A NAVISTAR COMPANY

2004–2006

High Pressure Oil System Diagnostics

Study Guide

INTERNATIONAL®

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NOTES

Introduction

Welcome to Low ICP Diagnostics online training.

The goal of this program is to provide you with the procedures required to properly diagnose low injection control pressure (commonly called the ICP). Low ICP diagnostics procedures described in this program are performed as part of the Hard-Start/No-Start diagnostics. These tests would be performed only if the electronic service tool shows low injection control pressure during cranking.

These procedures apply to I-6 engines, years 2004 through 2006. Procedures used in the 2007 I-6 engines are similar.

The diagnostic procedures covered in this course will help you diagnose problems efficiently, so that you can "repair it right the first time," helping to build customer satisfaction.

Objectives

Upon successful completion of this program, you will be able to:

- **Identify the component locations**
- **Identify the diagnostic procedures**
- **Identify the special tools required for each procedure, and**
- **List the correct order of the diagnostic procedures**

"These procedures apply to I-6 engines, years 2004 through 2006. Procedures used in the 2007 I-6 engines are similar. "

This course is divided into four lessons.

- **Introduction**
- **System Overview**
- **Diagnostics Lesson**
- **Practice**

This course is divided into four lessons. The **Introduction** explains how to use this training program. The **System Overview** explains how the high-pressure oil system functions under normal conditions, and where problems can occur. The **Diagnostics lesson** will teach you about the tools and diagnostic tests to use for Low ICP Diagnostics. Each of these lessons will conclude with Knowledge Check exercises, which will allow you to test your understanding of key points from the lesson.

The final lesson of this course is a **Practice** session. In this lesson, you will diagnose problems in a simulated environment. Your responses to the Knowledge Checks and Practice will not be recorded.

The Resources available in this course can be downloaded and printed. Resources include the TSI Letter for Low ICP Diagnostics, a Study Guide, and a diagnostic flow chart.

You should complete the lessons in order. Once complete, individual lessons are available to you from the Quick Menu.

You can save or print the resources provided in this course through the Resources button. As with all courses, you will need to complete a post-test to obtain passing credit.

System Overview Module 1

Overview

In this lesson, we'll review the purpose and components of the high-pressure oil system. We'll look at what happens in a properly functioning system, and then go over the various things that can go wrong.

The high-pressure oil system is vital to proper engine function. Problems in the high-pressure oil system usually result in low oil pressure, which in turn can cause hard-start or no-start symptoms.

The fuel management system is one of the most important engine systems. If this system is to function, both the high pressure oil system and the lube oil system must operate correctly.

The high-pressure oil system uses the engine's lube oil to provide pressurized oil to the fuel injectors.

Oil stored in the reservoir is fed into the high-pressure oil pump, then oil drawn from the reservoir is constantly refilled by the engine lubrication system.

Objectives

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- **Identify the component locations**

"If the fuel management system is to function, both the high pressure oil system and the lube oil system must operate correctly. "

The high-pressure oil pump delivers oil through the high-pressure hose to the high-pressure manifold beneath the valve cover. The manifold then feeds the oil into the injectors, where it provides the force required to inject fuel into the combustion chambers.

Now let's take a closer look at the key components of the High-pressure Oil System. Click the highlighted areas of the screen to learn more about each component.

High-Pressure Oil Reservoir

The **High-Pressure Oil Reservoir** is refilled by the engine's lube oil pump. Oil stays in the reservoir until drawn into the high pressure pump. The reservoir is made of the two halves of the front cover.

"The reservoir is made of the two halves of the front cover."

High-Pressure Oil Pump

The gear-driven **High-Pressure Oil Pump** pressurizes the oil for use within the injector. Pressure can be as low as 800 psi at idle and as high as 4000 psi at full load at rated speed.

High-Pressure Hose

The **High-Pressure Hose** carries the oil from the pump to the High-pressure Manifold (commonly called the Rail).

High-Pressure Rail and Inlet Adapters

"The Inlet Adapters connect the Rail to the Fuel Injectors."

Pressurized oil is carried through channels in the **High-Pressure Rail** to the Inlet Adapters or what many technicians call pucks. The **Inlet Adapters** connect the Rail to the Fuel Injectors.

