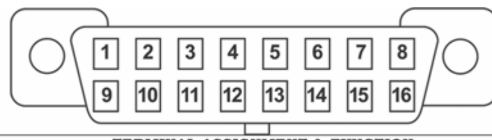
Next Generation Engine Management Part 2, Introduction to OBD II Systems

Course Code 0831224



TERMINAL ASSIGNMENT & FUNCTION			
		DaimlerChrysler Corporation	
PIN	**SAE/ ISO**	**A (1994MY - 2002MY+)**	**B (2002MY+)**
1	Manufacturer Discretionary	RKE Programming Input	not used
2	SAE J1850 (+)	SAE J1850 10.4 Kbps	SAE J1850 10.4 Kbps
3	Manufacturer Discretionary	CCD (+)	not used
4	Chassis Ground	Power Ground	Power Ground
5	Signal Ground	Signal Ground	Signal Ground
6	ISO 15765-4 CAN-C (+)	SCI A Rx (Receive) (*Engine*)	ISO 15765-4 CAN-C (+)
7	ISO 9141-2 K-line ISO 1423-4 K-line	ISO 9141-2 K-line/ SCI Tx (Transmit) (*Engine/Transmission*)	SCI Tx (Transmit) (*Engine*)
8	Manufacturer Discretionary	A/D Signal Output/Switched Ignition	Switched Ignition
9	Manufacturer Discretionary	SCI B Rx (Receive)/ J1850 Flash Enable	SCI Rx (Receive) (*Trans.*)/ J1850 Flash Enable
10	SAE J1850 (-)	Reserved	Reserved
11	Manufacturer Discretionary	CCD (-)	not used
12	Manufacturer Discretionary	SCI C Rx (Receive)	SCI Rx (Receive) (*Engine*)
13	Manufacturer Discretionary	Lo-Driver/SCI Tx (Transmit) (*Body/Chassis*)	not used
14	ISO 1565-4 CAN-C (-)	SCI D Rx (Receive) (*Transmission*)	ISO 15765-4 CAN-C (-)
15	ISO 9141-2 L-line/ ISO 14230-4 L-line	Inverted SCI Tx (Transmit)	SCI Tx Transmit (*Trans.)*
16	Unswitched Battery Voltage	Battery Voltage	Battery Voltage

Introduction to OBD II Systems

TABLE OF CONTENTS

INTRODUCTION

OBD II regulations require that more vehicle systems be monitored for more types of failures than were done in the past. OBD II has increased vehicle complexity, but it has also simplified diagnosis by standardizing systems, function and terminology.

This course will explain OBD II requirements and why they are necessary. It will describe current emission control systems, diagnostic tools, Diagnostic Trouble Codes (DTCs) and Monitors. How OBD II systems work, and three specific Monitors will be discussed in detail. The content of this course is based on the Speed Density fuel system, which is used on most Chrysler Group gasoline-powered vehicles.

STUDENT LEARNING OBJECTIVES

Upon completion of this course, you should be able to:

- Understand how OBD II began, and how it is currently implemented.
- Identify the components necessary for OBD II.
- Understand how OBD II identifies emissions concerns using the Federal Test Procedure.
- Identify and interpret the different types of DTC information.
- Identify and interpret different operating conditions of the fuel system.
- Identify the different types and status of the Monitors.
- Run the O_2 Monitor and interpret the results.
- Run the Misfire Monitor and interpret the results.
- Have a basic understanding of the EVAP purge system.
- Run the NVLD Monitor and interpret the results.

ACRONYMS

The acronyms listed here are used throughout this course:

- AIR Air Injection Reaction System
- BCM Body Control Module
- BTS Ambient/Battery Temperature Sensor
- CKP Crankshaft Position Sensor
- CMP Camshaft Position Sensor
- CO Carbon Monoxide
- CO2 Carbon Dioxide
- DLC Data Link Connector
- DRBIII® Diagnostic Readout Box – 3rd Generation
- DTC Diagnostic Trouble Code
- ECT Engine Coolant Temperature Sensor
- EELD Evaporative Emissions Leak Detection
- EGR Exhaust Gas Recirculation
- EPA Environmental Protection Agency
- ETC Electronic Throttle Control
- EVAP Evaporative Emissions System
- FTP Federal Test Procedure
- HC Hydrocarbons
- IAC Idle Air Control
- IAT Intake Air Temperature Sensor
- I/M Inspection and Maintenance Program
- JTEC Jeep/Truck Engine Controller
- KOEO Key On Engine Off
- KOER Key On Engine Running

- LDP Leak Detection Pump
- LTFT Long Term Fuel Trim
- MAP Manifold Absolute Pressure Sensor
- MDS2® Mopar Diagnostic System – 2nd Generation
- MIL Malfunction Indicator Lamp
- NGC Next Generation Controller
- NOx Oxides of Nitrogen
- NTC Negative Temperature Coefficient
- NVLD Natural Vacuum Leak Detection
- N2 Nitrogen
- OBD II On-Board Diagnostics – 2nd Generation
- ORVR On-Board Refueling Vapor Recovery
- O2 Oxygen
- PCM Powertrain Control Module
- PCV Positive Crankcase Ventilation Valve
- PTC Positive Temperature Coefficient
- PWM Pulse Width Modulated
- RPM Revolutions Per Minute
- SAE Society of Automotive Engineers
- SBEC Single Board Engine Controller
- SO2 Sulfur Dioxide
- SRI Service Required Interval
- STFT Short Term Fuel Trim
- T-MAP Throttle MAP (calculated MAP value)
- TPS Throttle Position Sensor
- VSS Vehicle Speed Signal
- WOT Wide Open Throttle

MODULE 1 OBD OVERVIEW

THE ENVIRONMENT

The effects of internal combustion engine emissions on the environment and air quality have been a concern for many years. Today, more than 6.3 billion vehicle miles are driven every day. Emissions from mobile internal combustion engines (automobiles and light trucks) are mostly water vapor and carbon dioxide, but other harmful substances are also emitted by these engines.

About half of the ozone and nearly all of the carbon monoxide emissions are attributed to mobile sources. A typical vehicle emits about a half ton of pollutants annually, and a vehicle with defects or in poor condition emits many times that amount. Direct health consequences caused by vehicle pollutants include increased levels of carcinogens and irritants to eyes and respiratory and cardiovascular systems. In addition to concerns about pollution, there are also good reasons to conserve petroleum resources. The United States has less than 5% of the world's population, yet we consume more than 40% of the world's petroleum. Maintaining and repairing vehicles not only reduces levels of pollutants but also improves fuel economy and will stretch petroleum reserves.

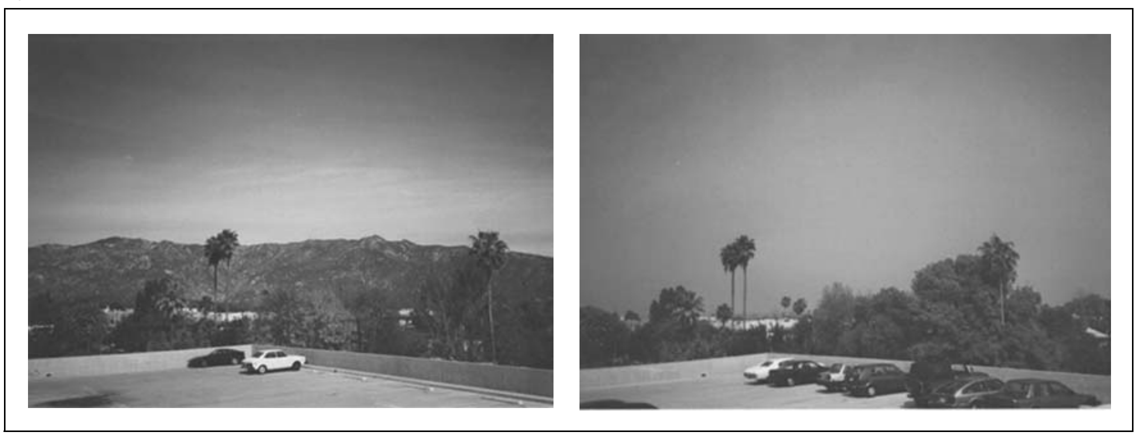


Figure 1 Los Angeles CA Area With And Without Smog

Engine Emissions

While tailpipe emissions are mostly water vapor and carbon dioxide, other harmful substances are also emitted by these engines. Emissions from internal combustion engines include:

- **Water Vapor (H_2O):** Not toxic and not a pollutant, produced by burning hydrocarbon fuels such as gasoline.
- **Carbon Dioxide (CO_2):** Not toxic and not a pollutant, but it is considered a greenhouse gas and a contributor to global warming. Much of the CO_2

increase in the atmosphere is a result of burning gasoline in internal combustion engines - for every gallon of gasoline burned, about twenty pounds of CO_2 are added to the atmosphere.

- **Carbon Monoxide (CO):** A colorless, odorless, poisonous gas that produced when there is insufficient oxygen to form carbon dioxide. This can occur, for example, when the mixture is too rich. CO can cause dizziness, headaches, impaired judgment, and in large concentrations, death from oxygen starvation.
- **Hydrocarbons (HC):** Unburned fuel that is either left over from incomplete combustion or evaporates from the vehicle fuel system. Emissions during refueling and tailpipe emissions are both significant. HC combines with oxides of nitrogen (NOx) in the presence of sunlight to form Photochemical Smog, which creates a brownish haze and contributes to respiratory problems and eye irritation.
- **Oxides of Nitrogen (NOx):** Compounds that are produced when combustion temperatures in the engine's cylinders exceeds approx. 2500°F (1400°C). Above these temperatures, normally inert nitrogen (N_2) combines with oxygen (O_2) to form several different compounds which again contribute to smog, respiratory problems and eye irritation.
- **Sulfur Dioxide (SO_2):** A colorless gas with a pungent rotten egg odor. High sulfur content in gasoline leads to SO_2 production in the catalytic converter. It can cause respiratory irritation, heart problems, and increased risk of asthma.
- **Toxins (Benzene, Formaldehyde, Butadiene and others):** Emitted by motor vehicles and are known carcinogens and are toxic in low concentrations.

OBD II LEGISLATION

Federal Legislation

The Federal Government has passed laws over the years in an effort to improve air quality standards. The first federal air pollution research program began in 1955. Federal emissions standards milestones are listed below:

- **1963:** Congress passed the Clean Air Act legislation. This Act provided states with money to develop air pollution control programs.
- **1965:** Amendments to the Clean Air Act - auto emission standards first applied nationwide in 1968
- **1970:** The Clean Air Act amendments of 1970 created the Environmental Protection Agency (EPA) and gave the agency broad powers to regulate vehicle pollution.

- **1971:** Evaporative emissions standards enacted
- **1972:** First Inspection and Maintenance (I/M) program introduced
- **1973:** NOx emissions standards enacted
- **1975:** First catalytic converters introduced
- **1977-78:** Amendments to the Clean Air Act
- **1989:** Gasoline volatility standards enacted
- **1990:** Clean Air Act amendments
- **1995:** I/M 240 testing required for gasoline powered vehicles in non-attainment zones
- **1996:** On-Board Diagnostics II (OBD II) vehicle compliance required

Features of the 1990 Clean Air Act amendments include:

- Stricter tailpipe emissions for cars, trucks and buses
- Expanded Inspection and Maintenance programs with more stringent testing
- Alternative fuel development encouraged
- Study of engines in boats, farm and construction equipment, stationary sources, lawn mowers, etc.
- Mandatory alternative transportation programs such as car-pooling in heavily polluted cities

California Air Resources Board

In 1961, the predecessor to the California Air Resources Board (CARB) mandated the use of Positive Crankcase Ventilation (PCV) systems in the state. This was the first auto emission control standard in the country. PCV systems were mandated for the entire country in 1963. In 1966, Air Injection Reaction (AIR) systems were added to cars sold in California.

In 1971 California adopted the first oxides of nitrogen reduction standards in the nation. In the early 1980s, CARB began developing regulations that would require all vehicles sold in that state to have On-Board Diagnostics I (OBD I) capabilities by 1988.

OBD I

OBD I standards were in effect between 1988 – 1996. OBD I required monitoring the following:

- Fuel Metering
- Exhaust Gas Recirculation (EGR)
- Other Emissions-Related Electrical Components

If the monitoring system detected a malfunction in any of the above systems, a Malfunction Indicator Light (MIL) was required to illuminate. Also, Diagnostic Trouble Codes (DTCs) were required to store information identifying the failure. The DTC could be retrieved either by using a Scan Tool or by commanding the MIL to blink-out the code numbers (flash codes).

