Owners Manual

Bulletin No. 5277775-00

Bulletin No. 5277775 (January 2012)

Owners Manual

- N/NT/NTA-855 (14)
- V/VT/VTA-1710 (28)
- KT/KTA/KTTA-1150 (19)
- KT/KTA-2300 (38)
- KTA-3067 (50)

Visit us at www.cumminsindia.com

Cummins India Limited
Registered Office : Kothrud, Pune 411 038 (India)
Phones : 25380240, 25385435, 25381105 Fax : (020) 25387125
Visit us at : www.cumminsindia.com

Foreword

Dear Customer,

Congratulations and thank you for purchasing a piece of equipment powered by Cummins. We believe we make the best Diesel engines in the country and each time you purchase a piece of equipment, you reaffirm your confidence. But far more important than the product, is the customer support we provide. Ownership of a Cummins engine, entitles you to,

- The best warranty policy in the industry
- Largest dealer network
- 24 hour customer assistance cell
- Various training program

We hope you will take advantage of all we offer.

We again thank you for your purchase and hope you will write back with lots of suggestions and feedback.

This is an engine operation and maintenance manual, not a repair manual. This O&M Manual is for all applications of the models mentioned on inner cover page. 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 dealer 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 dealer to obtain available repair manuals and arrange for training of personnel.

Engine Identification

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 :

NTA-855-C or NTA-14-C
N = 4 valve head
T = Turbocharged
A =- Aftercooled
855 = Cubic Inch Displacement
C = Construction Application
14 = Litres

KTA-1150-G or KTA-19-G
K - Engine Series
T = Turbocharged
A = Aftercooled
1150 = Cubic Inch Displacement
19 = Litres

KTTA-19-C
K=Engine series
TT= With Double Turbocharger
A=Aftercooled
C=Construction Application
19= Litres

VTA-1710-G, VTA-1710-M
or NTA-28-G, VTA-28-M
V = Type Engine
1710 = Cubic Inch Displacement
28=Litres
G = Engine for Generator set Application
M = Engine for Marine Application

NTA-855-BC or NTA-14-BC
N= 4 valve Head
T=Turbocharged
A= Aftercooled
855=Cubic Inch displacement
BC=Big Cam
14 = Litres

Engine Data Plate : Engine Model - KTA - 1150, VT - 1710

Warning :– injury may result and warranty is voided if fuel rate rpm or altitude exceed published maximum values for this model & application.		
model	Rated Bhp./rpm	Lub–oil–As per IS 496
mfg. date	s.o.no.	Fuel oil–HDS as per IS 1460
B.S.F.C. As per IS 10002	cpl.	engine no.
M I	Cummins India Limited Registered Office : I	

Engine Data Plate : Engine Model - NTA - 855, KTA - 1150-L, KTA - 1150-F

Warning :- injury may result and warranty is voided if fuel rate rpm or altitude exceed published maximum values for this model & application	
model	s.o.no
mfg.date	date of delivery
cpl injection timing Inch	engine no.
Manufactured by. Cummins India Limited	Registered Office Kothrud, Pune 411 038 India

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Section 7 - Specifications and Torque

Section 8

CUMMINS OWNER ASSISTANCE

Cummins India Limited backs its engines with expert service and complete parts support. We built a service network of Cummins dealers, the largest in INDIA devoted exclusively to Cummins diesel engines. We trained our people to provide the Cummins owner with sound advice, expert service and professional treatment at all Cummins locations.

Any problem that you have in connection with the sale, operation or service of your engine can be handled at the nearest Cummins location. Occasionally, you may feel a problem has not been handled to your satisfaction. At those times, we urge you to pursue the problem until you are satisfied.

Not all problems are of engineering nature, several arise from communication gaps or sheer misunderstanding; either or both the parties may be involved in the procedures to see a simple way out. The field person may also be immobilized if he faces a real policy decision.

In all such events, we sincerely request you to take your problem to the higher levels till you are fully satisfied.

We suggest the following points of contact :

1. If problem originates with a salesperson or service technician, talk to the sales or service manager.
2. If problem originates with a sales or service manager, talk to the owner of the service location who is the dealer.
3. If problem originates with a dealer, please call the nearest Cummins Diesel Sales & Service, Regional Office. Most problems are solved at or below the regional office level. Their phone numbers and addresses are listed. However, before you can, please write down the following information and have it ready.
   - A. Name and location of the Cummins dealer.
   - B. Type and make of equipment.
   - C. Engine model and serial number.
   - D. Total miles/kms. or hours of operation.
   - E. Nature of problem.
   - F. Summary of the current problem arranged in the order of occurrence.

If you still have problems please write to :

Manager Customer Quality & Field Service Engineering

Cummins India Limited

Registered Office : Kothrud Pune 411 038 (India)

We do request that above steps be followed in order. Most of the actual work on an engine can be performed at the original location, so please give them a chance to satisfy you first.

CUMMINS ENGINE SERVICE TRAINING COURSES

Services Training Courses are available for customer's technical personnel involved in Cummins Engine Maintenance, Operation and Repair. These courses are conducted on a scheduled basis in Pune Service Training Schools, by

Cummins India Ltd

(Distribution Business Unit)

35/A/1/2, Erandawana, Pune, Maharashtra 411038
Telephone: (91-20) 25431234, 25430066, 25431703
Fax: (91-20) 25439490 Toll Free:-1-800-2332000

Customers, desirous of availing the training facilities may contact the Training Manager, at above address.

The service training courses offered are :

1. Engine Familiarization and Maintenance Course
2. Engine Rebuild Course
3. Cummins PT Fuel System Course
4. Correspondence Course Part I & II.

The service Training School also makes available Service Training Publications pertaining to Cummins Engine Maintenance, Operation Repair. The list is available with,

Training Manager,

Cummins India Ltd

(Distribution Business Unit)

35/A/1/2, Erandawana, Pune, Maharashtra 411038
Telephone: (91-20) 25431234, 25430066, 25431703
Fax: (91-20) 25439490 Toll Free:-1-800-2332000

CUSTOMER ASSISTANCE CELL

Customer Assistance Cell

Have a Question or comment, need information or want assistance for your Cummins Engine or just want to talk to someone who will listen and promptly resolve a problem then please

Dial : 020 (PUNE) 25436680

Fax : 020 (PUNE) 25445916

Toll Free : 1-800-2332000 - BSNL/MTNL or 020-25436680

e-mail : Powermaster-India@Cummins.com

Parts Assistance

When you need help to locate correct part numbers, want a copy of Engine Build Record, need more information on genuine spares or you are eager to know about new development in parts for your engine, Cummins Customer Assistance Cell is there to help you. Also when you want to know the despatch details for parts of under warranty engines, please call us.

Technical Information & Service Assistance

When you need to know the warranty coverage, operation and maintenance practices or repair procedures, want to carry out diagnosis, Customer Assistance Cell will give you the details you need like Fuel Pump & Injector Calibration, Control Parts list, Injection timing details. You will also get details of various types of services offered by Cummins.

Training & Literature

Cummins provides a wide range of training programmes and publishes various types of literature to aid our customers in using their Cummins Engines. Customer Assistance Cell will provide you the training schedule for the year and seat availability. You will also be guided on literature and cut models available for sale.

Service Network

When you need to know our authorised dealer for genuine Cummins parts, service support or to carry out component repairs, Customer Assistance Cell will guide you to the correct location where these services are available. You can also ask for 24 Hour contact information on our nation-wide network of authorized dealers for parts and service support.

Customer Relation

Cummins is dedicated to Customer Satisfaction. If you have a concern, a complaint or suggestion about how we can improve our product and services please contact us, our Customer Assistance Team is waiting to listen to you. Also, when you are pleased with your Cummins engine, we would like to hear from you.

We value your inputs.

Customer Assistance Team

The Customer Assistance Team is available to answer telephone queries from 7.30 A.M. to 8.30 P.M. seven days a week. Our Customer Assistance Cell will ensure that you get prompt response and assistance to your satisfaction. Telephoning us is an easy way to contact us. You can also send a fax, e-mail, or write to us at the Customer Assistance Cell, at Cummins Sales and Service (India) Limited.

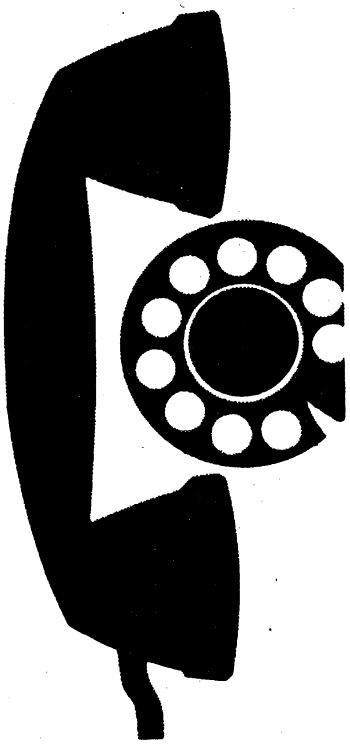
CUMMINS
CUSTOMER ASSISTANCE CELL

Cummins India Limited
Registered Office : Kothrud, Pune 411 038 (India)

Cummins India Ltd
(Distribution Business Unit)
35/A/1/2, Erandawana, Pune, Maharashtra 411038
Telephone: (91-20) 25431234, 25430066, 25431703
Fax: (91-20) 25439490 Toll Free:-1-800-2332000

24 Hour Emergency Service

In the very unlikely event of you are not receiving the normal prompt attention from our field force, following are the residence telephone numbers of our officers for assistance.



While asking for assistance please provide the following information.

1. **Your Name & Phone or Fax Number.**
2. **Engine Serial Number.**
3. **Name of the Customer.**
4. **Engine Location.**
5. **General Description of Assistance required.**

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10 MAINTENANCE STEPS FOR CUMMINS ENGINES

1. KEEP DIRT OUT OF THE ENGINE.
2. MAINTAIN A LUBRICATING FILM ON ALL BEARING SURFACES.
3. REGULATE THE ENGINE'S FUEL.
4. CONTROL OPERATING TEMPERATURE.
5. GUARD AGAINST CORROSION.
6. LET THE ENGINE BREATHE.
7. PREVENT OVER-SPEEDING.
8. KNOW YOUR ENGINE'S CONDITION.
9. CORRECT PROBLEMS WHILE THEY ARE SIMPLE.
10. SCHEDULE & CONTROL YOUR ENGINE MAINTENANCE.

Please use the card below to fill in all the information about your engine and send the same to us. This is prepaid.

NO POSTAGE STAMP NECESSARY IF MAILED IN INDIA

CUMMINS CUSTOMER CARE SERVICE

Cummins distributors and dealers are dedicated to provide you with the service you expect from a Cummins engine. Therefore, we invite your comments and suggestions as to how we can improve our service or assist you. You know best how we can serve you better.

Please use this space for your comments and suggestions.

_____

_____

_____

_____

Name _____ Engine Model _____

Address _____ Engine Serial Number _____

City _____ State _____ Date of Purchase _____

Telephone / Mobile _____ E-mail _____

Location of Equipment _____ Number of Hours Done _____

Postage will be paid by Addressee

BUSINESS REPLY CARD

PERMIT No. 176
Ex-Servicemen's Colony P.O.
PUNE - 411 038.

No Postage Stamp necessary if posted in India

To,

Customer Assistance Cell
Cummins India Limited
(Distribution Business Unit)
35/A/1/2, Erandawana, Pune - 411038

Section i - Introduction

Section i - Introduction

Section Contents

To the Owner and Operator

Preventative maintenance is the easiest and least expensive type of maintenance. Follow the maintenance schedule recommendations outlined in Maintenance Guidelines (Section 3).

Keep records of regularly scheduled maintenance.

Use the correct fuel, oil, and coolant in your engine as specified in Engine Specifications, Section 11.

Personnel at Cummins Authorized Repair Locations have been trained to provide expert service and parts support. If you have a problem that can **not** be resolved by a Cummins Authorized Repair Location.

About the Manual

This manual contains information needed to correctly operate and maintain your engine as recommended by Cummins India Ltd. Additional service literature can be ordered from your Cummins distributor. For problems with literature orders, contact Cummins India Ltd., Kothrud, Pune 411 038.

This manual does **not** cover vehicle or equipment maintenance procedures. Consult the vehicle or equipment manufacturer for specific maintenance recommendations.

Each section is preceded by a "Section Contents" to aid in locating information.

How to Use the Manual

This manual is organized according to intervals at which maintenance on your engine is to be performed. A table that states the required intervals and the checks to be made is located in Section 3. Locate the interval at which you are performing maintenance. Then follow the steps given in that section for all the procedures to be performed. In addition, all of the procedures done under previous maintenance intervals **must** be performed.

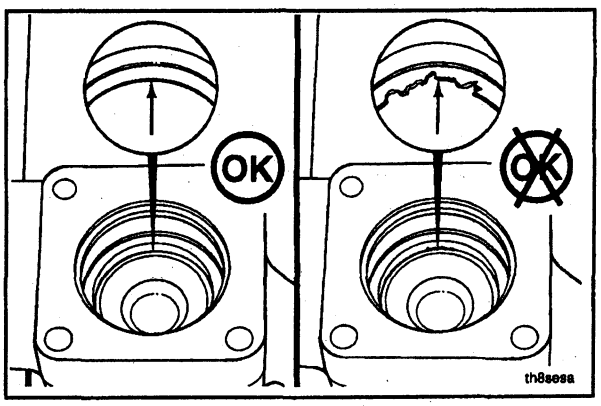
Keep a record of all the checks and inspections made. A record form for recording date, mileage/kilometer or hours, and what maintenance checks were performed is located in Section 3.

Refer to Section 11 for specifications recommended by Cummins India Ltd., for your engine/Specifications and torque values for each engine system are given in that section.

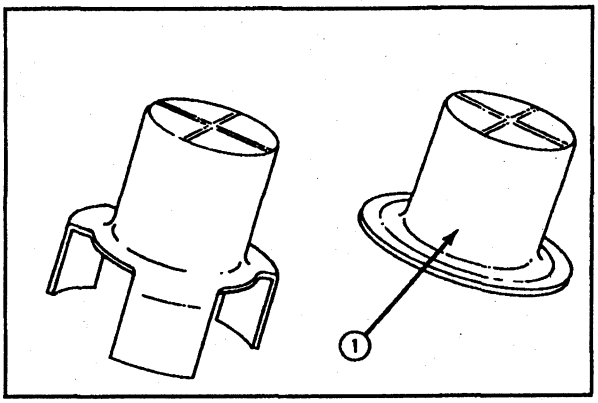
Illustrations

Use the illustrations in this manual as a guide to perform the action or the repair described. Many illustrations are generic and will **not** look exactly like the engine or the parts used in your application. In order to provide clarity to illustrations, some illustrations show parts removed that are **not** related to the specific parts given in the text.

Most of the illustrations contain symbols to indicate an action required or to indicate an **acceptable (OK)** or **unacceptable (not OK)** condition.



The illustrations are intended to show repair or replacement procedures. The illustration can differ from your application, but the procedure given will be the same.



General Safety Instructions

Important Safety Notices

⚠ WARNING ⚠

Improper practices, carelessness, or ignoring the warnings can cause burns, cuts, mutilation, asphyxiation or other personal injury or death.

Read and understand all of the safety precautions and warnings before performing any repair. This list contains the general safety precautions that must be followed to provide personal safety. Special safety precautions are included in the procedures when they apply.

- Work in an area surrounding the product that is dry, well lit, ventilated, free from clutter, loose tools, parts, ignition sources and hazardous substances. Be aware of hazardous conditions that can exist.
- Always wear protective glasses and protective shoes when working.
- Rotating parts can cause cuts, mutilation or strangulation.
- Do not wear loose-fitting or torn clothing. Remove all jewelry when working.
- Disconnect the battery (negative [-] cable first) and discharge any capacitors before beginning any repair work. Disconnect the air starting motor if equipped to prevent accidental engine starting. Put a "Do Not Operate" tag in the operator's compartment or on the controls.
- Use ONLY the proper engine barring techniques for manually rotating the engine. Do not attempt to rotate the crankshaft by pulling or prying on the fan. This practice can cause serious personal injury, property damage, or damage to the fan blade(s) causing premature fan failure.
- If an engine has been operating and the coolant is hot, allow the engine to cool before slowly loosening the filler cap to relieve the pressure from the cooling system.
- Always use blocks or proper stands to support the product before performing any service work. Do not work on anything that is supported ONLY by lifting jacks or a hoist.
- Relieve all pressure in the air, oil, fuel, and cooling systems before any lines, fittings, or related items are removed or disconnected. Be alert for possible pressure when disconnecting any device from a system that utilizes pressure. Do not check for pressure leaks with your hand. High pressure oil or fuel can cause personal injury.
- To reduce the possibility of suffocation and frostbite, wear protective clothing and ONLY disconnect liquid refrigerant (Freon) lines in a well ventilated area. To protect the environment, liquid refrigerant systems must be properly emptied and filled using equipment that prevents the release of refrigerant gas (fluorocarbons) into the atmosphere. Federal law requires capturing and recycling refrigerant.
- To reduce the possibility of personal injury, use a hoist or get assistance when lifting components that weigh 23 kg [50 lb] or more. Make sure all lifting devices such as chains, hooks, or slings are in good condition and are of the correct capacity. Make sure hooks are positioned correctly. Always use a spreader bar when necessary. The lifting hooks must not be side-loaded.
- Corrosion inhibitor, a component of SCA and lubricating oil, contains alkali. Do not get the substance in eyes. Avoid prolonged or repeated contact with skin. Do not swallow internally. In case of contact, immediately wash skin with soap and water. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. IMMEDIATELY CALL A PHYSICIAN. KEEP OUT OF REACH OF CHILDREN.
- Naptha and Methyl Ethyl Ketone (MEK) are flammable materials and must be used with caution. Follow the manufacturer's instructions to provide complete safety when using these materials. KEEP OUT OF REACH OF CHILDREN.
- To reduce the possibility of burns, be alert for hot parts on products that have just been turned off, exhaust gas flow, and hot fluids in lines, tubes, and compartments.

- Always use tools that are in good condition. Make sure you understand how to use the tools before performing any service work. Use ONLY genuine Cummins® or Cummins ReCon® replacement parts.
- Always use the same fastener part number (or equivalent) when replacing fasteners. Do not use a fastener of lesser quality if replacements are necessary.
- When necessary, the removal and replacement of any guards covering rotating components, drives, and/or belts should only be carried out be a trained technician. Before removing any guards the engine must be turned off and any starting mechanisms must be isolated. All fasteners must be replaced on re-fitting the guards.
- Do not perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.
- Some state and federal agencies in the United States of America have determined that used engine oil can be carcinogenic and can cause reproductive toxicity. Avoid inhalation of vapors, ingestion, and prolonged contact with used engine oil.
- Do not connect the jumper starting or battery charging cables to any ignition or governor control wiring. This can cause electrical damage to the ignition or governor.
- Always torque fasteners and fuel connections to the required specifications. Overtightening or undertightening can allow leakage. This is critical to the natural gas and liquefied petroleum gas fuel and air systems.
- Always test for fuel leaks as instructed, as odorant can fade.
- Close the manual fuel valves prior to performing maintenance and repairs, and when storing the vehicle inside.
- Coolant is toxic. If not reused, dispose of in accordance with local environmental regulations.
- The catalyst reagent contains urea. Do not get the substance in your eyes. In case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water. Do not swallow internally. In the event the catalyst reagent is ingested, contact a physician immediately.
- The catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. Always wear protective gloves and eye protection when handling the catalyst assembly. Do not get the catalyst material in your eyes. In Case of contact, immediately flood eyes with large amounts of water for a minimum of 15 minutes. Avoid prolonged contact with skin. In case of contact, immediately wash skin with soap and water.
- The Catalyst substrate contains Vanadium Pentoxide. Vanadium Pentoxide has been determined by the State of California to cause cancer. In the event the catalyst is being replaced, dispose of in accordance with local regulations.
- California Proposition 65 Warning - Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

Definition of Terms

AFC	Air Fuel Control
API	American Petroleum Institute
ASA	Air Signal Attenuator
ASTM	American Society of Testing and Materials
C	Celsius
CARB	California Air Resources Board
C.I.D.	Cubic Inch Displacement
cm	Centimeter
CPL	Control Parts List
cSt	Centistokes
DCA	Diesel Coolant Additive
E.C.S.	Emission Control System
EPA	Environmental Protection Agency
F	Fahrenheit
ft-lb	Foot Pound
GVW	Gross Vehicle Weight
Hg	Mercury
HP	Horsepower
H_2O	Water
in-lb	Inch Pound
kg	Kilograms
km	Kilometers
km/l	Kilometers per Liter
kPa	Kilopascal
l	Liter
m	Meter
mm	Millimeter
MPa	Megapascal
MPH	Miles Per Hour
MPQ	Miles Per Quart
N•m	Newton-meter
OEM	Original Equipment Manufacturer
ppm	Parts Per Million
psi	Pounds Per Square Inch
RPM	Revolutions Per Minute
S.A.E.	Society of Automotive Engineers

Engine Operating Range

⚠ CAUTION ⚠

Operating the engine beyond high idle speed can cause severe engine damage. The engine speed must not exceed 1850 RPM under any circumstances. When descending a steep grade, use a combination of transmission gears and engine or service brakes to control the vehicle and engine speed.

Cummins heavy-duty engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed (RPM). This is consistent with recommended operating practices for good fuel economy.

Excessive full throttle operation below peak torque RPM will shorten engine life to overhaul, can cause serious engine damage, and is considered engine abuse. Peak torque RPM varies from 1,100 RPM to 1,500 RPM, depending upon rated engine speed.

