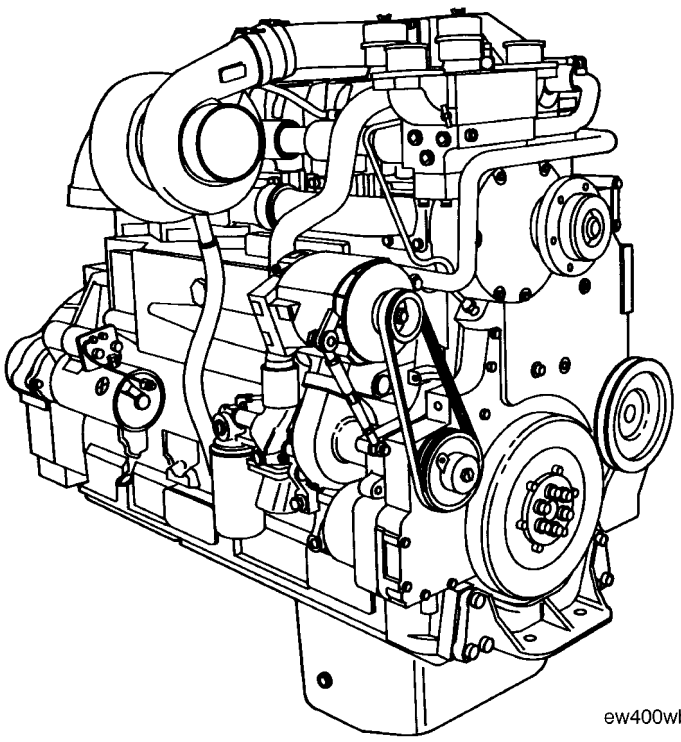
Troubleshooting and Repair Manual K19 Engines



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NOTES

Foreword

T This manual provides instructions for troubleshooting and repairing the K19 Engine in the chassis. Component and assembly rebuild procedure are provided in the K19 Engine Shop Manual.

The manual is organized to guide a service technician through the logical steps of identifying and correcting problems related to the engine.

This manual does not cover vehicle or equipment problems. Consult the vehicle or equipment manufacturer for repair procedures.

A series of specific service manuals (Shop, Specifications, Alternative Repair, and so on.) are available and can be ordered by filling out and mailing the Literature Order Form located in the Service Literature Section 14.

The repair procedures used in this manual are recommended by Cummins Engine Co., Inc. Some service procedures require the use of special service tools. Use the correct tools as described.

Reporting of errors, omissions, and recommendations for improving this publication by the user is encouraged. Please use the postage paid, self addressed Literature Survey Form in the back of this manual for communicating your comments.

The specifications and rebuild information in this manual is based on the information in effect at the time of printing. Cummins Engine Company, Inc. reserves the right to make any changes at any time without obligation. If differences are found between your engine and the information in this manual, contact a Cummins Authorized Repair Location, A Cummins Division Office, or the factory

The latest technology and the highest quality components were used to produce this engine. When replacement parts are needed, we recommend using only genuine Cummins or ReCon® exchange parts. These parts can be identified by the following trademarks:

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Section i - Introduction

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About the Manual

This Troubleshooting and Repair Manual is intended to aid in determining the cause of engine-related problems and to provide recommended repair procedures. The manual is divided into sections. Some sections contain reference numbers and procedure numbers. The reference numbers provide general information, specifications, diagrams, and service tools, where applicable. The procedure numbers describe specific repair procedures and are referred to in the Troubleshooting Logic Charts.

How to Use the Manual

The manual is organized to provide an easy flow from problem identification to problem correction. A list of troubleshooting symptoms containing the most common engine problems is on Page T-2 in the Troubleshooting Section. Complete the following steps to locate and correct the problem:

(STEP 1.) Locate the symptom on the list.

Reference is made to the page number where the″Troubleshooting Logic Chart″ is found.

(STEP 2.) The left column of the ″Troubleshooting Logic Chart″ indicates a probable cause, starting at the top with the simplest and easiest to repair or most likely to occur, and continuing downward to the most difficult and least likely to occur.

The right column provides a brief description of the corrective action with a procedure number or bulletin number reference for the repair procedure.

(STEP 3.) Locate the probable cause in the left column, and then turn to the procedure referenced in the right column or consult the bulletin number specificed.

The repair procedures are listed by system (cooling, lubricating oil, combustion air, compressed air, fuel, electrical, and base engine components).

(STEP 4.) The Troubleshooting Logic Charts are based on the following assumptions:

1. The engine has been installed according to the manufacturer's specifications.
2. The easiest repairs are done first.
3. ″Generic″ solutions to cover problems with the most common applications and OEM's (Original Equipment Manufacturer).

Symbols

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

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

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

Indicates a **REMOVAL or DISASSEMBLY** step.

Indicates an **INSTALLATION or ASSEMBLY** step.

INSPECTION is required.

CLEAN the part or assembly.

PERFORM a mechanical or time **MEASUREMENT**.

LUBRICATE the part or assembly.

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

TIGHTEN to a specific torque.

PERFORM an electrical **MEASUREMENT**.

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

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

Simbolos

Los símbolos siguientes son usados en este manual para clarificar el proceso de las instrucciones. Cuando aparece uno de estos símbolos, su significado se especifica en la parte inferior.