OBD I systems had limitations. They did not detect many emission-related problems such as misfire and catalytic converter failures. By the time components failed and were detected, the vehicle may have been creating excessive pollution for some time.

If the problem went away, the MIL turned OFF and storage of the DTC was not required. However, in Chrysler vehicles, DTC memory was typically maintained for 50 startups as long as battery power was provided.

OBD I did not require standardization for the Data Link Connector (DLC), the DTCs or the criteria to illuminate the MIL.

OBD II

Starting with the 1996 model year, vehicles were required to comply with OBD II diagnostics standards. OBD II created unified standards for communications protocols, DLC design and location, DTCs, terminology and MIL illumination criteria.

With intermittent faults, the MIL will remain illuminated for a defined period of time (typically three trips) and will go out only if the problem does not recur. The DTC will also remain in memory for an extended time.

OBD II regulations require the following:

- Use of an on-board computer to monitor the condition of electronic components and systems
- MIL illumination if a detected failure could cause HC, CO or NOx emissions to exceed a threshold, typically 1.5 times the allowable Federal Test Procedure standard
- Retention of information about operating conditions when a fault occurs (Freeze Frame Data)

- Standardized specifications for the DLC including design, location and terminal layout to allow generic scan tool access
- A list of mandated DTCs with standardized definitions
- Standardized electrical system component terms and acronyms
- Availability of Service Information to all persons engaged in vehicle service and repair
- Drive Cycle

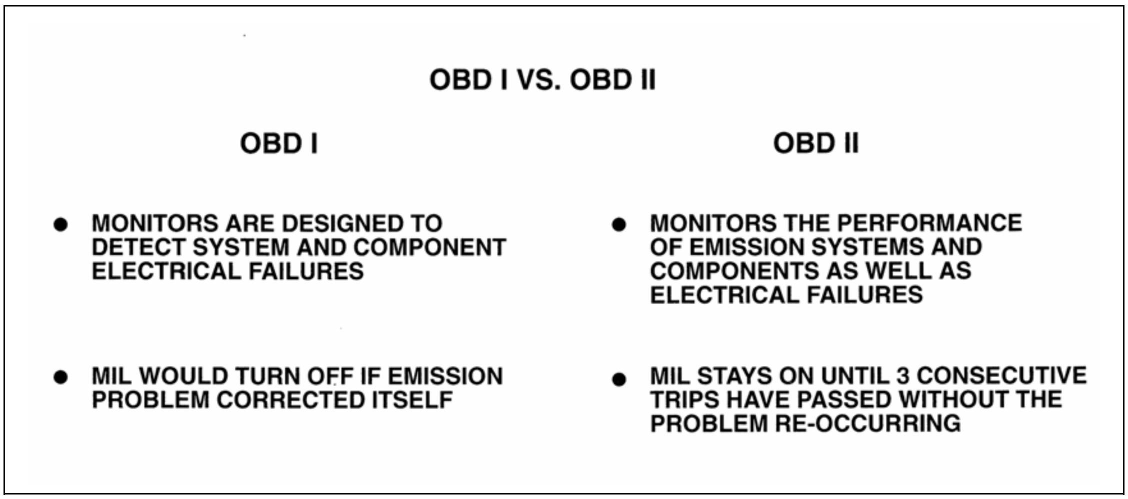


Figure 2 OBD I vs OBD II

Drive Cycle

A Drive Cycle occurs when a vehicle is driven in a specific way to allow most monitors to run and perform their tests. Drive Cycles can specify calibrated values for engine temperature increase, vehicle speed, time, and other parameters. Drive Cycles are calibrated for different models and engines, and the requirements vary widely. This is a typical Federal Test Procedure Drive Cycle:

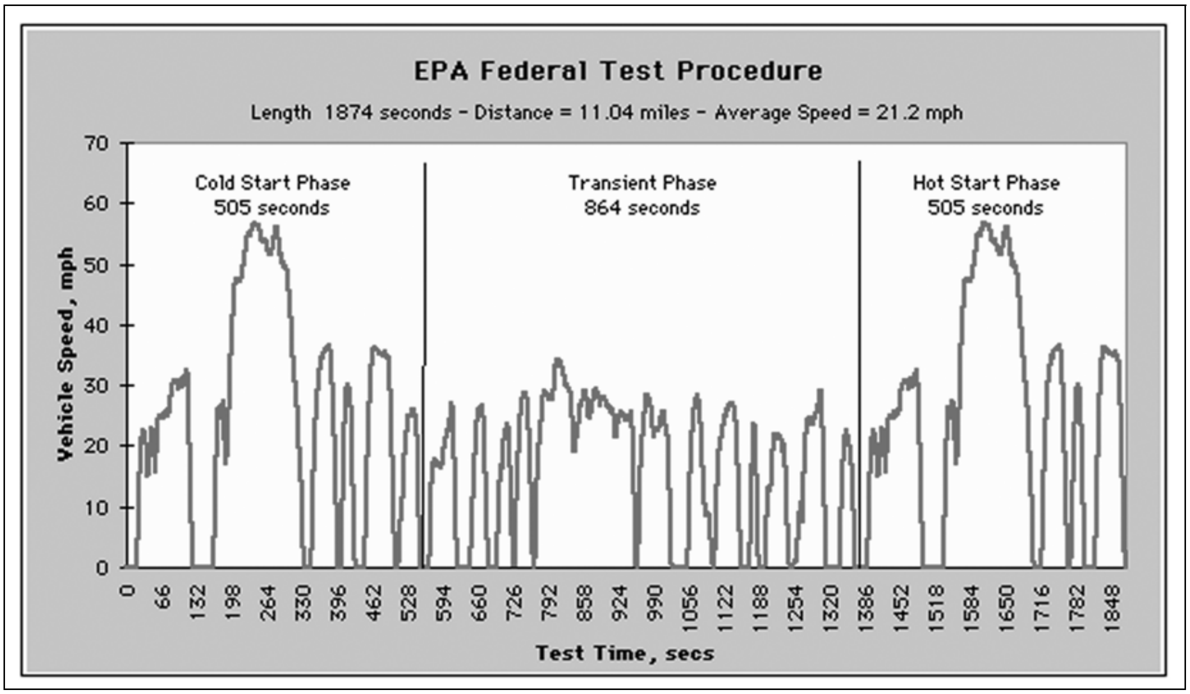


Figure 3 EPA Federal Test Procedure Drive Cycle

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MODULE 2 DIAGNOSTIC TOOLS

SERVICE INFORMATION

DaimlerChrysler Service Manuals provide vehicle repair information, component removal and replacement instructions. Diagnostic Procedures Manuals are diagnostic guides for proper troubleshooting.

DIAGNOSTIC READOUT BOX 3RD GENERATION (DRB III®) SCAN TOOL

The DRB III® Scan Tool is a Chrysler-specific portable computer/analyzer. It communicates with the vehicle through the DLC connector and is capable of two-way communications with an OBD II-compliant vehicle. It can access DTCs, controller inputs and outputs, switch states and controller software levels. It can perform active system tests by controlling components and systems.

The DRB III® displays all OBD II information processed by the PCM. The tester can display Freeze Frame, DTCs, Monitor enabling conditions and trip counters.

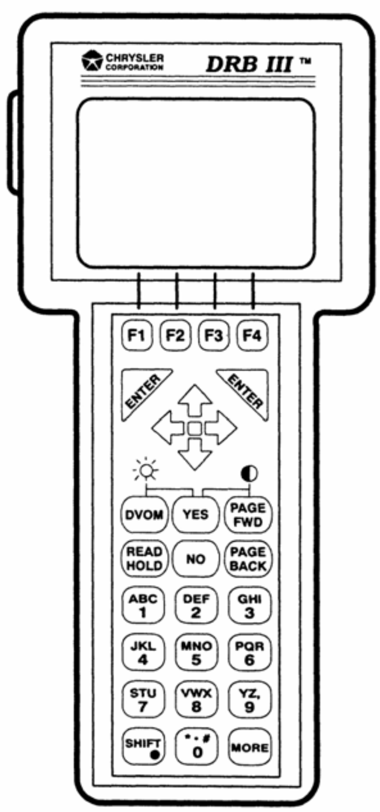

Figure 4 DRB III Scan Tool

STARSCAN SCAN TOOL

The new StarSCAN Scan Tool uses a keypad and a touch-screen interface. The StarSCAN must be used on vehicles with CAN-Bus communications to the DLC. This begins with 2004 HB and LX models. The StarSCAN is a standalone device and does not need to communicate with the MDS2. Flash files and updates will be downloaded directly over the internet. The tool is battery-powered and has a plug-in charger.

For the latest information, refer to this internet site: www.dcctools.com.

Figure 5 StarSCAN Scan Tool

TECHCONNECT

TechCONNECT is a secure internet website available through DealerCONNECT. The site provides technicians with access to scan tool and control module flash updates, and vehicle service and diagnostic information.

EVAP SYSTEM TESTING AND LEAK DETECTION

The first tool released for testing the integrity of the EVAP system was the EVAP System Pressure Tester. The Pressure Tester pressurizes the system and the Ultrasonic Leak Detector is then used to locate leaks. The pump includes an air hose, flow control switches, a pressure gauge and battery power leads.

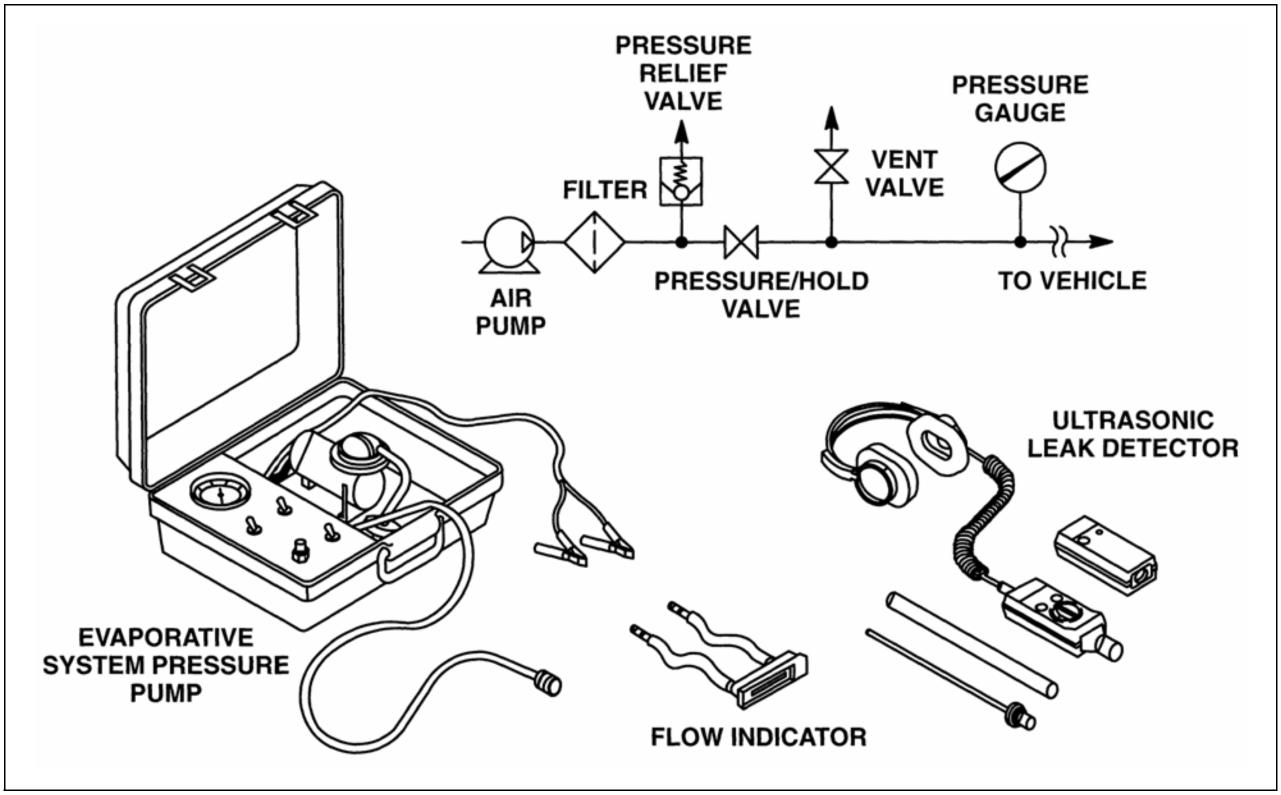

Figure 6 EVAP Pressure Tester and Ultrasonic Leak Detector

Currently, the required special tool for EVAP system leak testing is the Evaporative Emissions Leak Detection (EELD) Tester. The EELD can be used to test any EVAP system for leaks. The tester has a regulated air supply and a flow meter which can be used to pressurize the system to verify system integrity. The tester can produce smoke that leaves a residue that is visible in ultraviolet light.