Fuel Injectors

High-pressure oil is pumped to the **Fuel Injectors**, where it is used to raise the pressure of the fuel within the injector. When the desired fuel pressure is met, and the injector is energized, fuel is injected into the cylinder

Injection Control Pressure (ICP) Sensor

The **Injection Control Pressure (ICP) Sensor** measures the oil pressure within the rail and sends the result to the ECM.

Engine Wiring Harness

The **Engine Wiring Harness** connects the electronic components of the system, allowing the Engine Control Module (ECM) to receive inputs from the ICP Sensor and to send signals to the Injection Pressure Regulator (IPR) Valve.

ECM

The **ECM** controls the IPR Valve by monitoring the pressure readings of the ICP Sensor and comparing them to the desired values.

IPR Valve

The **IPR Valve** is attached to the High-pressure Oil Pump. It controls the injection pressure by modulating the amount of oil that drains back into the pan. The IPR is controlled by the ECM.

"It controls the injection pressure by modulating the amount of oil that drains back into the pan."

When the high-pressure oil system stops functioning properly, your job will be to track down the failed component. There may be a failure in the pump or IPR.

"I don't want to have to replace the entire pump if the problem is a leaky O-ring or a failed IPR. Replacing the wrong part just wastes my time."

Technician: "On the job, I do see failed IPR Valves and Pumps. But I always run the recommended diagnostics, because I don't want to have to replace the entire pump if the problem is a leaky O-ring or a failed IPR. Replacing the wrong part just wastes my time."

There could be a fault in the engine wiring harness or the ECM itself that disrupts the signal coming from the ECM to the IPR. That could be caused by a break in a wire or maybe just a corroded IPR connector. Or there could be a leak in the hose, a leak in the rail, or a biased ICP Sensor sending incorrect signals to the ECM.

Technician: "Yup, I've seen those O-rings on the rail adapters fail. But at least now I can replace the adapter and not the entire rail!"

It's also possible that your low oil pressure isn't caused by one of these components. When oil isn't getting to the High-pressure Oil System, there could be a problem with the Lube Oil System, which requires a different set of diagnostics not covered in this course.

Technician: "I have seen an engine where the injectors caused the low ICP. On that engine the spool valve in the top of one injector failed and high pressure oil leaked out through the drain ports. That case was a hard one, so I called tech Services for help."

Diagnostics Module 2

Introduction

In this lesson, we'll walk through the ICP Diagnostic tests. There are six tests in total.

1. High Pressure Oil System Test
2. IPR Control System Test
3. High Pressure Oil Pump Test
4. IPR Block-Off Test
5. High Pressure Oil Rail Leak Test
6. ICP Unplugged Test

These tests should be completed in the order presented, to make your diagnostic efforts as efficient as possible.

Technician: "Make sure you follow Safety guidelines like always."

The diagnostic tests we'll cover in this lesson are outlined for you in the TSI Letter. You can download and print the letter from the Resources button in this program. Before we get started, let's go over the diagnostic tools you will use to perform these test.

Objectives

Upon successful completion of this program, you will be able to:

- **Identify the diagnostic procedures**
- **Identify the special tools required for each procedure, and**
- **List the correct order of the diagnostic procedures**

"These tests should be completed in the order presented, to make your diagnostic efforts as efficient as possible."

TOOLS

These are the tools you will use for the diagnostic tests covered in this lesson. Click each one to familiarize yourself with its name and function.

Electronic Service Tool

The Electronic Service Tool, or EST, is a computerized diagnostic tool. You'll use the EST for Tests 1 and 2. To review software procedures for the EST, see "Diagnostic Software Operation" in the Engine Diagnostic Manual on ISIS.

IPR Breakout Harness

The IPR Breakout Harness is used to apply battery voltage and ground to the IPR.

"The IPR Breakout Harness is used to apply battery voltage and ground to the IPR."

ICP Adapter Kit

The ICP Adapter Kit allows you to connect an ICP sensor to the end of the high pressure hose.

ICP Test Sensor

The ICP Test Sensor is used in the end of the high pressure hose when testing the system.

