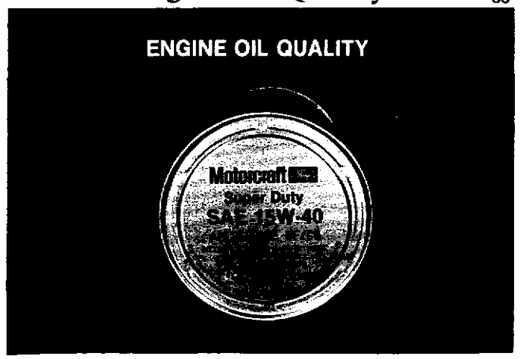
Engine Oil Quality

86

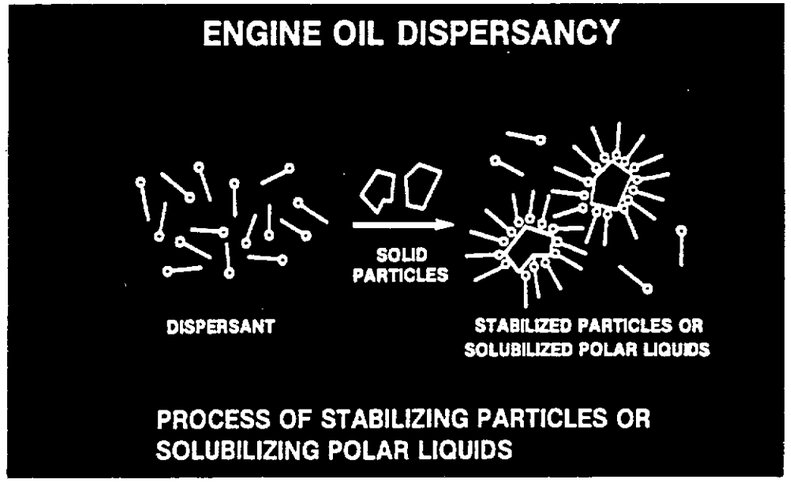


Choosing an engine oil of correct quality and proper viscosity and following recommended oil-change intervals are essential to good engine starting, performance and long-term durability.

Oil quality is most commonly described by API (American Petroleum Institute) engine service categories. Use oils meeting the API categories of both SF and CD (SF/CD). Do not use oils labeled as only SF or only CD, as they could cause piston ring sticking or excessive valve train wear.

Engine Oil Dispersancy

87



In all diesel engines, soot is formed as the fuel burns. Some of this soot gets past the piston rings into the oil. The ability of an engine oil to suspend this soot in fine particles and keep it from settling out as sludge, or clogging oil filters is called "dispersancy". This dispersancy ability for suspending soot varies among API SF/CD quality oils. Extensive laboratory and truck testing in 6.9 liter diesel engines indicates that oils with improved dispersancy also reduce the effect of soot buildup or the increase in the viscosity (thickness) of the used oil. Thus, during cold starting, engine cranking and oil flow to the bearings are improved. In addition, oils with improved dispersancy tend to reduce engine wear.

The dispersant in the lube oil additive package is polar (+/-) in structure, and in any polar system, likes (+/+, -/-) repel each other. The polar head of the dispersant has an affinity for the solid particles (soot) and therefore surrounds them as is illustrated. Because the solid particles (soot) are now surrounded by the head of the dispersant and the dispersant is polar in structure, the soot particles become suspended and separated in the oil and cannot coagulate (combine) and form sludge.

To obtain maximum engine life, and improve cold starting, use oils meeting both API categories SF/CD. Ford's Motorcraft Super Duty 15W40 SF/CD engine oil (green can) is an excellent product and meets the lubricating requirements of the 6.9L diesel, including some very beneficial qualities not yet covered by API classification.

Verify Engine Oil for Recommended Classification

88

Experience has shown that using quality oils meeting SF/CD classification has a positive impact on reducing oil breakdown and providing acceptable oil consumption.

Tests have revealed that engine oils meeting the SF/CD specifications consistently demonstrate the superior ability to control wear metals, viscosity changes and soot levels all of which affect oil consumption and engine life.

Motorcraft Super Duty 15W40 SF/CD (green can) meets these specifications and is highly recommended for use in the 6.9L diesel.

Recommended Method of Checking Engine Oil Level

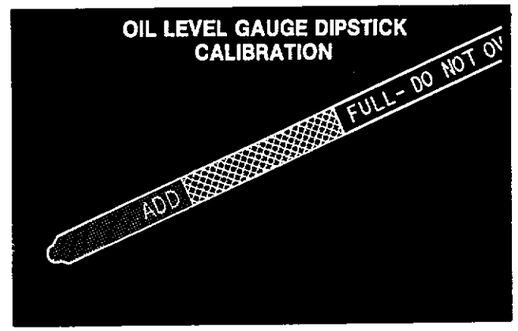
89

In order to measure engine oil levels consistently and accurately it is useful to employ the following recommendations:

- Park vehicle on level surface: Low oil level readings will be obtained if the vehicle is sloped away from the dipstick.
- Have engine at normal operating temperature as oil expands at the rate of one percent per 25°F (14°C) change and coincides with the dipstick calibration. In addition, allow a fifteen (15) minute engine shutdown period to assure that oil contained in the upper parts of the engine has returned to the oil pan.
- Have dipstick loop directed inboard as this eases installation and minimizes wiping action on oil level gauge.
- Read oil level on both sides of gauge and use highest level (reading) for the actual engine oil level.

Oil Level Gauge Dipstick Calibration

90



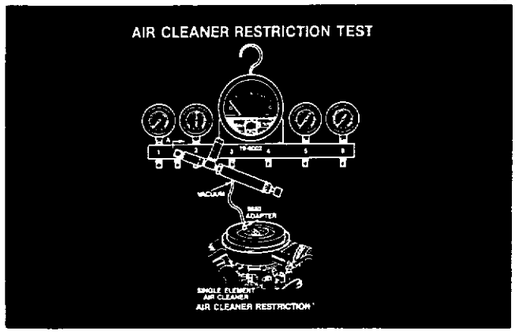
Correct oil level gauge calibration can be verified by draining the engine oil and filling the engine/oil pan with nine (9) quarts (8.5 liters) of oil. Assuming that the oil level gauge is properly seated, correct oil level gauge calibration is indicated if the oil level is within 1/16 inch of the "full" mark.