Engine Shut-Down

Engine Operation Before Shutdown

It is important to idle the 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 can rise as much as 38°C [100°F]. The results of the extreme heat can be seized bearings or loose oil seals.

NOTE: Do **not** idle for excessively long periods.

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

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.

NOTES

Section 1 - Operating Instructions

Section Contents

Operating Instructions

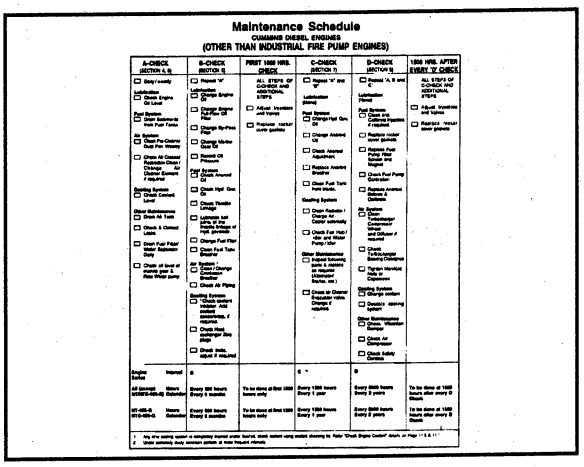
The engine operator must assume responsibility of engine care while engine is being operated. There are comparatively few rules which operator must observe to get best service from a Cummins Diesel Engine.

General - All Applications

1.0 GENERAL INFORMATION

Correct care of your engine will result in longer life, better performance and more economical operation.

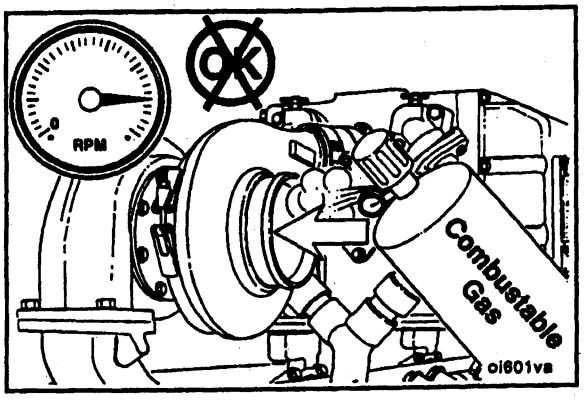
- Follow the daily maintenance checks listed in Maintenance Guidelines, Section 3.



- Check the oil pressure indicators, temperature indicators, warning lights and other gauges daily to make sure they are operational.

⚠ WARNING ⚠

DO NOT OPERATE A DIESEL ENGINE WHERE THERE ARE OR CAN BE COMBUSTIBLE VAPORS. These vapors can be sucked through the air intake system and cause engine acceleration and over-speeding, which can result in a fire, an explosion and extensive property damage. Numerous safety devices are available, such as air intake shutoff devices, to minimize the risk of overspeeding where an engine, due to its application, might operate in a combustible environment, such as due to a fuel spill or gas leak. Remember, Cummins has no way of knowing the use you have for your engine. THE EQUIPMENT OWNER AND OPERATOR ARE RESPONSIBLE FOR SAFE OPERATION IN A HOSTILE ENVIRONMENT. CONSULT YOUR CUMMINS AUTHORIZED REPAIR LOCATION FOR FURTHER INFORMATION.



1.1 Starting the Engine

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

> **⚠ CAUTION ⚠**
> While starting the engine do not touch the Throttle or Throttle Lever.

Normal Starting Procedure

> **⚠ WARNING ⚠**
> Before starting, check to make sure everyone is clear of engine and equipment, to prevent accidents.

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

1.1.1 On units equipped with air activated prelube device, open air valve until oil pressure is registered on oil pressure gauge to activate piston in prelube device which will lubricate all moving parts in engine.

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

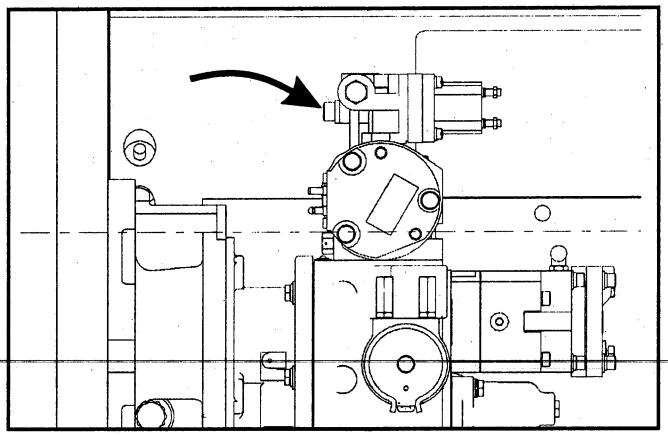
1.1.2 Set throttle for idle speed and disengage driven Unit.

1.1.3 For marine engines open sea cocks to permit raw water flow through heat exchanger and marine gear oil cooler. Place marine gear in neutral.

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

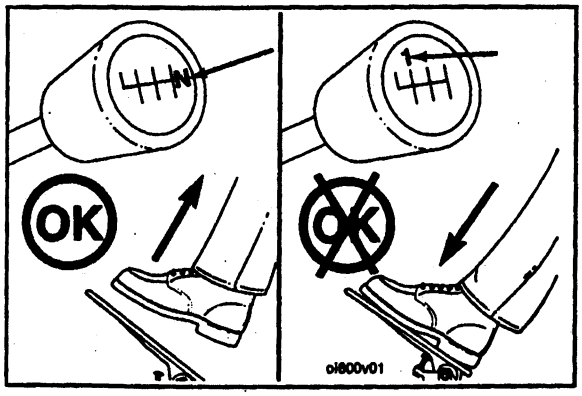
1.1.4 Open manual fuel shut-down valve, if so equipped. Ref. Fig. 1-1. Electric shut-down valves operate as switch is turned on. A manual override knob provided on forward end of electric shut-down valve allows valve to be opened in case of electric power failure. To use, turn fully clockwise; return to "run" position after electric repair.

1.1.5 Press starter button or turn switch key to "start" position and crank the engine till it fires.



> **⚠ CAUTION ⚠**
> To prevent permanent cranking motor damage, do not crank engine for more than 10 seconds continuously. If the engine does not start after about three repeated attempts, with an interval of two minutes between successive starts then the starter should not be operated and the fuel system has to be checked for any faults.

1.1.6 At the initial start or after oil or filter changes and after engine has run for a few minutes, shut it down and wait for 15 minutes for oil to drain back into pan. Check engine oil level again, add oil as necessary to bring oil level to "H" mark on dipstick. The drop in oil level is due to absorption by oil filters.

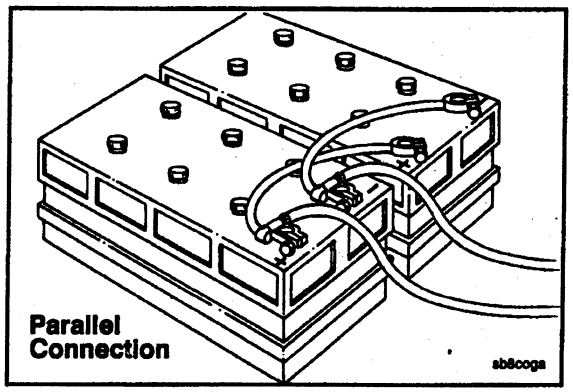


1.2 Normal Starting Procedure (Above O°C [32°F])

- Disengage the driven unit, or if equipped, put the transmission in neutral.
- Start the engine with the throttle in the idle position.

Engines equipped with air starters require a minimum of 480 kPa [70 psi] compressed air pressure.

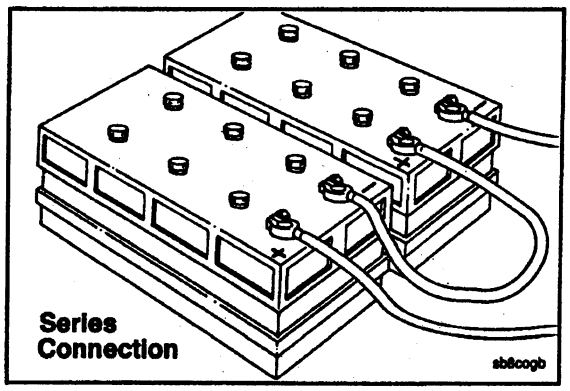
To prevent damage to the starter, do **not** engage the starting motor for more than 30 seconds. Wait two (2) minutes between each attempt to start engine (electrical starting motors only).



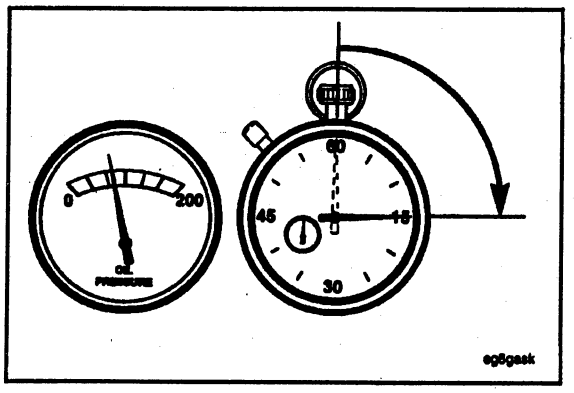
⚠ CAUTION ⚠

When using jumper cables to start the engine, make sure to connect the cables in parallel; positive (+) to positive (+) and negative (-) to negative (-). When using an external electrical source to start the engine, turn the disconnect switch to the OFF position. Remove the key before attaching the jumper cables.

The accompanying illustration shows a typical parallel battery connection. This arrangement doubles the cranking amperage.

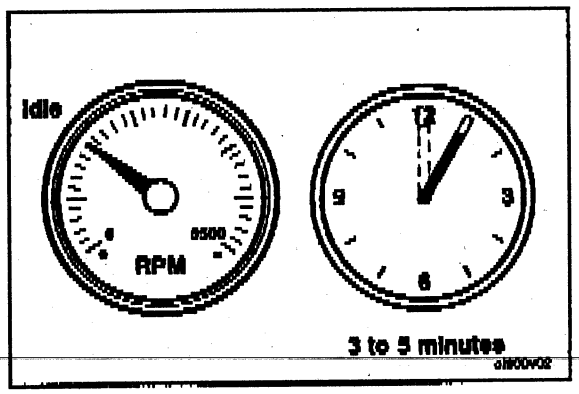


This illustration shows a typical series battery connection. This arrangement, positive to negative, doubles the voltage.

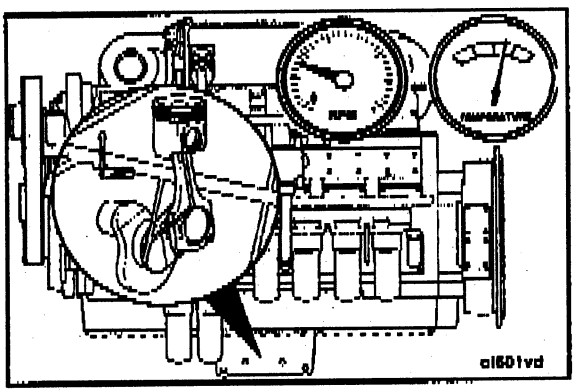


- Engine oil pressure **must** be indicated on the gauge within 15 seconds after starting. If oil pressure is **not** registered within 15 seconds, shut off the engine immediately to avoid engine damage. Confirm the correct oil level in the oil pan.

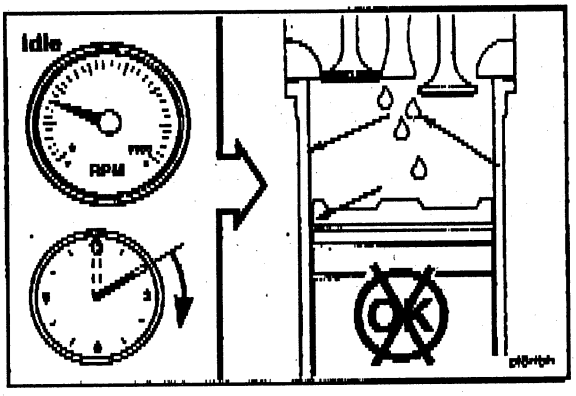
- Idle the engine three (3) to five (5) minutes at approximately 1,000 RPM before operating with a load.



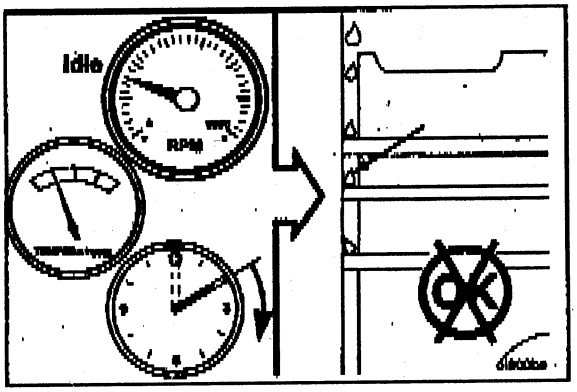
- When starting a cold engine, increase the engine speed (RPM) slowly to provide adequate lubrication to the bearings, and to allow the oil pressure to stabilize.

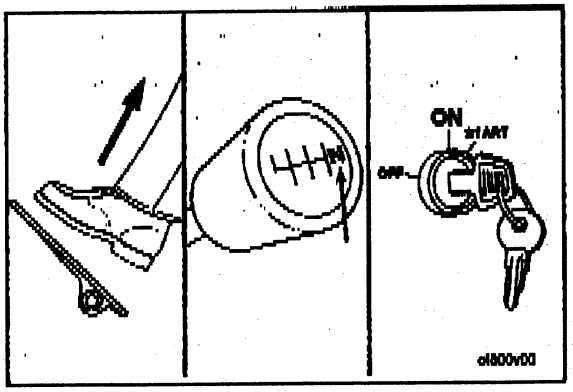


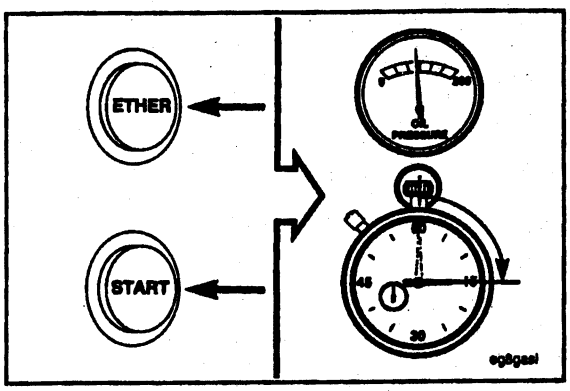
Do **not** idle the engine for excessively long periods. Long periods of idling, more than 10 minutes, can damage an engine because combustion chamber temperatures drop so low the fuel will **not** burn completely. This will cause carbon to clog the injector spray holes and piston rings, and can cause the valves to stick.

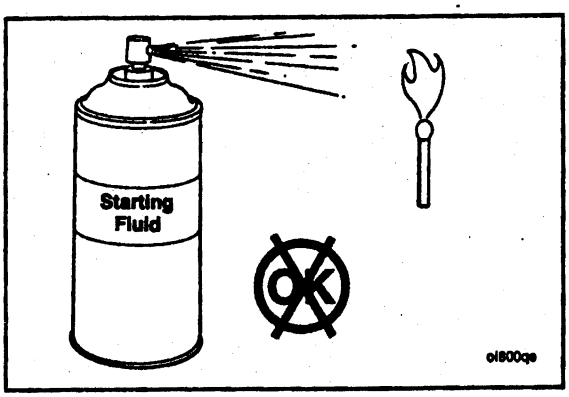


If the engine coolant temperature becomes too low, 60°C [140°F], raw fuel will wash the lubricating oil off the cylinder walls and dilute the crankcase oil; therefore, all moving parts of the engine will **not** receive the correct amount of lubrication.









1.3 Cold Weather Engine Operation

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 engine **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.

1.4 Cold Weather Starting

Using Starting Fluid with Mechanical or Electrical Metering Equipment

- Set the throttle at idle.
- Disengage the driven unit, or if equipped, put the transmission in neutral.
- Activate the switch to open the fuel pump shutoff valve.
- While cranking the engine, inject a metered amount of starting fluid.
- Engine oil pressure **must** be indicated on the gauge within 15 seconds after starting.

Using Starting Fluid without Metering Equipment

⚠ WARNING ⚠

Do not use volatile cold starting aids in underground mine or tunnel operations due to the potential of an explosion. Check with the local Mines Inspector for instructions.

⚠ CAUTION ⚠

Do not use excessive amounts of starting fluid when starting an engine. The use of too much starting fluid will cause engine damage.

Due to increased safety hazards and potential for engine damage, Cummins India Limited does **NOT** recommend the use of starting fluid without metering equipment.

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 will 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 that starting and operation are possible in the lowest temperature to be encountered requires :

a. use of correct materials.

b. Proper lubrication, low temperature lubricating oils. Refer to Lubricating Oil Specifications, Section V.

c. Protection from the low temperature air. The metal temperature does **not** change, but the rate of heat dissipation is affected.

d. Fuel of a proper grade for the lowest temperature.

e. Heating to be provided to increase the engine block and component temperature to a minimum of -32°C [-25°F] for starting in lower temperatures.

f. Proper external heating source available.

g. 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 temperature -54°C [65°F]. 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.

It is possible to operate diesel engine in extremely cold environments if they are properly prepared and maintained. The correct lubricants, fuels and coolant **must** be used for the cold weather range for which the vehicle is being operated. Refer to the chart below for recommendations in different operating ranges.

Winterize 0° to -23°C [32° to -10°F]	**Winterize -23° to -32°C [-10° to -25°F]**	**Winterize -32° to -54°C [-25° to -65°F]**
Use ethylene glycol antifreeze to protect to -29° C [-20°F]	Use 50 percent ethylene glycol antifreeze, 50 percent water mixture.	Use 60 percent ethylene glycol antifreeze 40 percent water mixture.
Use multi viscosity oils meeting API, CE or CH4 specifications.	Use multi viscosity oil meeting API, CE or CH4 specifications.	Use Artic oil meeting API, CE or CH4 specifications.
Fuel to have maximum cloud and pour points 6°C [10°F] lower than ambient temperature in which engine operates.	Fuel to have maximum cloud and pour points 6°C [10°F] lower than ambient temperature in which engine operates.	Fuel to have maximum cloud and pour points 6°C [10°F] lower than ambient temperature in which engine operates.

1.4.1 Cold Weather Starting Aids

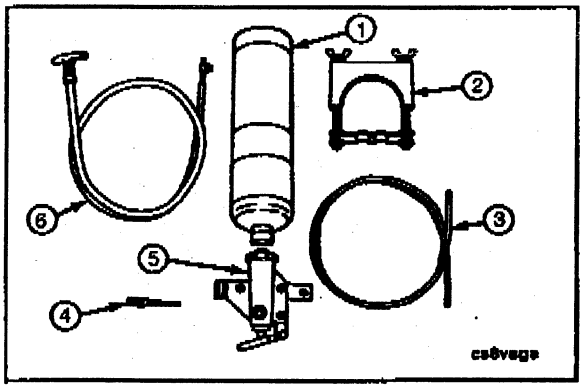
Ether Starting Aids

⚠ WARNING ⚠

Starting fluid contains ether and is extremely flammable. Misuse or mishandling can cause an explosion. NEVER handle starting fluid near an open flame. NEVER use starting fluid with a preheater, glow plug, flame thrower or other type of electrical starting equipment. Do NOT breathe the fumes as serious injury to the human respiratory system will result. Fuel oil or volatile fuel cold starting aids are NOT to be used in underground mine or tunnel operations.

⚠ CAUTION ⚠

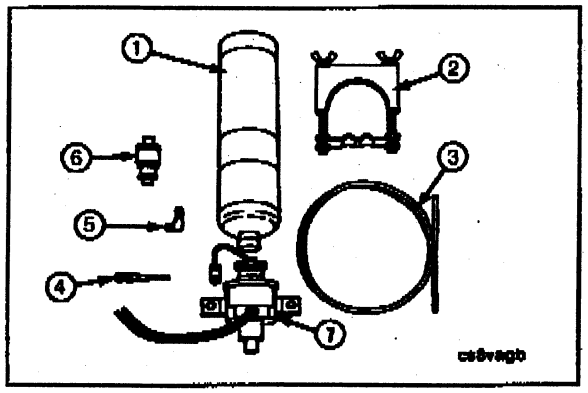
Using too much starting fluid will cause extremely high pressures and detonation in the engine cylinders, resulting in damage to the cylinder parts and bearings. Too much starting fluid can also cause damage from engine overspeed.



1.4.2 Manually Operated Ether Valve

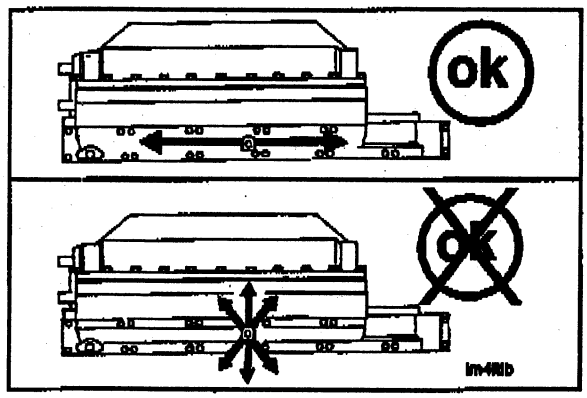
The manually operated ether valve includes the valve body assembly (5), clamp (2), and nylon tube (3). The fuel cylinder (1), atomizer fitting (4) and pull control (6) **must** be ordered separately.