Figure 7 EELD Tester

Notes: ____

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MODULE 3 EMISSION CONTROL SYSTEMS

PRE-OBD II COMPONENTS

Positive Crankcase Ventilation (PCV)

The Positive Crankcase Ventilation (PCV) System was one of the first emission control systems used. It was first used in California in 1961 and nationwide in 1963. The PCV system allows crankcase blowby gases (mostly unburned HC) to flow into the intake manifold and be burned with the air/fuel mixture. The PCV system replaces the old road draft tube which permitted blowby gases to be vented to the atmosphere.

The PCV Valve is a metering valve that controls this flow based on intake manifold vacuum. When the engine is OFF and when positive pressure, like a backfire, occurs in the intake manifold, the PCV Valve plunger is back-seated. This prevents all flow.

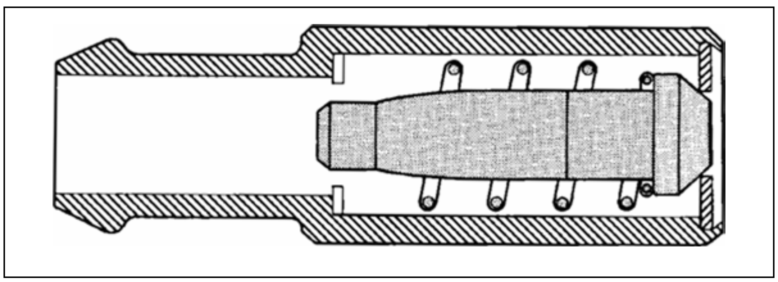


Figure 8 PCV Valve Plunger Back Seated - Closed

When intake manifold vacuum is high during cruise and idle, manifold vacuum pulls the PCV Valve plunger to fully compress a spring. The plunger restricts flow in this position.

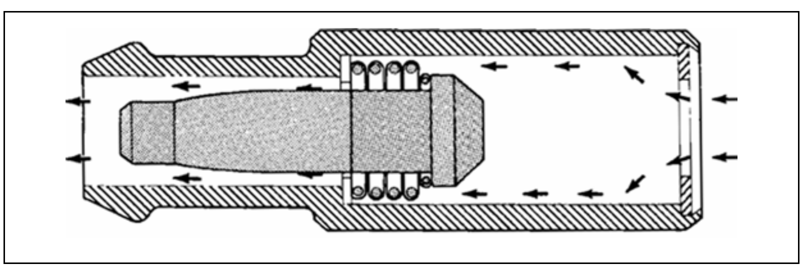


Figure 9 PCV Valve Plunger Front Seated – Low Flow

Moderate intake manifold vacuum causes the plunger to balance spring tension and the plunger is in a mid-position. This allows the greatest flow rate.

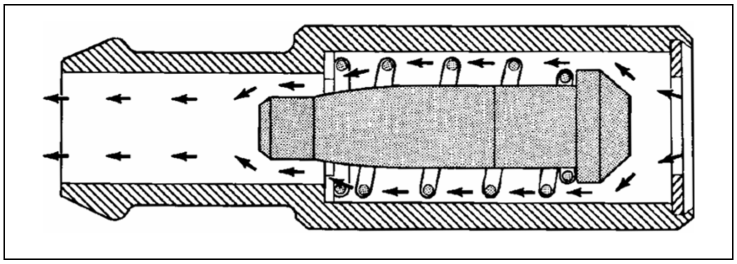


Figure 10 PCV Valve Plunger Mid-Position – High Flow

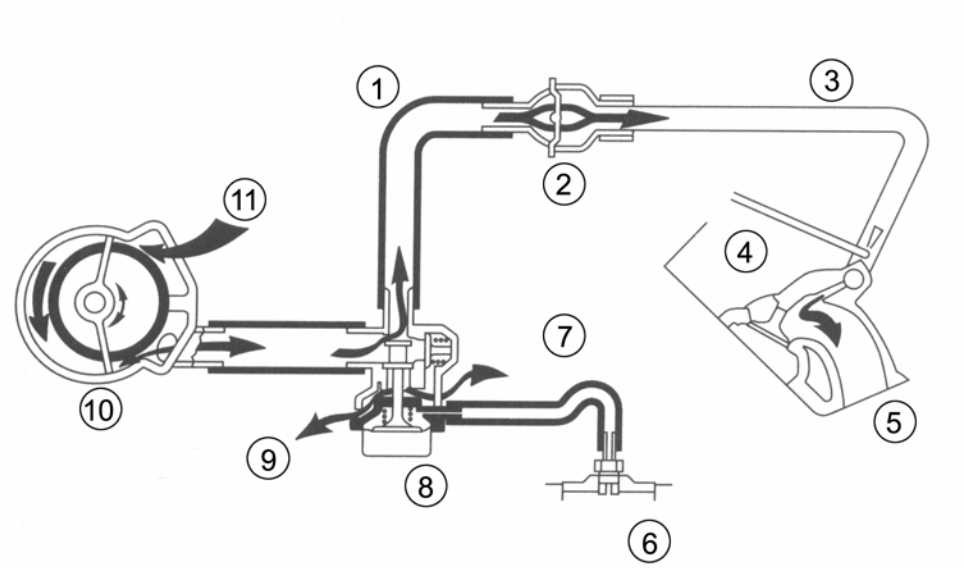
Some PCV systems use a fixed orifice in place of a PCV Valve. The fixed orifice is a calibrated opening in the line from the crankcase to the intake manifold that regulates the flow.

Air Injection Reaction (AIR)

First used in California in 1966, Air Injection Reaction (AIR) Systems, also known as Secondary Air Systems, were also one of the first emission control systems used.

AIR systems reduce hydrocarbon and carbon monoxide emissions by injecting air directly into the exhaust and/or the catalytic converter. This air provides extra oxygen to promote continued burning (oxidation) of the HC and CO that may not have burned in the engine cylinder. This burning takes place in the exhaust manifold or in the catalytic converter, depending upon where the air is injected. AIR can help catalytic converters to light-off faster.

The air is pumped by an engine-driven pump. More recently, electric motor pumps have been used.

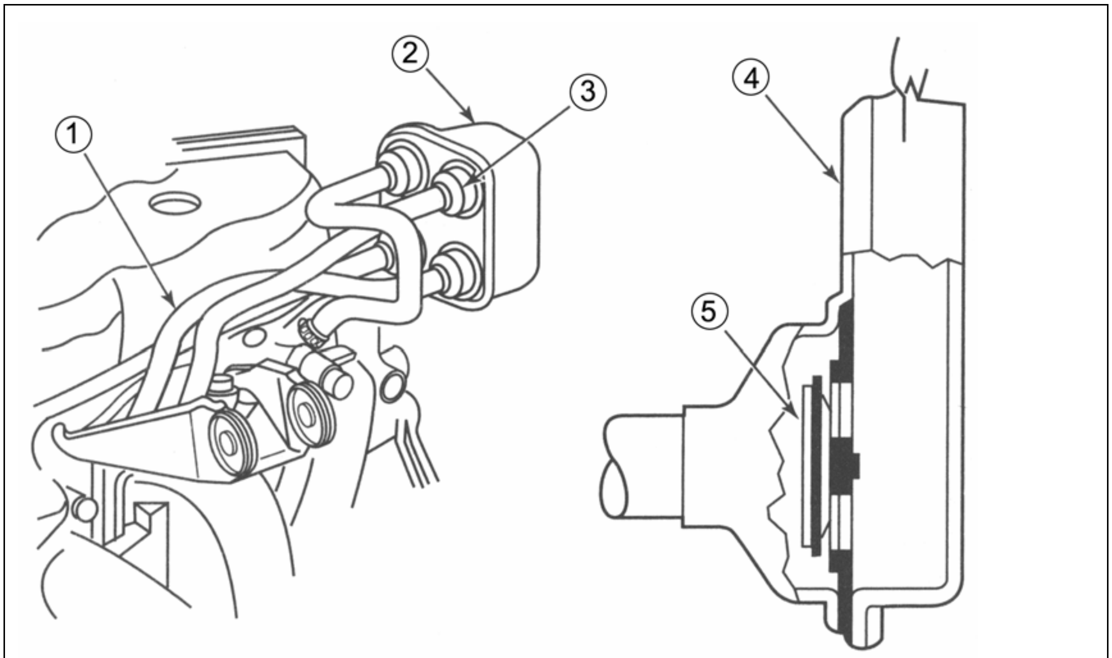


1	Formed Hose	7	High Speed By-Pass
2	Check Valve	8	Diverter Valve
3	Crossover Pipe	9	Deceleration By-Pass
4	Exhaust Valve	10	Air Pump
5	Exhaust Port	11	Air In
6	Manifold Vacuum Source		

Figure 11 AIR System – Engine Driven Pump

Pulsed air injection systems rely on exhaust system pressure waves to draw in ambient air. Exhaust gases leaving the cylinder are followed by a negative pressure pulse when the exhaust valve closes as the gases travel down the exhaust system.

When exhaust pressure pulses are negative, fresh air is drawn in past a check valve and into the exhaust manifold. When exhaust pressure is positive, the check valve prevents exhaust from flowing back up the air pipe.



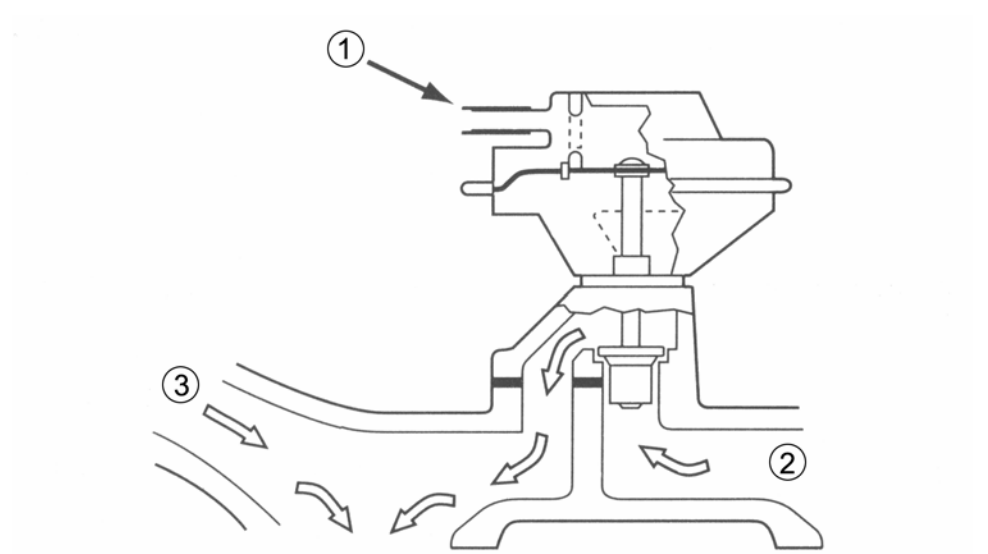
1	Manifold Pipes
2	Pulse Air Valve
3	Check Valves
4	Section Through Valve
5	Check Valve

Figure 12 Pulsed AIR System

Exhaust Gas Recirculation (EGR)

Exhaust Gas Recirculation (EGR) Systems have been used since the early 1970s. The Exhaust Gas Recirculation (EGR) system dilutes the incoming air/fuel mixture and displaces a portion of the burnable mixture with inert exhaust gases. Recycling some inert exhaust gases back into the intake air/fuel mixture can lower combustion temperatures and reduce the quantity of Oxides of Nitrogen (NOx) formed. EGR also improves fuel economy, since less air and fuel enter the cylinders, and it reduces engine knocking.

The EGR valve controls the flow of exhaust gases to the intake manifold. The valve can be operated by vacuum or electrically with a solenoid.



1	EGR Vacuum Port
2	Exhaust Gas
3	Intake Air

Figure 13 EGR Valve

Catalytic Converters

Reactions take place in catalytic converters to reduce amounts of harmful pollutants in the engine exhaust. Catalytic converters were first used in 1975. Ceramic blocks with a large number of honeycomb passages provide the substrate for the catalyst materials and a very large surface area. Platinum, palladium and rhodium are typically the catalyst materials applied to the substrate. When hot, these elements speed the chemical reactions that take place in the converter.

The first catalytic converters were two-way catalytic converters which oxidized excess hydrocarbons (HC) and carbon monoxide (CO) to form water vapor (H_2O) and carbon dioxide (CO_2).