ADVERTENCIA - Serios daños personales o daño a la propiedad puede resultar si las instrucciones de Advertencia **no** se consideran.

PRECAUCION - Daños menores pueden resultar, o de piezas del conjunto o el motor puede averiarse si las instrucciones de Precaución **no** se siguen.

Indica un paso de **REMOCION** o **DESMONTAJE.**

Indica un paso de **INSTALACION** o **MONTAJE.**

Se requiere **INSPECCION.**

LIMPIESE la pieza o el montaje.

EJECUTESE una **MEDICION** mecánica o del tiempo.

LUBRIQUESE la pieza o el montaje.

Indica que se dará una **LLAVE DE TUERCAS** o el **TAMAÑO DE HERRAMIENTA.**

APRIETESE hasta un par torsor específico.

EJECUTESE una **MEDICION** eléctrica.

Para información adicional refiérase a otro emplazamiento de este manual o a otra publicación anterior.

El componente pesa 23 kg [50 lb] o mas. Para evitar dano corporal empleen una cabria u obtengan ayuda para elevar el componente.

Symbole

In diesem Handbuch werden die folgenden Symbole verwendet, die wesentliche Funktionen hervorheben. Die Symbole haben folgende Bedeutung:

WARNUNG - Wird die Warnung **nicht** beachtet, dann besteht erhöhte Unfall- und Beschädigungsgefahr.

VORSICHT - Werden die Vorsichtsmassnahmen **nicht** beachtet, dann besteht Unfall- und Beschädigungsgefahr.

AUSBAU bzw. **ZERLEGEN.**

EINBAU bzw. **ZUSAMMENBAU.**

INSPEKTION erforderlich.

Teil oder Baugruppe **REINIGEN.**

DIMENSION - oder **ZEITMESSUNG.**

Teil oder Baugruppe **ÖLEN.**

WERKZEUGGRÖSSE wird angegeben.

ANZUG auf vorgeschriebenes Drehmoment erforderlich.

Elektrische **MESSUNG DURCHFÜHREN.**

Weitere Informationen an anderer Stelle bzw. in anderen Handbüchern.

Das teil weigt 23 kg [50 lb] oder mehr. Zur vermeidung von koerperverletzung winde benutzen oder hilfe beim heben des teils in anspruch nehmen.

Symboles

Les symboles suivants sont utilisés dans ce manuel pour aider à communiquer le but des instructions. Quand l'un de ces symboles apparaît, il évoque le sens défini ci-dessous:

AVERTISSEMENT - De graves lésions corporelles ou des dommages matériels considérables peuvent survenir si les instructions données sous les rubriques ″Avertissement″ **ne** sont **pas** suivies.

ATTENTION - De petites lésions corporelles peuvent survenir, ou bien une pièce, un ensemble ou le moteur peuvent être endommagés si les instructions données sous les rubriques ″Attention″ **ne** sont **pas** suivies.

Indique une opération de **DEPOSE.**

Indique une opération de **MONTAGE.**

L'INSPECTION est nécessaire.

NETTOYER la pièce ou l'ensemble.

EFFECTUER une **MESURE** mécanique ou de temps.

GRAISSER la pièce ou l'ensemble.

Indique qu'une **DIMENSION DE CLE** ou **D'OUTIL** sera donnée.

SERRER à un couple spécifique.

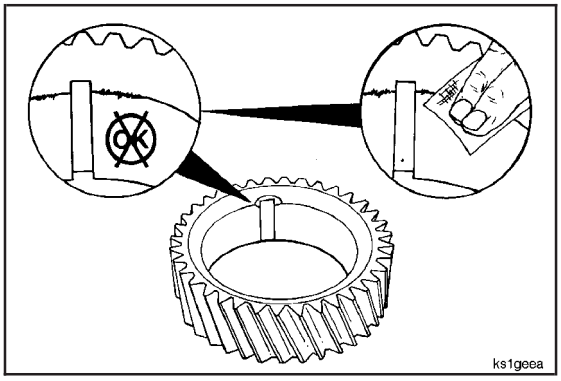
EFFECTUER une **MESURE** électrique.

Se reporter à un autre endroit dans ce manuel ou à une autre publication pour obtenir des informations plus complètes.

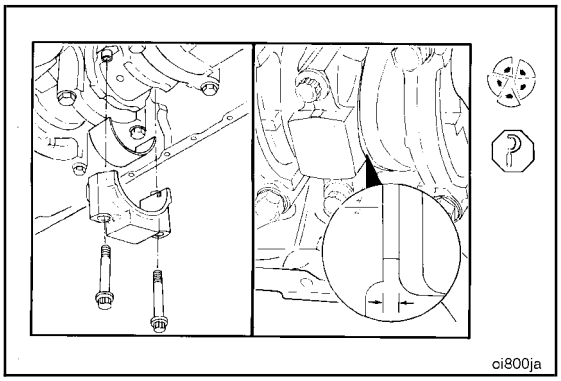
Le composant pese 23 kg [50 lb] ou davantage. Pour eviter toute blessure, employer un appariel de levage ou demander de l'aide pour le soulever.

Illustrations

The illustrations used in the ″Repair Sections″ of this manual are intended to give an example of a problem and to show what to look for and where the problem can be found. Some of the illustrations are ″generic″ and might **not** look exactly like the engine or parts used in your application. The illustrations may contain symbols to indicate an action required and an acceptable or **not** acceptable condition.