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



1.4.3 Electrically Operated Ether Valve

The electrically operated ether valve includes the valve body (7), 90 degree elbow (5), clamp (2), push button switch (6), and nylon tube (3). A thermostat is mounted to the cylinder block or coolant passage and stops electrical power to the atomizer solenoid when the engine is warm. See the Parts Catalog for fuel cylinder 91) and fuel atomizer fittings (4). These fittings **must** be ordered separately, as required.



1.4.4 Atomizer Installation Recommendations

The atomizer fittings **must** be mounted in the engine air intake manifold 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.

1.4.5 Preheater Glow Plug Type System

The glow plug system supplies heat to the cumbustion chambers, so compression temperatures are sufficient to ignite fuel.

To aid in starting engine when temperature is 50°F (10°C) or below, an intake air preheater is recommended. The Preheater equipment consists of a handpriming pump to pump fuel into intake manifold, and a switch to turn on glow plug which is electrically heated by battery. Fuel burns in intake manifold and heats intake air. Ref. Fig.1.2 for typical Cold Starting Aid Arrangement.

⚠ WARNING ⚠

Do not use vapor in conjunction with preheater as it could result in a fire.

To use preheater for cold starting:

a. Set throttle in idle position. Turn glow plug toggle switch to 'ON' position. Red indicator light must be on.

b. After red light has been on for 20 seconds, start cranking engine. As soon as engine begins rotating, operate preheater priming pump to maintain 80 to 100 psi (552 to 689 kPa) fuel pressure. Use of primer before the 20-second interval will wet glow plug and prevent heating.

c. If engine does not start within 30 seconds, stop cranking. Wait one or two minutes and repeat cranking operation.

d. After engine starts, pump primer slowly to keep engine idling smoothly. In cold weather this may require 4 to 5 minutes or longer. Do not accelerate engine.

e. When the engine has warmed up so it does not falter between primer strokes, stop pumping. Close and lock primer. Turn off glow plug toggle switch. (Red indicator light will go out.)

f. If engine gives no indication of starting during first three full strokes of preheater pump, touch-check intake manifold for heat. If no heat check electrical wiring. If wiring is all right, remove 1/8 inch pipe plug from manifold near glow plug and close glow plug manual switch for 15 seconds and observe glow plug through 1/8 inch pipe plug hole. The glow plug should be white hot; if not, connect wiring to a 6- or 12-volt (as used) source and check amperage; it should be 30 to 32 (min.) amperes. If glow plug is all right, check manual switch and resistor (if used) and replace if necessary.

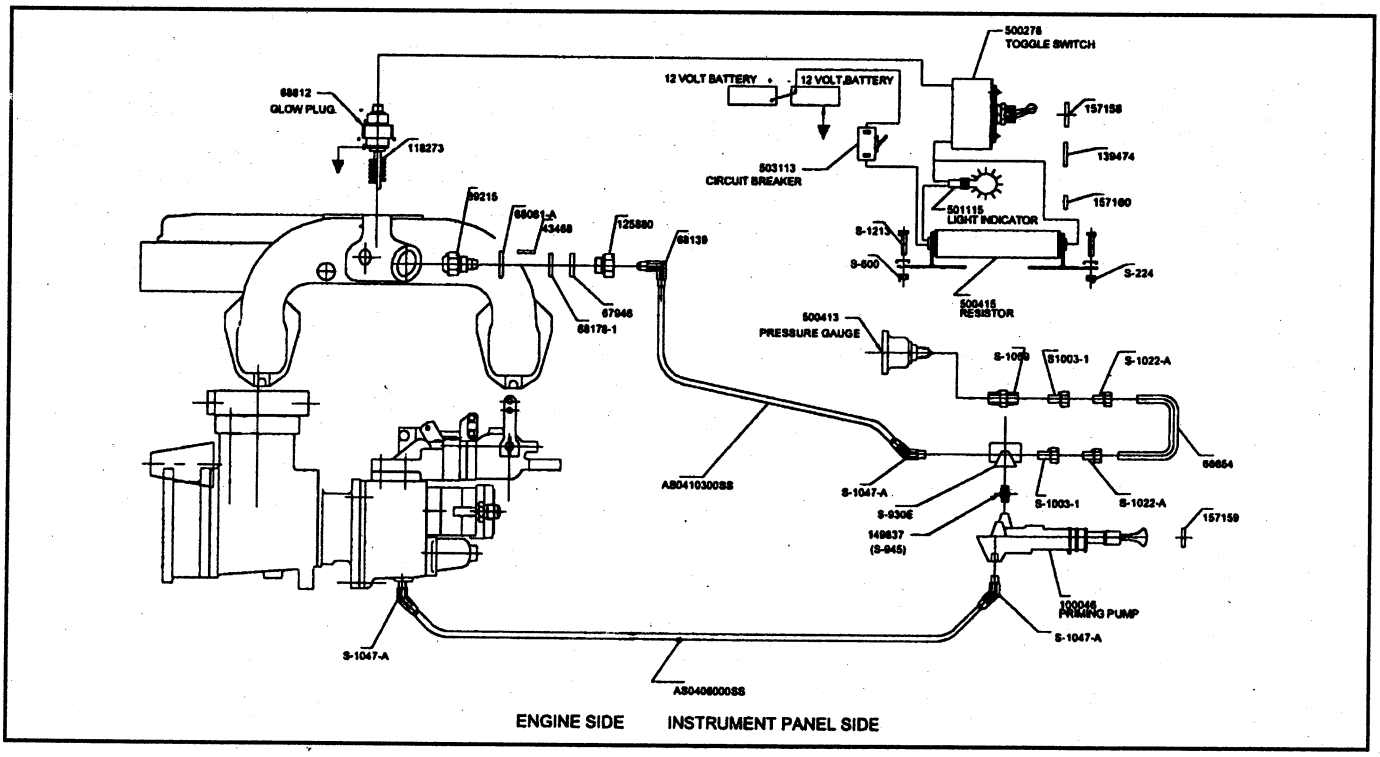
Note : Preheater priming pump, switches and resistor are located at the instrument panel and are to be checked during engine starting.

The cold starting aid approved for use on Cummins Engines, has been based upon starting aid capabilities to –25°F (–32°C).

2.0 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 favourable 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 equipment being housed inside a heated building. For an



Ref. Fig. 1.2. Typical Cold Starting Aid Arrangement

engine starting with a parasitic load, such as a fire pump, coolant temperature must be a minimum of 120°F (49°C).

2.1 Speed Pattern for Marine application – Pleasure Boat or Light Duty

For normal cruising operation; maintain engine rpm at approximately 90 percent of rated rpm. This will give adequate power as well as economical fuel consumption.

2.2 Continuous Duty

For continuous duty operation, engine governors are normally set for reduced rpm and fuel rate. Therefore a reduced cruise speed is not necessary.

Marine Gear Operation

Movement of a single lever on the control valve to neutral, forward or reverse controls the marine gear operation. If so desired, the control lever may be interlocked with the throttle; therefore, the marine gear should be shifted to forward or reverse before the throttle is moved from idle position and returned to neutral when the throttle is closed.

> **⚠ WARNING ⚠**
> Never shift the control lever to any position with the engine running faster than 1000 rpm.

Refer to gear manufacturer's manual for procedures, temperatures and recommended oil pressures.

2.3 Oil Temperature

The oil temperature gauge normally should read between 167°F (75°C) and 221°F (105°C). Under full load conditions, an oil temperature of 240°F (116°C) for a short period is not a cause for alarm.

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

During warm-up period, apply load gradually until oil temperature reaches 140°F (60°C). While oil is cold it does not do a good job of lubricating. Continuous operating 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.

2.4 Water Temperature

A water temperature of **75°C to 95°C (167° to 203°F)** is the best assurance that working parts of the engine have expanded evenly to the most favourable oil clearances. Maximum engine coolant temperatures should not exceed **95°C (203°F).**

Keep thermostats always in the engine, avoid long periods of idling, and take necessary steps to keep water temperature up to a minimum of **75°C (167°F).** If necessary in cold weather, use radiator shutters or cover a part of the radiator to prevent overcooling.

2.5 Oil Pressure

Normal engine oil pressure at 221°F (105°C) should be between **3 to 7 kg/cm²** at rated speed and 1 to 2 kg/cm² at low idle speed. If your engine is provided with DFC system, pressure at rated speed should be 2.4 to 3.1 kg/cm² and 0.7 kg/cm² minimum at idle speed.

Note : Please note that oil pressure will vary with temperature.

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

2.6 Engine Exhaust

The engine exhaust is a good indicator of engine operation and performance. A smoky exhaust may be due to a poor grade of fuel, dirty air cleaner, overfueling, or poor mechanical conditions.

If engine exhaust is smoky, corrective action should be taken.

2.7 High Altitude Operation

Some engines, particularly naturally aspirated, lose horsepower when 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.

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

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

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

a. Place the VS speed control lever in operating position.

b. Lock the standard throttle in full-open position.

c. Engage power take-off.

To return to standard throttle :

a. Disengage power take-off.
b. Return standard throttle to idle position.
c. Lock the VS speed control lever in maximum speed position.

2.9 Stop engine immediately if any parts fail

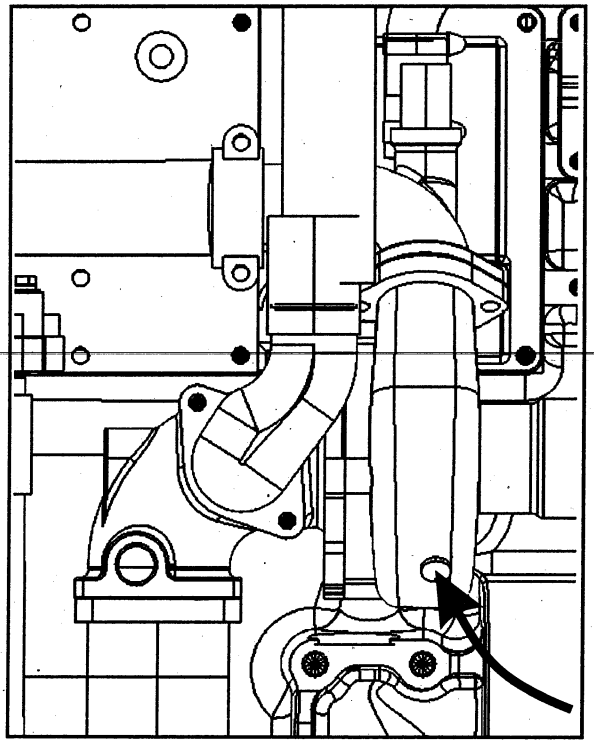
Practically all failures give some warning to the operator before the parts fail and ruin the engine. Many engines are saved because alert operators heed warning signs (sudden drop in oil pressure, unusual noises, etc.) and immediately shut down the engine.

2.10 Engine Coolant

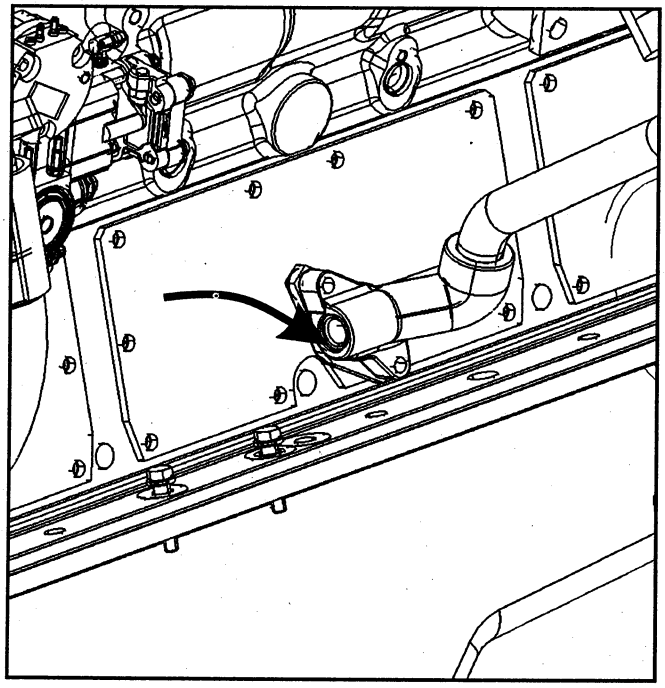
a. For cold-weather operation, use of permanent type antifreeze with rust inhibitor additives is recommended.

b. Drain cylinder block and heads on all engines by opening petcocks and removing drain plugs as shown in Fig's. 1-2 to 1-6. If an air compressor (Fig. 1-6), heat exchanger or other 'water cooled' accessory is used, open petcock and drain. Failure to properly drain engine and accessories may cause serious damage during freezing weather.

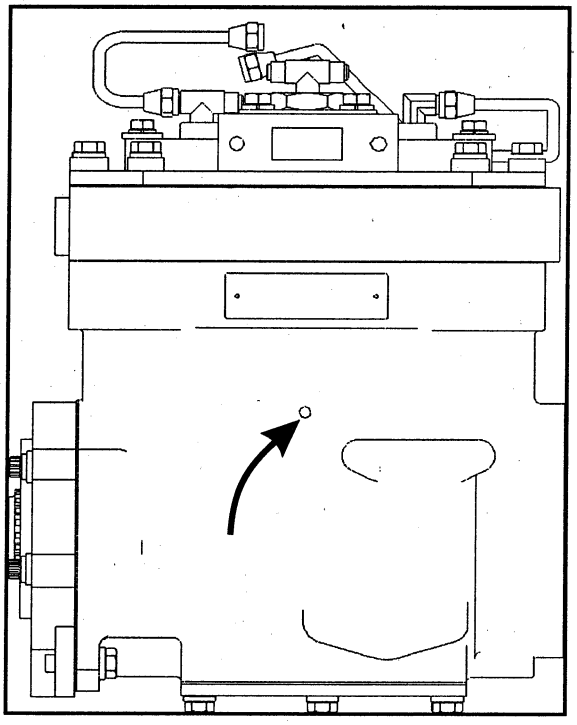
c. Immersion-type water and oil heaters are available for engines used in cold-weather operations.



Ref. Fig 1-5 KTA-3067 Coolant drain point



Ref. Fig. 1-2. V-28 Coolant drain point



Ref. Fig 1-6. Two cylinder air compressor coolant drain

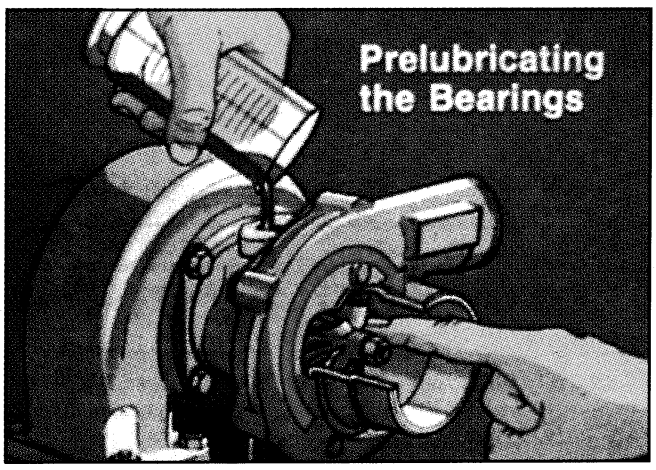
3. OIL PAN CAPACITIES

Table 1-1 : Oil Pan Capacities

Engine Litres	Engine C.I.D.	Lub oil Capacity	
		High U.S. gal. (Litres)	Low U.S. gal. (Litres)
14	855	7 (27)	5 (19)
19	1150	10 (38)	8.5 (32)
28	1710	18 (68)	16 (61)
38	2300	30 (114)	23 (87)
50	3067	40 (152)	32 (122)

Capacities listed are for oil pan used only on G-drive applications. Total system capacities vary with filter sizes and length of oil lines. Please refer to Engine Data Sheet for Oil capacities on other application.

4. PRIMING THE LUBRICATING SYSTEM



Ref. Fig. 1-7. Prelubricating turbo

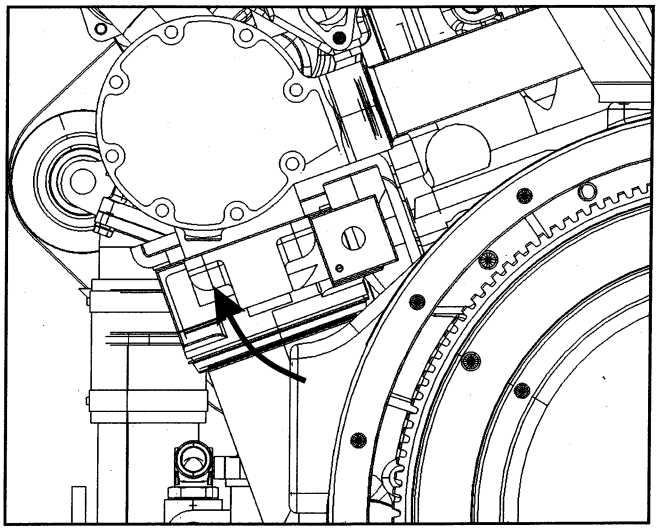
Note : On turbocharged engines, remove oil inlet line from the turbocharger and prelubricate bearing by adding 2 to 3 oz. (50 to 60 cc) of clean lubricating oil. Reconnect oil supply line.

a. Fill crankcase to "L" (low) mark on dipstick. See "Lubricating Oil Specifications", Section 11.
b. Remove plug from head of lubricating oil filter housing (Ref. Fig's. 1-7, 1-8) or filter can to prime system. On the KT-1150 Engines remove plug from front of oil cooler housing. Ref. Fig. 1-11.

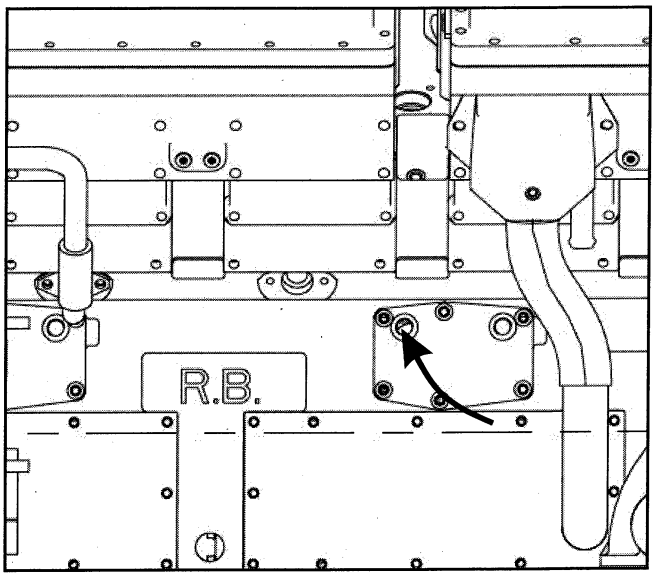
⚠ CAUTION ⚠

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

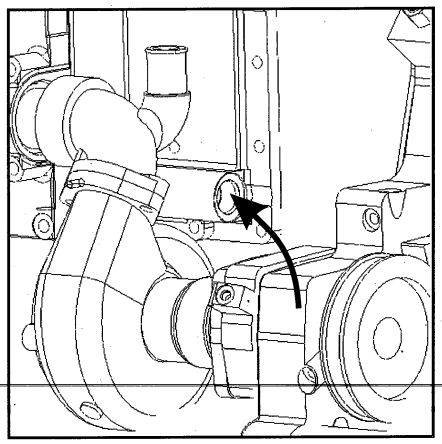
c. Connect a hand or motor-driven priming pump line from source of clean lubricating oil to plug boss in housing.
d. Prime until a 30 psi (207 kPa) minimum pressure is obtained. Bar engine for 2 or 3 rotations while priming.



Ref. Fig. 1-9. Lubricating system priming point—V-1710 engines



Ref. Fig. 1-10. Lubricating system priming point—KT(A) 2300/3067 engines.



Ref. Fig. 1-11. Lubricating system priming point—KT/KTA-1150 engines.

d. Crank engine at least 15 seconds (with fuel shut-off valve closed or disconnected to prevent starting), while maintaining external oil pressure at a minimum of 15 psi (103 kPa). Check that oil has reached up to all points in tappets (Remove Tappet covers).

f. Remove external oil supply and replace plug in lubricating oil filter housing, torque 15 to 20 ft-lbs (20 to 27 N•m).

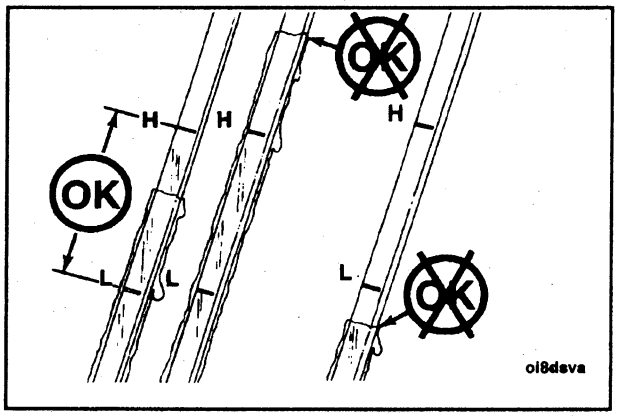
⚠ CAUTION ⚠

Clean areas of any lubricating oil spilled while priming or filling crankcase.

g. Fill crankcase to "H" (high) mark on dipstick with oil meeting specifications, listed in Section 11. No change in oil viscosity or type is needed for new or newly rebuilt engines.