Oil filter change is not required to verify dipstick calibration but is a recommended service policy when changing oil and is required for the 2000 mile (3200 kilometer) oil consumption verification program that is addressed as one of the steps in this section.

If the oil filter is changed, remember to add the additional quart of oil required for the filter after the oil level gauge calibration check is made.

Air Cleaner Restriction Test

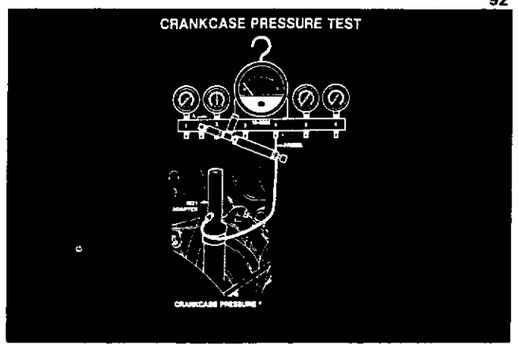
91



Measure air cleaner restriction to assure that it does not exceed 25" H_2O. Excessive restriction can cause an increase in oil consumption.

Crankcase Pressure Test

92



Crankcase pressure measurement is an indicator of power cylinder condition, i.e., rings, piston, cylinder wall.

If crankcase pressure reading exceeds 6" H_2O the power cylinders should be inspected.

The 2000 Mile Oil Consumption Verification Program

93

Initiate the 2000 (3200 kilometers) Mile Oil Consumption Verification Program as described in TSB 85-7-16.

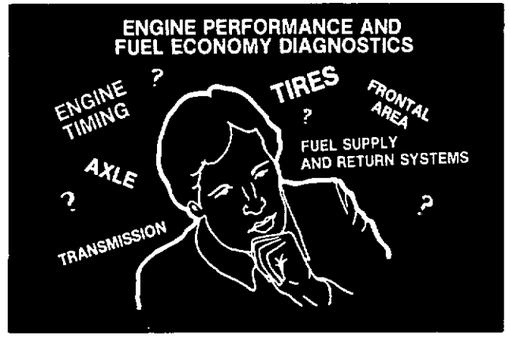
- Owner continues to monitor engine oil level daily per recommended method. If makeup oil is required, condition should be verified by the dealer. Do not add oil unless oil level is at or below the add mark.
- If engine oil consumption is not within the acceptable guidelines, inspect for proper installation of valve stem oil shields and seals and correct as required. Refer to TSB 84-19-20 and/or Light Truck Shop Manual (B).
- If repair is made, re-perform the 2000 mile verification test.
- If oil consumption problem persists, engine teardown and inspection is necessary.

NOTE

Engine teardown is not recommended prior to 7500 miles (12,000 kilometers) if oil consumption is marginal as the piston rings may seat and oil consumption could then become acceptable.

Engine Performance and Fuel Economy Diagnostics

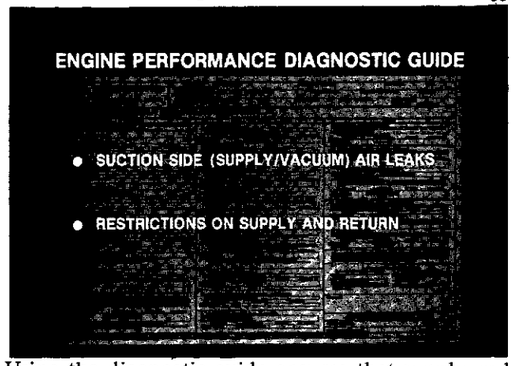
94



Diagnosing performance and fuel economy varies from vehicle to vehicle. Therefore, a brief program has been put together to aid in determining acceptable performance and/or economy on a given vehicle so that a thorough and correct analysis is conducted.

Engine Performance Diagnostic Guide

95



Using the diagnostic guide ensures that supply and return systems are functioning correctly so that engine performance can be properly assessed. The areas of major concern are:

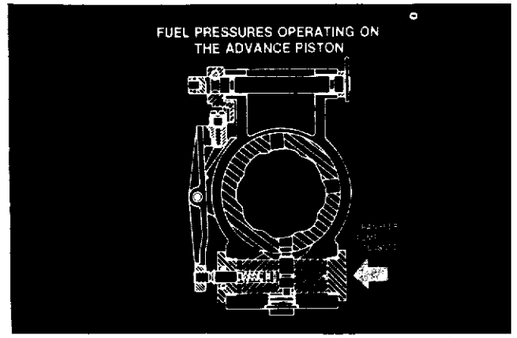
- SUCTION SIDE (SUPPLY/VACUUM) AIR LEAKS
- RESTRICTIONS ON SUPPLY AND RETURN

Suction side air leaks and restrictions in the fuel supply and return affect injection timing and can result in deterioration of engine performance that could gradually progress to a significant loss of power and economy and excessive smoke.

Timing changes due to restrictions of the supply and return systems can be better understood by reviewing the advance operation of the injection pump.

Fuel Pressures Operating on the Advance Piston

96



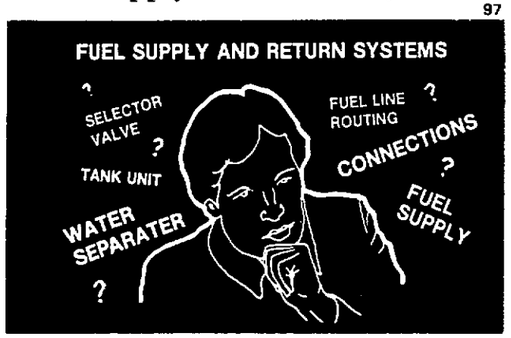
As can be seen in the illustration, basically two pressures are acting on the advance piston. Transfer pump pressure promotes advance piston movement and housing pressure opposes piston movement.

A restricted fuel return line increases housing pressure, and adversely affects engine performance. Higher fuel return pressures (greater than 1 psi), increase injection pump housing pressure which is opposing advance piston movement. This causes retarded injection pump timing, loss of performance and excessive smoke.

In addition, a fuel supply line to the engine that is restricted will have the same adverse affect on engine performance as above. Restricted fuel supply lowers transfer pump pressure which limits advance piston movement and retards injection pump timing. In addition, a restricted supply line causes fuel starvation the same as a restricted fuel filter.