Digital Multimeter

The Digital Multimeter (DMM) is used to measure voltage.

Pressure Sensor Breakout

The Pressure Sensor Breakout harness is used to connect Vref and ground to the test sensor when testing the pump.

IPR Block-Off Tool

The IPR Block-Off Tool replaces the IPR so you can determine if the pump or IPR have failed.

Low ICP Diagnostics

"If the Hard-Start/ No-Start Diagnostics shows low injection control pressure, then you should begin the Low ICP Diagnostics."

Low ICP diagnostics are performed as part of the standard Hard-Start/No-Start diagnostics. The first six tests on the Hard-Start/No-Start Diagnostic Form are required tests. If Step 6, the EST Data List, shows low injection control pressure, then you should begin the Low ICP Diagnostics.

Note that ICP while cranking the engine should have at least 870 psi, or 1.2 volts if using a voltmeter. Many of the diagnostic tests involve cranking

the engine. In order to get the most accurate readings, you need to crank the engine for about 20 seconds.

Next let's walk through each ICP test.

TEST 1: ICP System Test

Test 1, the ICP System Test, will tell you if the ICP is correct while cranking and if the lube oil pressure is sufficient to fill the reservoir.

Technician: "Before you start Test 1, do a visual inspection. If you can actually see oil leaking, you might have found your problem! Also, if your visual inspection leads you to replace a leaking hose, make sure you use two wrenches to tighten the hose fittings. Using only one wrench will cause a later failure."

All you need for Test 1 is the EST. There are two possible results for this test: either you'll continue to Test 2, or you'll stop ICP Diagnostics and begin Lube Oil System Diagnostics.

"Test 1, the ICP System Test, will tell you if the ICP is correct while cranking and if the lube oil pressure is sufficient to fill the reservoir."

"If your visual inspection leads you to replace a leaking hose, make sure you use two wrenches to tighten the hose fittings. Using only one wrench will cause a later failure."

Now let's perform the test. Use the EST to measure the Engine Oil Pressure and Injection Control Pressure while cranking the engine about 20 seconds.

At this point you have your first possible result. If you're reading zero engine oil pressure, your problem isn't in the high-pressure oil system; it's somewhere in the Lube Oil System, which feeds oil into the high-pressure system. You should go to Lube Oil System Diagnostics in the appropriate service manual on ISIS.

If you have engine oil pressure while cranking, but the ICP is low, you can assume the reservoir has oil.

If you have engine oil pressure while cranking, but the ICP is low, you can assume the reservoir has oil.

If you have low engine oil pressure, you should check to see if there's oil in the reservoir. Loosen the EOP sensor and watch for oil trying to get past the threads of the sensor.

If there's no oil in the reservoir, you should go to Lube Oil System Diagnostics to determine why oil is not getting to the reservoir. If there is oil in the reservoir, continue to Test 2.

Test 2: IPR Control System Test

The IPR Control System Test checks for malfunctions in the IPR circuits. You'll need the EST and an IPR breakout harness for this test.

The IPR Control System Test checks for malfunctions in the IPR circuits.

There are three possible outcomes. 1. You may need to repair or replace the engine harness. 2. The problem could be in the ECM. Or 3, this test does not determine the defect, in which case you will continue to Test 3.

To perform the IPR Control System Test, remove the IPR connector and check the harness connections for corrosion. If you find corrosion on the IPR harness, clean, repair, or replace as required and then run the test.

If there's no corrosion, install the breakout harness to the IPR connector. Do not connect the breakout harness to the engine harness. Use jumper wires to connect the B+ and a good ground to the breakout harness. Crank the engine briefly and check the ICP reading on the EST.

If the either the engine harness or the ECM are the problem, the ICP will now jump up to about 4,000 psi.

If you still have a low psi when performing this test, you should continue to Test 3.

Technician: "It's pretty rare for the ECM or the engine harness to go bad. But this test is easy to do, and can save you a lot of hassle if you catch the problem here. So don't skip it!"