5. CHECKING ENGINE OIL LEVEL

A dipstick oil gauge is located on the side of the engine. Ref. Fig. 1-12. The dipstick has an "H" (high) and "L" (low) 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.



Ref. Fig. 1-12. Checking engine oil level

Use of Lub Oil By-Pass Filter

5.1. All engines manufactured by Cummins India Limited must be fitted with by-pass filter EXCEPT for engines for following applications where the by-pass filter may be used as "Optional" part.

a) All natural aspirated engines.
b) All engines for fire fighting pumps
c) All stand-by turbine starting engines.

5.2 Fill Marine Gear (for Marine Engines only)

The marine gear is a separate unit and carries its own lubrication. Fill housing according to manufacturer's recommendations.

Start engine and briefly operate the gear in both forward and reverse.

⚠ CAUTION ⚠

Never operate marine gear with oil level below "L" mark or above "H" mark on dipstick.

Check Raw Water Pump Oil Level (If oil sump is provided)

(For Marine Engines only)

Check oil level in raw water pump if pump has an oil sump.

a. Remove pipe plug from side of pump.
b. Fill housing with hypoid SAE 90 oil; replace plug.

5.3 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 engine. Oil level in governor sump must be at full mark on dipstick.

6. OTHER CHECKS

6.1 Check Air Connections

Check air connections to compressor and air equipment, as used, and to **air cleaners and air crossovers to assure all are secured.**

6.2 Check Engine Coolant Supply

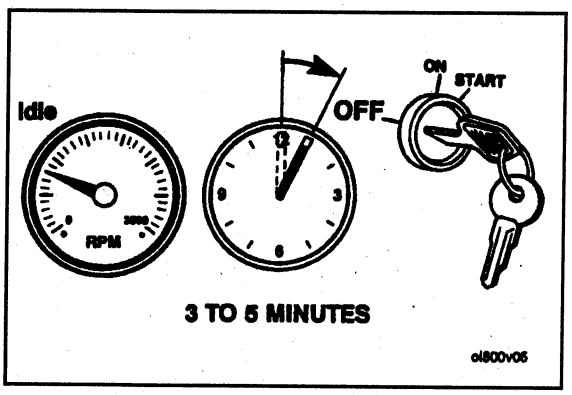
a. Remove the radiator or heat exchanger cap and check engine coolant level. Add coolant as needed.

b. Make visual check for leaks and open water filter shut-off valves.

6.3 Prime Raw Water Pump (For Marine Engines Only)

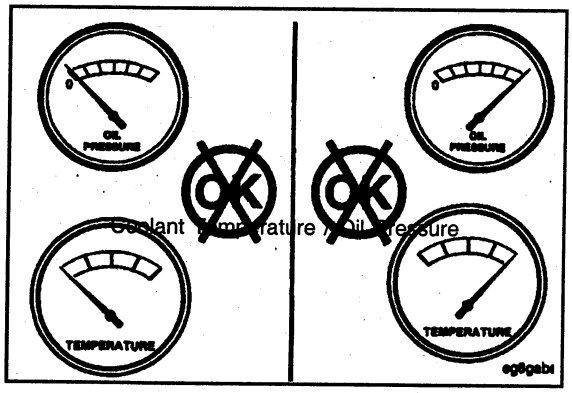
The Gillmec Type pumps require initial priming. The pump will continue to self prime at all subsequent starts unless the pump body has been emptied deliberately. Fill pump body prior to connecting inlet connection.

Note : Prior to initial priming/commissioning ensure that sea water supply line/piping is thoroughly flushed and clean to ensure that system is free from any metal particles or burrs.



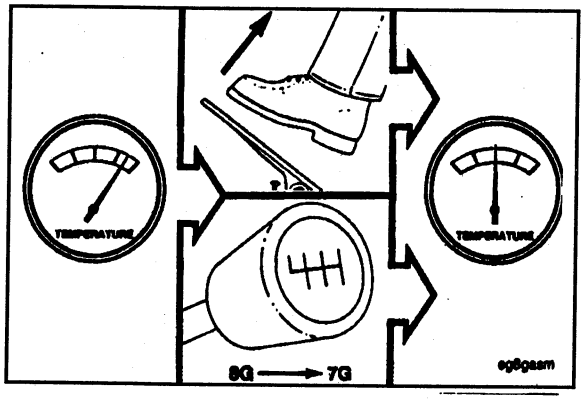
7. OPERATING THE ENGINE

- Allow the engine to idle three (3) to five (5) minutes before shutting it off after a full load operation. This allows adequate cool down of pistons, cylinder liners, bearings and turbocharger components.
- Do not operate the engined at full throttle below peak torque engine speed (RPM) for extended periods (more than 30 sec) of time.



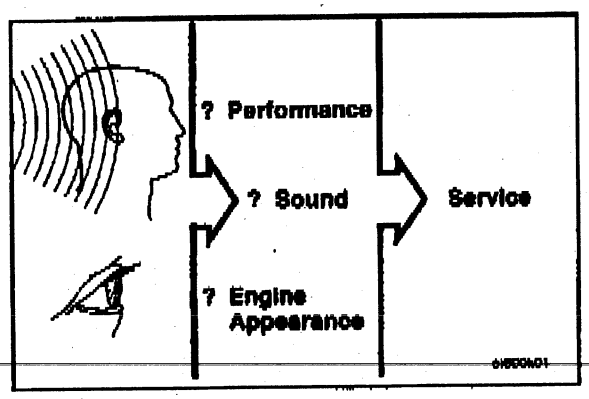
NOTE : Continuous operation with low coolant temperature, below 60°C [140°F], or high coolant temperature, above 100°C [212°F], can damage the engine.

a. Monitor the oil pressure and coolant temperature gauges frequently. Refer to Lubricating Oil system Specifications or Cooling System Specifications, Section V, for recommended operating pressures and temperatures. Shut off the engine if any pressure or temperature does **not** meet the specifications.



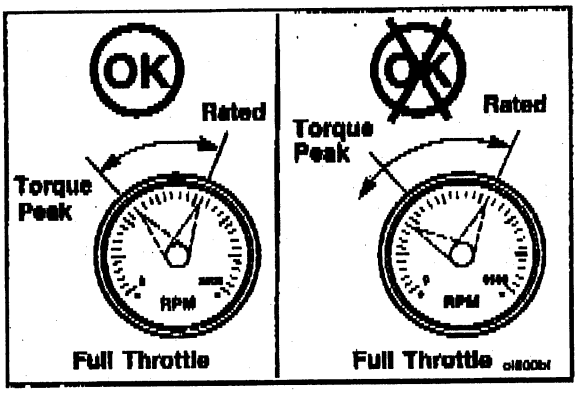
b. If an overheating condition starts to occur, reduce the power output of the engine by releasing the throttle pressure or shifting the transmission to a lower gear or both until the temperature returns to normal operating range. If engine temperature does **not** return to normal, shutoff the engine and refer to Troubleshooting, Section T, or contact a Cummins Authorized Repair Location.

- Most failures give an early warning. Look and listen for changes in performance, sound or engine appearance that can indicate service or engine repair is needed. Some changes to look for are as follows :
  - Engine misfires
  - Vibration
  - Unusual engine noises
  - Sudden changes in engine operating temperature or pressure
  - Excessive smoke
  - Loss of power
  - An increase in oil consumption
  - An increase in fuel consumption
  - Fuel, oil or coolant leaks.

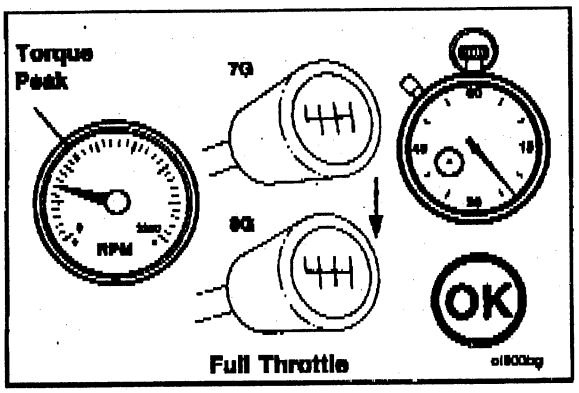


7.1 Engine Operating Range

Excessive full throttle operation below peak torque RPM (lugging) will shorten engine life to overhaul, can cause serious engine damage and is considered engine abuse. Cummins engines are designed to operate successfully at full throttle under transient conditions down to peak torque engine speed.

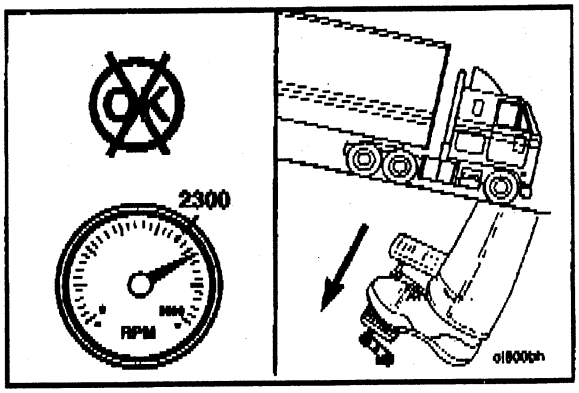


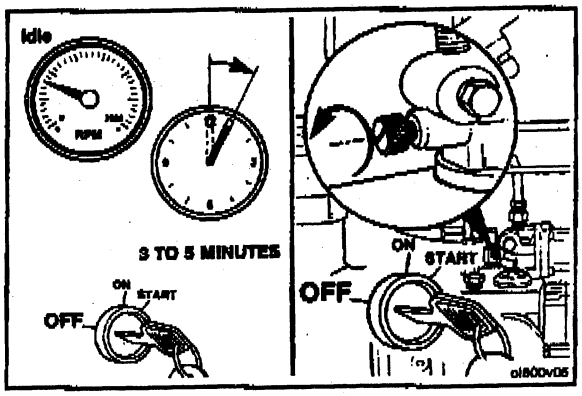
Operation of the engine below peak torque RPM can occur during gear shifting due to the difference of ratios between transmission gears, but engine operation **must not** be sustained more than 30 seconds at full throttle below peak torque RPM.

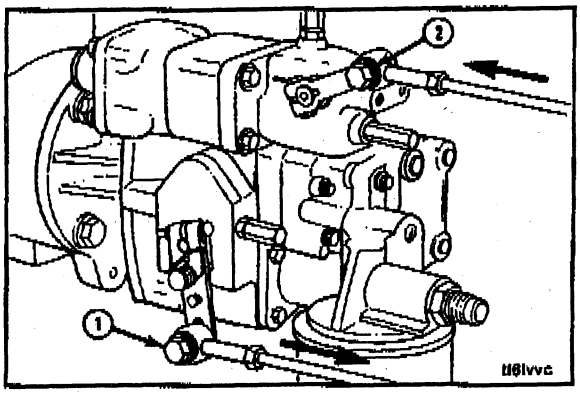


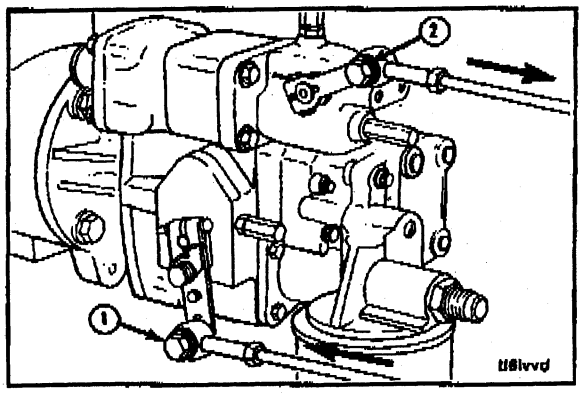
⚠ CAUTION ⚠

Operating the engine beyond high idle speed can cause severe engine damage. The engine speed MUST NOT exceed 2,400 RPM under any circumstances. When descending a steep grade, use a combination of transmission gears or vehicle braking systems to control the vehicle and engine speed.









Ref. Fig. 1-13. Power Take-off Application

8. ENGINE SHUT-DOWN

- Allow the engine to idle three (3) to five (5) minutes after a full load operation before shutting it off. This allows the engine to cool gradually and uniformly.
- Turn the ignition key switch to the OFF position. If the engine fails to stop running, rotate the manual fuel shutoff thumb screw **counter-clockwise** to make sure the valve is **not** being held open by the manual override screw.

8.1 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 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 above 360°F. The results of extreme heat may be seized bearings or loose oil seals.

8.2 Do Not Idle Engine for Excessively Long Periods

Long periods of idling are not good for an engine because 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 stucked valves.

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

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

8.3 Turn Switch Key to 'Off' Position to Shut Down the Engine

The engine can be shut-down completely by turning off the switch key on installations equipped with an electric shut-down valve, or by turning the manual shut-down valve knob. Turning off the switch key which controls the electric shut-down valve always stops the engine unless override button on shut-down valve has been locked in open position. If manual override on electric

shutdown valve is being used, turn button fully counterclockwise to stop engine. Refer to 'Normal Starting Procedure'. VALVE CANNOT BE REOPENED BY SWITCH KEY UNTIL AFTER ENGINE COMES TO COMPLETE STOP. NEVER TURN OFF THE SWITCH KEY WHILE GOING DOWN HILL. With the engine still in gear, fuel pressure will build up against the shut-down valve and may prevent it from operating when the switch key is turned on.

⚠ CAUTION ⚠

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

Do Not Use the Compression Release Lever to Stop the Engine

Some old engines are equipped with a compression release lever. Pulling this lever lifts the intake or exhaust (depending on engine model) valve push tubes and opens the valves. The push tubes are lifted off their sockets and extensive wear on the balls and sockets will result from using the compression release to stop the engine.

The compression release lever can be used as an aid in cranking, before starting, or while making injector and valve adjustment, but not to stop the engine. However CIL has obsoleted use of decompression system.

9. POWER TAKEOFF APPLICATION WITH

Variable Speed Controls

The variable speed governor on power takeoff applications is used to control engine speed at the desired RPM.

To engage the variable speed governor with the engine idling on standard throttle :

a. Put the variable speed control lever (2) in the idle position. Ref. Fig. 1.13.

b. Lock the standard throttle lever (1) in the full open position.

c. Adjust the variable speed control lever (2) to the speed desired.

To return to standard throttle operation :

a. Return the standard throttle lever (1) to the idle position.

b. Lock the variable speed control lever (2) in the maximum speed position.

10. STEP TIMING CONTROL (STC)

Some engine models are equipped with step timing control (STC), formerly called HVT (Hydraulic Variable Timing). STC allows the engine to operate in advanced injection timing immediately after start-up and light duty engine load conditions, and to return to normal timing during medium and high engine load conditions.

Benefits include :

- Improved cold weather idling characteristics.
- Reduced cold weather white smoke.
- Improved light load fuel economy.

11. ENGINE CONTROLS

The Electronic Control Panel (ECP) or Electronic Control Panel with Speed Governor (ECPG) was being supplied with CIL Engine earlier. The most advance engine controls are being supplied with CIL engines now. The details of the engine controls and the respective bulletin nos. for Users' Manual are listed below. Please refer to the specific bulletin numbers for information on engine controls supplied with your engine.

Note : The Users' Manual applicable for your engine is supplied with the engine.

Sr. No.	Engine Model	KVA rating	Controller		O&M manual	
			Old	Current	Old	Current
1	NTA-855-G2-I	320	ECPG	PCC3300	3243803	0914-0101
2	NTA-14-G3	380	ECPG + PCC3100	PCC3300	3243803 + 3243804	0914-0101
3	KTA-19-G9	500	ECPG + PCC3100	PCC3300	3243803 + 3243804	0914-0101
4	VTA-28-G3-I	600	ECPG + PCC3100	PCC3300	3243803 + 3243804	0914-0101
5	VTA-28-G5-I	625	ECPG + PCC3100	PCC3300	3243803 + 3243804	0914-0101
6	KTA-38-G2-I	750	ECP + EFC + PCC2100 + PCC3100	PCC3300	3243782 + 3243804 + 0900-0534	A028T799
7	KTA-38-G3-I	800	ECP + EFC + PCC2100	PCC3300	3243782 + 0900-0534	A028T799
8	KTA-38-G5	1010	ECP + EFC + PCC2100 + PCC3100	PCC3300	3243782 + 0900-0534 + 3243804	A028T799
9	KTA-50-G3	1250	ECP + EFC + PCC2100 + PCC3100	PCC3300	3243782 + 0900-0534 + 3243804	A028T799
10	KTA-50-G8	1500	ECP + EFC + PCC2100 + PCC3100	PCC3300	3243782 + 0900-0534 + 3243804	A028T799

Note : *These controls are not supplied now on engines.

Engine Preservation Procedure

Introduction

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

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

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

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

iii) Engine preservation procedure for engines installed in equipment.

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

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

NOTE :

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

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

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

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

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

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

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

Cooling System Passage :

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

ii) Fuel Passage:

No external treatment is required.

iii) Lubricating Oil Passage :

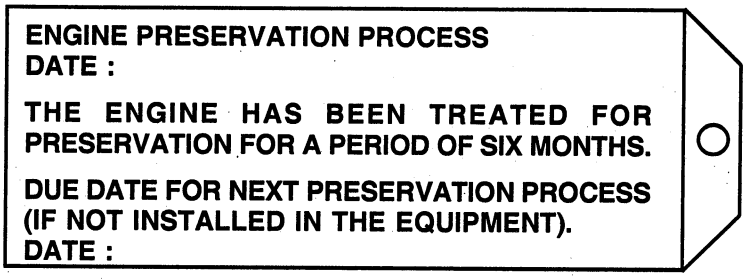
SR NO	DESCRIPTION	REMARKS
a	Prepare engine for Lub oil priming.	Use lub oil priming pump for priming.
b	Prime the engine with engine lub oil 15W40. (CH-4 category)	Use engine Lub oil trolley for priming. Circulate the lub oil till the lub pressure gauge shows 1 kg / cm sq. pressure. It will take max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

NOTE :

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

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

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



3) Engine preservation procedure for engines installed in equipment.

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

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

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

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

i) Clean off all accumulated dirt from exterior of engine

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

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

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

v) Check and correct the engine belt tensioning.

vi) Refer Section 1 for engine starting instructions.

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

Down-Hill Operation

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

Section 2 - Industrial Fire Pump Engines

Section Contents

Industrial Fire Pump Engines

Fire pump engines are built and applied under conditions set down by agencies such as Tarif Advisory Committee (TAC), National Fire Protection Association-20 (NFPA-20), 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.

1. ENGINE STARTING PROCEDURE

1.1 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.

a. Close all cooling system drains.

b. Remove the heat exchanger cap, check or fill the engine coolant supply; open the water filter inlet and outlet valves.

c. Prelubricate the engine with oil meeting API Class CH4 and viscosity of SAE 15W40. 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.

d. Check the crankcase oil level and fill to the 'H' mark on the dipstick.

e. 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.

f. Idle speed may be adjusted by turning the governor idle adjustment screw **counter-clockwise** to decrease RPM or **clockwise** to increase RPM.

g. Verify that the lube oil system is under pressure.

h. 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).

i. Set the overspeed stop switch. Refer to the sections on overspeed switches following this section.

j. Stop the engine and check the engine oil and expansion tank coolant levels. Top up if necessary. Clean the raw water strainer.

k. Start the engine and bring it to the fire pump required operating speed.

l. Adjust the raw water pressure regulator to obtain the required pressure.

m. **Readjust the engine speed if necessary.**

n. **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.**

o. Shut off the engine. Contact operating personnel responsible for fire protection system that engine is ready for service. Obtain authorized signature of acceptance.

1.2 Normal Operation

The unit should be operated at least once a week, during this, the engine must reach normal operating temperature. The engine is started and stopped under load on some installations. High water temperature alarm if provided may activate after stopping due to after boiling.

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.

2. ENGINE COOLING SYSTEM

2.1. Heat Exchanger

These engines are cooled by a heat exchanger in which the engine cooling water circulating around the heat exchanger tube bundle is cooled by raw water (from the discharge side of the fire pump) flowing through the tubes of the heat exchanger bundle.

2.1.2 Radiator Cooling

Radiator type of cooling is also used based upon the customer requirement.

By radiator, the hot engine coolant is cooled by ambient air as medium through fan. The coolant is passed through radiator in coolant circuit & the ambient air is forced through the radiator by a centrifugal fan for cooling of the engine cooling with radiator type installation, at least 1 metre space should be maintained in front of the radiator for proper ventilation.

2.2. Water Flow

The engine water flows through the heat exchanger to the engine water pump, through the engine around the cylinder liners, through the heads, out to the water-cooled exhaust manifolds (if provided), through the thermostats and finally back to the heat exchanger for cooling before it starts its return trip through the engine.

Raw water used for cooling the engine water is supplied from the fire pump prior to the pump discharge flange. It is forced through a cooling loop, by fire pump pressure to the heat exchanger where it flows through the tubes in the bundle and is discharged to an open waste cone.

NOTE : It is recommended that the fire pump engine must be test at least once in a week. The test should be carried out at engine operating temperature.

3. USE OF LUB OIL BY-PASS FILTER

The engines for fire pump applications are not provided with lub oil by-pass filter.

4. REVERSE ROTATION OF PUMP

Engines are used as prime movers on various fire fighting installations as well as for city water supply schemes.

Generally, combination of multiple motor driven pumps along with engine driven pumps are utilised which are fed with positive suction and deliver to common header/ hydrant. Whenever such installations are made, manually operated gate valves and / or non return valves (NTVs) are provided in the individual delivery line of the each pump. Similar arrangements are made for city water supply schemes when water source is at lower level and city is located at height.