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



General Safety Instructions

Important Safety Notice

WARNING

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

- Make sure the work area surrounding the product 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 crankshaft. 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 you slowly loosen the filler cap and relieve the pressure from the cooling system.
- Do **not** work on anything that is supported ONLY by lifting jacks or a hoist. **Always** use blocks or proper stands to support the product before performing any service work.
- Relieve all pressure in the air, oil, and the 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 prevent 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 capture and recycling refrigerant.
- To avoid 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 contains alkali. Do **not** get the substance in your 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 avoid burns, be alert for hot parts on products that have just been turned OFF, and hot fluids in lines, tubes, and compartments.
- **Always** use tools that are in good condition. Make sure you understand how to use them 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 lessor quality if replacements are necessary.
- Do **not** perform any repair when fatigued or after consuming alcohol or drugs that can impair your functioning.

General Repair Instructions

This engine incorporates the latest diesel technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

- **Cummins Engine Company, Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety-related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:**

  Air Compressor
  Air Controls
  Air Shutoff Assemblies
  Balance Weights
  Cooling Fan
  Fan Hub Assembly
  Fan Mounting Bracket(s)
  Fan Mounting Capscrews
  Fan Hub Spindle
  Flywheel
  Flywheel Crankshaft Adapter
  Flywheel Mounting Capscrews
  Fuel Shutoff Assemblies
  Fuel Supply Tubes
  Lifting Brackets
  Throttle Controls
  Turbocharger Compressor Casing
  Turbocharger Oil Drain Line(s)
  Turbocharger Oil Supply Line(s)
  Turbocharger Turbine Casing
  Vibration Damper Mounting Capscrews

- **Follow All Safety Instructions Noted in the Procedures.**
  - Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, injestion and contact with such substances. **Always** use good safety practices with tools and equipment.
- **Provide A Clean Environment and Follow the Cleaning Instructions Specified in the Procedures**
  - The engine and its components **must** be kept clean during any repair. Contamination of the engine or components will cause premature wear.
- **Perform the Inspections Specified in the Procedures.**
- **Replace all Components or Assemblies Which are Damaged or Worn Beyond the Specifications**
- **Use Genuine Cummins New or ReCon® Service Parts and Assemblies**
  - The assembly instructions have been written to use again as many components and assemblies as possible. When it is necessary to replace a component or assembly, the procedure is based on the use of new Cummins or Cummins ReCon® components. All of the repair services described in this manual are available from all Cummins Distributors and most Dealer locations.
- **Follow The Specified Disassembly and Assembly Procedures to Avoid Damage to the Components.**

Complete rebuild instructions are available in the shop manual which can be ordered or purchased from a Cummins Authorized Repair Location. Refer to Section 14, Literature, for ordering instructions.

General Cleaning Instructions

Solvent and Acid Cleaning

Several solvent and acid-type cleaners can be used to clean the engine parts. **Cummins Engine Company, Inc. does not recommend any specific cleaners. Always** follow the cleaner manufacturer's instructions.

Experience has shown that the best results can be obtained using a cleaner that can be heated to 90 to 95 degrees Celsius [180 to 200 degrees Fahrenheit]. A cleaning tank that provides a constant mixing and filtering of the cleaning solution will give the best results.

Remove all the gasket material, o-rings, and the deposits of sludge, carbon, etc., with a wire brush or scraper before putting the parts in a cleaning tank. Be careful **not** to damage any gasket surfaces. When possible, steam clean the parts before putting them in the cleaning tank.

Warning: Acid is extremely dangerous, and can damage the machinery. Always provide a tank of strong soda water as a neutralizing agent.

Rinse all of the parts in hot water after cleaning. Dry completely with compressed air. Blow the rinse water from all of the capscrew holes and the oil drillings.

If the parts are **not** to be used immediately after cleaning, dip them in a suitable rustproofing compound. The rustproofing compound **must** be removed from the parts before installation on the engine.

Steam Cleaning

Steam cleaning can be used to remove all types of dirt that can contaminate the cleaning tank. It is a good way to clean the oil drillings.

Warning: Wear protective clothing to prevent personal injury from the high pressure and extreme heat.

Do **not** steam clean the following parts:

1. Electrical Components
2. Wiring
3. Injectors
4. Fuel Pump
5. Belts and Hoses
6. Bearings

Glass or Plastic Bead Cleaning

Glass or plastic bead cleaning can be used on many engine components to remove carbon deposits. The cleaning process is controlled by the size of the glass or plastic beads, the operating pressure, and the cleaning time.

Caution: Do not use glass or plastic bead cleaning on aluminum piston skirts. Do not use glass bead cleaning on aluminum ring grooves. Small particles of glass or plastic will embed in the aluminum and result in premature wear. Valves, turbocharger shafts, etc., can also be damaged. Follow the cleaning directions listed in the procedures.

NOTE: Plastic bead blasting media, Part No. 3822735, can be used to clean aluminum ring grooves. Do **not** use any bead blasting media on pin bores or aluminum skirts.