Fuel Supply and Return System

97



As is apparent from the previous discussion, correct operation of the fuel supply and return systems is vital in obtaining optimum engine performance.

The following areas can cause air leakage or restrictions that limit engine performance.

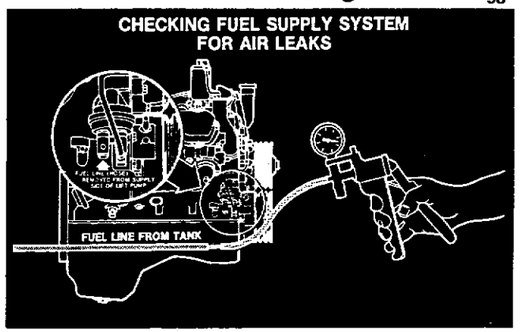
- All fuel line routings and connections.
  Check all connections for tightness and sealing condition to ensure that air leakage (suction side) is not occurring. All hose routings should be traced to determine if any restrictions exist either on the supply or return.

- Water separator.
  Typically results in a suction side air leak. However, in severe cold if water is contained in the separator it could freeze and cause a restriction to the fuel supply.
- Fuel tank selector valve.
  The selector valve can cause a restriction to the fuel supply and/or return. It also can result in a running out of fuel condition if the valve (controlled electrically) does not switch when the instrument panel switch is changed. The fuel gauge (instrument panel) will read the fuel level of the tank that the dash fuel tank selector switch is positioned at. When, because the selector valve did not change, the fuel level of the tank being drawn from is empty, the engine runs out of fuel and quits.

- Fuel gauge sending unit.
  The sending unit can pull air through the check-ball bypass. This was improved in Model Year 1985 and is thoroughly discussed and illustrated on page 5 in the "Improvements" section of this update.

Checking Fuel Supply System for Air Leakage

98



To determine if suction side leak exists, remove supply line (hose) from mechanical lift pump and apply 3" vacuum to the removed hose and vacuum decay should not occur. If vacuum does not hold, a suction side air leak exists and repair is required.

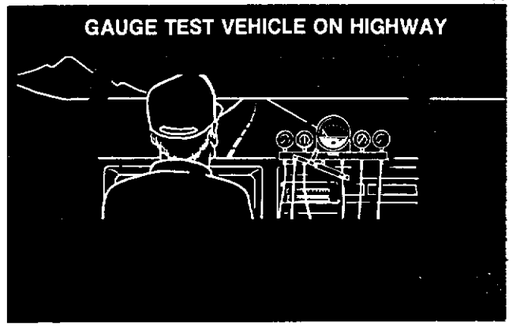
Vehicle Performance Tests

99

The following tests may have to be performed on the vehicle when diagnosing engine/vehicle performance.

Gauge Test Vehicle on Highway

100



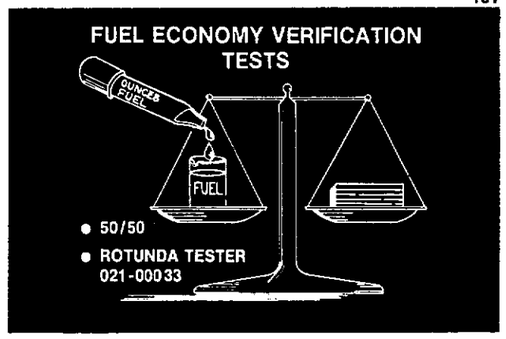
Operating vehicle on highway with gauge bar instrumentation in cab would primarily be used when a stalling or severe loss of power is experienced when operating the vehicle at highway speeds and in-shop diagnostics do not indicate a problem.

NOTE

Care must be exercised during any test of this type to ensure safe vehicle operation. It is recommended that two people perform this test: one to operate the vehicle and one to observe the gauges and record data.

Fuel Economy Verification Tests

101



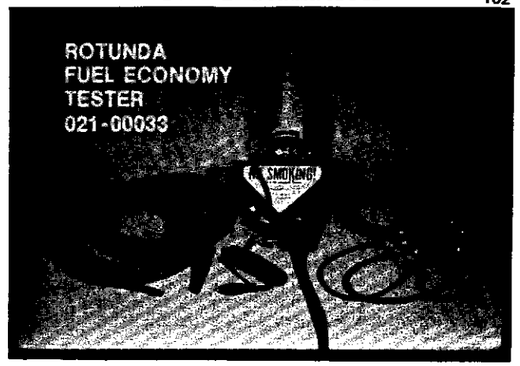
50/50 Economy Test

This test requires topping off a fuel tank and road testing vehicle fifty (50) miles (80 kilometers) out and return back the same fifty (50) miles (80 kilometers). Re-fuel (top off) fuel tank and calculate fuel economy.

Application and chassis differences which are discussed under "Performance Evaluation" affect fuel economy and guidelines for different chassis configurations may be obtained by contacting your Field Representative.

Rotunda Fuel Economy Tester 021-00033 Tester Installation

102



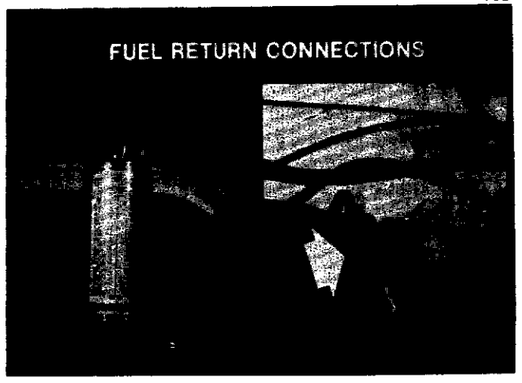
Rotunda Tester 021-00033 was released for fuel injected gasoline engines and can be utilized on the 6.9L diesel by performing the following:

NOTE

Routing of all test hoses through the grill will facilitate the installation and the road test.

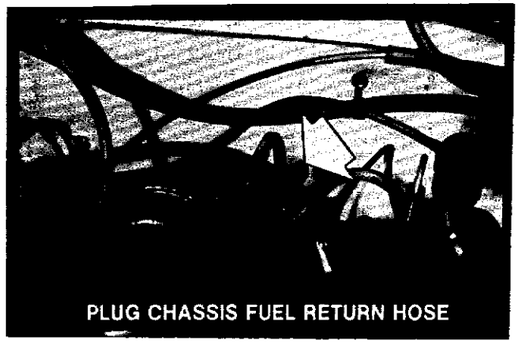
1. Remove air cleaner.