It has been noticed over the years that operational / installation lapses i.e. wrong positioning of manual control valve, quality issues related to functioning of NRVs and growth of sea mass, debris, entrapment of sea shells cause improper sealing of NTV. Water in the delivery pipe flows back to in-operative pump causing the pump to rotate it in reverse direction. As generally pump to engine coupling used are of direct drive type, the engine also starts rotating in reverse direction along with the pump. All gear pumps of the engine i.e. lubricating oil & PT fuel pump rotate in reverse. This in turn leads to rotation of various engine parts with out lubrication causing severe damages to components mainly, camshaft, cambushes, cylinder blocks, connecting rod bearing, main bearings & crankshaft etc.

The solutions to this problem are :

- Training and awareness of the operating staff of consequences in case manual gate valves are not positioned appropriately as per safety & operational requirements.
- Use good quality non return valves and manual gate valves and their maintenance.
- Ensure NRV sealing while commissioning new engines.
- Do periodic inspection and maintenance of NRVs and gate valves to prevent occurrences of such failure.

5. WATER HEATER TANK :

Guidelines for connecting water heater to engines.

- Mount water heater tank along the base rail.
- Connect the adaptors, thermostat, heater etc., as per layout diagram.
- Ensure that the water heater is always on, so that the desired engines water temperature (38-49°C) is maintain. This is important. The water heater tank is provided so that engine is always ready to take instant load, in case of fire alarm.

Use of water heater tank :

Please refer to the Sketch 2-1 for typical mounting of the water heater tank. The details of per connecting water heater tank are given below.

- Typical schematic for cooling circuit
- Part Nos & their position in the circuit
- Electrical specifications for heater & thermostatic switch

The Thermostat provided for coolant heaters is to be adjusted in the field in such a way that water temperature is maintained between 38°C & 49°C. This adjustment depends upon working environments of the fire pump application engines (ambient temperature), quantity of coolant in the cooling system etc.

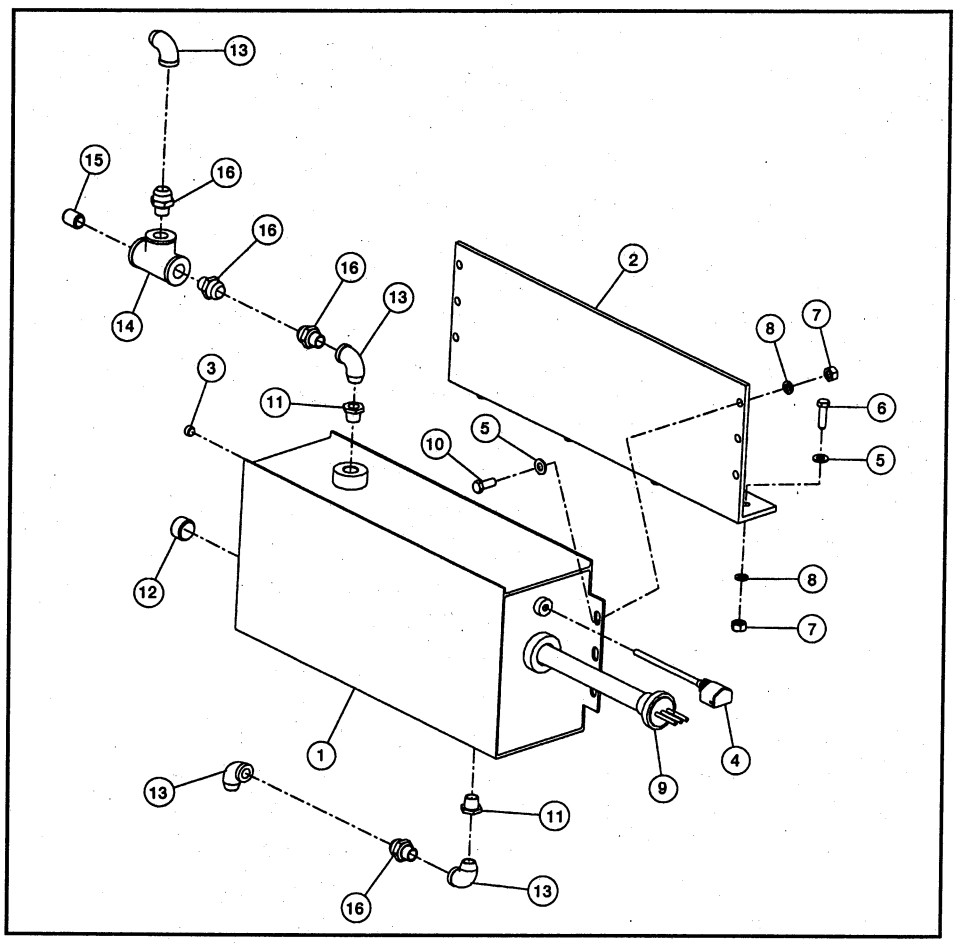


Fig. 2-1 : Typical sketch for connecting Water Heater Tank

Tank Water Heater Part No. 21/24/3247847 consists of

Sr. No.	Part No.	Description	Qty.
1	3226056	Tank, Water Heater	1
2	3226144	Bracket, Water Heater	1
3	0067622	Plug, Pipe	1
4	3226055	Valve, Thermost	1
5	S670	Washer, Plain	10
6	S106	Screw, Hexagon	4
7	S200	Nut, Regular	10
8	S608	Washer, Lock	10
9	3226053	Heater, Engine	1
10	S145	Screw, Hexagon Head Cap	6

Sr. No.	Part No.	Description	Qty.
11	S904A	Bushing, Reducing Pipe	2
12	S966E	Plug, Pipe	1
13	S988	Elbow, Plain Street Pipe	4
14	S981	Tee	1
15	S939B	Nipple, Plain Pipe	1
16	119984	Connector, Male	4
17	S962	Plug, Pipe	2
18	AK16100SS	Hose, Flexible	1
19	AK16070SS	Hose, Flexible	1

NOTES

Section 3 - Maintenance Operation

Section Contents

Maintenance Operations

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

1. Maintenance Schedule

For Industrial Fire Pump Engines Only

EQUIPMENT SR. NO. **ENGINE SERIAL NO.** _____

A-CHECK (SECTION 4, 5)	B-CHECK (SECTION 6)	FIRST 1500 HRS. CHECK	C-CHECK (SECTION 7)	D-CHECK (SECTION 8)	1500 HRS. AFTER EVERY 'D' CHECK
☐ Daily **Lubrication** ☐ Check Engine Oil Level **Fuel System** ☐ Drain Sediment from Fuel Tanks ☐ Drain Water from the Water Separator ☐ Check Fuel Supply **Air System** ☐ Check Air Cleaner **Cooling System** ☐ Check Coolant Level **Other Maintenance** ☐ Check leaks and Correct ☐ Check Engine Lubricating Oil and Water Heater ☐ Check Raw Water Strainer ☐ Check Starting Batteries ☐ Check belts, adjust if required	☐ Repeat "A" **Lubrication** ☐ Change Engine Oil ☐ Change Engine Full-Flow Oil Filter ☐ Record Oil Pressure **Fuel System** ☐ Check Throttle Linkage ☐ Clean Fuel Tank Breather ☐ Change Fuel Filters **Air System** ☐ Clean / Change Crankcase Breather ☐ Check Air Cleaner Restriction **Cooling System** ☐ Check coolant inhibitor. Add coolant concentrate, if required. ☐ Record Water Temp. ☐ Record RPM	ALL STEPS OF C-CHECK AND ADDITIONAL STEPS ☐ Adjust Injectors and Valves ☐ Replace rocker cover gaskets	☐ Repeat "A" and "B" **Cooling System** ☐ Check Heat Exchanger Core ☐ Clean readiator or change air cooler externally **Fuel System** ☐ Clean Fuel Tank from inside. **Other Maintenance** ☐ Inspect following items and replace as reqd. (Alternator/ Starter, etc.) ☐ Check air Cleaner Evacuator valve. Change if required.	☐ Repeat "A, B and C" **Fuel System** ☐ Clean and Calibrate injectors if required. **Air System** ☐ Replace rocker cover gaskets ☐ Tighten Manifold Nuts or Capscrews ☐ Check Turbocharger Compressor and Turbine wheel. ☐ Check Turbocharger bearing clearance. **Other Maintenance** ☐ Steam Clean Engine ☐ Tighten Mounting Bolts and Nuts (As Required) ☐ Check Crankshaft End Clearance ☐ Check Vibration Damper ☐ Check Safety Controls ☐ Change coolant. Descale cooling system	ALL STEPS OF C-CHECK AND ADDITIONAL STEPS ☐ Adjust Injectors and Valves ☐ Replace rocker cover gaskets
Engine Series **Interval** **All** **Hours Calendar**	**B** **Every 300 hours Every 6 months**	**To be done at first 1500 hours only**	**C** **Every 1500 hours Every 1 year**	**D** **Every 6000 hours Every 2 years**	**To be done at 1500 hours after every D Check**

Notes : 1. Perform checks on operating basis of interval that occurs first.
2. Any time cooling system is completely drained and/or flushed, check coolant using coolant checking kit.
3. It is suggested to operate the engine at operating temperatures once in a week.

2. Daily Engine Log Book (Only For Genset Engines)

ENGINE STARTED AT _____ HRS. _____ HRS. _____ HRS.

ENGINE STOPPED AT _____ HRS. _____ HRS. _____ HRS.

TOTAL _____ HRS _____ HRS. _____ HRS.

HOURS RUN TILL YESTERDAY _____

HOURS RUN TODAY _____

TOTAL HOURS _____

GENSET ROOM

TEMPERATURE _____

DATE : _____

ENGINE							ALTERNATOR					
				(HEAT EXCHANGER RAW WATER)								
TIME (HRS.)	L.O.P.	L.O.T.	W.T.	TEMP. - IN	TEMP. - OUT	PRESS	VOLTAGE	CURRENT	HZ	PF	KW	KWh

DIESEL FILLED _____LTS._____HRS._____LTS._____HRS.

LUB OIL TOP UP _____LTS._____HRS._____LTS._____HRS.

OBSERVATION REGARDING SMOKE CONDITION, LEAKAGES IF ANY, ENGINE SOUND ETC.

_____

_____

_____

Maintenance due after_____Hrs._____Carried out detail.

SAMPLE FOR REFERENCE ONLY

3. MAINTENANCE SCHEDULE

a. Schedule 1, Schedule II

The maintenance schedules should be used to establish maintenance practices for Cummins standby or continuous duty generator sets.

Schedule I is used with standby applications. (Refer page 3.7)

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 5514 / ISO 3046 1987 overload rating and DIN "B" 6270.

Schedule II is used with continuous duty applications. (Refer page 3.8)

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 5514 / ISO 3046 1987 and DIN "A" 6270 for generator set applications.

b. Using The Suggested Schedule Check Sheet

Actual operating environment of the engine governs the maintenance schedule. The suggested check sheet 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.

c. 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 0°C and below must also be equipped with a lubricating oil heater. When using a lubricating oil heater Immersed in oil, the maximum temperature of heater surface in contact with oil, should be less than 300°F (149°C) to minimize formation of hard carbon on the heating element.

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.

d. Cummins Continuous Duty Generator Sets

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

4. Stand-By Duty Generator Set Maintenance

Engine Systems	Schedule I		Checks A Daily	A Weekly	A Monthly	B 6 Mos./300* Hrs.	B 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 Concentration of Coolant			●	●	●
		— Belt Condition and Tension			●	●	●
		— Fan Hub. Drive Pulley and Water Pump					●
		— Motor operated Louvers			●	●	●
	Change:	— Water Filter				●	●
	Clean:	— Water Separator	●			●	
		— 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 Exhaust 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				●	●
Switch gear	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			●	●	●

5. Continuous Duty Generator Set Maintenance

Engine Systems		Schedule II	Checks A Daily	B 6 Mos./ 300* Hrs.	C 1 Year/ 1500 Hrs.	D 2 Years/ 6000 Hrs.	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 Concentration of Coolant		●	●	●	●
		— Belt Condition and Tension	●	●	●	●	●
		— Fan Hub, Drive pulley and Water Pump		●	●	●	●
	Change:	— Water Filter		●	●	●	●
	Clean:	— (Water Separator)	●				
		— 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	●	●	●	●	●
		— 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 Manifold and Turbocharger Capscrews				●	●
Engine Related	Check:	— For Unusual Vibration	●	●	●	●	●
		— Vibration Damper				●	
		— Crankshaft End Play					●
		Tighten mounting Hardware				●	
	Clean:	— Engine				●	
	Grease:	— Fan Pillow Bloc Bearings		●	●	●	●
Electrical	Check:	— Battery Charging System				●	
		— Batter Electrolyte Level					
		Specific Gravity		●	●	●	●
		— Grow 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					●

NOTES

Section 4 - "A" Maintenance Checks - Daily

Section Contents

"A" Maintenance Checks

This Section gives details of operation to be performing daily. These are very simple and just to be checked to get good performance.

Daily Checks

1. DAILY REPORT

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 .

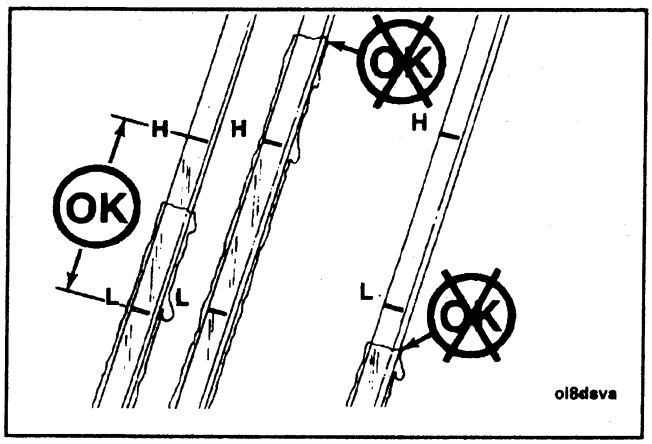
Comparison and intelligent interpretation of the daily report along with a practical follow-up action will eliminate practically all failures and emergency repairs.

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.

2. CHECK ENGINE OIL LEVEL

a. Check oil level with dipstick oil gauge located on the engine. Fig. 4-1. For accurate readings, oil level should not be checked for approximately 15 minutes after engine shut-down. Keep dipstick with the oil pan with which it was originally shipped. Keep oil level as near "H" (high) mark as possible.



Ref. Fig. 4-1. Checking engine oil level.

> **⚠ CAUTION ⚠**
>
> Never operate the engine with oil level below the "L" (low) mark or above the "H" (high) mark.

b. If necessary, add oil of the same quality and brand as already in the engine. See Section 11.

3. DRAIN SEDIMENT FROM FUEL TANKS / FUEL FILTER / WATER SEPARATOR

Loosen the fuel tank drain cock or plug, if used, and drain approximately 1 cup of fuel to remove water and sediment. Close the drain cock or plug.

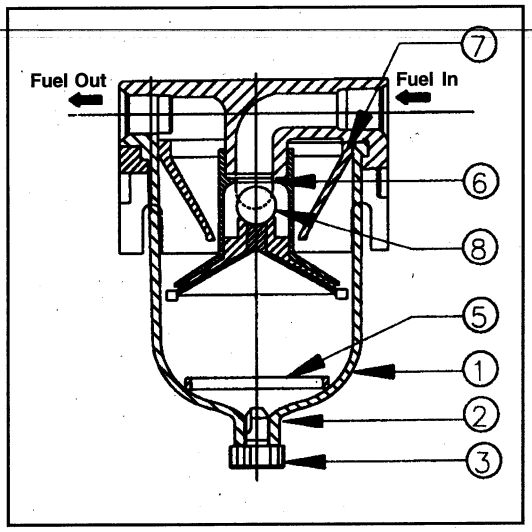
If more moisture than usual is present when checking the fuel tanks, it may be advisable to install a water separator.

Contact the nearest Cummins Dealer for a water separator that meets requirements.

Drain plugs are located in the bottom of some fuel filter cases and in the sump of some fuel supply tanks. More condensation of water vapor occurs in a partially filled fuel tank than in a full one. Therefore, fuel supply tanks should be kept as nearly full as possible. Warm returning fuel from the injectors heats the fuel in supply tank. If the fuel level is low in cold weather, the fact, that upper portion of the tank is not being heated by returning fuel, tends to increase condensation. In warm weather both the supply tank and the fuel are warm. In the night, however, cool air lowers the temperature of the tank much more rapidly than the temperature of the fuel. Again this tends to increase condensation.

The general construction of the fuel and water separator is as shown in Fig 4-2. It uses centrifuging principle for separating out the water or sludge from diesel. The water or sludge is collected in the bottom of the

polycarbonate plastic can and is drained out manually by operating the drain valve provided at the bottom of the can. For this operation, the engine should be shut down and upper handle is required to be unscrewed so as to induct atmospheric pressure on the can. After draining out water/sludge, close the drain valve and tighten the top 'T' handle.

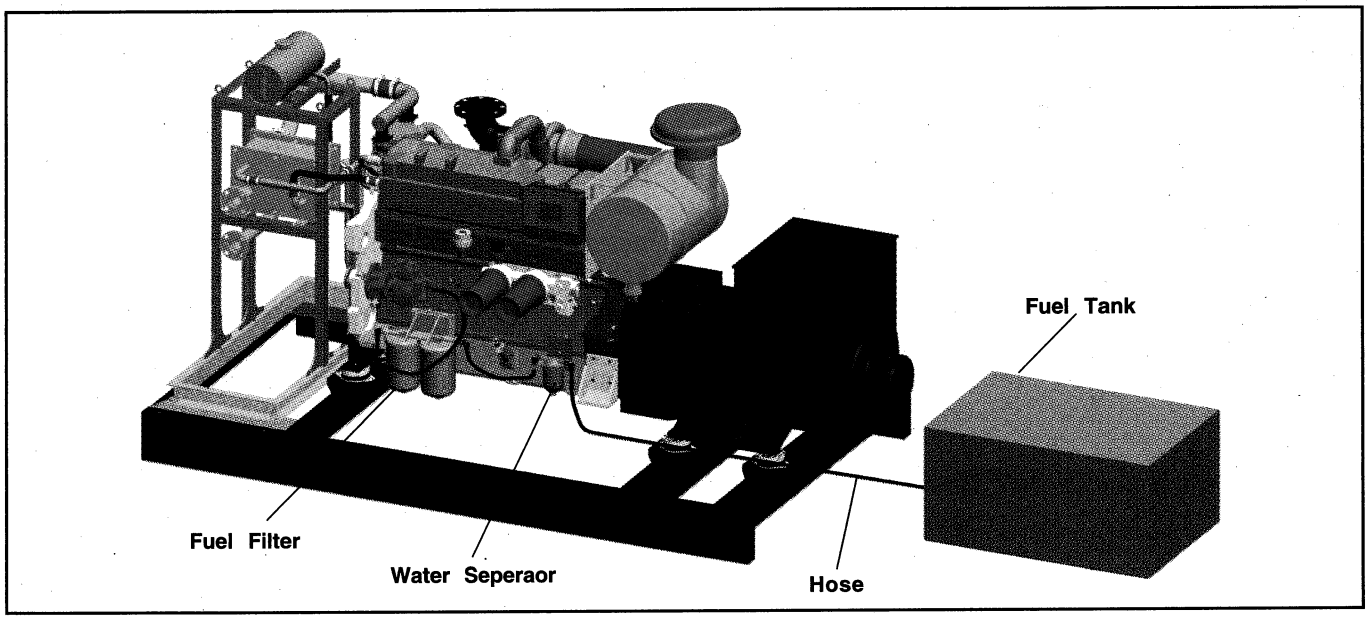


Ref. Fig. 4-2 Water separator

Ref. No.	Description	Ref. No.	Description
01	Bowl	05	Float
02	Seal O ring	06	Seal (ball check)
03	Valve drain	07	Seal ring
		08	Ball check

When vacuum drop is 8.00 inches (203.2 mm) of mercury column replace the filter assembly.

Cummins India Limited has also developed a water separator which can be used with the existing fuel filter assembly. This water separator should be connected in between fuel tank and fuel filter with suitable hoses. For construction of this water separator refer Fig. No. 4-2. The instructions to drain water/ sludge are given on its Decal. These decals are applied on the filter container/plastic can. The instructions should be read and followed precisely to get the satisfactory performance from this filter and water separator unit. Cummins India Limited recommends that fuel filter & water separators be checked and drained daily (more often if extreme conditions exist until the precise condition of the fuel is known). Only after this evaluation you can determine the service interval that can safely be used for your particular application without exceeding the water reservoir capacity. A typical layout for water seperator, fuel filter and fuel tank is shown in Ref. Fig. 4-3.



Ref. Fig. 4-3 Typical Layout for Water Separator & Fuel Filter on Engine

4. FILL MARINE GEAR

The marine gear is a separate unit and carries its own lubrication. Fill housing according to manufacturer's recommendations.

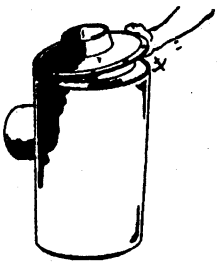
> **⚠ CAUTION ⚠**
>
> Never operate marine gear with oil level below "L" mark or above "H" mark on dipstick.
>
> Check Raw Water Pump Oil Level (If oil sump is provided) (For Marine Engines only)

Check oil level in raw water pump if pump has an oil sump.

1. Remove pipe plug from side of pump.
2. Fill housing with hypoid SAE 90 oil; replace plug.

5. AIR CLEANER SERVICE TIPS

Don't remove element for inspection.