Follow the equipment manufacturer's cleaning instructions. The following guidelines can be used to adapt to manufacturer's instructions:

1. Bead size:
   - Use U.S. size No. 16-20 for piston cleaning with plastic bead media, Part No. 3822735.
   - Use U.S. size No. 70 for piston domes with glass media.
   - Use U.S. size No. 60 for general purpose cleaning with glass media.
2. Operating Pressure:
   - Glass: Use 620 kPa [90 psi] for general purpose cleaning.
   - Plastic: Use 270 kPa [40 psi] for piston cleaning.
3. Steam clean or wash the parts with solvent to remove all of the foreign material and glass or plastic beads after cleaning. Rinse with hot water. Dry with compressed air.
4. Do **not** contaminate the wash tanks with glass or plastic beads.

Definition Of Terms

A.C.:	Alternating Current
ACT Harness:	The wiring harness used to connect the actuators to the ECM
Alligator Clip:	An electrical test clip attached to the end of a wire
API:	American Petroleum Institute
ASA:	Air Signal Attenuator
ASTM:	American Society of Testing and Materials
ATDC:	After Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is moving downward on the power stroke or intake stroke.
BDC:	Bottom Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is at its lowest position in the cylinder.
BTDC:	Before Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is moving upward on the power stroke or exhaust stroke.
C:	Celsius
CAC:	Charge Air Cooler
CARB:	California Air Resources Board
CELECT™:	A fuel control system that electronically controls the fuel injection to improve fuel economy and to reduce the exhaust emissions. The system does this by controlling the torque and horsepower curve, AFC (smoke) function, engine high speed, engine low idle speed and the road speed. The CELECT™ system also can control fan clutch operation, engine brake enabling and turbocharger wastegating. Additional electronic features include cruise control, PTO, gear down protection, progressive shifting, automotive or VS governor and idle shutoff.
C.I.D.:	Cubic Inch Displacement
Circumferential Direction:	In the direction of a circle in respect to the centerline of a round part or a bore.
Cm:	Centimeter
Compulink™:	A Cummins service tool used for electronic system analysis and to reprogram the system
Concentricity:	A measurement of the **difference** between the centers of **either** two or more parts, **or** the bores in one part.
CPL:	Control Parts List; this listing identifies the specific parts that **must** be installed on the engine to meet agency certification.
cSt:	Centistokes
Cummins Sealant:	This is a one part Room Temperature Vulcanizing (RTV) silicone rubber, adhesive and sealant material having **high** heat and oil resistance, and **low** compression set. Some of the equivalent products are Marston Lubricants, Hylosil, Dow Corning, Silastic 732, Loctite Superflex, General Electric 1473, and General Electric 1470.
DCA:	Diesel Coolant Additive

D.C.:	Direct Current
Deutsch Connector:	An electrical connector
Dye Penetrant Method:	A method used to check for cracks in a part by using a dye penetrant and a developer. Use Part No. 3375432 Crack Detection Kit, or equivalent.
End Clearance:	The clearance in an assembly determined by pushing the shaft in an axial direction **one way,** and then pushing the shaft the **other way.**
Echek™	A Cummins hand held service tool used for electronic system analysis, adjusting features and programmable parameters.
ECM:	Electronic Control Module.
E.C.S.:	Emission Control System
EPA:	Environmental Protection Agency
EPS:	Engine Position Sensor
E.S.N.:	Engine Serial Number
ESS:	Engine Speed Sensor
F:	Fahrenheit
ft-lb:	Foot Pound
GVW:	Gross Vehicle Weight
Hammer:	A hand tool consisting of a hard steel head on a handle.
Hg:	Mercury
HP:	Horsepower
H_20:	Water
ID:	Inside Diameter
in-lb:	Inch Pound
kg:	Kilograms
km:	Kilometers
km/l:	Kilometers per Liter
kPa:	Kilopascal
l:	Liter
Loctite 290:	A single component, anaerobic, polyester resin, liquid sealant compound that hardens between closely fitted metal surfaces producing a tough, hard bond with good characteristics. An equivalent product is Perma-Lok HL 126.
Loctite 609:	A single component anaerobic, liquid adhesive that meets or exceeds the requirements of MIL-R-46082A (MR) TYPE 1. Some of the equivalent products are Loctite 601 and Permabond HL 138.
Lubriplate 105:	A mineral oil base grease with calcium soap (2 percent to 6 percent), and zinc oxide (2 percent to 4 percent) additives.
m:	Meter
Magnetic Particle Inspection:	A method of checking for cracks in **either** steel **or** iron parts. This method requires a Magnaflux machine, or an equivalent machine that imparts a magnetic field on the part being checked.

Mallet:	A hand tool consisting of a soft head; **either** wood, plastic, lead, brass, **or** rawhide on a handle.
MAX:	Maximum allowed
MIN:	Minimum allowed
Mini-Gen:	Speed Sensor
mm:	Millimeter
MPa:	Megapascal
MPH:	Miles Per Hour
MPQ:	Miles Per Quart
N•m:	Newton-meter
No.:	Number
OD:	Outside Diameter
OEM:	Original Equipment Manufacturer
OEM Harness:	The wiring harness used to connect the ECM to the vehicle
OS:	Oversize
ppm:	Parts Per Million
Protrusion:	The **difference** in the height between two parts in the assembled state.
psi:	Pounds Per Square Inch
PTO:	Power Takeoff
RPM:	Revolutions Per Minute
S.A.E:.	Society of Automotive Engineers
SEN Harness:	The wiring harness used to connect the engine system sensors to the ECM
STD:	Standard
TC:	Torque Converter; used when referring to the torque converter cooler.
TDC:	Top Dead Center; refers to the position of the piston or the crankshaft rod journal. The piston is at its highest position in the cylinder. The rod journal is pointing straight up toward the piston.
TIR:	Total Indicator Reading; used when measuring the concentricity or the run out. The TIR refers to the total movement of the needle on a dial indicator, from the most **negative** reading to the most **positive** reading.
VOM:	Volt Ohm Meter
VS:	Variable Speed
VSS:	Vehicle Speed Sensor

Water Pump Grease:

A premium high temperature grease that will lubricate antifriction bearings continually from **minus** 40 C [**minus** 40 F] to **plus** 150 C [**plus** 350 F].

