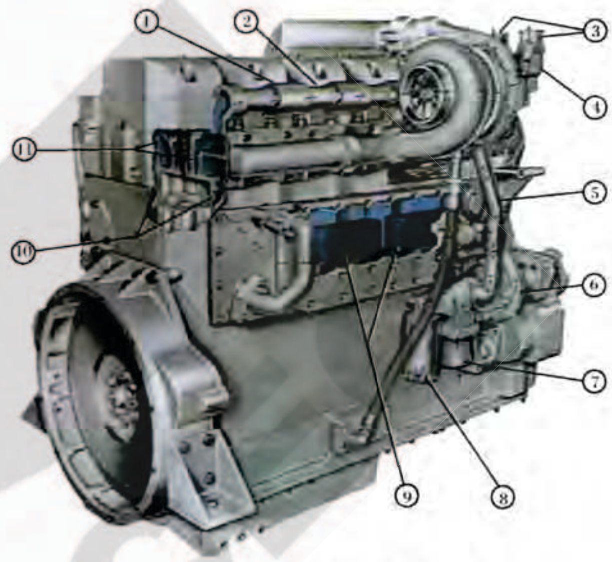


Fig. 5-13 Coolant flow --- KT(A)-19

1. WATER MANIFOLD
2. TRANSFER TUBE
3. WATER "OUT"
4. THERMOSTAT HOUSING
5. BY-PASS TUBE
6. WATER PUMP
7. WATER "IN"
8. WATER FILTER
9. LUBRICATING OIL COOLERS
10. WATER "THROUGH" BLOCK
11. WATER "THROUGH" HEADS

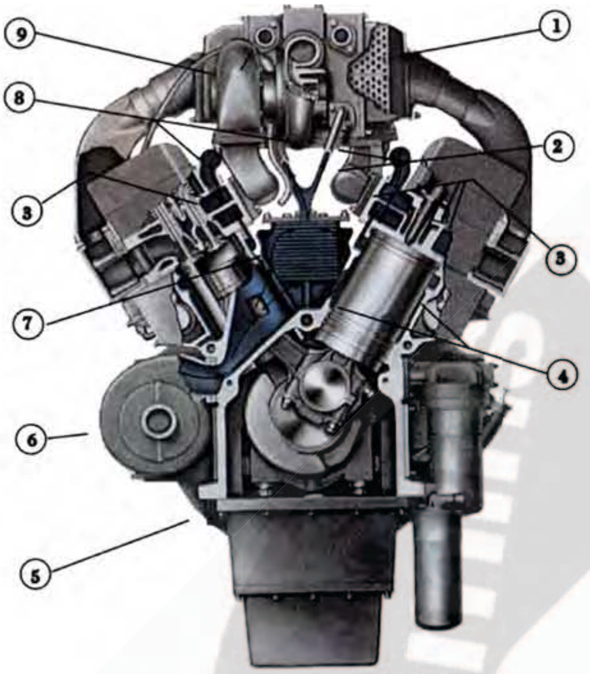


Fig. 5-14 Coolant flow --KTA38 Engine

1. AFTERCOOLER ELEMENTS
2. AFTERCOOLER COOLANT SUPPLY
3. COOLANT PASSAGES IN HEADS
4. LOOANT AROUND LINERS
5. COOLANT INLET
6. WATER PUMP
7. COOLANT IN BLCK "V"
8. COOLANT TRANSFER TUBE (HEAD TO HEAD)
9. AFTERCOOLER OUT TO THERMOSTAT HOUSING

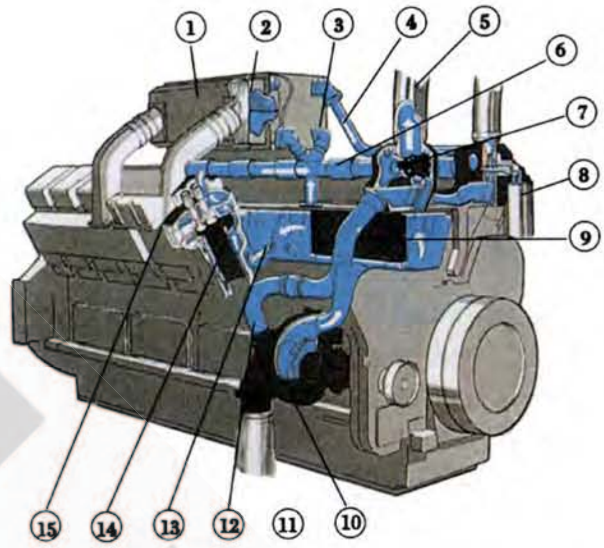


Fig. 5-15 Coolant flow schematic - KTA-50 Engine

1. AFTERCOOLER HOUSING
2. AFTERCOOLER CORE
3. AFTERCOOLER COOLANT SUPPLY
4. AFTERCOOLER COOLANT RETURN
5. COOLANT RETURN TO RADIATOR
6. COOLANT TRANSFER TUBE (HEAD TO HEAD)
7. THERMOSTAT
8. COOLANT FILTERS
9. OIL COOLANT
10. WATER PUMP
11. COOLANT SUPPLY FROM RADIATOR
12. BYPASS TUBE
13. COOLANT IN BLOCK "V"
14. CYLINDER LINER
15. CYLINDER HEAD

Air System

The engine requires hundreds of gallons of air for every gallon of fuel that it burns. For the engine to operate efficiently it must breathe freely; intake and exhaust systems must not be restricted.