Such a check will always do more harm than good. Ridges of dirt on the gasket sealing surface can drop on the clean filter side when the gasket is released. Stick with the regular maintenance schedule, or, if you service by restriction, believe the gauge or restriction indicator. Get a new indicator if you don't trust your current one.

Never rap a filter to clean it.

Rapping hard enough to knock off dust damages the filter and destroys your engine protection. Deeply embedded dirt is never released by tapping. It is always safer to keep operating until you can change to a fresh Filter.

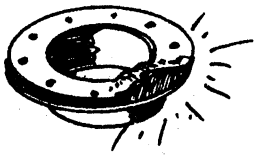
Never judge the filter's life by looking at it..... Measure the airflow restriction.

A dirty-looking filter may still have plenty of life left, while carbon contamination is not visible to the eye. You can't see the dirt that's embedded deep within the filter paper. Your best bet for lowest filter maintenance costs and best engine performance is to follow a restriction gauge. It's a smart, low-cost investment.

Never leave an air cleaner open longer than necessary.

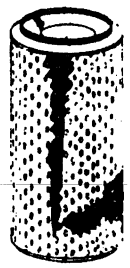
Your open air cleaner is a direct entry to the engine! Keep it protected during Filter changes. If the housing is not going to be reassembled immediately, cover the opening. The only way to be sure nothing got in, is to make sure nothing can get in!

Don't ignore a worn or damaged gasket in the housing.



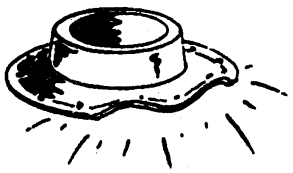
If your air cleaner has a cover gasket, replace it with a new one. Always check to be sure that no piece of the old gasket remains in the housing and that the gasket is not worn. If your filter model calls for a new gasket with each use, never reuse the old one.

Don't use a damaged or bunched filter.



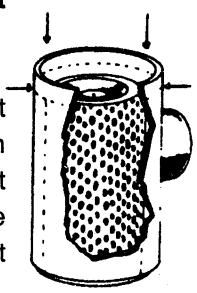
Never install a dented or punctured filter because it cannot protect properly against contamination. A dent can make a firm seal impossible or can indicate damaged media. A filter with bunched pleats saps engine power and fuel dollars.

Never use a warped cover on a housing.



Replace it with a new cover as soon as possible. A warped or damaged cover cannot make a proper seal. Also check to ensure that there is no damage to the air cleaner housing that could cause a leak.

Never substitute an incorrect element model number.



Filters may look almost identical, but even a fraction of an inch difference in size can prevent a good seal or affect cfm delivery. It's always better to use the dirty filter until you can get the correct one.

6-Step Filter Element Replacement

1. Remove the old element gently 'Baby' that dirty filter, until you get it clear of the housing. Accidentally bumping it while still inside means dropped dirt and dust that will contaminate the clean side of your filter housing, before the new filter element has a chance to do its job.

2. Always clean the inside of the housing carefully Dirt left in the air cleaner housing spells death for your engine. Use a clean, damp cloth to wipe every surface clean. Check it visually to make sure it's clean before putting in a new filter.

3. **Always clean the gasket sealing surfaces of the housing .**

An improper gasket seal is one of the most common causes of engine contamination. Make sure that all hardened dirt ridges are completely removed, both on the bottom and top of the air cleaner.

4. **Check for uneven dirt patterns**

Your old filter has valuable clues to dust leakage or gasket sealing problems. A pattern on the element clean side is a sign that the old filter element was not firmly sealed or that a dust leak exists. Identify the cause of that leak and rectify it before installing a new filter.

5. **Press your fresh gasket to see that it springs back**

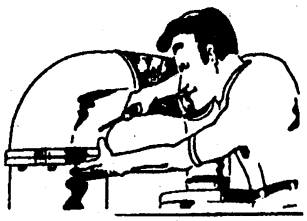
Make sure your new filter is made with a highly compressible gasket that springs back (promptly) when finger pressure is released. A high quality gasket is one of the most important parts of the filter.

6. **Make sure the gasket seats evenly**

If you don't feel the gasket seating evenly for a perfect seal, you don't have protection. Re-check to see if the sealing surface in the housing is clean, and ensure that the filter is the correct model. It may be too short for the housing.

7. **Ensure air-tight fit on all connections and ducts**

Check that all clamps and flange joint are tight, as well as the air cleaner mounting bolts. Seal any leaks irnmediately — leaks mean dirt is directly entering your engine



Proper Servicing is Essential

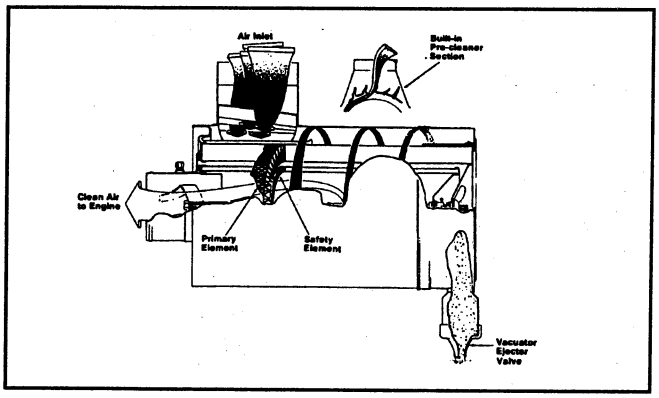
Proper air cleaner servicing results in maximum engine protection against the ravages of dust. Proper servicing can also save you time and money by maximizing filter life and air cleaning efficiency.

Two of the most common problems are:

A) *Over Servicing.* New filters increase in dust cleaning efficiency as dust builds up on the media. Don't be fooled by filter appearance! The filter should look dirty. By using proper filter measurement tools, you will use the full life of the filter at maximum efficiency.

B) *Improper Servicing.* Your engine is vulnerable to abrasive dust contaminants during the servicing process. The most common cause of engine damage is careless servicing procedures.

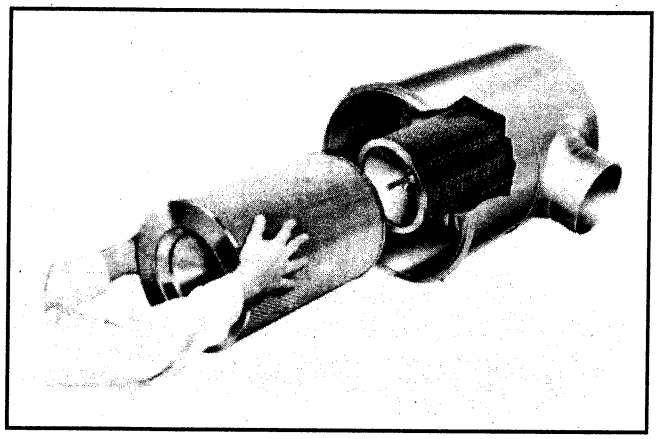
By following the steps listed above, you can avoid unnecessary risk to the engine.



Air cleaner (light duty)

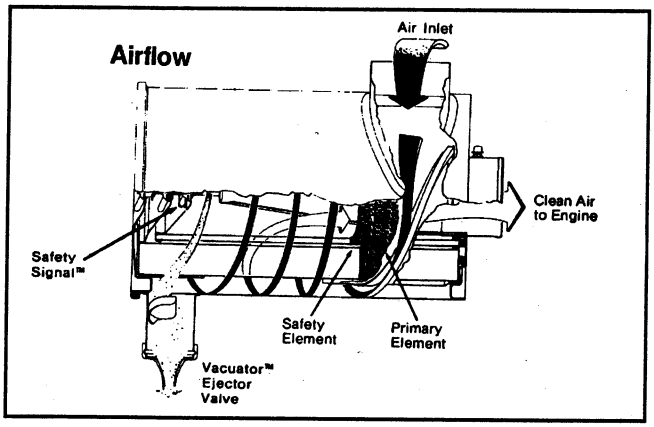
To change element:

1. Loosen clamp assembly which holds cup assembly to body air cleaner.
2. Remove cup assembly.
3. Loosen wing nut of outer element and remove it.
4. Loosen wing nut of inner element and remove it.



Removing elements.

Heavy duty air cleaners have pre-cleaners with cyclone tube in addition to elements.



Air cleaner (heavy duty)

Cleaning and Inspection of precleaner (Heavy duty)

1. Clean pre-cleaner openings of all soot, oil film and any other objects that may have become lodged in openings. Remove any dust or dirt in lower portion of pre-cleaner and aspirator tubing. Inspect inside of air cleaner housing for foreign material.

2. Inspect dirty precleaner for soot or oil. If there is soot inside cyclone tubes, check for leaks in engine exhaust system, exhaust "blow-back" into air intake and exhaust from other equipment. If precleaner appears "oily", check for fumes escaping from crankcase breather. Excessive oil mist shortens life of any dry-type precleaner.

3. Inspect clamps and flexible hose or tubing to be sure all fittings are airtight on cleaners with exhaust aspirators.

Inspection before Starting Engine

A. General

1 Check engine accessory mountings for damage / looseness. Correct as required - YES / NO
2 Check engine and coupling alignment - YES / NO
3 Check endplays and record in attached sheet - YES / NO
4 Check belts tension and adjust if necessary - YES / NO
5 Check batteries and electrical connections - YES / NO
6 Check and ensure proper clamping of front and rear Engine mounting bolts and its Torque - YES / NO
7 Check for the free rotation of the rotating parts - YES / NO
8 Check and remove all protective caps if any on breather and Exhaust Outlet /Fuel Drain -YES / NO

B. Fuel System

1 Drain sediments from fuel tank, if required flush fuel tank - YES / NO
2 Drain water from water separator - YES / NO
3 Ensure All Fuel Line Connections are secured properly to Avoid Air Entry - YES / NO
4 Replace Fuel Filter If Preservation is Carried Out -YES / NO

C. Cooling System

1 Check coolant level, pH Value & type of coolant Concentrate. Record the same - YES / NO
2 Check all hoses / Pipes / Couplings for proper connections - YES / NO
3 Check vent line. Ensure radiator cap is fixed and securely tight at all times. - YES / NO
4 Check belts tension / Alignment and adjust if necessary- YES / NO
5 Ensure there are no coolant leakages -YES / NO

D. Lube Oil System

1 Check Lube Oil level. Add oil up to 'H' marks if found less- YES / NO
2 Record brand, grade and category of oil. Use recommended oil as per O&M manual - YES / NO
3 Ensure all the plugs of Lube system / its connections/hoses fittings are properly Secured /Tightened - YES / NO
4 Ensure there are no leakages -YES / NO

E. Air System

1 Ensure pre-cleaner/hood is fitted on Air Cleaner-YES / NO
2 Ensure Vacuum indicator is fitted. Record its part no and range-YES / NO
3 Check air cleaner for dents / damages-YES / NO
4 Check air piping for sealing, proper support and tightness of hose clamps-YES / NO
5 Check air cleaner mounting bolts for tightness-YES / NO
6 Check engine breather vent. Extend vent outlet away from air cleaner / radiator -YES / NO
7 Check presence of heavy duty air cleaner for high dusty condition-YES / NO

F. Exhaust System

1 Check for exhaust piping Alignment -visual inspection at OEM Places -YES / NO
2 Check & perform the inspection more specifically as per guidelines of P-check and ensure proper support to Exhaust Piping -YES / NO
3 Check exhaust piping in the acoustic enclosure at OEM places -YES / NO
4 Check exhaust pipe diameter -YES / NO
5 Check for no of bends -YES / NO
6 Check and ensure protection for rain water entry -YES / NO

G. Inspection While Operating Engine

1 Check for Engine sound, correct immediately if observed any abnormality -YES / NO
2 Check smoothness of throttle operations -YES / NO
3 Check proper functioning of gauges & record discrepancies-YES / NO
4 Check for vibrations, smoke and functioning of all rotating parts, shut off the engine if observed any abnormality-YES / NO

H. Receipt of Literature

1 Operation & Maintenance Manual -YES / NO
2 Parts Catalogue -YES / NO
3 Warranty Administration Booklet -YES / NO
4 EFC Governor User's Manual (In case of G drive engine) -YES / NO
5 PCC user's Manual (In case of G drive engine with PCC) -YES / NO
6 Any other specific literature - YES/ NO - If Yes note details

I. Customer has agreed to

1 Contact Dealer for B check @ .....hrs. Or .....Months from date of 'A' check which ever occurs earlier. (As per O and M Manual)
2 Procure recommended oil & filters at own cost.
3 Follow warranty terms & conditions.
4 Idle the engine for minimum 5 minutes after starting and before shutting off the engine. (Except AMF Set)
5 Procure recommended engine spares from Cummins authorized dealers.
6 Avail after sales service from authorized network of Cummins.
Carry out 'A' maintenance check - daily as per O and M Manual.

NOTES

Section 5 - "A" Maintenance Checks - Weekly

Section Contents

"A" Maintenance Checks

This Section gives details of operation to be performing daily. These are very simple and just to be checked to get good performance.

Weekly Checks

Check Engine Belts

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

Using appropriate gauge, Fig. 5-2 check and / or adjust belts to tension as indicated in Table 5-1.

In-line Engine Water Pump Belts (No Idler)

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

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

   d. Snug clamp ring capscrew farthest from belts, on exhaust side to 5 ft-lbs (7 N•m).
   e. Snug two capscrews above the first one to 5 ft-lbs (7 N•m).

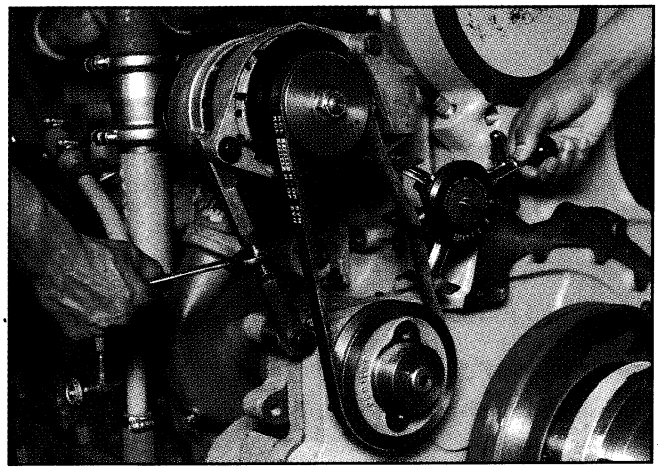


Fig. 5-1. Checking belt tension with ST-1138

   f. Finish tightening by tightening alternate link 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 belt tension.

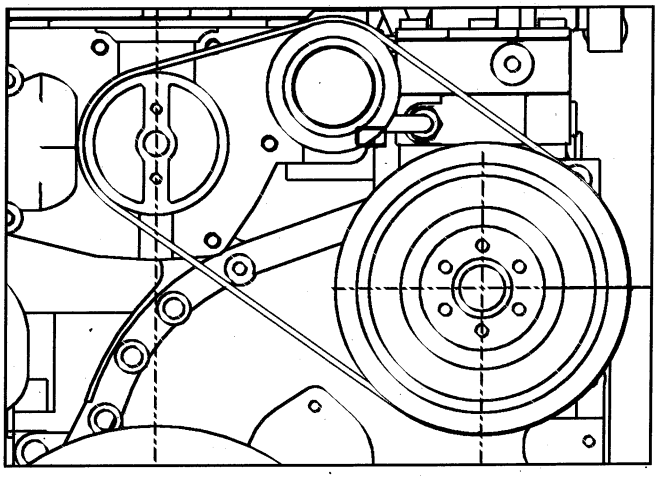


Fig. 5-2. Water pump with idler on NH/NT series engine

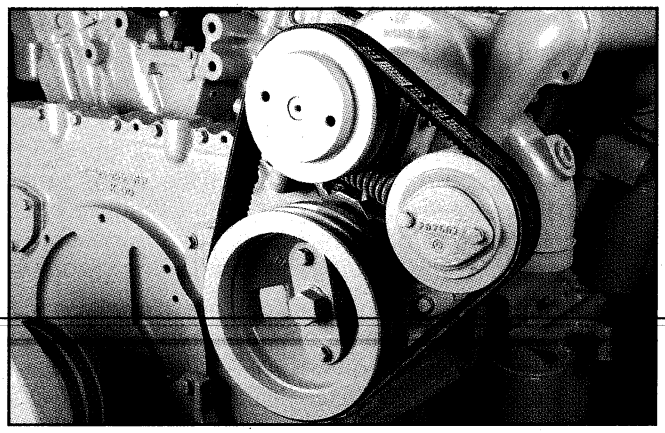
Final belt tension was not obtained by adjustment alone. The water pump body was pulled straight by snugging the capscrews in the order described, thus increasing belt tension to final value.

Table 5-1 : Belt Tension (Pounds)

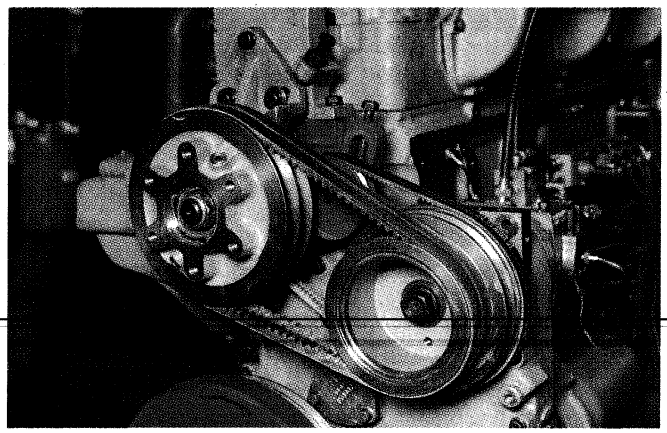
Belt Width Inches	Belt Gauge No.	* New Belt Tension ± 10	**Belt Tension After Run-in ± 10
Standard "V" Belt			
1/2	ST-1274	140	100
11/16	ST-1138	140	100
3/4	ST-1138	140	100
7/8"	ST-1138	140	100
Poly-V 6 Rib	ST-1293	150	130
NT-855 (Water pump with idler)			
15/32	ST-1274	130	80

* New belts must be re-tensioned to values listed under "New Belt Tension".

** Used belts should be retensioned to values listed under "Belt tension after run-in"



Ref. Fig. 5-3. Checking engine oil level



Ref. Fig. 5-4. Fan hub installation NT 855 (FFC)

In-line Engine Water Pump Belts (With Idler)

1. Loosen locknut securing idler pulley to bracket or water pump. Fig. 5-3.

2. Tighten water pump idler pulley bolt till sufficient tension is obtained. Retighten locknut securing idler pulley to idler bracket to 45 to 55 ft. lbs.

3. Check belt tension as per Table 5-1.

Note : Self tensioning idler if present on V-1710 belt driven water pumps requires no adjustment or belt tension check.

Fan Drive Belts

1. Loosen large locking nut using rachet spanner 3244252 on fan hub shaft or capscrews securing fan hub shaft to mounting bracket. The fan hub will fall out of line when this is done.

2. Turn the adjusting screw to increase belt tension.

3. Tighten the locknut or capscrews until the fan hub is straight. Snug the nut to maintain hub in proper alignment with the fan hub bracket.

△ CAUTION △

Do not adjust to full tension with the adjusting screw, this would result in over- tightening.

4. Belt tension should read as indicated in Table 5-1 on applicable gauge.

5. Tighten NH/NT Engines locknut to 350 ft-lbs using ratchet spanner 3244252. Tighten the four 1/2 inch capscrews Fig. 4-5 on NT FFC Engines to 75 to 85 ft-lbs (101 to 115 N•m)

6. Recheck belt tension.

7. Back out adjusting screw one-half turn to prevent breakage

Generator/Alternator Belts

Belt tension should be as indicated in Table 5-1 when measured with the applicable gauge.

Belt Installation

If belts show wear or fraying replace as follows :

1. Always shorten distance between pulley centers so 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 belts and cause early failure.

2. Always replace 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 pulley centers.

4. Belts should not bottom on pulley grooves nor should they protrude over 3/32 in (2.4 mm) above top edge of groove.

5. Do not allow belts to rub any adjacent parts.

6. Adjust belts to proper tension.

Readjusting New Belts

All new belts will loosen after running for 5 minutes and must be readjusted to “belt tension after run-in” Ref. Table 5-1.

Section 6 - "B" Maintenance Checks - 300 hrs. / 6 months

Section Contents

"B" Maintenance Checks

At each "B" Maintenance Check, perform all the "A" Checks in addition to the following. This check should be carried out at every 300 hour of operation or at every six month.

300 hrs / 6 months Checks

1. LUBRICATING OIL SYSTEM

a. Lubricating Oil Change Intervals

Note : If the lubricating oil is drained from the oil pan to make an engine repair, new oil must be used. Do not use oil after it has been drained from the oil pan.

Maintaining a proper "B" maintenance check interval is a very important factor in preserving the integrity of an engine. Lubricating oil contamination is the direct result of engine operation and load factor involved. The amount of contamination generated depends on the amount of fuel the engine consumes. At each "B" check interval it is recommended to change the full-flow filter and the by-pass filter.

The total lubricating system upto capacity in litres can be determined by adding high level of the lubricating oil in the oil pan and the capacities of the full-flow and bypass filters.

b. Lubricating Oil Analysis

Lubricating oil and filter change period can be determined by laboratory tests of used oil. The analysis 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 of 300 hrs/6 months (the oil change period for N-4.8-G engines is 500 hours of operation or every 6 months) 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. NH, V and K models must be in separate groups. Use common nomenclature for engines. 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 8 engines. The selection of engines for each sub-group should be completely random.

Oil samples should be taken from each of the engines in the sub-groups at every 48-operating-hour interval. 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 analysis of the samples indicate that any one of the condemnation limits listed in Table 6-1 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.