TEST 3: High-pressure Oil Pump Test

Test 3 is the High-pressure Oil Pump Test. This test will determine whether you should continue diagnostics on the pump and IPR, or whether you need to take the valve cover off

Test 3 is the High-pressure Oil Pump Test. This test will determine whether you should continue diagnostics on the pump and IPR, or whether you need to take the valve cover off to check for leaks in the system. You will need the Pressure Sensor Breakout harness, the ICP Adapter Tool, the ICP Test Sensor, and the Digital Multimeter for this test.

Technician: "You may know this diagnostic as the Deadhead Test."

There are two possible outcomes for this test. If you discover that the problem lies with the pump or IPR valve, you will proceed to Test 4. If this diagnostic determines that the problem is not in the pump or the IPR, you will continue to Test 5.

To perform Test 3, reconnect the engine harness to the IPR. Then remove the high-pressure oil hose from the fitting at the cylinder head.

Technician: "Make sure you use two wrenches to loosen the hose from the fitting. Using a backup wrench can help you keep the hose from twisting and being damaged."

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Then install the ICP Adapter Tool and ICP Test Sensor. Disconnect the engine harness from the MAP sensor. Connect the breakout harness to the engine harness MAP sensor connector and to the ICP test sensor. Then insert the red lead of the DMM to the green lead of the breakout harness.

Now crank the engine and monitor the voltage on the DMM. With the ICP Test Sensor connected to the engine harness you should have at least 1.2 volts.

If the voltage is under 1.2 volts, the problem is either the oil pump or the IPR. Proceed to Test 4 to determine which of these needs to be replaced.

If the voltage reaches 1.2 volts, you have sufficient pressure to start the engine, so the high pressure pump and the IPR valve look good. Proceed to Test 5, the Rail Leak Test.

TEST 4:IPR Block-Off Test

Use Test 4 only if Test 3 indicated a problem with the IPR valve or high pressure pump.

Use Test 4 only if Test 3 indicated a problem with the IPR valve or high pressure pump. Test 4, the IPR Block-Off Test, will tell us whether to replace the pump, or the IPR valve. You'll need the same tools as Test 3.

There are two possible outcomes for this test. You'll either replace the just the IPR valve, or replace the oil pump and IPR valve.

Technician: "If you replace the oil pump, you'll get a new IPR valve with it. But what if the pump isn't the problem? Better to replace just the bad valve than the entire pump!"

To run this test, retain the connections you had in Test 3 but remove the IPR valve.

Technician: "If your engine has an air compressor, one of the compressor head bolts will be in the way of the IPR connector. That makes it hard to take out the IPR. If you have to break the IPR to remove it, that's ok. At this point you're either gonna replace it on its own, or replace it along with the pump."

"If your engine has an air compressor, one of the compressor head bolts will be in the way of the IPR connector. If you have to break the IPR to remove it, that's ok."

Now install the IPR Block-Off tool. The DMM should still be set up from the last test. Crank the engine and monitor the voltage on the DMM.

If you get 4 volts or more, the IPR is the problem. Replace the IPR valve.

If you get a low reading, less than 3 volts, the pump is the problem. Replace the high-pressure oil pump.

TEST 5: Rail Leak Test

If Test 3 indicated that the problem was not with the IPR or pump, then the problem is under the valve cover.

If Test 3 indicated that the problem was not with the IPR or pump, then the problem is under the valve cover. Test 5 will tell us if there are leaks in the oil rail. You don't need any special tools for this test.

There are two possible results from this test: you will either need to repair the leaks in high pressure system, or you will continue to Test 6.

Remember that you will have the ICP adapter tool and ICP test sensor in place from Test 3. Remove them. Remove the DMM and the breakout harness as well. Then reconnect the high pressure hose to the cylinder head.

Technician: "Remember to use your backup wrench!"

To start this test, remove the valve cover following the procedures in the Engine Service Manual on ISIS.

Now have someone else crank the engine while you monitor the rail for leakage. Leaks will appear as ooze or spray, particularly around the inlet adapters and the injectors.

If you find leaks, remove the rail assembly and repair as needed. *Technician: Remember, each part on the rail can be replaced individually and a special tool is available to remove and replace the pucks.*

If you don't see any leaks, then the problem may be with the ICP sensor itself. Proceed to Test 6 to diagnose the ICP Sensor.