Some of the greases meeting this requirement are Aeroshell No. 5, Chevron SRI, Amoco Rykon Premium No. 2, Texaco Premium RB, and Shell Dolium R.

Aeroshell No. 5 is **not** compatible with the other greases and **must not** be mixed. Cummins Engine Co., Inc., uses Aeroshell No. 5 on new engines and components.

Section E - Engine and Component Identification

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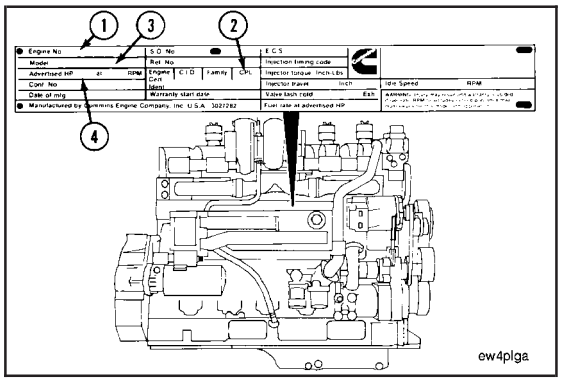
Engine Identification

Cummins Engine Nomenclature

The model name provides the following data:

K T T A 19

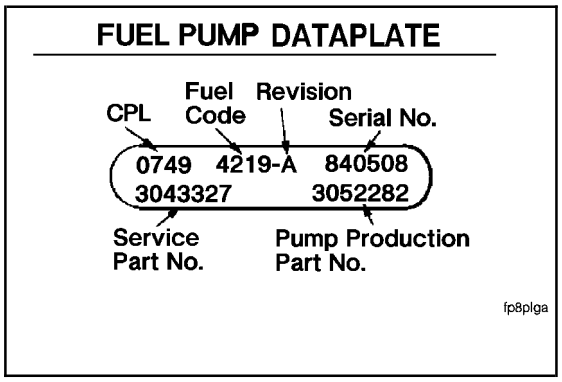
- 19 = Displacement in Litres
- A = Engine is Aftercooled
- T = Engine has Two Turbochargers
- T = Engine is Turbocharged
- K = Series (Family of Engines)



Engine Dataplate

The engine dataplate shows specific information about your engine. The engine serial number (E.S.N.) (1), Control Parts List (CPL) (2), Model (3), and Horsepower and RPM rating provide information for ordering parts and service needs.

NOTE: The engine dataplate **must not** be changed unless approved by Cummins Engine Company, Inc.



Fuel Pump Dataplate

The fuel pump dataplate is located on the top of the fuel pump. It provides information for fuel pump calibration.

General Specifications

Metric (U.S. Customary)

NOTE: Listed below are general specifications for this engine. Refer to each System Section for additional specifications.

Engine Speed ..... Refer to the engine dataplate for optional speed rating.

Displacement ..... 18.7 liters [1150 C.I.D.]

Bore and stroke ..... 158.75 mm x 158.75 mm [6.25 in x 6.25 in]

Engine Weight

- Dry ..... 1720 kg [3800 lb]
- Wet ..... 1800 Kg [3965 lb]

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

Valve and injector settings:

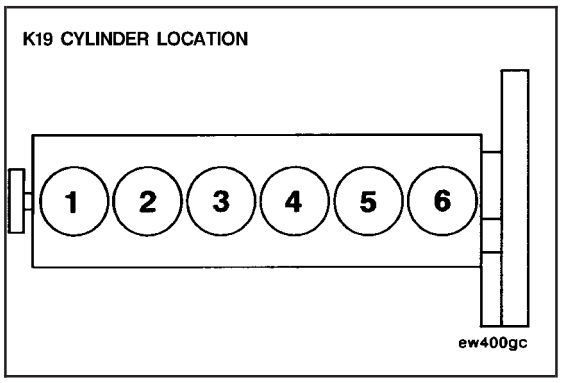
- Intake valve adjustment ..... 0.36 mm [0.014 in]
- Intake valve limits ..... 0.28 to 0.43 mm [0.011 to 0.017 in]
- Exhaust valve adjustment ..... 0.69 mm [0.027 in]
- Exhaust valve limits ..... 0.60 to 0.76 mm [0.024 to 0.030 in]
- PTD Non-Top Stop injector travel adjustment ..... 7.72 mm [0.304 in]
- PTD Non-Top Stop injector travel limits ..... 7.67 to 7.77 mm [0.302 to 0.306 in]
- HVT Non-Top Stop injector travel adjustment ..... 10.24 mm [0.403 in]
- HVT Non-Top Stop injector travel limits ..... 10.18 to 10.29 mm [0.401 to 0.405 in]
- STC Top Stop injector adjustment (in engine) ..... 0.6 to 0.7 N•m [5 to 6 in-lb]
- STC Top Stop injector recheck limits ..... 0.00 to 0.05 mm [0.000 to 0.002 in lash]
- STC Top Stop injector travel limit (total travel in engine) ..... 10.18 to 10.29 mm [0.401 to 0.405 in]
- Premium K STC injector adjustment (in engines) ..... 0.6 to 0.7 N•m [5 to 6 in-lb]
- Premium K STC injector re-check limits ..... 0.00 to 0.05 mm [0.000 to 0.002 in lash]
- Premium K STC injector travel limit (total travel in engines) ..... 12.47 to 12.57 mm [0.491 to 0.495 in]