1. Sample valve method
2. Vacuum Pump method
3. Oil drain method

Table 6-1 : Oil Contamination Guidelines

Property	Guidelines
Viscosity change @ 100°C (ASTM D-445)	± 1 SAE Viscosity grade or 4 cSt from the new oil
Fuel Dilution	5 Percent
Total acid number (TAN) (ASTM D-664)	2.5 number increase from the new oil value, maximum
Total base number (TBN) (ASTM D-2896)	2.5 minimum or, one half original (New Oil) value or equal to TAN
Water content ASTM (D-95)	0.2 percent maximum
Potential Contaminants :	
Silicon (Si)	15 ppm increase over new oil
Sodium (Na)	20 ppm increase over new oil
Boron (B)	25 ppm increase over new oil
Potassium (K)	20 ppm increase over new oil
Soot	1.5 percent mass of used oil maximum

NOTE : The contamination guidelines presented above are guidelines only. This does not mean values that fall on the acceptable side of these guidelines be interpreted as indicating the oil is suitable for further service.

*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 India Limited.

**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 6-1.

To determine whether the maximum oil change interval has been reached the properties in Table 6-1 should be determined by the laboratory methods specified. This table also specifies contamination limits to be used for determining the useful life of lubricating oils. This group of analysis and the methods are not generally part of the oil analyses offered by most commercial used oil analysis laboratories.

When any one of the contamination 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 contamination 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.

c. Oil Sample Collection

Three methods are commonly used to collect oil samples for analysis. They are :

1. **Sample Valve Method :** A valve is installed on the dirty side of the filter. When collecting a sample, the valve is wiped clean; and after the engine is brought up to operating temperature, the valve is opened. Stagnant oil is allowed to flow out, and a sample can be collected from the oil stream being pumped by the engine at idle.

2. **Vacuum Pump Method :** A length of tubing, measured against the dipstick, long enough to reach 25.4 to 51 mm (1 to 2 inches) below the oil level in the sump is attached to a hand operated vacuum pump. Immediately after stopping the engine at operating temperature, pump the sample into a clean, dry bottle. Always replace the tubing after each sampling to avoid the possibility of sample cross-contamination.

3. **Oil Drain Method :** Clean the area around the drain plug to avoid foreign contamination. Immediately after stopping the engine at operating temperature, remove the drain plug. After approximately 8 liters (2 gallons) of oil have streamed out, collect the sample from the continuous stream.

d. 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 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. (On 855, 1150, 2300 and 3067 series engines, and torque to 65 to 70 ft-lbs for cast iron or sheet metal oil pans. Apply 40 to 45 torque ft/lbs for aluminium oil pans).

3. Fill the crankcase to "H" (high level) mark on the dipstick.

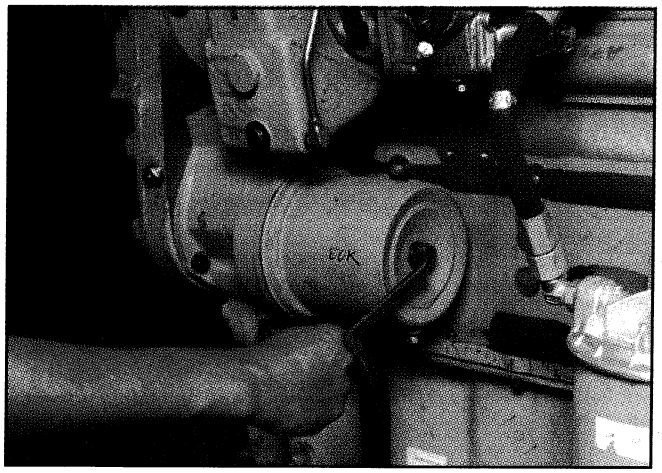
4. Start engine and visually check for oil leaks.

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 11, and genuine Cummins filters on engines.

e. Change Lubricating Oil Filter Elements

1. Loosen centre bolt securing lub oil filter to lubricating oil pump.



Changing lub pump mounted filter element.

2. Remove filter element, cut it open and check for metal particles, if found check for source. Discard "O" ring and element. Insert new filter element into the can.

3. Install new rectangular seal on the pilot located on the lub pump.

4. Install can and element assembly with it's mounting bolt and washers.

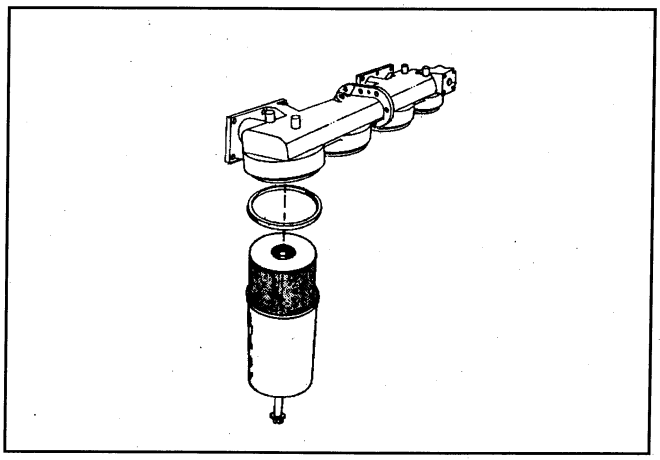
5. Remove NPTF plug on can, fill clean oil and replace the plug.

6. Torque the can retaining bolt to 30 to 35 ft. lbs. (41 to 47 N•m).

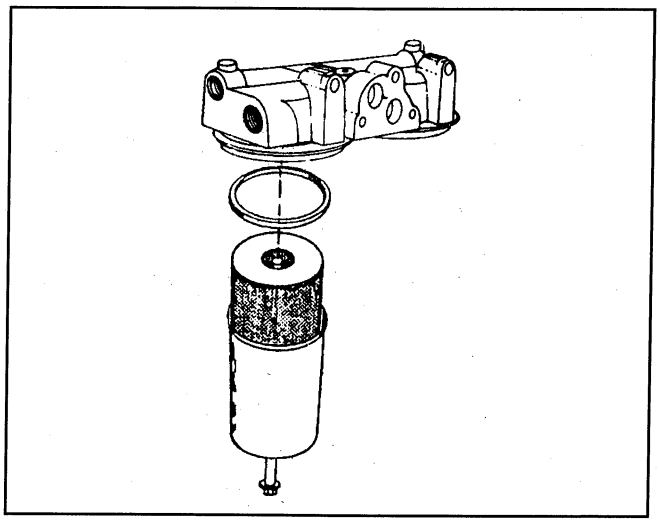
7. Run the engine, check for leaks, recheck engine oil level; add oil as necessary to bring the oil level to "H" mark on the dipstick.

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

On K19, V28, KV38 and KV 50 to change element lub oil, remove centre bolt, takeout element and seal "O" ring and discard them. Replace new element and "O" ring. Fill can with oil and mount element and can back to the position. Torque bolt to the 30 to 35 ft-lbs.



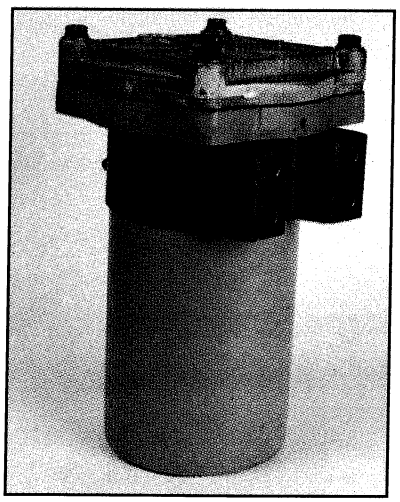
Changing L.O. element on KV-12/KV-16 engines.



Changing L.O. element on K6 engines.

f. Change Super Lub Oil By-Pass Filter Element

1. Loosen four capscrews from head and remove head super L.O. by-pass filter.



Super L.O. Bypass filter

2. Takeout element and remove ring sealing between head and shell.

3. Replace ring sealing and element. Fill filter with some oil and reassemble.

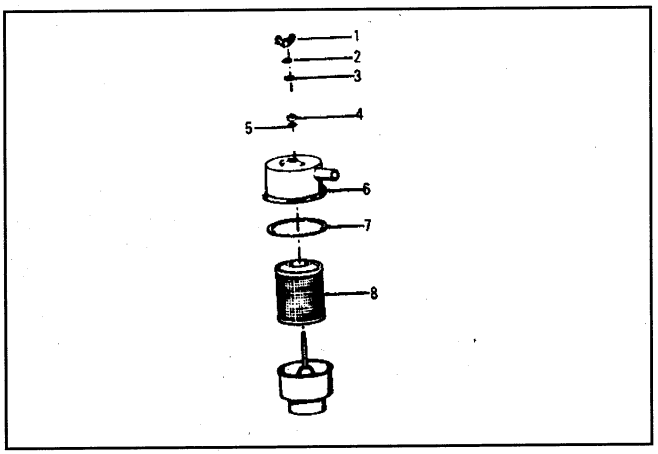
4. Run the engine, check for leaks, shut down the engine. Add oil as necessary to bring the oil level to the "H" mark on the dipstick.

g. Clean / Change Crankcase Breather

There are two types of breathers used on CIL engines. Element type breather on naturally aspirated engines and baffle type breather on turbocharged engines. In element type breather used on naturally aspirated engines element is to be changed. **It is not to be cleaned.** On turbocharged engines baffels from breather are to be cleaned.

Element type Breather

1. Remove the wing nut (1 Fig. 6-1), lock washer (2) and plain washer (3).



Ref. Fig. 6-1. Crankcase Breather-Element type.

2. Remove washer (4) and gasket (5).

3. Lift off the cover (6) and lift out the breather element (8).

4. Discard element, clean cover (6) and body. Inspect the body and cover for cracks, dents or breaks.

5. Install a new breather element (8).

6. Inspect gasket (7). Replace if necessary. Install the rubber gasket (7) in the Cover (6); position the cover assembly to the body.

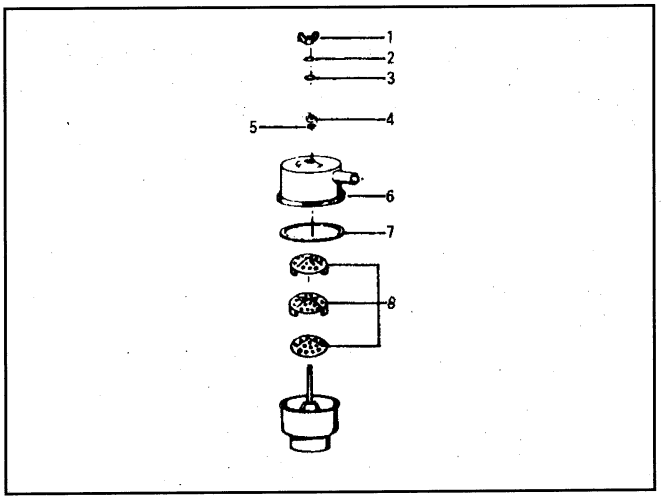
7. Inspect gasket (5). Replace if necessary. Install the gasket (5), washer (4), (3), (2) and wing nut (1). Tighten securely.

h. Baffel type Breather – Cleaning and Inspection

Procedure for removing and inspection is similar to element type breather.

After removing baffels. Clean them in suitable solvent. Inspect and replace if necessary.

Install baffels back to the position and assemble the breather assembly as described under element type breather.



Crankcase breather—Baffel type

i. 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.**

2. COOLING SYSTEM

Cummins engines are provided with Borate base coolant (Coolant Additive Concentrate - (CAC). To ensure adequate corrosion protection checking coolant at every B Check is essential. The checking procedures are detailed below :

a. Check Coolant Additive Concentrate

Coolant Additive Concentrate (CAC) is Borate base chemical compound. When mixed with water in pre-determined quantity, and used as coolant in diesel engine protects internal coolant passages against corrosion, rusting and pitting.

During engine operation the chemicals from CAC are depleted. Coolant Additive Concentrate is added during 'B' check of engine to maintain the concentration level and to replenish the depleted chemicals in following steps. (Refer Annexure Table for CAC requirement at 'B' check for Genset application).

a. Open radiator top tank / heat exchanger expansion tank cap & add Coolant Additive Concentrate.

b. If Coolant Additive Concentrate cannot be accommodated into the cooling system, drain appropriate amount of coolant from the system. This drained coolant can be used for top up if collected & stored in clean container.

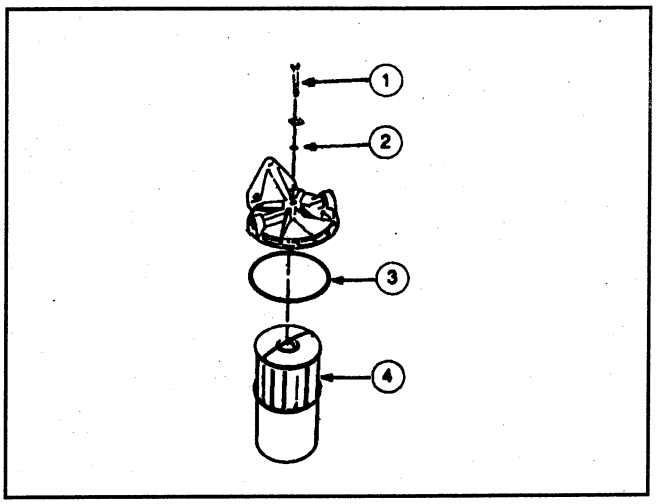
c. Do not overfill.

Please refer to Section 11 for coolant checking details.

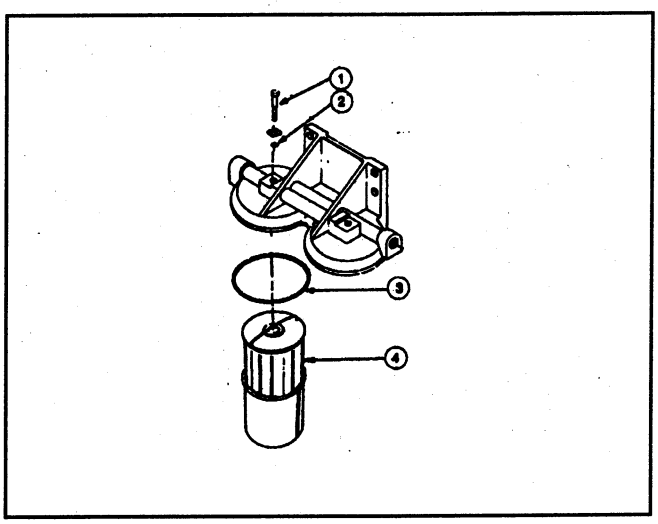
FUEL SYSTEM

a. Change Fuel Filter Element (Ref. Fig. 6-2 & 6-3)

Loosen capscrew (1) which holds shell to head. Discard 'O' rings (2) and (3). Similarly discard element fuel filter (4). Install new 'O' rings (2) and (3). Install new element. Fill can with fuel and assemble shell to head with capscrew (1).



Ref. Fig. 6-2 Changing fuel filter element.



Ref. Fig. 6-3 Changing duel elements.

b. Clean fuel tank breather

Remove and clean fuel tank breather.

c. Check Throttle Linkage

Operate linkage with hand to check for freeness. Adjust, if necessary. Lubricate ball joints or the throttle linkage of hydraulic governor.

d. Check air piping

Visually inspect hoses, pipes for damages / cracks and clamps for looseness. Correct if necessary.

NOTES

Section 7 - Specifications and Torque

Section Contents

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 ensuring long life and satisfactory performance.

Lubricant, Fuel and Coolant

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: Oils that meet the low temperature [0°F (–18°C)] 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 grade oils.

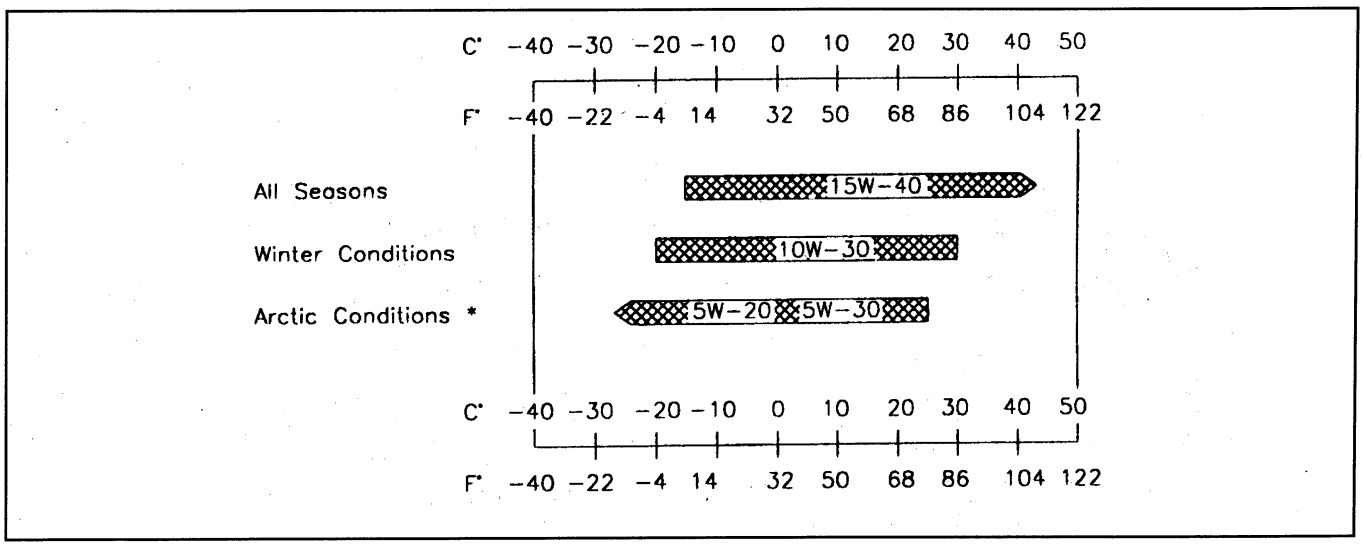
Multigraded oils are generally produced by adding viscosity index improver additives to retard the thinning effects, a low viscosity base oil will experience at engine operating temperatures. Multigraded oils that meet the requirements of the API classifications, are recommended for use in Cummins engines.

Cummins recommends the use of multigraded lubricating oil with the viscosity grades shown in Table 11-1 which 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 use of multigraded lubricating oil improves oil consumption control, improved engine cranking in cold conditions while maintaining lubrication at high operating temperatures and may contribute to improved fuel consumption. Cummins does not recommend the use of single grade lubricating oils.

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 lubricating 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 of oil as the temperature of the oil in the engine oil sump reaches the lower end of the ranges shown in Table 7-1.

Table 7-1 : Cummins Recommended SAE Oil Viscosity Grades vs Ambient Temperatures



Note : For temperature consistently below -25°C (-13°F) refer to lub oil manufacturer for recommendations.

Engine Oil Recommendations for Cummins Engines

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

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

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

This provides several advantages such as,

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

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

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

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

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

⚠ CAUTION ⚠

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

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

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

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

Note

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

Grease Recommendations

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

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

Specifications and Torque

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Lubricant, Fuel and Coolant

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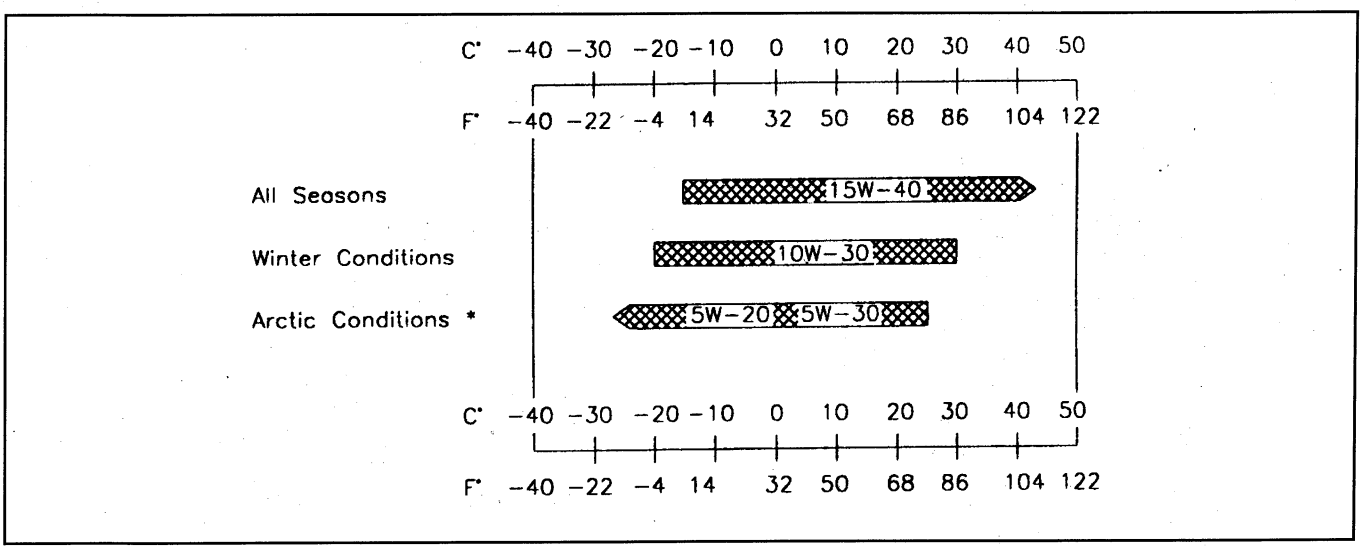
Multigraded oils are generally produced by adding viscosity index improver additives to retard the thinning effects, a low viscosity base oil will experience at engine operating temperatures. Multigraded oils that meet the requirements of the API classifications, are recommended for use in Cummins engines.