TEST 6: ICP Sensor Test

Test 6 checks for a biased ICP Sensor or problems in the ICP circuit.

The last component in the diagnostic chain is the ICP Sensor. Test 6 checks for a biased ICP Sensor or problems in the ICP circuit. You don't need any special tools for this test. The diagnostic outcome here should be that you Replace ICP Sensor or repair the ICP circuit.

To perform this test, make sure that all the system components are installed and the engine is ready to start. The

valve cover should still be off, however. Then unplug the ICP Sensor from the valve cover gasket harness. Attempt to start the engine.

If the engine starts, the fault was with the ICP sensor. Replace it and retest.

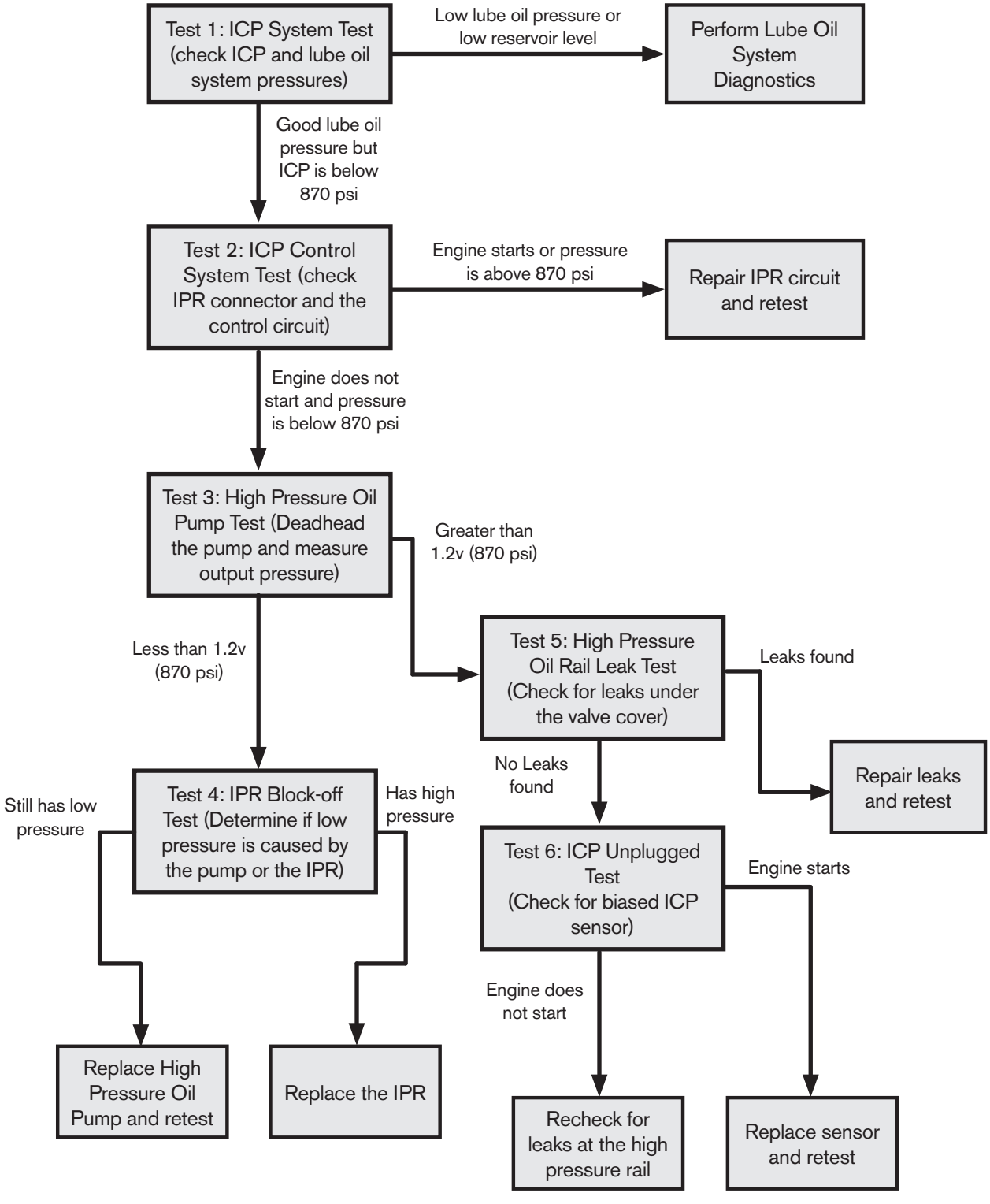
Technician: "If the engine does not start, check the rail for leak. You can double check your diagnostic results working backwards since you already have the valve cover off."