103



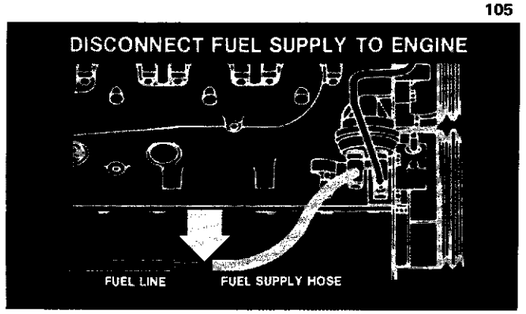
2. Using spare test hose (3/8" ID x 15' length) provided with tester, connect tester tap marked "return" (top of tester canister) to engine fuel return line. Engine fuel return line is located at the left (driver's side) rear of engine inboard of the glow plug controller.

104



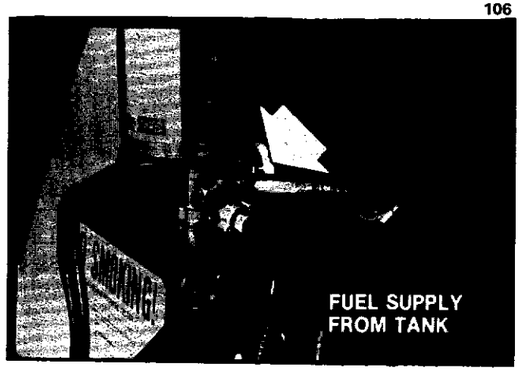
3. Plug chassis fuel return hose (disconnected in Step 2) to prevent dust and debris from entering.

105



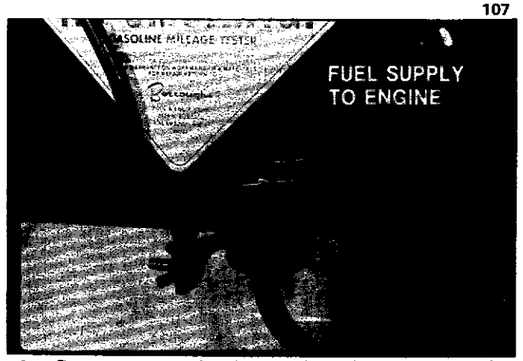
4. Remove chassis fuel supply hose to mechanical lift pump at the steel fuel line just downstream of the mechanical lift pump. Installing a Vice Grip on the hose prior to removal prevents filter draining.

106



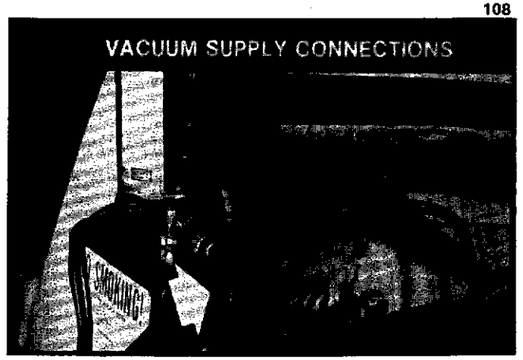
5. Using 2nd spare test hose (3/8" ID x 15' length) provided w/tester connect tester tap marked "tank" to chassis fuel supply line coming from tank removed in Step 4.

107



6. Connect supply hose that is permanently attached to tester to supply side (inlet) of mechanical lift pump removed in Step 4.

108



7. Connect spare test length of vacuum hose provided with tester between tap marked "vacuum" on tester to any accessible vehicle vacuum source.

8. Install air cleaner.

9. Prime system and start vehicle per tester instructions.

10. Bleed system by pressing in on air bleed (Schrader valve) on fuel filter header and check connections for leaks.

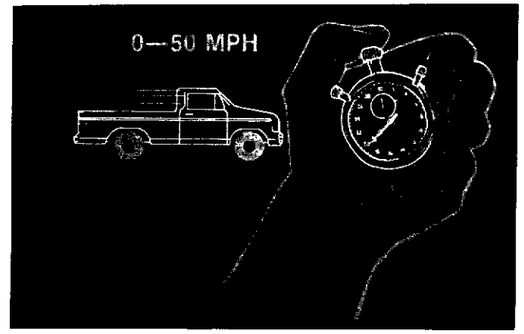
11. Road test vehicle calculating fuel economy per tester instructions.

CAUTION

Because of the large volume of returned fuel on diesel engines it will be necessary to operate the tester in "test" position more often to prevent tester overfill.

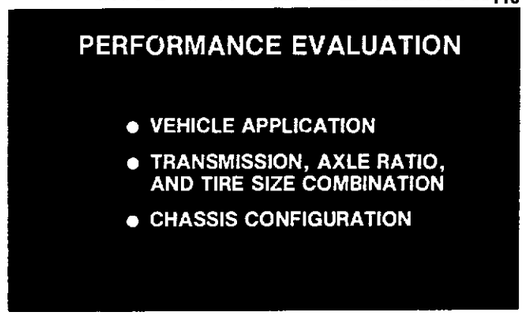
Time Vehicle From Zero to 50 MPH

109



Zero to 50 MPH (80 km/h) time is an indicator of performance and definitve acceleration times accounting for chassis differences may be obtained by contacting your Field Representative.

Vehicle Performance Evaluation 110



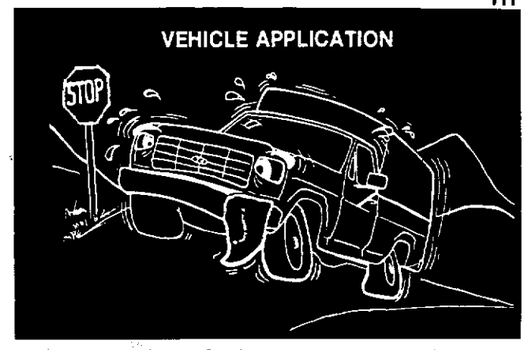
To properly diagnose a performance or economy complaint, the following need to be considered as a concern may not exist when the entire vehicle is considered.

- Vehicle application
- Transmission, axle ratio and tire size
- Chassis configuration

Each of these areas will now be discussed individually.