The latest technology is the three-way catalytic converter, which still oxidizes HC and CO, but adds a second ceramic block with catalysts that reduce oxides of nitrogen (NOx). The NOx is reduced to nitrogen (N_2) and oxygen (O_2). The exhaust from the engine reaches the reduction catalyst first, then the oxidation catalyst behind it.

A three-way catalytic converter is most efficient when the air/fuel ratio is maintained at stoichiometry, or 14.7:1. The engine management system maintains this air/fuel ratio.

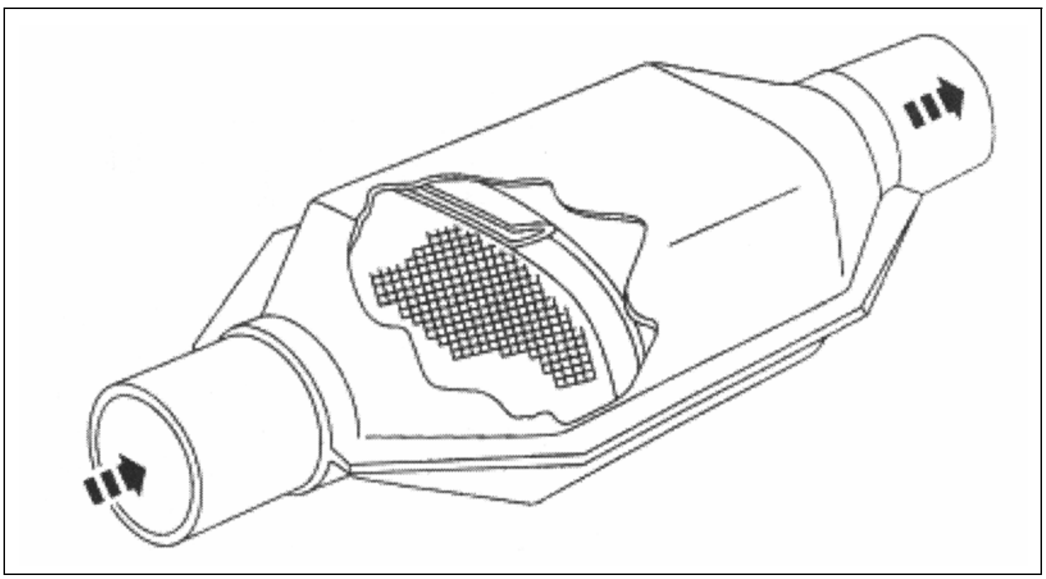


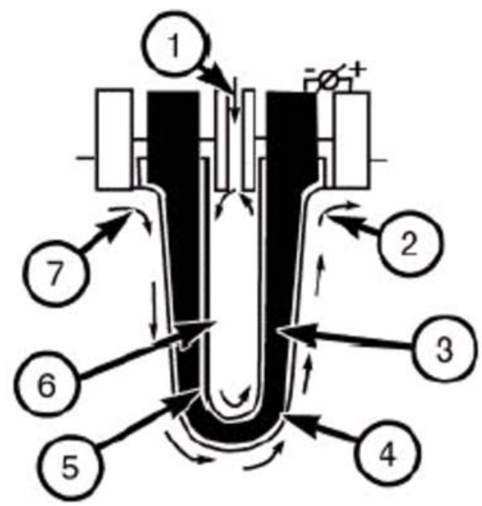
Figure 14 Catalytic Converter

Oxygen Sensors

Oxygen sensors provide a signal to the PCM for oxygen content in the exhaust and make the closed-loop feedback engine management system possible. The PCM infers air/fuel ratio from the sensor signal for oxygen content and adjusts the quantity of fuel injected based on the signal in order to keep the air/fuel ratio at stoichiometry (14.7:1).

Oxygen sensors have a zirconium dioxide element that compares ambient oxygen with oxygen levels in the exhaust. The sensor generates a voltage when hot. Typically the signal voltage is between 0.0 – 1.0V depending upon the oxygen level in the exhaust. When the level of oxygen in the exhaust is high, the signal voltage is low. When the level of oxygen in the exhaust is low (and the difference compared with ambient oxygen is greater), the signal voltage is high.

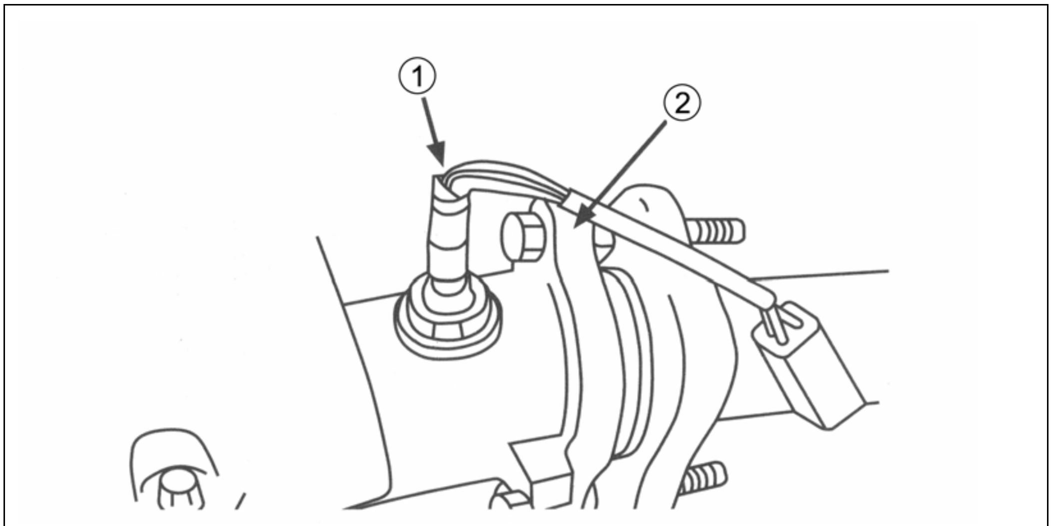
The oxygen sensor is located where it can sense engine-out exhaust gases, upstream from the catalytic converter.



1	Outside Air	5	Inner Electrode
2	Exhaust Oxygen	6	Ambient Oxygen
3	Solid Electrolyte	7	Exhaust Oxygen
4	Outer Electrode		

Figure 15 Oxygen Sensor Operation

Oxygen sensors must be hot to generate a reliable signal. Early one-wire sensors relied entirely on exhaust heat to maintain operating temperature. Today, all oxygen sensors have electric heater circuits to bring them up to operating temperature quickly and to maintain that temperature (572°F (300°C) min.).



1	Heated Oxygen Sensor
2	Exhaust Manifold Outlet

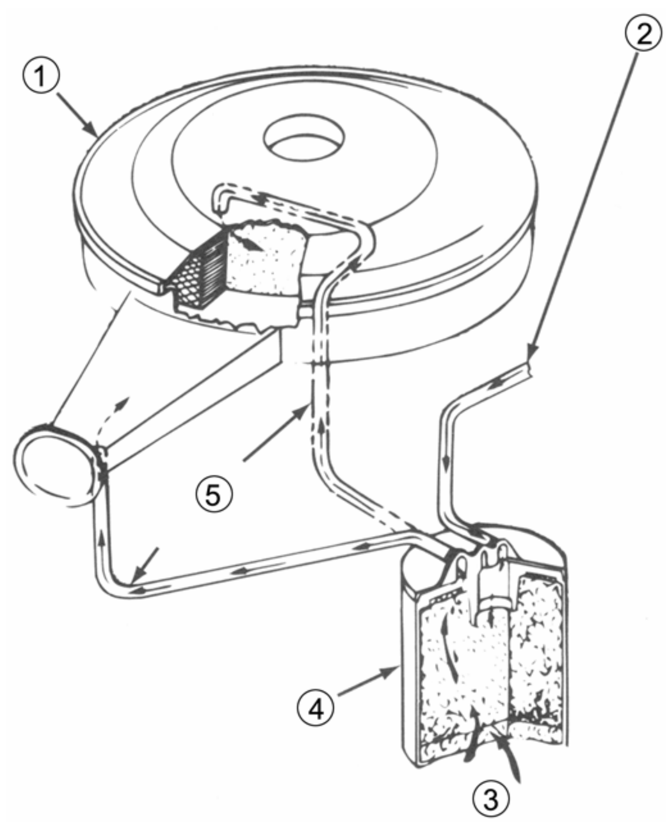
Figure 16 Heated Oxygen Sensor

Evaporative Emissions (EVAP)

The Evaporative Emissions (EVAP) System stores fuel vapors (unburned hydrocarbons or HC). Evaporating fuel in the tank and from refueling is absorbed and stored in the charcoal canister. Engine vacuum causes air flow through the canister during engine operation. This flow purges HC and meters it into the intake manifold.

Early EVAP systems were simple with few controls. Typically purge flow occurred whenever the engine ran and the throttle was open beyond idle.

EVAP systems today are much more carefully controlled. Typically the PCM controls a purge solenoid to regulate flow.



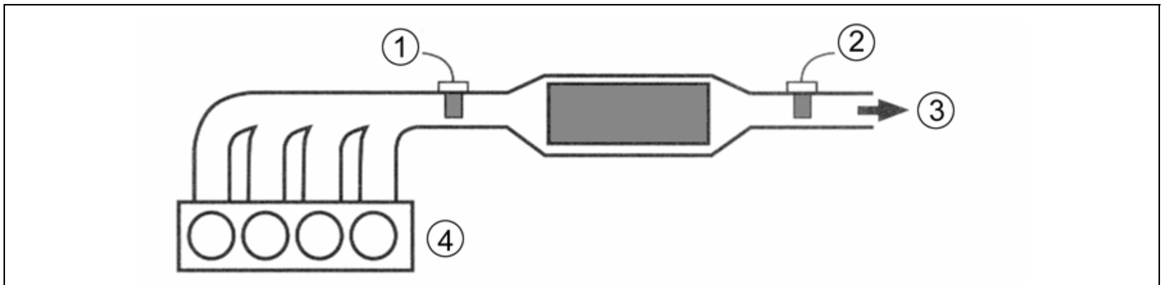
1	Air Cleaner	4	Vapor Storage Canister
2	Vapor Vent Line From Fuel Tank or Carburetor	5	Purge Line Alternative Locations
3	Purge Air		

Figure 17 Early EVAP System

OBD II COMPONENTS

Downstream Oxygen Sensors

OBD II regulations require that catalytic converter efficiency be monitored and tested. Downstream oxygen sensors are placed after the catalytic converter to accomplish this. The PCM compares the signals from both upstream and downstream oxygen sensors to judge the health of the catalytic converter. A good catalytic converter can store excess oxygen, so the signal waveform of a downstream oxygen sensor should show fewer oscillations than the waveform of an upstream sensor. When the upstream and downstream waveforms become too similar, the PCM knows that the catalytic converter is failing.