Compression Ratio:

- KT 15.5:1
- KTA ..... 14.5:1 or 15.5:1
- KTA-C(700) 13.8:1
- KTTA 13.8:1

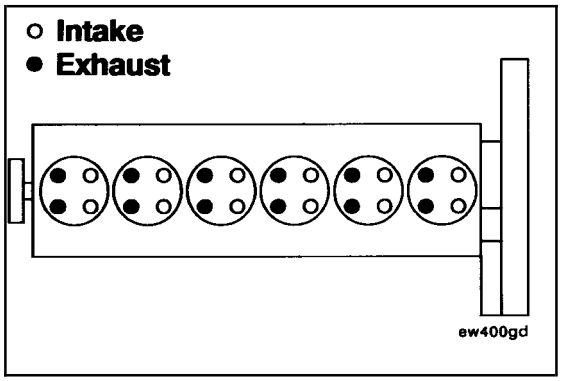
Crankshaft Rotation (viewed from the front of the engine) ..... Clockwise

General Engine Data



Cylinder location and Firing Order:

1-5-3-6-2-4



Intake and **Exhaust** Valve locations.

Air Induction System

Maximum Allowable Intake Restriction:

- With Clean Filter Element ..... 380 mm-H_2O [15 in-H_2O]
- With Dirty Filter Element ..... 635 mm-H_2O [25 in-H_2O]

Lubricating Oil System

Oil Pressure, Main Oil Rifle (15W40 oil at 107°C [225°F]):

- (Idle) RPM ..... 138 kPa to 483 kPa [20 psi to 75 psi]
- (Rated) RPM ..... 345 kPa to 517 kPa [50 psi to 75 psi]

Oil Temperature - Maximum ..... 120°C [250°F]

Oil Pan Capacity ..... Refer to Section 11

Cooling System

Coolant Capacity (Engine ONLY) ..... 30 Liters [32 U.S. Quarts]

Standard Thermostat Range ..... 80°C to 90°C [175°F to 195°F]

Coolant Pressure Cap (Minimum) ..... 50 kPa [7 psi]

Coolant Temperature
Minimum Top Tank ..... 70°C [160°F]
Maximum Top Tank ..... 95°C [203°F]

Exhaust System

Back Pressure - Maximum ..... 75 mm-Hg [3 in-Hg]

Exhaust Pipe Size (Normally Acceptable Inside Diameter)

- KTTA ..... 152 mm [6 inch]
- KTA ..... 127 mm [5 inch]
- KT ..... 127 mm [5 inch]

Fuel System

NOTE: For performance and fuel rate values, refer to the engine data sheet, or the fuel pump code for the particular model involved.

Maximum Allowable Restriction to Pump (at rated power):

- With Clean Filter ..... 100 mm Hg [4 in Hg]
- With Dirty Filter ..... 200 mm Hg [8 in Hg]

Maximum Allowable Return Line Restriction ..... 63 mm Hg [2.5 in Hg]

Maximum Allowable Return Line Restriction
with Check Valves and/or Overhead Tanks ..... 165 mm Hg [6.5 in Hg]

Electrical System

Minimum Recommended Battery Capacity

System Voltage	Ambient Temperatures			
	-18°C (0°F)		0°C (32°F)	
	Cold Cranking Amperes	Reserve Capacity* Amperes	Cold Cranking Amperes	Reserve Capacity* Amperes
12 Volt**	1800	640	1280	480
24 Volt***	900	320	640	240

* **Note:** The number of plates within a given battery size determines reserve capacity. Reserve capacity is the length of time sustained cranking can occur.

** **Note:** Not recommended for K19 Engines.

*** **Note:** CCA ratings are based on two, 12 volt batteries in series.

Batteries (Specific Gravity)

Battery State of Charge	Specific Gravity @ 27°C [80°F]
100%	1.260-1.280
75%	1.230-1.250
50%	1.200-1.220
25%	1.170-1.190
Discharged	1.110-1.130