Vehicle Application

111



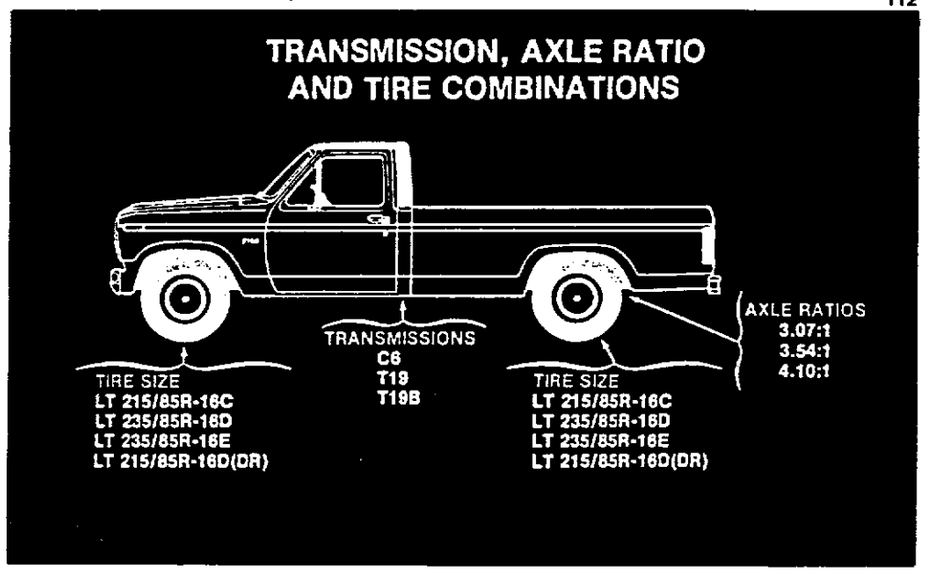
An understanding of vehicle operating conditions is essential to evaluating performance and economy, and more specifically, what is acceptable/normal performance for a given unit. Operating conditions the technician should consider are:

- Is unit operating with severe loads (upper end of GVW or GCW range)?
- Does unit operate primarily in city stop and go traffic?
- Does unit have extended idling time?
- Is unit operated at above maximum legal highway speed limits?
- Is the unit operated in mountainous regions and complaint is centered around hill/mountain climbing?

While 6.9L powered units do operate in these conditions, the acceptable/normal performance and economy would be different from a unit operating in a less demanding application.

Transmission, Axle Ratio and Tire Combination

112

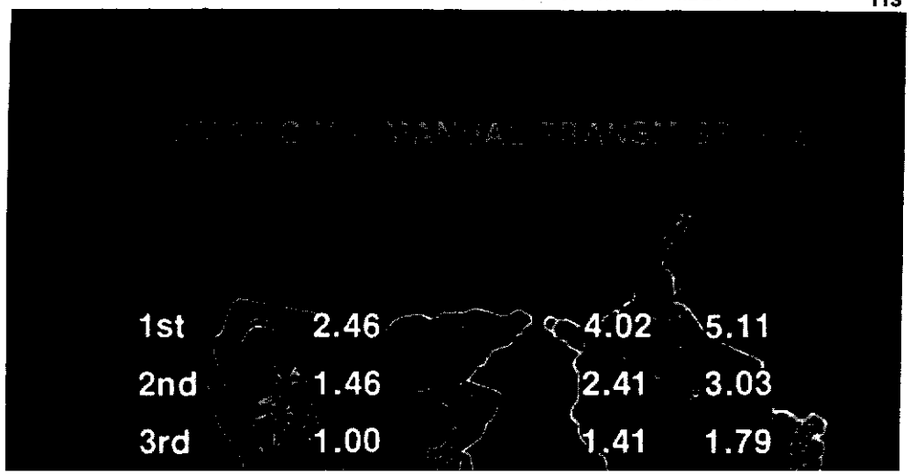


Just as vehicle application affected performance and economy, in similar ways so can the vehicle specifications.

There are many different transmission, axle ratio and tire combinations, each of which will now be addressed individually. Although each part will be discussed individually, it is the combination of all the areas that ensures proper performance analysis.

Automatic versus Manual Transmission

113



Performance variances of the automatic versus manual transmission can best be understood by reviewing the gear ratios of the automatic (C6) versus the manual transmission.

Gear Ratio

Gear	C6	T19B	T19
1st	2.46	4.02	5.11
2nd	1.46	2.41	3.03
3rd	1.00	1.41	1.79
4th	—	1.00	1.00

As can be seen from the above table, the gear reduction is not as low with the automatic (C6) transmission. Because the lower gearing is not available, pulling/take off capability is less and a customer may perceive this as a lack of power.

In addition, because of the gearing that is available with the automatic transmission, more horsepower

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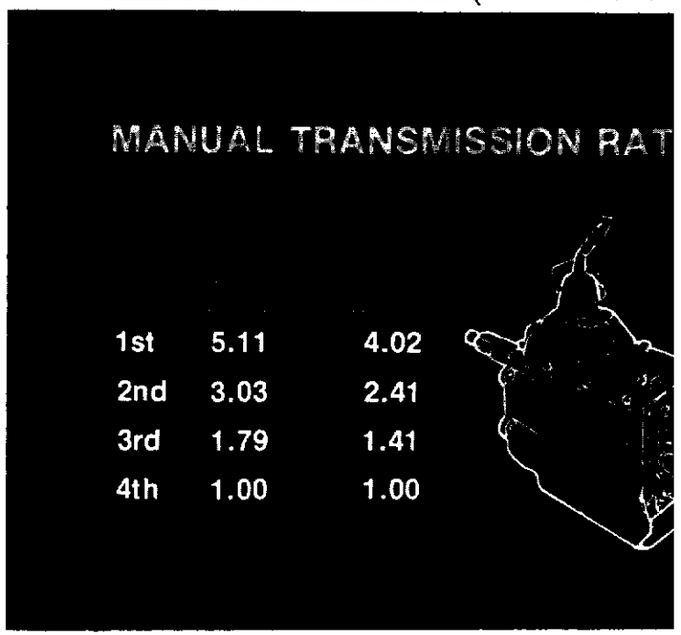
Manual Transmissions (T19 versus



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As can be seen from the above table, the gear reduction is not as low with the automatic (C6) transmission. Because the lower gearing is not available, pulling/take off capability is less and a customer may perceive this as a lack of power.