The intake air should always be routed through an air cleaner. The cleaner may be mounted on the engine or equipment and may be oil bath, paper element or composite type depending upon engine application. Air is routed from the air cleaner directly to the intake air manifold, or turbocharger.

KT/KTA 19 Aftercooler

An aftercooler (or intercooler as it is sometimes called) is a device in the engine intake system designed to reduce intake air temperature and/or preheat intake air temperature.

The aftercooler consists of housing, used as a portion of the engine intake air manifold, with an internal core. The core is made of tubes through which engine coolant circulates. Air is cooled or heated by passing over the core prior to going into the engine combustion chambers.Therefore, improved combustion results from better control of the intake air temperature cooling or warming as applied by the aftercooler.

KT/KTA 38 and KTA 50 Aftercooler

The aftercooler consists of housing, mounted above the cylinder block, with (2) internal cores. The cores through which engine coolant circulates, cools or heats the air passing over the core prior to going into the engine combustion chambers. Therefore, improved combustion results. Fig 5-25 and 5-26.

Turbocharger

The turbocharger forces additional air into the combustion chambers so the engine can burn more fuel and develop more horsepower than if it were naturally aspirated. In some cased the turbo-charger is used for the engine to retain efficiency (balanced fuel to air ratio) at altitudes above sea level.

The turbocharger consists of a turbine wheel and a centrifugal blower, or compressor wheel, separately encased but mounted on and rotating with a common shaft.

The power to drive the turbine wheel --- which in turn drives the compressor --- is obtained from the energy of the engine exhaust gases. The rotating speed of the turbine changes as the energy level of gas changes; therefore, the engine is supplied with enough air to burn fuel for its load requirements. Fig's.5-27, and 5-28. The turbocharger is lubricated and cooled by engine lubricating oil.

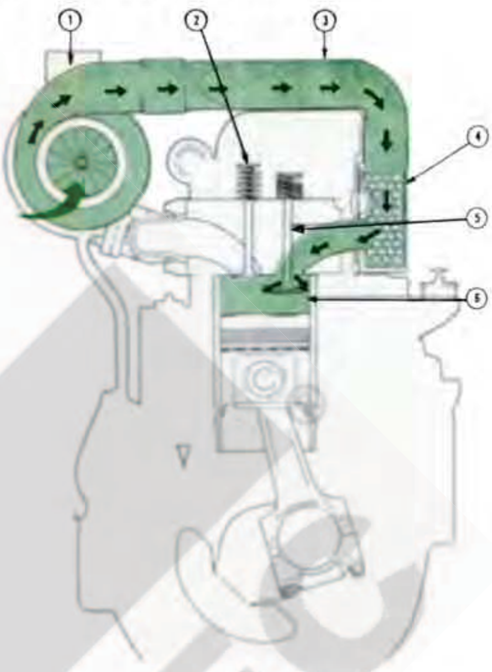


Fig. 5-16 Intake air flow schematic -KT(A)-19 engine

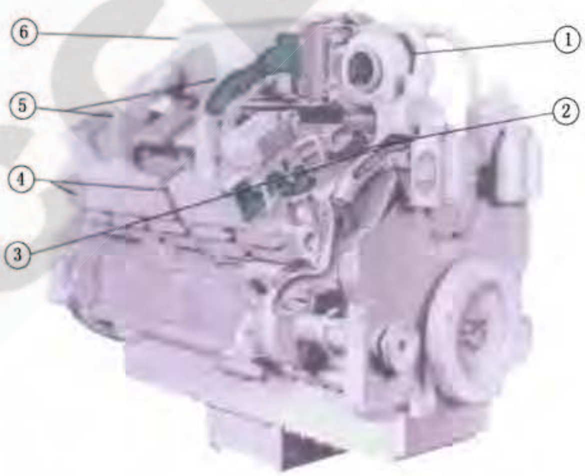


Fig.5-20 Intake air flow -KT(A)-38 Engine

1. TURBOCHARGER
2. INTAKE VALVES
3. INTAKE PORT
4. INTAKE MANIFOLD
5. INTAKE CROSSOVER
6. AFTERCOOLER

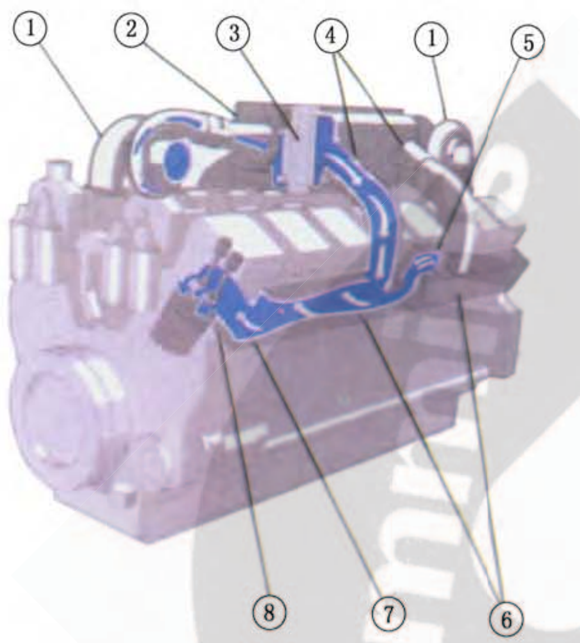


Fig. 5-21 Intake air flow schematic - KTA50 Engine

1. TURBOCHARGER
2. AFTERCOOLER HOUSING
3. AFTERCOOLER CORE
4. INTAKE CORSSOVEER TUBES
5. MANIFOLD EQUALIZER
6. INTAKE MANIFOLD
7. INTAKE PORT
8. INTAKE VALVE

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