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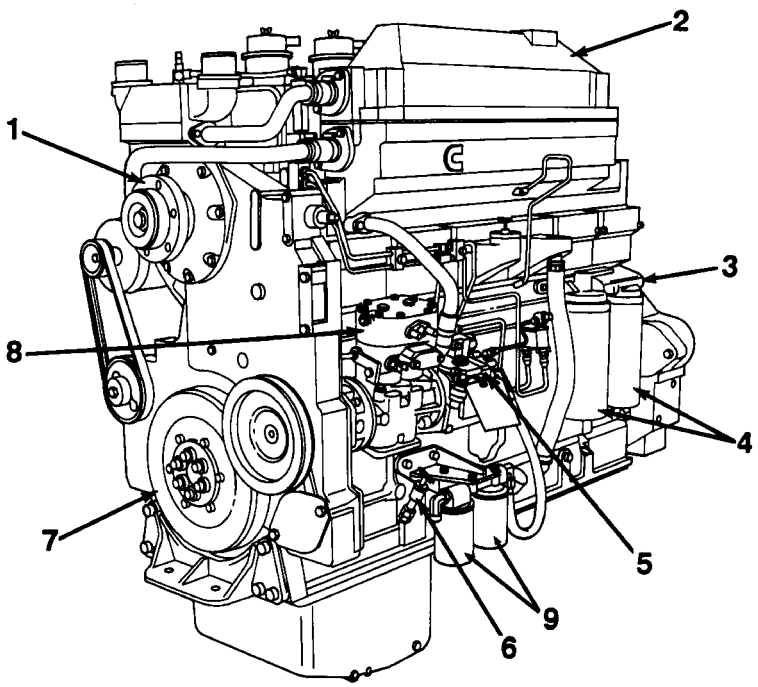
External Engine Components

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



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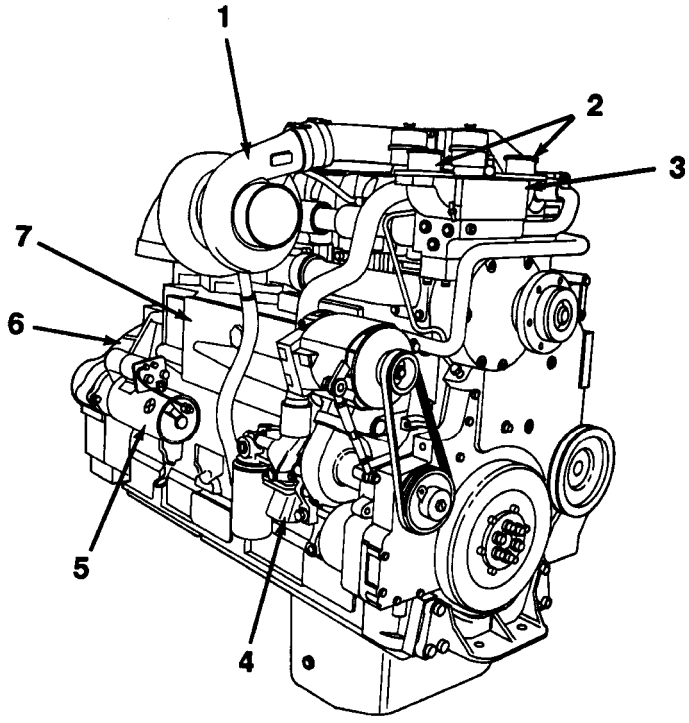
FUEL PUMP SIDE - KTA19

1. Fan Hub (Gear Driven Type)
2. Aftercooler Assembly
3. Bypass Oil Filter Supply
4. Full Flow - Oil Filters
5. Fuel Pump
6. Dipstick
7. Vibration Damper
8. Air Compressor
9. Fuel Filters



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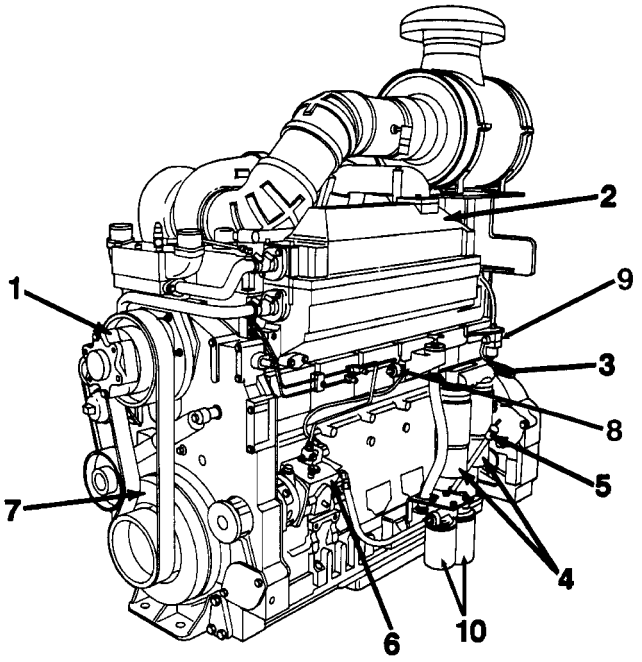
EXHAUST SIDE - KTA19

1. Turbocharger
2. Coolant Outlet
3. Thermostat Housing
4. Coolant Inlet
5. Starting Motor
6. Flywheel Housing
7. Engine Oil Cooler Assembly

FUEL PUMP SIDE - KTTA19

1. Fan Hub (Belt Driven)
2. Aftercooler Assembly
3. Bypass Oil Filter Supply
4. Full Flow - Oil Filters
5. Dipstick
6. Fuel Pump
7. Vibration Damper
8. STC Fuel Pressure Switch
9. STC Oil Control Valve
10. Fuel Filters