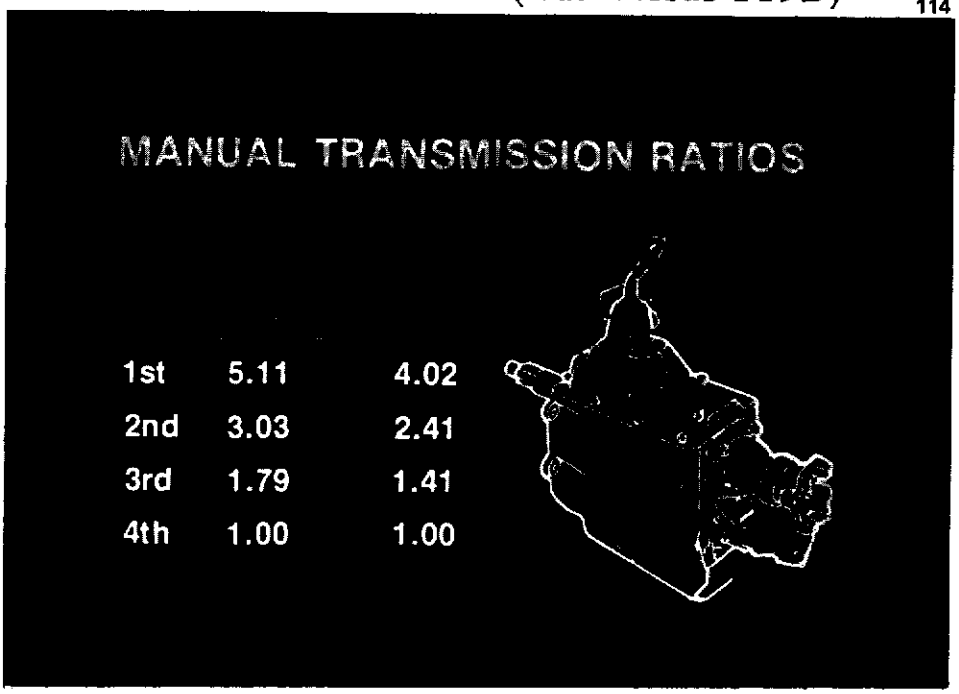
In addition, because of the gearing that is available with the automatic transmission, more horsepower is required to propel the vehicle at a given speed and therefore, less fuel economy is obtained.

Also, parasitic losses (through the torque converter and hydraulics) are greater in automatic transmissions than manuals and therefore less horsepower is transmitted to the wheels resulting in lower fuel economy and possible performance concerns. The above described performance and economy concerns are compounded by heavily loaded vehicles. Therefore direct comparisons of fuel economy and performance cannot be made of vehicles equipped with manual and automatic transmissions.

NOTE

If a question persists concerning performance of a 6.9L powered unit equipped with the C6 automatic transmission, a converter stall test should be performed. Refer to Light Truck Shop Manual (Vol. A) for stall speed specification.

Manual Transmissions (T19 versus T19B)



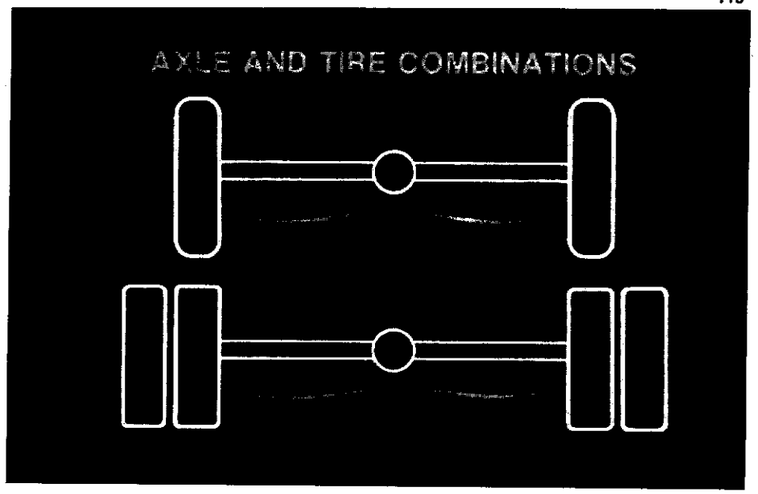
There have been two (2) manual transmissions used in production with the 6.9L diesel. The T19 wide ratio and T19B close ratio.

Performance concerns were realized on 1983 model year vehicles with the T19 wide ratio transmission with regards to the wide split between third and fourth (lack of power after 3-4 shift). Service Bulletin 84-4-29 was released addressing this and the T19B (close ratio) was utilized in production beginning in March 1984.

Again, as was described in the automatic transmission discussion, transmission gearing may be perceived as a power concern.

Axle and Tire Combinations

115



Three areas concerning axle and tire combinations with reference to performance and economy are:

- Dual Versus Single Rear Wheels

  Due to added rolling resistance, increased wind resistance of the vehicle and smaller (less rolling radius) tires, lower fuel economy is realized on a unit equipped with dual rear wheels versus a single rear wheel unit.

- After Market Oversize Tires: Not Ford Authorized Installation

  The use of oversize tires can change overall gear ratio affecting speedometer calibration and in some instances, engine performance (see "Matching Axle Ratio to Vehicle Application" below). In addition, increased tire surface area increases rolling resistance, resulting in a corresponding compromise in fuel economy.

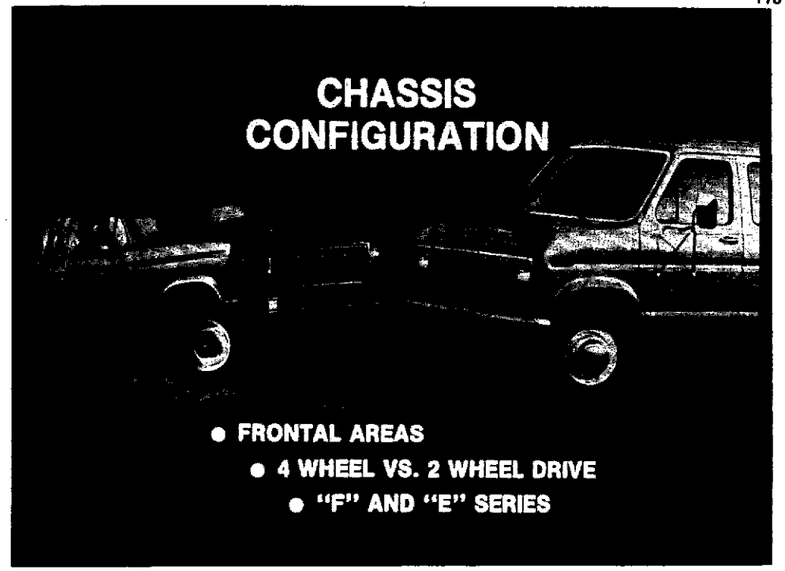
- Matching Axle Ratio to Vehicle Application

  The proper axle ratio for the application will optimize both performance and fuel economy. An example is that a 4.10:1 axle can improve economy over a 3.54:1 or 3.07:1 if the vehicle operates predominately at the maximum GVW or GCW. The reason being, that with the proper gear, the engine operates in its range of optimum performance and therefore, improved economy is realized on such an application.