Cummins recommends the use of multigraded lubricating oil with the viscosity grades shown in Table 11-1 which 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 use of multigraded lubricating oil improves oil consumption control, improved engine cranking in cold conditions while maintaining lubrication at high operating temperatures and may contribute to improved fuel consumption. Cummins does not recommend the use of single grade lubricating oils.

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 lubricating 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 of oil as the temperature of the oil in the engine oil sump reaches the lower end of the ranges shown in Table 7-1.

Table 7-1 : Cummins Recommended SAE Oil Viscosity Grades vs Ambient Temperatures



Note : For temperature consistently below -25°C (-13°F) refer to lub oil manufacturer for recommendations.

Engine Oil Recommendations for Cummins Engines

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

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

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

This provides several advantages such as,

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

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

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

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

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

⚠ CAUTION ⚠

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

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

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

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

Note

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

Grease Recommendations

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

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

Penetration

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

* Federal Test Method Std. No. 791a

⚠ CAUTION ⚠

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

Fuel Oil Recommendations

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

TABLE 7-4: REQUIREMENTS FOR HIGH SPEED DIESEL FUEL AS PER IS 1460 : 2005

Sr. No.	Characteristics	Requirement		Method of test Ref. to [P;] of IS 1448/ISo/ASTMD/ IP/EN/Annex of this Standard
		Bharat Stage II	Bharat Stage III	
1	2	3	4	5
1	Acidity, Inorganic	Nil	Nil	[P : 2]
2	Acidity, total mg. of KOH/g *Max.*	To report	To report	[P : 2]
3	Ash, percent by mass *Max.*	0.01	0.01	[P : 4]/ISo 6245
4	Carbon residue (Ramsbottom) on 10 percent residue[1], percent by mass, *Max*	0.30	0.30	[P : 8]/ISo 10370
5	Cetane Number[2], *Min.*	48[3]	51[3]	[P : 9]/ISO 5165
6	Cetane index[2], *Min.*	*46*[3]	*46*[3]	D 4737/ISo 4264
7.	Pour point[4], *Max.*			[P : 10]/D 5949 or D 5950 or D 5985
	a) Winter	3°C	3°C	
	b) Summer	15°C	15°C	
8	Copper strip corrosion for 3 hours at 100°C	Not worse than No. 1	Not worse than No. 1	[P : 15]/ISO 2160
9	Distillation percent *v/v,* recovered			[P : 18]/ISO 3405
	a) at 350°C, *Min.*	85	—	
	b) at 360°C, *Min.*	—	95	
	c) at 370°C, *Min.*	95	—	
10	Flash point : (a) Abel, °C *Min.*	35	35	[P : 20]
	b) Pensky Martens closed cup[5], °C, *Min.*	66	66	[P : 21]
11	Kinematic viscosity cSt at 40°C	2.0 to 5.0	2.0 to 4.5	[P : 25]ISO 3104
12	Sediment, percent by mass *Max*	0.05	—	[P : 30]
13	Total contamination, mg / kg	—	24	EN 12662
14	Density at 15°C[6],kg/m^3	820-860	820-845	[P : 16]or [P:32][7]/D 4052 ISO 3675 or ISO 12185
15	Total sulphur[8], mg / kg, *Max*	500	350	IP : 336 or D 4294[9] ISO 14596orISO 8754/P :83/D 2785/D 5433/D2622/D3120
16	Water content, percent (v/v)	0.05	—	[P : 40]/ISo 3733/ISO6296
	Water content mg / kg, *Max*	—	200	ISO 12937
17.	Cold Filter Plugging Point (CFPP)[4], *Max.*			[P : 110]/D6371
	a) Winter	6°C	6°C	
	b) Summer	18°C	18°C	
18	Total sediments[10], mg. per 100 ml. *Max.*	1.5	—	Annex A/ISO 11205/D2274[10]
19	Oxidation stability, g/m^3, *Max*	—	25	ISO 12205 or D 2274
20	Polycyclic aromatic hydrocarbon (PAH), precent by mass, *Max*	—	11	IP 391 or EN 12916
21	Lubricity corrected wear scar diameter (wsd 1.4) at 60°C, microns, *Max*	460	460	ISO 12156-1
22	Oxygen content[11] percent by mass, *Max*	0.6	0.6	Annex B

Table 7-3 : Recommended Fuel Oil Properties :

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

Coolant Specifications

Cooling System

Cummins engines are provided with fleetcool XB Coolant Additive Concentrate - (CAC) and premix coolant. To ensure adequate corrosion protection, checking coolant at every B Check is essential. The checking procedures and the details of the Coolant Checking Kit are given below :

Salient Features of CAC

- Safe / environmental & user friendly
- Easy operation, time saving at 'B' check.
- To be filled in through Radiator / make up (auxiliary) tank Cap
- Cost benefit to the customer at 'B' check.
- Easy checking process.

CAC Availability form and Checking

CAC is available in two forms,

a) Coolant Additive Concentrate, which can be mixed with water of **1:16** proportion and,

b) Pre-mixed coolant, which can be directly added in cooling system. To check the coolant concentration Test Strip and a Test Kit are available.

Make Up Coolant Specifications

Where possible, it is recommended that a supply of make-up coolant be prepared to the following specifications, using soft water. Chromate treatment of coolant assures constant level of concentration when coolant is added.

2. Coolant Additive Concentrate (CAC)

A. Coolant Additive Concentrate

It is supplied in plastic red colour containers having different part nos. for different volumes. The colour of the coolant additive concentrate is deep purple.

Part Number	Description	Qty.
3167214	Coolant additive concentrate	0.5 lt.
3167215	Coolant additive concentrate	1 lt.
3167216	Coolant additive concentrate	2 lt.
3167217	Coolant additive concentrate	5 lt.
3167218	Coolant additive concentrate	10 lt.

B. Pre-mixed Coolant

It is supplied in plastic white colour containers having different part nos. for different volumes. The colour of the coolant is pink.

Part Number	Description	Qty.
		Effective from Aug. 04
3167221	Pre-mixed Coolant	5 lt.
3167222	Pre-mixed Coolant	10 lt.
3167223	Pre-mixed Coolant	20 lt.
3167224	Pre-mixed Coolant	205 lt.

C. Test strip

New Test strip is introduced. Test strip is required to check coolant concentration and are packed individually in a foil pack.

Part Number	Description
4912590	Test strip

D. Test Kit

Test kits are supplied in cardboard boxes.

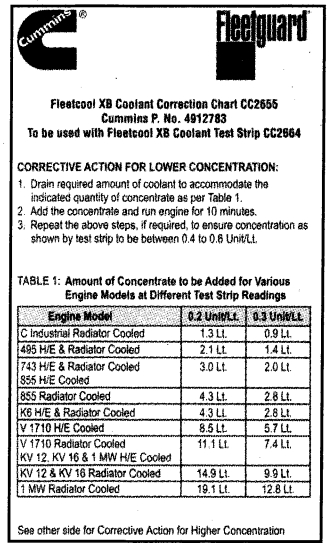
Part Number	Description
4912590	Test Kit

This consists of

a) 2 test strips,

b) a clear plastic beaker

c) a dropper to collect the coolant.



Fleetcool XB Coolant Correction Chart CC2655
Cummins P. No. 4912783
To be used with Fleetcool XB Coolant Test Strip CC2664

CORRECTIVE ACTION FOR LOWER CONCENTRATION:

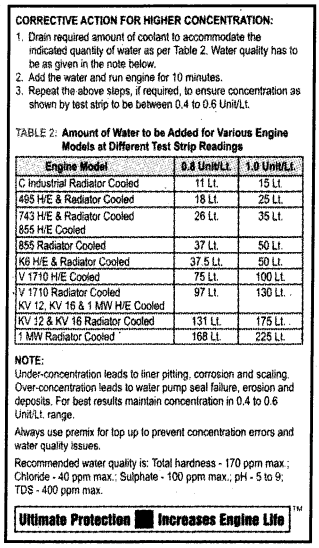
1. Drain required amount of coolant to accommodate the indicated quantity of concentrate as per Table 1.
2. Add the concentrate and run engine for 10 minutes.
3. Repeat the above steps, if required, to ensure concentration as shown by test strip to be between 0.4 to 0.6 Unit/Lt.

TABLE 1: Amount of Concentrate to be Added for Various Engine Models at Different Test Strip Readings

Engine Model	0.2 Unit/Lt.	0.3 Unit/Lt.
C Industrial Radiator Cooled	1.3 Lt.	0.9 Lt.
495 H/E & Radiator Cooled	2.1 Lt.	1.4 Lt.
743 H/E & Radiator Cooled 855 H/E Cooled	3.0 Lt.	2.0 Lt.
855 Radiator Cooled	4.3 Lt.	2.8 Lt.
K6 H/E & Radiator Cooled	4.3 Lt.	2.8 Lt.
V 1710 H/E Cooled	8.5 Lt.	5.7 Lt.
V 1710 Radiator Cooled KV 12, KV 16 & 1 MW H/E Cooled	11.1 Lt.	7.4 Lt.
KV 12 & KV 16 Radiator Cooled	14.9 Lt.	9.9 Lt.
1 MW Radiator Cooled	19.1 Lt.	12.8 Lt.

See other side for Corrective Action for Higher Concentration

Front Page of concentration correction table



CORRECTIVE ACTION FOR HIGHER CONCENTRATION:

1. Drain required amount of coolant to accommodate the indicated quantity of water as per Table 2. Water quality has to be as given in the note below.
2. Add the water and run engine for 10 minutes.
3. Repeat the above steps, if required, to ensure concentration as shown by test strip to be between 0.4 to 0.6 Unit/Lt.

TABLE 2: Amount of Water to be Added for Various Engine Models at Different Test Strip Readings

Engine Model	0.8 Unit/Lt.	1.0 Unit/Lt.
C Industrial Radiator Cooled	11 Lt.	15 Lt.
495 H/E & Radiator Cooled	18 Lt.	25 Lt.
743 H/E & Radiator Cooled 855 H/E Cooled	26 Lt.	35 Lt.
855 Radiator Cooled	37 Lt.	50 Lt.
K6 H/E & Radiator Cooled	37.5 Lt.	50 Lt.
V 1710 H/E Cooled	75 Lt.	100 Lt.
V 1710 Radiator Cooled KV 12, KV 16 & 1 MW H/E Cooled	97 Lt.	130 Lt.
KV 12 & KV 16 Radiator Cooled	131 Lt.	175 Lt.
1 MW Radiator Cooled	168 Lt.	225 Lt.

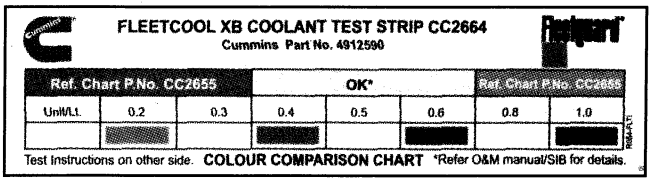
NOTE:
Under-concentration leads to liner pitting, corrosion and scaling. Over-concentration leads to water pump seal failure, erosion and deposits. For best results maintain concentration in 0.4 to 0.6 Unit/Lt. range.

Always use premix for top up to prevent concentration errors and water quality issues.

Recommended water quality is: Total hardness - 170 ppm max.; Chloride - 40 ppm max.; Sulphate - 100 ppm max.; pH - 5 to 9; TDS - 400 ppm max.

Ultimate Protection Increases Engine Life™

Back Page of CCT



FLEETCOOL XB COOLANT TEST STRIP CC2664
Cummins Part No. 4912590

Ref. Chart P.No. CC2655			OK*			Ref. Chart P.No. CC2655	
Unit/Lt.	0.2	0.3	0.4	0.5	0.6	0.8	1.0

Test Instructions on other side. COLOUR COMPARISON CHART *Refer O&M manual/SIB for details.

Test Strip Pin 4912590

d) Fleetcool XB Concentration correction table part no. 4912783.

IMPORTANT NOTE

Shelf life for Coolant Additive Concentrate & Pre-mixed Coolant is 5 years & that of test strip is one year.

It is proven that high concentration of fleetcool XB coolant causes gel effect leading to water pump seal surface damage. Lower concentration of fleetcool XB coolant cause liner pitting. Purpose of this note is to emphasize need to control fleetcool XB coolant concentration within band of 0.4 to 0.6 units per liter. The Coolant Checking Strip Part number 3167225 is superseded by new part number 4912590. The new test strip is supplied with engine effective from August 2004.

For correct coolant concentration adjustment Tabulated card Part no 4912783 is included in each Coolant checking kit Part No. 3167226. This card tabulates amount of coolant to be removed and to be topped up with water for reducing excess concentration.

In case of lower concentration, tabulation gives amount of coolant to be replaced with Coolant concentrate in order to increase concentration.

Tabulation is done for different models and for different measured concentrations. It is advisable to run the engine for few minutes after coolant concentration correction and recheck concentration in order to ensure that it is within 0.4 to 0.6 units per liter.

The tabulation is aimed to attain coolant concentration correction in one go and avoid iteration i.e no repeat adjustment should be required.

It is advised that always top up radiator with pre mix coolant to avoid frequent checking with Coolant Checking Strip.

Checking is recommended in case of following conditions –

1. At the time of initial commissioning,
2. When coolant is totally replaced / excessive coolant loss occurs
3. When concentration levels are unknown / doubtful.

Special Instructions :

For all old engines using fleetcool XB coolant, it is strongly recommended that coolant concentration should be checked and controlled within 0.4 to 0.6 units per liter. In case it is excess of 0.6, immediate correction as per tabulation Card Part No. 4912783 provided in Coolant test kit Part No. 3167226 is required.

INSTRUCTIONS FOR USE

The Coolant Additive Concentrate and pre-mixed coolant is supplied with each engine as,

- Required quantity of Coolant Additive Concentrate as per engine model.
- Coolant test kit 3167226
- Pre-mixed coolant for top up.

1) First fill at the time of engine commissioning Genset Applications

a) Add Coolant Additive Concentrate supplied in kit in radiator top tank / expansion tank (Ref. Picture 1).

Picture 1

b) Fill the remaining system by water till the system is completely filled.

Industrial Applications

The total coolant capacity varies for different engine models and applications. Hence following procedure to be followed to maintain concentration level of CAC.

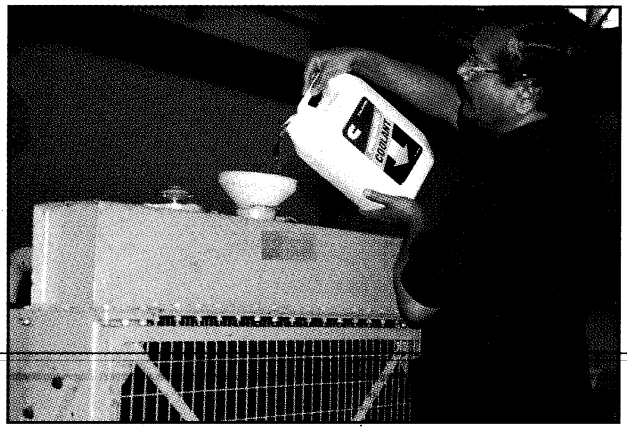
a) Prepare coolant mixture by mixing 15 parts of water with 1 part of Coolant Additive Concentrate supplied in kit and stir for thorough mixing.

b) Fill the system completely with this coolant. Measure and note down the system capacity for further reference purpose.

2. Coolant Top Up

If system is topped up by water it leads to dilution of the coolant i.e. coolant concentration becomes lower. In order to maintain the coolant concentration it is must to top up the system by pre-mixed coolant only and not by water.

To facilitate top up, pre-mixed coolant is made available. This Pre-mixed coolant is to be used as supplied. Do not dilute.



Picture 2

If pre-mixed coolant is not available, mix 15 parts of water : 1 part of Coolant Additive Concentrate and use this coolant for top up.

Improper cooling system top-up is the primary reason for low concentration levels in the coolants which in term causes corrosion and liner pitting.

3. Coolant Checking

In normal operating condition with system maintained as per above, the coolant will be maintained to the required specifications and no checking is required. However coolant checking is suggested as audit check, at every 1500 hrs./6 months during operation. Checking is also suggested in case of following :

— At the time of commissioning the engine,

— When coolant is totally replaced / excessive coolant loss occurs

— When concentration levels are unknown / doubtful. Coolant checking is very easy with the use of Test Strip.

During coolant checking two coolant properties namely coolant concentration and pH value of coolant are to be checked as follows :

Concentration

This can be checked by Test Kit, using following method:

i. Remove the top tank cap of radiator/heat exchanger, use dropper or open vent cocks in the cooling system & collect coolant sample in the beaker.

ii. Allow the coolant temperature to reach room temperature.

iii. Remove 'Test Strip' from the pack. Dip the strip in coolant for 3 seconds.

iv. Remove strip and shake briskly to remove excess coolant.

v. Wait for 45 seconds. Compare the colour of the strip with the colour chart within next 30 seconds.

vi. Take action as shown in the colour chart.

pH of coolant

No special checking kit is required for this property. This is only visual check. Special colour indicator has been added in the new CAC whose colour changes with pH. When colour of the coolant is pink the pH is within limit. (8.5 to 10.0 pH)

If coolant becomes colourless, then it indicates very low level of concentration. Hence add CAC as required to maintained the concentration level.

4. Coolant Replacement

At **6000** hrs. of operation or after two years, it is necessary to replace the coolant.

Important Note :

Use of good quality water along with CAC is important for optimum cooling system performance. Water used in cooling system must meet following specifications.

Hardness	(as $CaCO_3$)	- 170 ppm max
Chlorides	(as Cl)	- 40 ppm max
Sulfate	(as SO_4)	- 100 ppm max
pH		- 5 to 9
TDS (Total Dissolved Solids)		- Less than 400 ppm.

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

Coolant

Water coolant is important for cooling system performance. Excessive levels of calcium and magnesium contributes to scaling problems and excessive levels of chlorides and sulphates cause cooling system corrosion. The quality of water must meet the requirements listed below :

Water maximum levels

- Calcium Magnesium (Hardness) 170 PPM as ($CaCO_3$ + $MgCO_3$)
- Chloride 40 PPM as (Cl)
- Sulphur (Sulphates) 100 PPM as (SO_4)

To ensure adequate corrosion protection check engine coolant per procedure under Check Engine Coolant in section 6.

Check magnesium plate for pitting or being eaten away, change if more than 50% of area is lost, where Corrosion Resistor is used.

Details of Coolant Capacity with Radiator & H.E. Engines

Sr. No	KVA Rating	Engine Model	Actual Coolant capacity with Radiator (Ltrs.)	Actual Coolant capacity with HE (Lt)
1	15	X1.7 G1	3.5	Not Applicable
2	20	X2.5 G1	4.75	Not Applicable
3	25	X2.5 G2	4.75	Not Applicable
4	30	S3.8 G3	7	Not Applicable
5	40	S3.8 G4	7	Not Applicable
6	50	S3.8 G6	7	Not Applicable
6	62.5	S3.8 G7	8.3	Not Applicable
7	82.5	6BT5.9 G1	24	Not Applicable
8	100	6BTA5.9 G1-I	22.5	Not Applicable
9	125	6BTA5.9 G2-I	22.5	Not Applicable
10	140	6BTAA5.9 G1-I	22	Not Applicable
11	160	6CTA8.3 G1-I	25	Not Applicable
12	180	6CTA8.3 G2-I	30	Not Applicable
13	200	6CTAA8.3 G1-I	32	Not Applicable
14	250	6CTAA8.3 G4	42	Not Applicable
15	320	NTA 855 G2-I	88	36
16	380	NTA 14 G3	77	36
17	500	KTA 19 G9	162	60
18	600	VTA 28 G3-I	155	212
19	625	VTA 28 G5-I	155	212
20	750	KTA 38 G2-I	305	225
21	1010	KTA 38 G5	255	200
22	1250	KTA 50 G3	415	290
23	1500	KTA 50 G8	480	300

NOTES

Section 8 - Trouble shooting

Section Contents

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 dealers. 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 dealers to perform maintenance, if required.

Electronic Governor Controller (EFC) :

On Gen drive engines EFC Governor option is provided for better performance. Refer to Section 1 for detaios on engine controls. The Electronic Control Panel (ECP) or Electronic Control Panel with Speed Governor (ECPG) was being supplied with CIL Engine earlier. The most advance engine controls are being supplied with CIL engines now. The details of the engine controls and the respective bulletin nos. for Users' Manual are listed below. Please refer to the specific bulletin numbers for information on engine controls supplied with your engine.

Trouble Shooting

Cummins Engines

	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	Excessive Engine Vibration	Excessive Noise	Excessive Crankcase Pressure
CAUSES																																
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												●	●	●																	
	incorectly Assembled Governor Weights													●	●	●																
	High-Speed Governor Set Too Low							●	●																							
	Water in Fuel and/or Waxing	●	●						●		●			●	●																	
	AFC Calibration Incorrect	●					●	●			●																				●	
	Damaged/Worn AFC Pluger Seal/Barrel										●																					
	Fuel Pump Calibration Incorrect					●	●	●	●		●	●	●	●	●																●	
	Injector Flow incorrect		●			●	●	●	●		●	●																				
	AFC Air Leak, Belows							●			●																					
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																			●		●	●									
	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																		●						●							
	Geartain 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						●																								●	

Operator Manual

Our energy working for you.™

Power Generation

PowerCommand® 3.3 Control

English – Original Instructions

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