Practice

In this practice section, you'll get a chance to walk through Low ICP Diagnostics yourself. As we progress through each test, you can keep track of the test results. For some tests, you may need to click and drag components on the screen (for instance, to connect a harness). You'll also have some decisions to make as you go along. If you haven't already done so, you can print the TSI letter, a test flow diagram, and a list of steps for each test, available from the Resources button. There are a total of eight engines for you to test. These steps must be completed on your computer.

"In this practice section, you'll get a chance to walk through Low ICP Diagnostics yourself."

2004–2006 I-6
Low ICP Diagnostics



Low ICP Diagnostics Tests

For I-6 Engines 2004-2006
(Procedures for I-6 2007 are similar)

Operating Specs: the engine requires a minimum of 870 psi/1.2V to start

1: ICP System Test

This test is used to determine if the EOP is sufficient to fill the reservoir.

- ☐ Crank engine approximately 20 seconds; record EOP & ICP
- ☐ If EOP is low, check oil reservoir for oil)

2: IPR Control System Test

This test checks the complete IPR circuit for faults

- ☐ Remove IPR harness
- ☐ Check for corrosion
- ☐ Connect IPR Breakout harness to B+ and ground (Do not connect to the engine harness).
- ☐ Crank engine for approximately 20 seconds
- ☐ If engine starts, or if pressure exceeds 870 psi, check IPR circuit for opens and shorts to ground.

3: High-pressure Oil Pump Test

This test checks the system output with the under valve-cover components disconnected from the system

- ☐ Remove hose from cylinder head fitting (use a backup wrench to avoid hose damage)
- ☐ Install ICP adapter tools & ICP test sensor
- ☐ Disconnect MAP sensor connector
- ☐ Connect pressure sensor breakout harness to ICP test sensor and MAP sensor harness
- ☐ Insert DMM into pressure sensor breakout harness and measure ICP signal voltage
- ☐ Crank engine for approximately 20 seconds
- ☐ Record voltage. If voltage is greater than 1.2, there is a leak under the valve cover, go to test 5.
- ☐ If the voltage is less that 1.2, the combination of pump and IPR will not produce the correct pressure, go to test 4.

4: IPR Block-Off Test

When a pump assembly has low pressure this test will determine if the cause is the pump or the IPR

- ☐ Retain setup from Test 3 (ICP adapter tools & ICP test sensor in the end of the high pressure hose and the pressure sensor breakout harness)
- ☐ Remove IPR Valve (the IPR connector can be broken off for easy removal; do not remove the air compressor head bolt)
- ☐ Install IPR block-off tool
- ☐ Crank engine
- ☐ Record voltage: with a good pump the pressure will exceed 4,000 psi (about 4v on the DMM) If the pressure is still below starting pressure requirement (1.2v), the pump is defective. If the pressure is high, the IPR is defective.

5: High-pressure Oil Rail Leak Test

This test is used to locate leaks under the valve cover

- ☐ Remove the ICP adapter & ICP test sensor.
- ☐ Reattach the hose to the head (Use a backup wrench on the fitting)
- ☐ Reinstall the harness connector to the MAP sensor
- ☐ Remove valve cover
- ☐ look for oil leaks under the valve cover while the engine is cranking
- ☐ If no oil leaks are detected, go to test 6.

6: ICP Unplugged Test

When test 3 results point to a leak under the valve cover and test 5 finds no leaks, this test checks the ICP sensor for possible bias

- ☐ Set up for normal function with valve cover off
- ☐ Unplug the ICP sensor
- ☐ Crank engine: if no leaks were found in test 5, and the engine starts with the sensor disconnected, the sensor or the circuit is biased.