1	Upstream O_2 Sensor	3	Exhaust Gas
2	Downstream O_2 Sensor	4	Engine

Figure 18 Downstream Oxygen Sensor Location

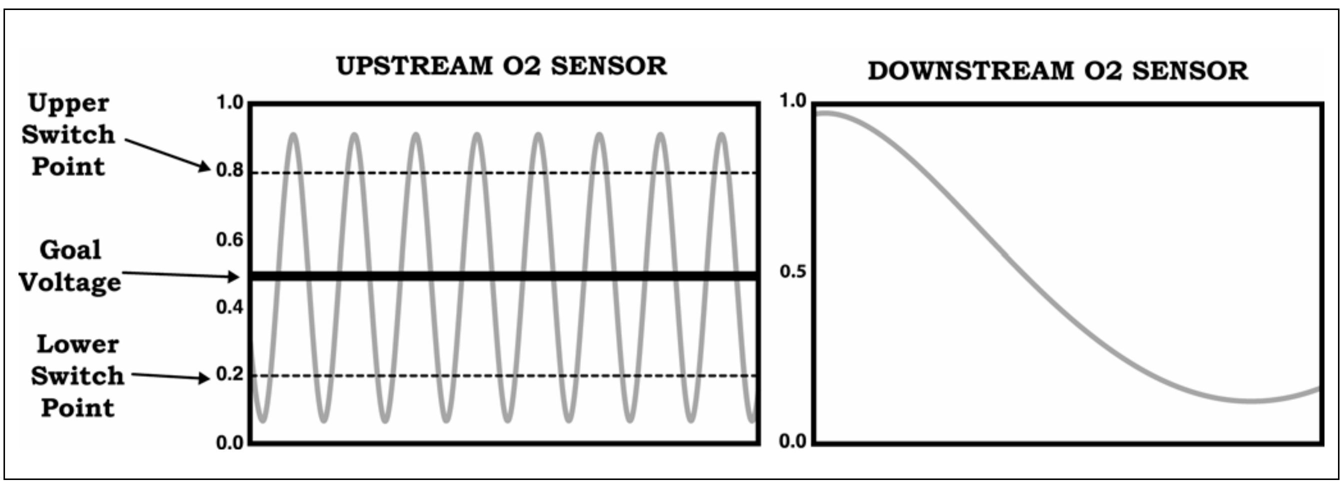
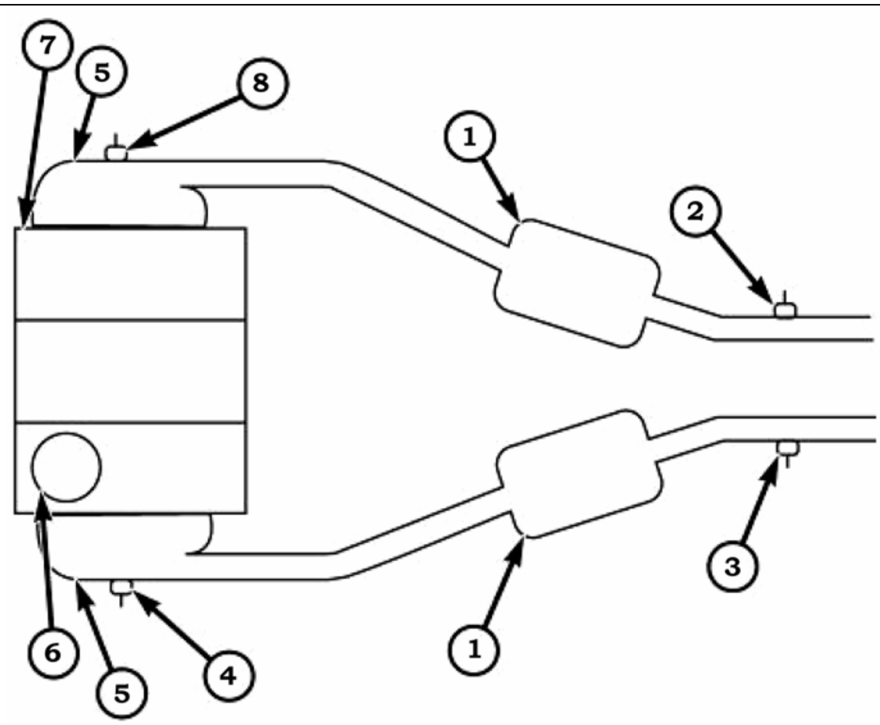


Figure 19 Upstream and Downstream O_2 Sensor Signals

Oxygen Sensor Locations and Naming

O_2 sensors are named by their location. Typical names are 1/1, 1/2, 1/3, 2/1, etc. The first digit indicates the bank of the engine served by the O_2 sensor. A first digit "1" indicates the O_2 sensor is on the same bank as number 1 cylinder. A first digit "2" represents a location on the bank opposite number 1 cylinder. The second digit represents upstream (1), downstream (2) or mid-catalyst (3) locations. As an example, "1/2" would represent an O_2 sensor located downstream, on the bank with number 1 cylinder. Upstream and downstream sensors operate in a similar way but may not be interchangeable due to physical differences.



1	Catalytic Converter	5	Exhaust Manifold
2	Oxygen Sensor (2/2)	6	Cylinder #1
3	Oxygen Sensor (1/2)	7	Engine
4	Oxygen Sensor (1/1)	8	Oxygen Sensor (2/1)

Figure 20 Oxygen Sensor Naming Conventions

EVAP Leak Detection

Fuel and EVAP systems that leak can add significant amounts of fuel vapors (HC) to the atmosphere. OBD II regulations require that vehicle on-board diagnostics monitor EVAP systems for leaks. Over the years, several different methods have been used to detect leaks.

- Engine manifold vacuum and EVAP system pressure sensor
- Leak Detection Pump and switch
- Natural Vacuum Leak Detection Assembly and switch

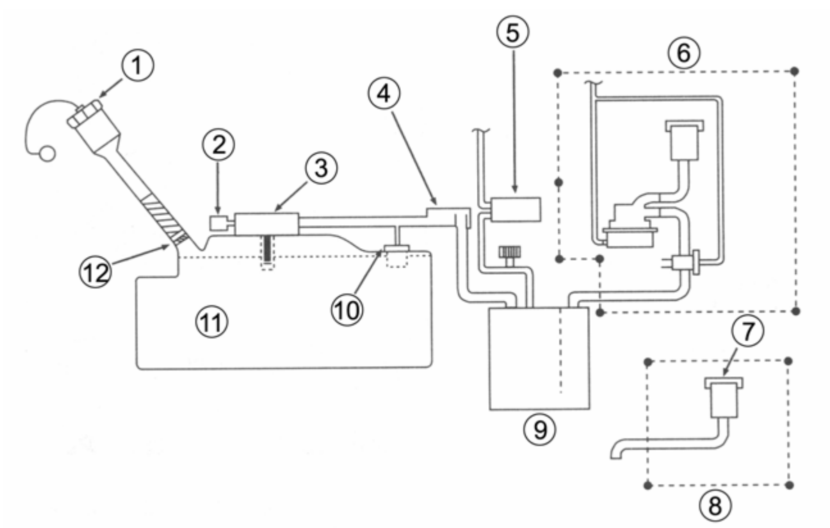
All of these methods apply either pressure or vacuum to a sealed EVAP system and then monitor for the rate of pressure or vacuum decay that would indicate a leak.

Onboard Refueling Vapor Recovery (ORVR)

Previous EVAP systems vented fuel vapor (HC) emissions during refueling. The Onboard Refueling Vapor Recovery (ORVR) system greatly reduces these HC emissions. ORVR was first introduced on some 1998 passenger vehicles.

Fuel flowing into the small-diameter tank filler tube (approx. 1" I.D.) creates a venturi effect which draws air into the fill tube. During refueling, the fuel tank is vented to the charcoal canister to capture HC vapors. With air flowing into the filler tube, no fuel vapors escape to the atmosphere.

Once the HC vapors from refueling are captured by the canister, the vehicle's computer-controlled EVAP purge system draws the HC out of the canister for the engine to burn. The vapor flow is metered by the purge solenoid so that there is minimal impact on driveability or on tailpipe emissions.



1	Fuel Cap	7	Breather Element
2	Liquid Trap	8	W/O LDP
3	Control Valve	9	Canister
4	Liquid Separator	10	Rollover Valve
5	Purge	11	Fuel Tank
6	W/LDP	12	Check Valve

Figure 21 Onboard Refueling Vapor Recovery System

Notes:

MODULE 4 SPEED DENSITY FUEL CONTROL REVIEW

SPEED DENSITY EQUATION

Most Chrysler Group vehicle use Speed Density fuel control systems. This system changes fuel injection quantity largely based on changes in engine speed and load. Other parameters modify the basic fuel calculation. The Speed Density Equations below are a representation of how NGC, JTEC and SBEC controllers calculate fuel injector pulse width in order to maintain a stoichiometric (14.7:1) air/fuel ratio.

This shows a representation of the Speed Density Equation used by SBEC and JTEC controllers to modify fuel injection quantity:

Load	Base PW Calculation	O2	Adaptive	P.W.
$\frac{\text{RPM}}{\text{Max RPM}}$ (X) $\frac{\text{MAP}}{\text{Baro}}$	(X) TPS (X) ECT (X) IAT (X) Sensed B+ (X) LT	(X) Up02	(X) STFT (X) LTFT	= Pulse Width

Figure 22 JTEC/SBEC Speed Density Equation

NGC controllers utilize a new updated representation of the Speed Density Equation to modify fuel injection quantity. Because of the increased capabilities of NGC, the equation is a little different. EGR flow and extra fuel from EVAP purge are also part of the equation now. This is a representation of the NGC Speed Density Equation:

Air Flow	Fuel Modifiers	Feedback Input	Adaptives	P.W.
$\frac{\text{RPM}}{\text{Max RPM}}$ (X) $\frac{\text{MAP}}{\text{Baro}}$ (X) EGR Flow*	(X) TPS (X) ECT (X) IAT (X) Sensed B+	(X) Up O2	(X) ST (X) LT (X) Purge Vapor Ratio*	= Pulse Width

*Where Equipped

Figure 23 NGC Speed Density Equation

The following explains how the PCM derives each multiplier in the NGC Speed Density Equation:

Air Flow

The PCM calculates engine rpm from the Crankshaft Position (CKP) Sensor signal. The Camshaft Position (CMP) Sensor determines which of the two companion cylinders should receive fuel and spark. Basic airflow requirements are determined by dividing the current engine rpm value by the theoretical maximum (rated) rpm. The Speed Density Equation allows the PCM to determine the percentage of the maximum possible airflow currently entering the engine.

The Manifold Absolute Pressure (MAP) Sensor measures the level of pressure (vacuum) in the intake manifold to determine the level of engine load. This measurement is compared with atmospheric (barometric) pressure. The Speed Density Equation divides MAP by BARO to determine the level of engine load.

There is always a slight lag in response from the MAP sensor itself. Therefore, NGC vehicles calculate the expected MAP value based on inputs for throttle position, barometric pressure and IAC position. This is part of the “Model-Based Fuel Strategy” and this calculated value is called “T-MAP”. MAP sensor input validates this calculated value. Whenever a MAP DTC is set or a MAP problem occurs, the PCM will use the T-MAP value. T-MAP values will appear on the DRB III as “real” MAP values.

Exhaust Gas Recirculation (EGR) is used for control of NOx emissions and to improve fuel economy. Exhaust gases are metered through a valve into the intake manifold. Exhaust is mostly inert carbon dioxide and in the engine cylinder, it displaces a percentage of the incoming air. Because EGR gases effectively reduce the size of the combustion chamber, there is less room for air/fuel mixture. Less air is drawn in and less fuel is needed. The PCM compensates by reducing fuel quantity.

Fuel Modifiers

Throttle Position Sensor (TPS) input informs the PCM of operating conditions such as idle (Min TPS), wide open throttle (WOT), decel and the rate of throttle opening. These conditions can affect engine fuel requirements and the fuel injection pulse width calculation: acceleration enrichment, decel fuel shutoff, WOT indicating open loop while running or fuel injector shutoff (clear-flood) while cranking.

The Engine Coolant Temperature (ECT) Sensor is monitored to determine initial cranking injector pulse width and also temperature compensation while the engine is running.

Air density changes as a factor of air temperature and altitude. Denser air requires more fuel to maintain a stoichiometric air/fuel ratio. The Intake Air Temperature (IAT) Sensor allows the PCM to calculate the density of the incoming air and modify the Speed Density calculation accordingly.

The voltage applied to the fuel injectors affects how rapidly and how far the injector pintle opens. The quantity of fuel injected in a given amount of time changes with variations in voltage. Sensed B+ or sensed system voltage is monitored and used by the PCM to correct injector pulse width.

Feedback Input

The oxygen sensor provides the PCM with a feedback signal for oxygen levels in the exhaust. The PCM infers air/fuel ratio from this signal to see how well the Speed Density calculation has predicted fuel requirements for current engine speed, load and other conditions.

Open Loop Operation

The PCM is in Open Loop mode during a cold start when the oxygen sensors are below 660°F (349°C), and also when the engine is operated at wide open throttle (WOT). In Open Loop, the PCM ignores the oxygen sensors and performs air/fuel ratio adjustments based on pre-programmed values and inputs from other sensors.

Closed Loop Operation

In Closed Loop operation, the PCM monitors oxygen levels in the exhaust and makes air/fuel ratio adjustments based on oxygen sensor feedback. The upstream oxygen sensor voltage signal verifies that the fuel system is operating at the 14.7:1 stoichiometric ratio. All tailpipe emissions, HC, CO and NOx are at their lowest points simultaneously when this fuel ratio is maintained.

There are two types of Closed Loop operation:

Short-Term: Immediate corrections are made to the pulse-width in response to the oxygen sensor, but these values are not stored in memory. The parameters are:

- Engine temperature exceeds 30 - 35°F (-1 - 2°C)
- Oxygen sensor is switching
- All timers have timed out following the START to RUN transfer (the timer lengths vary, based upon engine temperature at key-on)

Long-Term: Values are stored in non-volatile memory based on short-term corrective values. The parameters are:

- Full operating temperature
- All timers have expired

Note: Times and temperatures may vary for each engine package.