  In contrast, on lightly loaded vehicles equipped with higher numerical (4.10:1) rear axle ratios, a reduction in fuel economy is realized due to increased engine RPM to maintain a given road speed.

Chassis Configuration

116



Basic chassis differences need to be realized when evaluating performance and economy. Areas that need to be addressed include:

- Frontal Areas

  Frontal area is negligible in terms of required horsepower at road speeds below 30 MPH (50 Km/h). Wind resistance does become a factor above 30 MPH (50 Km/h) and therefore, larger frontal areas require more horsepower to propel the vehicle which in turn requires more fuel and therefore results in lower fuel economy.

- Four Wheel Versus Two Wheel Drive

  The major difference between the four and two wheel drive units is the added parasitic horsepower loss of the additional drive train components, additional rolling resistance and weight of the 4 x 4 and in addition, the 4 x 4's decreased aerodynamics.

- F & E-Series

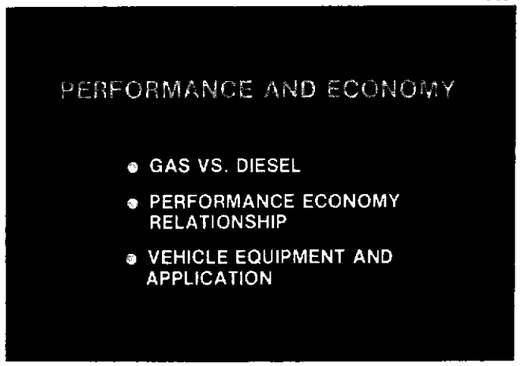
  Primarily the F-Series pick-up truck is more aerodynamic than the basic E-Series van body. In addition, the increased rolling radius of the larger standard tire on the F-Series provides better fuel economy than the standard tires on the E-Series.

- Auxiliary Equipment

  PTO operations or other diesel fueled equipment using vehicle fuel supply i.e., refrigeration units, diesel fueled heaters, etc. reduce overall economy.

Performance and Economy Relationship

117



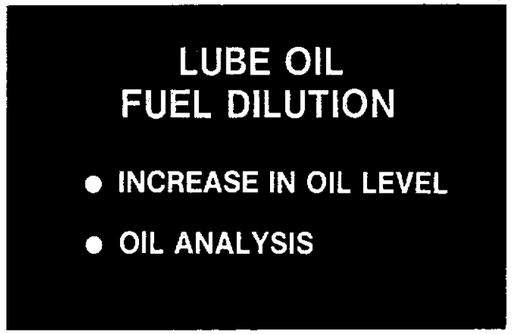
As a general rule, the following may be utilized in evaluating performance and economy:

The 6.9L typically provides a 40-50% improvement in fuel economy over a comparably equipped gas powered unit operating in the same application. If the economy falls within these guidelines then the engine performance is also acceptable. (Performance and economy are basically synonymous in that when the 6.9L is performing satisfactorily then economy is being obtained). Therefore, if performance is determined acceptable either through customer opinion, diagnostic tests, and/or 0-50 MPH (80 Km/h) testing, the unit is obtaining acceptable fuel economy.

Know the drive train of the vehicle and the application. Performance and economy concerns can be properly addressed by completely understanding the vehicle operation and the unit itself so as to determine that the truck is matched to the application. Understanding all the different combinations of vehicles, transmissions, axles, tires and applications provides the means to explain the differences in economy and performance concerns that customers approach the dealerships with, such as, "my friend gets 18.5 MPG and I only get 15 MPG" or "my truck does not pull like Joe's".

Lube Oil Fuel Dilution

118



Fuel dilution can manifest itself in many different ways of which there are two general areas that need to be addressed, one of which involves a mechanical concern and the other relates to normal engine operation and is a perceived problem:

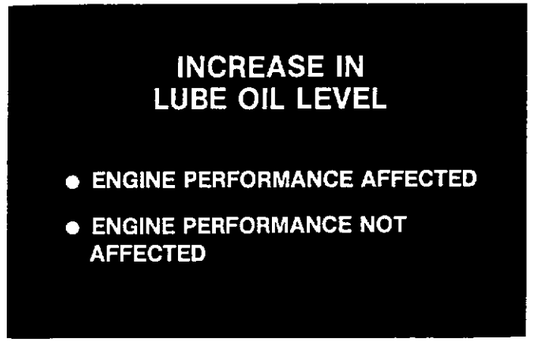
- Increased Lube Oil Level. A noticeable increase in the oil level above the "full" mark of the oil level gauge; this type of dilution is the result of a malfunction within the engine assembly, injection pump or nozzles.

- Lube Oil Analysis. Oil analysis can indicate a high percentage (10-15%) of fuel and an increase in the oil level will not be noticed. This is considered typical during normal oil drain intervals.

Both of these means of lube oil fuel dilution will now be discussed including possible causes. REMEMBER AN INCREASE IN OIL LEVEL IS THE BEST CRITERIA FOR DETERMINING DILUTION.