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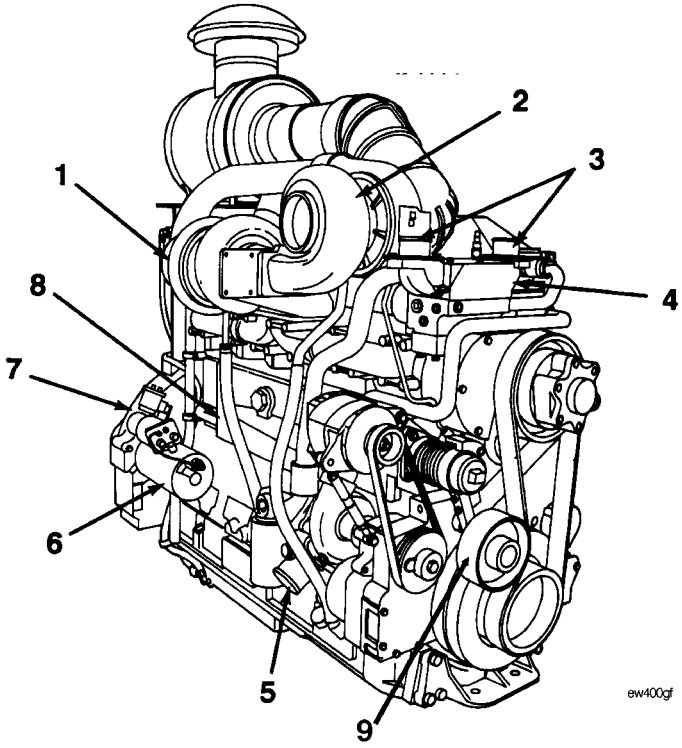
EXHAUST SIDE - KTTA19

1. Turbocharger (High Pressure)
2. Turbocharger (Low Pressure)
3. Coolant Outlet
4. Thermostat Housing
5. Coolant Inlet
6. Starting Motor
7. Flywheel Housing
8. Oil Cooler Assembly
9. Belt Tensioner



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Section T - Troubleshooting

Procedures and Techniques

A thorough analysis of the problem is the key to successful troubleshooting. The more information known about the problem, the faster and easier it can be solved.

The ″Troubleshooting Symptoms Charts″ beginning on page T-6 are organized so that a problem can be located and corrected by doing the easiest and most logical things first. Complete all steps in the sequence shown from top to bottom.

It is **not** possible to include all the possible solutions to problems that can occur; however, these charts should stimulate a thought process that will lead to the cause and correction of the problem.

Follow these basic troubleshooting steps:

- Get all the facts concerning the problem.
- Analyze the problem thoroughly.
- Relate the symptoms to the basic engine systems and components.
- Consider any recent maintenance or repair action that may relate to the problem.
- Double-check before beginning any disassembly.
- Solve the problem by using the logic charts and doing the easiest things first.
- Determine the cause of the problem and make a thorough repair.
- After repairs have been made, operate the engine to be sure the cause of the problem has been corrected.

For easy reference, an alphabetical listing of all the troubleshooting charts is printed on pages T-2 and T-3. A listing of the troubleshooting charts for each system is printed on pages T-4 and T-5.

Troubleshooting Charts

(Alphabetical Listing)

Page No.

1. Air Compressor Noise - Excessive T-31
2. Air Compressor Pumping Excessive Lubricating Oil T-28
3. Air Compressor Slow Air Pressure Rise T-26
4. Air Compressor Will Not Maintain Adequate Air Pressure But Not Pumping Continuously T-27
5. Air Compressor Will Not Pump T-29
6. Air Compressor Will Not Stop Pumping T-30
7. Alternator Malfunctioning T-60
8. Coolant in the Lubricating Oil T-21
9. Coolant Loss T-10
10. Coolant Temperature Above Normal T-6
11. Coolant Temperature Below Normal T-9
12. Crankcase Gases (Blowby) Excessive T-61
13. Engine Cranks But Will Not Start (No Exhaust Smoke) T-32
14. Engine Decelerates Poorly T-52
15. Engine Hard to Start or Will Not Start (Exhaust Smoke Present) T-34
16. Engine Noise Diagnostic Procedure T-63
17. Engine Noise Excessive T-64
18. Engine Power Output Low T-44
19. Engine Runs Rough or Misfires (Warm Engine) T-38
20. Engine Starts But Will Not Keep Running T-36
21. Engine Surges at High Idle T-54
22. Engine Surges at Low Idle T-42
23. Engine Surges Under Load T-43
24. Engine Vibration Excessive T-62
25. Engine Will Not Crank or Cranks Slowly (Air Starter) T-57
26. Engine Will Not Crank or Cranks Slowly (Electric Starter) T-58
27. Engine Will Not Reach Rated RPM When Loaded T-43
28. Engine Will Not Shut Off T-51
29. Exhaust Smoke Excessive Under Load T-50
30. Exhaust Smoke (White) at Idle Excessive (Warm Engine) T-66
31. Fuel Consumption Excessive T-56
32. Fuel in the Coolant T-12
33. Fuel in the Lubricating Oil T-22
34. Idle Rough T-40
35. Lubricating Oil Consumption Excessive T-18
36. Lubricating Oil Pressure High T-15
37. Lubricating Oil Pressure Low T-13

Troubleshooting Charts (Continued)

(Alphabetical Listing)

Page No.

38. Lubricating Oil Temperature Above Normal T-16
39. Lubricating Oil Sludge in the Engine Crankcase Excessive T-20
40. Lubricating or Hydraulic Oil in the Coolant T-17
41. Throttle Response Slow (Engine Dies Going Down Hill) T-55
42. Turbocharger Boost Pressure Low T-24
43. Turbocharger Leaks (Engine Oil or Fuel) T-25
44. Turbocharger Noise T-23