Short Term Adaptive

Short Term Adaptive or Short Term Fuel Trim (STFT), is an immediate correction to fuel injector pulse width. It is an immediate response to an O_2 sensor signal that is not switching or is consistently high or low. Short Term Adaptive begins functioning shortly after the vehicle has started, as soon as the oxygen sensor is heated to operating temperature.

Short Term Adaptive values change very quickly and are not stored when the ignition is OFF. The maximum range of authority for Short Term Adaptive is ±33% for NGC and JTEC, and ±25% for SBEC.

Long Term Adaptive

After the vehicle has reached full operating temperature, the correction factors generated by Short Term Adaptive will be stored in Long Term Adaptive or Long Term Fuel Trim (LTFT) memory cells. These long term values allow the Short Term Adaptive value to be brought back close to zero. Once this correction factor is stored in memory, it will be used by the PCM under all operating conditions, open loop and closed-loop.

Long Term and Short Term Adaptive can each change the pulse width by as much as ±33% (NGC and JTEC) or ±25% (SBEC) for a maximum total correction of ±66% (NGC and JTEC) or ±50% (SBEC) from the base pulse width calculation.

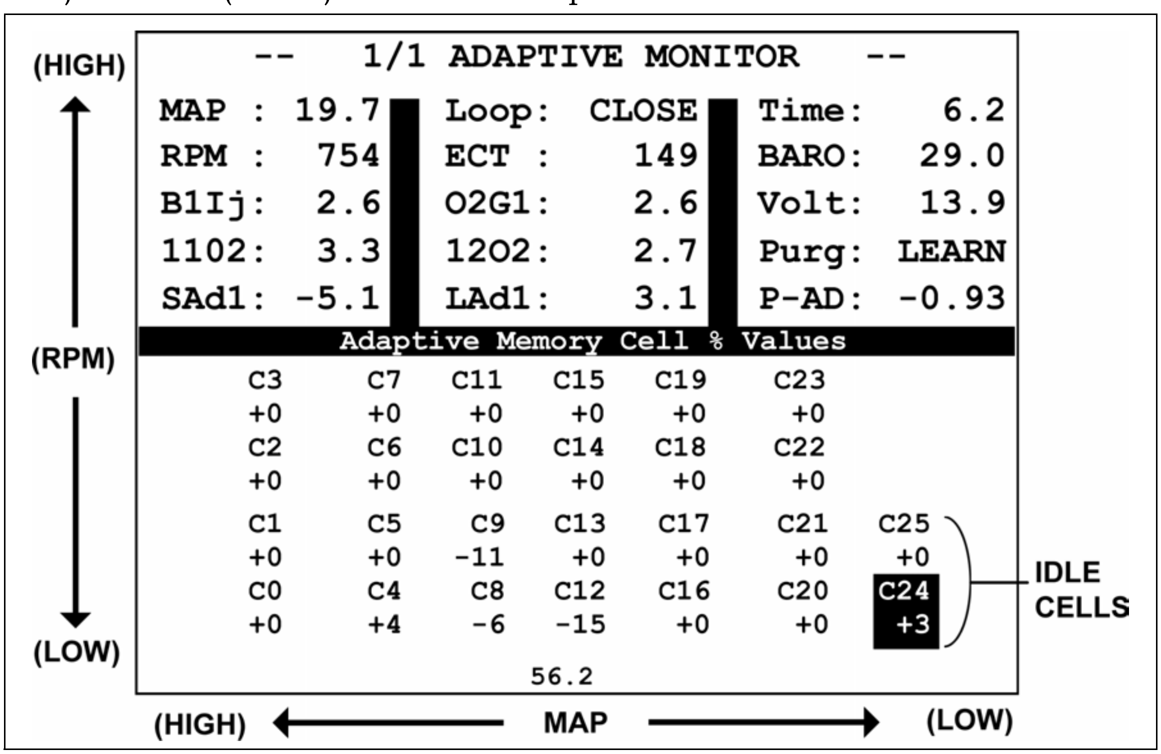


Figure 24 NGC Adaptive Fuel Monitor Screen

Purge Vapor Ratio

Purge Vapor Ratio is the proportion or concentration of fuel (Hydrocarbon) vapors in the EVAP system purge flow. If purge flow contains a high ratio of HC vapors, less fuel from the injectors is required.

ACTIVITY 1: FUEL ADAPTIVES

Notes:

MODULE 5 HOW DOES OBD II WORK?

OBD I systems had limited ability to check individual components. OBD II systems carry over the capabilities of OBD I systems with added improvements. OBD II diagnostics check component and system operation and can detect more types of faults.

All manufacturers were required to standardize parameters to make things easier for the technician. For example, much more information is stored when a fault occurs.

STANDARDIZATION

OBD II requirements have standardized parameters that in the past were optional for the manufacturer. The Society of Automotive Engineers (SAE) has created these mandatory standards:

- J1930: Standard Terminology
- J1962: Standard Data Link Connector
- J2012: Standard Diagnostic Trouble Codes
- J1850: Standard Communication Protocol
- J1978: Standard Generic Scan Tool
- J1979: Standard Protocol for Diagnostic Test Modes
- J2008: Availability of Emissions Service Info
- J2284/3: Standard for High Speed CAN Communications

TERMINOLOGY

In 1991 the SAE published Standard J1930 for electrical and electronic system terms, definitions, abbreviations, acronyms and diagnostics. This publication contains standards for naming current systems and systems under development. This standard applies to the following:

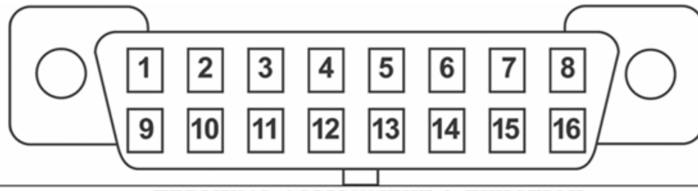
- Diagnostic, Service and Repair Manuals
- Bulletins and Updates
- Training Manuals
- Repair Data Bases
- Under-Hood Emissions Labels
- Emissions Certification Applications

DATA LINK CONNECTOR

OBD II requires the use of a single diagnostic link called a Data Link Connector (DLC). The DLC is a 16-pin connector of specified form per SAE Standard J1962.

The DLC is located on the left side of the vehicle, in or under the instrument panel. Technicians must be able to easily access the DLC from a kneeling position outside the vehicle.

The DLC and the on-board diagnostics must accept and recognize generic scan tools.



TERMINAL ASSIGNMENT & FUNCTION			
		DaimlerChrysler Corporation	
PIN	**SAE/ ISO**	**A (1994MY - 2002MY+)**	**B (2002MY+)**
1	Manufacturer Discretionary	RKE Programming Input	not used
2	SAE J1850 (+)	SAE J1850 10.4 Kbps	SAE J1850 10.4 Kbps
3	Manufacturer Discretionary	CCD (+)	not used
4	Chassis Ground	Power Ground	Power Ground
5	Signal Ground	Signal Ground	Signal Ground
6	ISO 15765-4 CAN-C (+)	SCI A Rx (Receive) (*Engine*)	ISO 15765-4 CAN-C (+)
7	ISO 9141-2 K-line ISO 1423-4 K-line	ISO 9141-2 K-line/ SCI Tx (Transmit) (*Engine/Transmission*)	SCI Tx (Transmit) (*Engine*)
8	Manufacturer Discretionary	A/D Signal Output/Switched Ignition	Switched Ignition
9	Manufacturer Discretionary	SCI B Rx (Receive)/ J1850 Flash Enable	SCI Rx (Receive) (*Trans.*)/ J1850 Flash Enable
10	SAE J1850 (-)	Reserved	Reserved
11	Manufacturer Discretionary	CCD (-)	not used
12	Manufacturer Discretionary	SCI C Rx (Receive)	SCI Rx (Receive) (*Engine*)
13	Manufacturer Discretionary	Lo-Driver/SCI Tx (Transmit) (*Body/Chassis*)	not used
14	ISO 1565-4 CAN-C (-)	SCI D Rx (Receive) (*Transmission*)	ISO 15765-4 CAN-C (-)
15	ISO 9141-2 L-line/ ISO 14230-4 L-line	Inverted SCI Tx (Transmit)	SCI Tx Transmit (*Trans.)*
16	Unswitched Battery Voltage	Battery Voltage	Battery Voltage

Figure 25 Data Link Connector Pin Locations

OBD II MONITORS

OBD II requires the diagnostic system to verify the operation of all emissions-related components and systems. Many of these components and systems were already being checked on OBD I systems. OBD II added additional tests.

The following is a list of required OBD II diagnostic tests:

Comprehensive Components

Comprehensive Components include all input and output components that can affect emissions. These components are monitored for electrical faults such as opens and shorts, similar to OBD I. In some cases, these components are also monitored for rationality and functionality. This will be discussed in more detail in Module 5.

Major Monitors

Major Monitors use the information gathered from Comprehensive Components to evaluate the overall performance of specific components or systems under specific operating conditions.

Major Monitors include the following:

- Fuel Control System
- Misfire
- Catalyst
- Oxygen Sensors
- Oxygen Sensor Heaters
- EGR System (if equipped)
- Secondary Air (if equipped)
- Evaporative (EVAP) System
    - Purge
    - Leak Detection

Some Monitors operate at all times while the engine is running. Other Monitors make their checks only once per trip (and when enabling conditions permit). You will see more information on Monitors in Modules 7 - 10.

PCM TASK MANAGER

The heart of the OBD II diagnostic system is the Powertrain Control Module (PCM). The PCM is a microprocessor-based digital computer that receives input signals from various switches and sensors. The PCM stores and processes this information and, based on these inputs, the PCM controls output devices to modify engine and vehicle operation.

The PCM is responsible for coordinating the operation of a large number of emission-related components. The PCM is also responsible for determining whether the diagnostic systems are operating properly. The software designed to carry out these responsibilities is called the Task Manager.

The Task Manager is the "traffic cop" that determines the occurrence and sequence of tests, events and functions. The Task Manager organizes and prioritizes the diagnostic procedures. In other words, the Task Manager determines whether enabling conditions have been met to run appropriate tests, monitors parameters during tests, and records test results. Task Manager responsibilities include:

- Monitor Test Sequence
- Monitor Trip Indicator
- Monitor Readiness Indicator
- MIL Illumination
- DTC Identification
- Freeze Frame Data Storage
- Similar Conditions Window

To ensure accurate test results, the Task Manager can decide whether to run or complete a monitor test based upon vehicle operating conditions. In some cases, the Task Manager can withhold specific monitor information until other related monitors have completed.

Pending

The Task Manager may not run a particular Monitor if the MIL is illuminated and a fault is stored. In these situations, the Task Manager postpones running the Monitor pending resolution of the fault. The Task Manager does not run the test until the problem is no longer present.

Conflict

The Task Manager may not run a particular Monitor if another test is in progress. In these situations, running one Monitor may adversely affect the results of another Monitor. If this conflict is present, The Task Manager does not run the second Monitor until the conflicting condition passes. Example: When the EVAP Monitor is in progress, the Task Manager will not run the EGR Monitor, since both tests watch changes in air/fuel ratio and adaptive fuel compensation.

Suspend

Sometimes the Task Manager may not allow a two-trip fault to mature, but will suspend the maturing of the fault if conditions exist that might lead to erroneous results. This reduces the chances of the MIL illuminating for the wrong fault. Example: If the PCM is storing one-trip faults for the Oxygen Sensor and EGR Monitors, the Task Manager may allow the EGR Monitor to run but will suspend the results until the Oxygen Sensor Monitor either passes or fails. That will permit the Task Manager to determine whether the failure is in the EGR system or an Oxygen Sensor.

TRIP COUNTERS

Trips are criteria used to turn OFF the MIL. A trip is defined as "starting the vehicle and operating it to meet the criteria necessary to run a given diagnostic test".

CARB requires three good trips to extinguish the MIL.

A Good Trip is an indication that the vehicle was operated under a specific set of operating conditions and no fault was detected. There are different types of Good Trips depending upon what the PCM is trying to verify.

Following an engine OFF period, the vehicle is driven so that all once-per-trip monitors run. With NGC, at least two minutes of run time are required for a Good Trip. NGC processes the Good Trip on shutdown. This means that you will have to cycle the key to see a Good Trip increment.

There are four Good Trip counters:

- Global Good Trip
- Fuel System Good Trip
- Misfire Good Trip
- Alternate Good Trip (appears on DRB III as Global Good Trip)
  - Comprehensive Components
  - Major Monitor

The Good Trip Counter is displayed on the DRB III.