Increase In Lube Oil Level

119



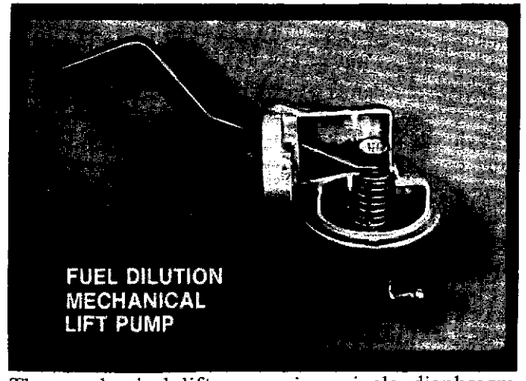
As the illustration points out, fuel dilution determined by an increase in the lube oil level can be categorized into two areas. The two areas are related to engine performance and depending on the performance of the engine, different probable causes should be investigated as follows:

- Engine Performance Affected
  - Mechanical lift pump
  - Injection nozzles
  - Valve train

- Engine Performance Not Affected
  - Fuel injection pump

Fuel Dilution – Mechanical Lift Pump

120



The mechanical lift pump is a single diaphragm pump and all fuel is contained below the diaphragm in the inlet and outlet circuitry of the pump. The inlet and outlet of fuel is controlled by two check valves contained within the pump. The pump also contains a shaft seal.

1. The supply pump can only cause fuel dilution if the diaphragm is leaking.

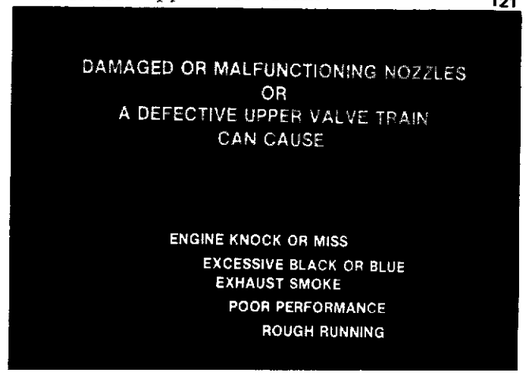
2. If the diaphragm is leaking, there will be an external fuel leak at the vent hole.

3. If there is not an external leak at the vent hole, the mechanical lift pump is not causing fuel dilution.

Fuel Dilution:

– Damaged or Malfunctioning Nozzles
– Defective Upper Valve Train

121



- Broken nozzle tip: Permits delivery of an excessive amount of non-atomized fuel to enter the power cylinder and creates a definite engine knock. Some of the raw fuel can pass the piston rings and dilute the lube oil.

- Stuck open nozzle: Predominantly caused by foreign material between nozzle valve and body or corrosion caused by water contaminated fuel. If this occurs, the same chain of events takes place as when the nozzle tip is broken, i.e., engine knock, smoke, etc.

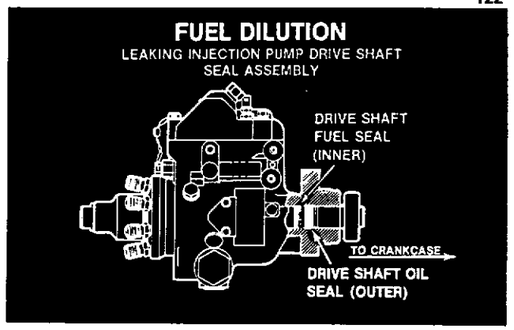
  Although a failed nozzle can cause dilution, usually another condition will be present that would indicate the nozzle is the defective part.

  - Engine Knock or Miss
  - Excessive Black or Blue Exhaust Smoke
  - Poor Performance
  - Rough Running
  - Defective Upper Valve Train:

Bent or broken push rods and/or broken rocker arm or support bracket can also cause dilution. As with the defective nozzle, a performance complaint will also be noticeable.

Fuel Dilution: Leaking Injection Pump Drive Shaft Seal

122



Another probable cause for dilution is in the injection pump. The pump drive shaft incorporates a double seal arrangement at the front of the pump. One seal is to prevent fuel (under approximately 10 PSI pump housing pressure) from entering the crankcase and the second seal contains engine oil in the crankcase. The two seals have a dead air space between them.

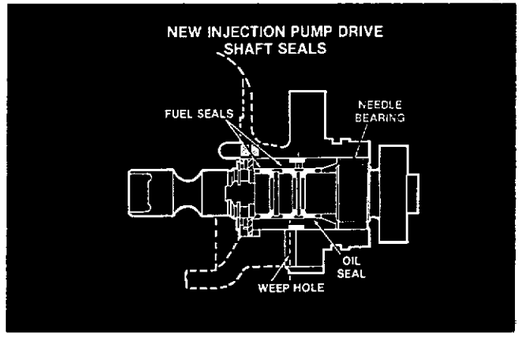
Fuel leaking past the seals can result in the lube oil being diluted by diesel fuel.

NOTE

This source of dilution will not be accompanied by other performance complaints such as the nozzle and valve train and typically the oil level will rise or be diluted more rapidly.

New Injection Pump Drive Shaft Seals

123



A three seal design (two fuel and one oil) and an external weep hole between the oil and fuel seals has been incorporated into the 6.9L injection pump beginning with the following engine serial numbers:

Standard: Serial Number 241647
High Altitude: Serial Number 248118

Because of the external weep hole, any seal leak will leak externally into the intake manifold valley pan and off the back of the engine. Therefore, the technician should remember to carefully inspect the top of the engine for fuel leakage when diagnosing leaks at the rear (rear oil seal) of the engine as it could be the pump.

Normal Lube Oil Dilution

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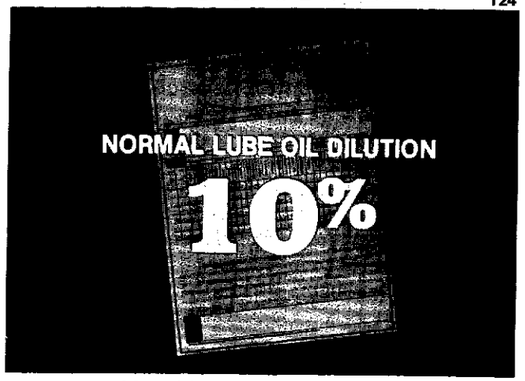

In severe cold ambient and/or during periods of extended engine idling (TSB 84-1-13), it is not abnormal to experience 10% to 15% fuel dilution of the lube oil within the normal oil drain interval. White smoke is also characteristic under these operating conditions.

Typically, the customer concern will be initiated by the results of oil analysis, and not due to an oil level increase which is considered abnormal.

As previously discussed, every engine has its own unique signature with regard to lube oil analysis. Incorrect interpretation of lube oil analysis pertaining to fuel dilution results in misdiagnosis and unnecessary replacement or repair of the following components:

- Injection pump
- Injection nozzles
- Mechanical lift pump

REMINDER

An increase in the lube oil level is the best criteria for determining dilution.

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