Global Good Trip

A Global Good Trip has taken place when all Monitors that run once per trip have run and have passed. The definition of a Global Good Trip varies by vehicle and model year. Typically, the Oxygen Sensor and Catalyst Efficiency Monitors must run in order to increment a Global Good Trip.

Fuel System Good Trip

A Fuel System Good Trip has taken place when the following conditions occur:

- Engine is in Closed Loop
- Operating in Similar Conditions Window
- Total Adaptive Memory Factor (Short Term Adaptive value and Long Term Adaptive value combined) does not exceed the threshold for a calibrated time

If the above conditions are met, the PCM will count a Good Trip toward erasing a fuel system monitor (rich/lean) DTC.

Misfire Good Trip

A Misfire Good Trip has taken place when the following conditions occur:

- Operating in Similar Conditions Window (SBEC/JTEC only)
- 1000 engine revolutions occur with no misfire

Alternate Good Trip

Alternate Good Trips are used in place of Global Good Trips for Comprehensive Components and Major Monitors. If the Task Manager cannot run a Global Good Trip, it will attempt to count an Alternate Good Trip.

The Task Manager counts an Alternate Good Trip for Comprehensive Components when the following conditions occur:

- Two minutes of engine run time
- No other faults occur

The Task Manager counts an Alternate Good Trip for Major Monitor when the monitor runs and passes. Only the Major Monitor that failed needs to pass to count an Alternate Good Trip.

Warm-Up Cycle

Warm-Up Cycles are counted by the PCM and are used to erase DTCs and Freeze Frames. Once the MIL has been extinguished by the Good Trip Counter, the PCM uses the Warm-Up Cycle Counter, which can be seen on the DRB III. CARB requires that 40 Warm-Up Cycles must occur before the PCM can self-erase a DTC and its Freeze Frame.

A Warm-Up Cycle is defined by CARB as follows:

- Engine Coolant Temperature Must Start Below And Rise Above 160°F (71°C)
- Engine Coolant Temperature Must Rise At Least 40°F (22.2°C)
- No Other Faults Occur

Drive Cycle

A Drive Cycle occurs when a vehicle is driven in a specific way. The procedure is designed to allow most monitors to run and perform their tests. Drive Cycles can specify calibrated values for engine temperature increase, vehicle speed, time, and other parameters. See “Federal Test Procedure” in Module 7.

Notes:

Notes:

MODULE 6 DIAGNOSTIC TROUBLE CODES (DTCS)

Diagnostic Trouble Codes (DTCs) are stored in PCM memory when a Monitor recognizes an abnormal condition within a system being checked. SAE standard J2012 and the EPA define OBD II standards for the five-digit alphanumeric DTC codes. The MIL will illuminate when a DTC is set, based on Monitor failure criteria.

DTCs can help speed diagnosis by telling the technician which systems are affected by the fault.

SAE J2012 requires a uniform DTC format. This format assigns alphanumeric codes to malfunctions and suggests standard definitions for all generic (SAE universal) DTCs. Manufacturers can also assign their own unique DTCs. The second digit indicates whether the DTC is generic or manufacturer-specific.

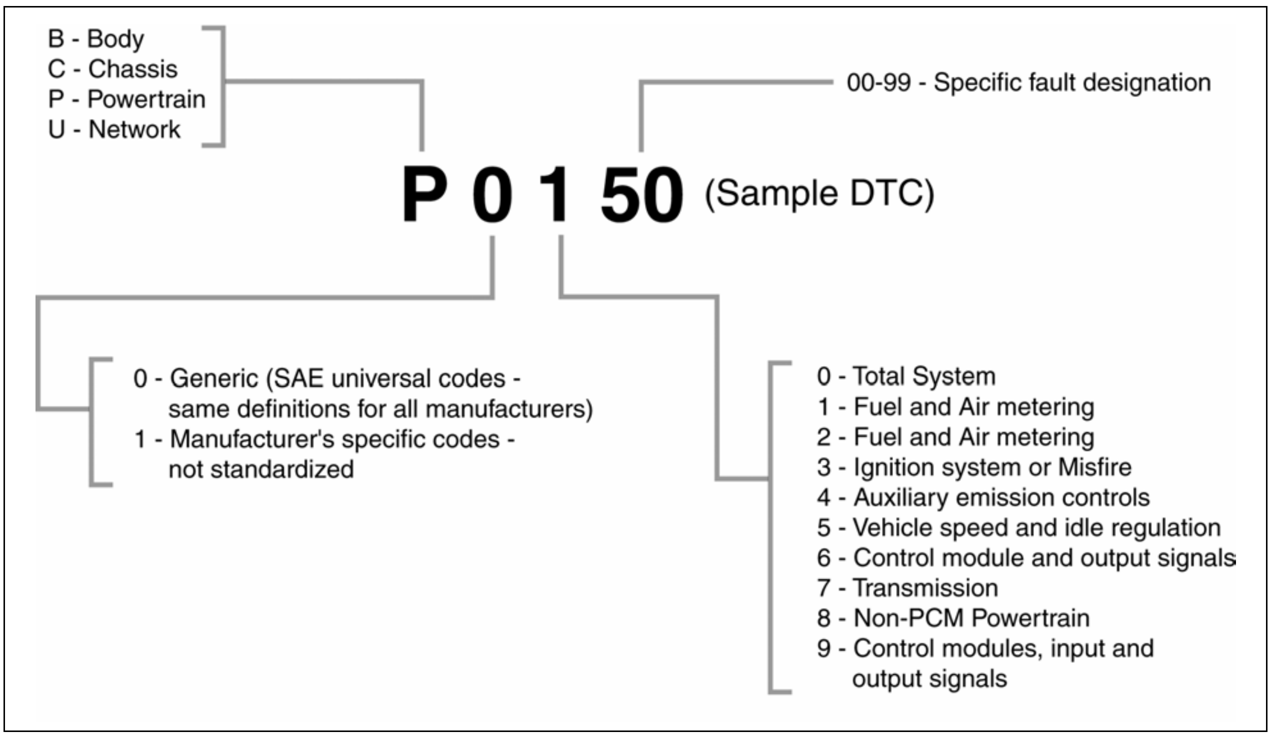


Figure 26 Diagnostic Trouble Code Format

HEX ID CODE

The Hex ID Code is a two-digit hexadecimal code read by the DRB III and MDS. A "$" appears before the two digits and identifies the code as a Hex code. The DRB III deciphers this code and displays the DTC text. The Hex code appears on the "On-Board Diagnostics Monitor" DRB III screen, and on the MDS when monitoring the Data Recorder and in the Service and Powertrain Diagnostics Procedures Manuals.

DTC TEXT

Diagnostic Trouble Code text appears on DRB III and MDS screens when reading DTCs. The text description will define the fault detected.

TYPES OF FAULTS

Circuit Continuity

Circuits for power train comprehensive components are tested for:

- Open Circuits
- Shorts to Ground
- Shorts to Positive (power)

Any circuit abnormality detected will cause a DTC to be set. Example: P0107 MAP SENSOR LOW can be caused by an open in the 5V supply or the supply circuit or signal circuit shorted to ground.

Rationality

In addition to continuity checks, OBD II systems also check power train component inputs for rationality. This means that the input signal is compared against other inputs and stored information to see if it makes sense under the current conditions.

Sensor inputs that are checked for rationality include:

- Manifold Absolute Pressure (MAP) Sensor
- Crankshaft Position (CKP) Sensor
- Camshaft Position (CMP) Sensor
- Vehicle Speed (VSS) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Intake Air Temperature (IAT) Sensor
- Throttle Position (TPS) Sensor
- Ambient/Battery Temperature (BTS) Sensor
- Oxygen Sensor
- Oxygen Sensor Heater
- Power Steering Switch
- Brake Switch
- Leak Detection Pump/NVLD Switch

- Park/Neutral Switch
- Transmission Controls
- CNG Fuel Temperature Sensor

Functionality

OBD II systems test PCM outputs for functionality as well as circuit continuity. When the PCM supplies a voltage to an output component, it can verify that the command was carried out by monitoring specific input signals for expected changes. For example, when the PCM commands the Idle Air Control (IAC) Motor to change position under certain operating conditions, it expects to see a specific target idle speed. If it does not, a DTC is stored.

Outputs that are checked for functionality include:

- Fuel Injectors
- Ignition Coils
- Idle Air Control (IAC) Motor
- Torque Converter Clutch (TCC) Solenoid
- Purge Solenoid
- EGR Solenoid
- Electric Air Pump
- Aspirator
- Leak Detection Pump Solenoid
- Radiator Fan Control
- Transmission Controls

DTC AND MIL STRATEGIES

Self-Clearing DTCs

If the PCM detects an emissions-related component fault or system fault, it will illuminate the MIL and set a DTC.

Most emissions-related faults must fail the diagnostic Monitor test on two consecutive trips for the MIL to illuminate. These tests are “Two Trip Monitors”.

When the first test fails, the Task Manager stores a pending DTC. If the component fails for a second time on the next trip, the DTC “matures” and the MIL is illuminated.

Non-emissions related Monitor tests illuminate the MIL after a single failure. These tests are known as “One Trip Monitors”. A DTC is set and the MIL illuminated after one failure.

If the component or system failure does not reoccur after three consecutive Good Trips, the MIL is turned OFF, but the stored DTC will remain in memory. If the failure does not repeat after 40 Warm-Up Cycles, the DTC will be erased from memory.

Distance Since MIL Set

This was phased in on some NGC vehicles in the 2000 model year to satisfy EURO requirements. The counter updates every 0.6 mi. (1.0 km). It stops counting when three consecutive Good Trips occur. The data remains in memory until 40 warmup cycles are completed. If another DTC is set, the counter starts again at zero.

DTCs and the DRB III

DTCs can be erased at any time with the DRB III. Erasing the DTC will also erase all stored OBD II Monitor information. This includes all counter information for warm-up cycles, start cycles, trips, and Freeze Frame Data.

DTC PRIORITIES

CARB has mandated that DTCs are entered and ranked according to priority. In earlier vehicles with limited memory storage, DTCs with higher priority overwrite lower priority DTCs. Later vehicles can store as many as eight DTCs before overwriting.

Non-emission related failures have the lowest priority. One trip failures of two trip faults have the next level of priority, followed by matured two trip failures. One trip and two trip failures of fuel system and misfire monitors have higher priority over non-fuel system and non-misfire faults.

- Priority 0: Non-emission related DTC
- Priority 1: One trip failure of a two trip fault, not for fuel system or misfire
- Priority 2: JTEC/SBEC: One trip failure of a two trip fault for fuel system and misfire
- Priority 3: Two trip failure or matured fault, not for fuel system or misfire

- Priority 4: JTEC/SBEC: Two trip failure or matured fault for fuel system and misfire.
- Priority 4: NGC: One trip failure of a two trip fault for fuel system and misfire
- Priority 5: (currently not used)
- Priority 6: NGC: Two trip failure or matured fault for fuel system and misfire

FREEZE FRAMES

When a fault is detected, the input data from various inputs and outputs is stored in the PCM's Freeze Frame memory.

Data stored in Freeze Frame is usually recorded at the first occurrence. If the fault is a Two Trip Fault, the MIL will not illuminate until after the second occurrence, but Freeze Frame Data is stored after the first occurrence. Freeze Frame data will only be overwritten by a different fault with a higher priority.

Freeze Frame data may include:

- Open/Closed Loop
- Calculated Load
- Engine Coolant Temperature
- Short Term Adaptive
- Long Term Adaptive
- Manifold Absolute Pressure
- RPM
- Vehicle Speed
- DTC (Hex)
- Freeze Frame Priority

WARNING: ERASING DTCS WITH A SCAN TOOL OR BY DISCONNECTING THE BATTERY WILL ALSO ERASE FREEZE FRAME DATA.

During model year 2000, Freeze Frame 1 and Freeze Frame 2 appeared. Freeze Frame 1 is the CARB-mandated Freeze Frame, and the previous rules for priority apply. When a failure occurs, the data first tries to occupy Freeze Frame 1. If Freeze Frame 1 is occupied with data of equal or greater priority, the data will occupy Freeze Frame 2. Data transfer between locations is not possible.

NGC PCMs have five Freeze Frame locations. The first is still the CARB-mandated Freeze Frame, but this has been expanded to include more data, such as IAC steps, P/N status, etc. Freeze Frame number 1 is the first failure regardless of priority. Freeze Frame 2 is the second failure, Freeze Frame 3 is the third failure, and the most recent failure is the last Freeze Frame. An intermittent or chronic condition could fill all five freeze frames with the same DTC, but snapshot conditions and priority could vary. Current rules state that for a two trip fault in the CARB-mandated Freeze Frame, only the priority is updated, not the data. EPA/CARB rules change often, so consult the Service Information for the latest information.

Service Required Interval (SRI) mileage is entered in a Freeze Frame. This is a PCM mileage counter that updates every 8.1 miles of continuous driving.

CARB Freeze Frame	Freeze Frame 1	Freeze Frame 2	Freeze Frame 3	Most Recent Freeze Frame
Order of Occurrence Does Not Matter	First Failure	Second Failure	Third Failure	Last Failure
Priority Does Matter	Priority Does Not Matter	Priority Does Not Matter	Priority Does Not Matter	Priority Does Not Matter
Could Be Trip Failure or DTC	Could Be Trip Failure or DTC	Could Be Trip Failure or DTC	Could Be Trip Failure or DTC	Could Be Trip Failure or DTC
Highest Priority Failure				

Figure 27 NGC Freeze Frame Rules

ACTIVITY 2: FREEZE FRAME, MIL RULES AND GOOD TRIPS

Notes: ____

Notes:

MODULE 7 MONITORS

OBD II MONITORS

OBD II Powertrain Control Modules (PCMs) use software called Monitors to check and verify the performance of emissions-related systems and components. Some Monitors operate at all times while the engine is running. Other Monitors make their checks only once per trip (and when enabling conditions permit).

The following Monitors are Continuous Monitors, and are actively checking whenever the engine is running:

- Comprehensive Components
- Fuel Control System (Fuel Trim)
- Misfire

The following Monitors are Once-Per-Trip Monitors. These Monitors do not run continuously, but run one time per trip after the necessary Enabling Conditions are met:

- Catalyst
- Oxygen Sensors
- Oxygen Sensor Heaters
- Evaporative (EVAP) System
  - Small Leak/Medium Leak/Large (Gross) Leak
  - NVLD Switch
  - LDP Switch
  - Purge
- EGR System (if equipped)
- Secondary Air (if equipped)

ONE-TRIP VS TWO-TRIP MONITORS

Some emissions system tests will set a DTC and illuminate the MIL the first time a failure is detected. These tests are known as “One-Trip Monitors”. Other diagnostic tests must fail more than one time before the PCM sets a DTC and illuminates the MIL. These tests are “Two-Trip Monitors”.

FEDERAL TEST PROCEDURE

The Federal Test Procedure (FTP) is a specific Drive Cycle used by the EPA to test vehicle emissions. A test vehicle is driven in a specific way to allow most monitors to run and perform their tests. Drive Cycles can specify calibrated values for engine temperature increase, vehicle speed, time, and other parameters. Drive Cycles are calibrated for different models and engines, and the requirements vary widely. This is a typical Federal Test Procedure Drive Cycle:

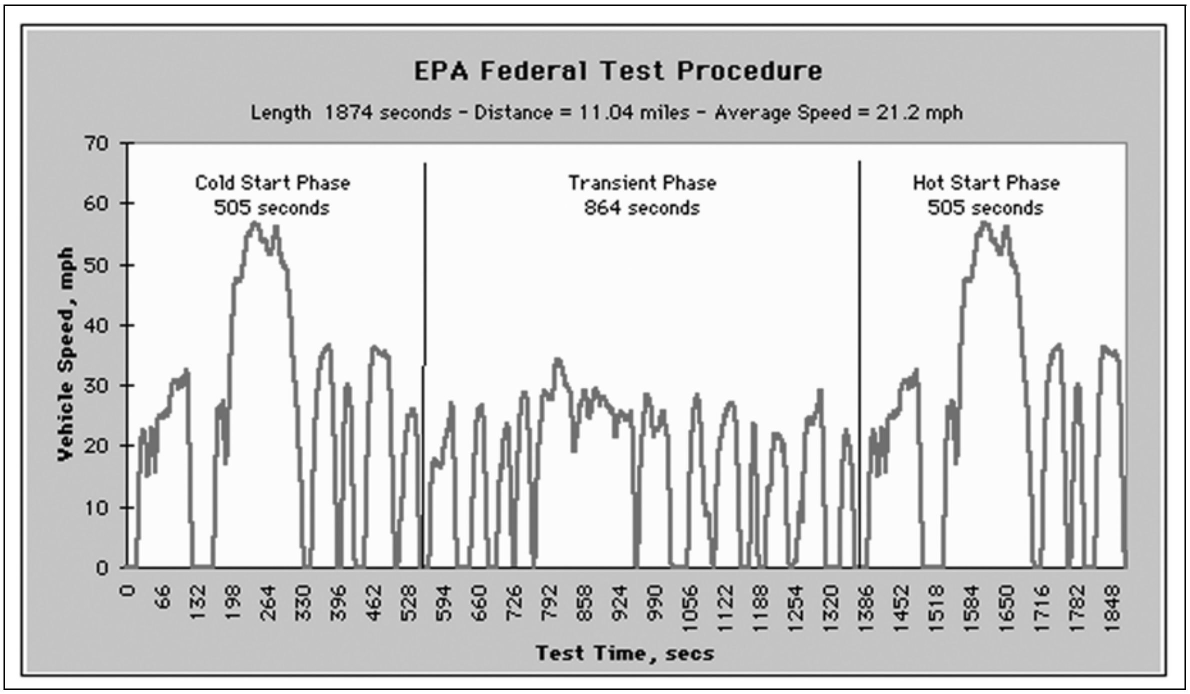


Figure 28 EPA Federal Test Procedure Drive Cycle

MONITOR STATUS

Monitor Status Conditions are a list of operating parameters or conditions that must be met for the monitor to run. The list of conditions that may permit a monitor to run or prevent or suspend monitor operation is calibrated and varies for each package.

The status of all monitors is displayed on the DRB III Monitor Status Screen. This screen shows only whether a monitor can be allowed to run or is running. The screen will not show the results.

ALL OBDII MONITOR STATUS	
OBD II GLOBALDISABLE:	NONE
1/1 O2 MON STATUS :	WAITING
CAT MON STATUS BNK1 :	WAITING
1/2 O2S MON STATUS :	WAITING
EGR MONITOR STATUS :	WAITING
EVAP SM LEAK STATUS :	INPROGRESS
EVAP MED LEAK DATA :	WAITING
EVAP LARGE LEAK STAT:	WAITING
NVLDSW STUCKOPENSTAT:	WAITING
NVLDSWSTUCKCLOSESTAT:	WAITING
PURGE MONITOR STATUS:	CONFLICT
56.2	

ALL OBDII MONITOR STATUS	
NVLD GEN EVAP STATUS:	WAITING
1/1 O2 HTR STATUS :	WAITING
1/2 O2 HTR STATUS :	WAITING
FUEL LEAN BNK1 STAT :	WAITING
FUEL RICH BNK1 STAT :	WAITING
MISFIRE MON STATUS :	WAITING
56.2	

Figure 29 OBD II Monitor Status Screens

Global Disable (NGC)

On NGC vehicles, monitors can be Globally Disabled if certain conditions occur. If there is more than one condition, the DRB III will display only one. The conditions are ranked by the DRB III in this order:

- New Cat Bnk2
- New Cat Bnk1
- Very Lo Batt
- Hi Ethanol
- PTO Engage
- Low Fuel
- High Fuel
- Hi Altitud
- Low Batt V
- Hi Batt V
- Lo Amb Temp
- Very Lo Amb

Not every condition affects every monitor. For example, Global Disable can display "High Fuel" and the monitor status can indicate "Waiting". In this example, the Global Disable condition is not calibrated to prevent that monitor from running, so the monitor can run and complete its test.

1/1 O2S Mon Status

This line displays the current status of the monitor. The monitor state is ranked by the DRB III and displayed in the following order:

- **Pass Test** – Displayed when the once-per-trip monitors (or non-continuous monitors) have completed and passed. Continuous monitors, once enabled are always In Progress and will never say Pass Test unless they have failed on a previous trip. When the failed continuous monitor (Fuel or Misfire), re-runs and passes on a following trip, Pass Test will be displayed when the monitor has completed enough time in the passing region. If the Fuel System Monitor fails, Pass Test will set when the calibrated amounted of time below the fail threshold is reached (approximately 30 seconds for the Fuel System Monitor). This is enough time to pass but not enough time to increment a Good Trip. Continue to run the engine for two minutes while still under the Fuel System Rich threshold, and then shut the Engine OFF. Upon restarting, the Good Trip counter will increment by one. All Good Trip counters for all NGC vehicles are processed on powerdown, but you will need to re-start the Engine to see the Good Trip counter increment).

– If Pass Test is displayed for a non-continuous monitor, the monitor will not run again. Therefore the monitor cannot fail after this point until the key is cycled and the enabling conditions are again met.

- **Fail Test** – This text is displayed when the monitor has run and failed. At this point no other monitor 'knows' or can 'see' that this monitor has failed. This is the first of two possible failures which can be set.

- **FailThsTrp** – This text is displayed when the Task Manager processes the "Fail Test" bit above. The Task Manager then checks to see if the monitor has been Suspended or not.

  – If the monitor has not been Suspended, the Task Manager will clear "Fail Test" and set "FailThsTrp" to inform other monitors that this monitor has failed. A one-trip failure or DTC will be recorded at this point.

  – If the monitor has been Suspended, the Task Manager will not set "FailThsTrp" and will not record a one-trip failure or DTC.

- **GloblDisab** – This text is displayed when this specific monitor has a global disable. This means that the monitor is disabled and will not run this trip. Look at "OBDII GlobalDisable" to identify the specific reason why the monitor is disabled.

- **Stopped** - This text is displayed when the monitor has been stopped for one of the following reasons:

  1. If the monitor is running "In Progress", the Task Manager 'suggests' to the monitor that it should stop, but the Task Manager does not stop the monitor. The monitor must stop itself in order to have an orderly exit of an intrusive test.
  2. When the monitor has completed (failing or passing).
  3. If the monitor is not running (not intrusive or not in progress), the Task Manager stops the monitor from starting due to another Fault. For

example, a MAP Sensor Shorted High DTC will prevent the Oxygen Sensor and Catalyst Monitors from running.

- **InProgress** – This text is displayed when the monitor is in progress and/or intrusive (running now).

- **Conflict** – This text is displayed when another monitor is running, or other enable conditions have not yet been met to allow this monitor to run (example: Closed Loop). This text is dynamic and can change from being displayed to not being displayed, as the monitor is 'conflicted' or not 'conflicted'. When this text is displayed, the monitor CANNOT run, but may run at some later point in the same trip. When the Conflict text is displayed, you may want to go to the "All OBDII Monitor Status" screen to see what other monitors may be running.

- **Suspended** – This text is displayed when a monitor has been Suspended from running during this trip due to another one-trip failure. For example, a misfire one-trip failure suspends the Catalyst Monitor. The Catalyst Monitor depends on the O_2 sensor and the O_2 sensor is adversely affected by the misfire.

- **Waiting** – This text is displayed when the enable conditions for this specific monitor have not yet been met, and it still can run this Trip.

  – If Waiting is displayed and the OBDII Global Disable displays anything other than "None" (e.g., Low Fuel Level), then the Global Disable displayed does not apply for this monitor.

Pending - SBEC/JTEC

On JTEC and SBEC vehicles, the Task Manager may not run a monitor if the MIL is illuminated and a fault is stored. If this occurs, the Task Manager postpones the monitor pending resolution of the fault. The Task Manager does not run the test until the problem is remedied. For example, when the MIL is illuminated for an O_2 sensor fault, the Task Manager does not run the Catalyst Monitor until the O_2 sensor fault is remedied. Running the test might produce inaccurate results since the Catalyst Monitor relies on a good O_2 sensor signal.

CARB READINESS

The DRB III CARB Readiness Status screen indicates whether or not the once per trip monitors have run. These monitors include EVAP, Catalyst, O_2 Response, O_2 Heater and EGR. Downstream O_2 is also a once per trip Monitor, but its listing is not required here.

Note: The CARB Readiness Status screen shows whether the monitors have run. The screen does not indicate whether the test passed or failed. A monitor can fail and the display will still indicate “YES”.

There is one listing on screen for each component type, even if the vehicle has more than one of the component. Example: multiple catalysts.

This screen shows that the PCM diagnostics have checked the appropriate systems. In some states, this information is used as part of an emissions or inspection test. This readiness information is kept in PCM memory until DTCs are erased.

The MIL can now indicate whether the monitors have run. With Key-ON-engine-not-running for at least twelve seconds, a flashing MIL indicates that the monitors have not run and are not ready. This capability is on all NGC, SBEC from 2001 and JTEC from 2002.

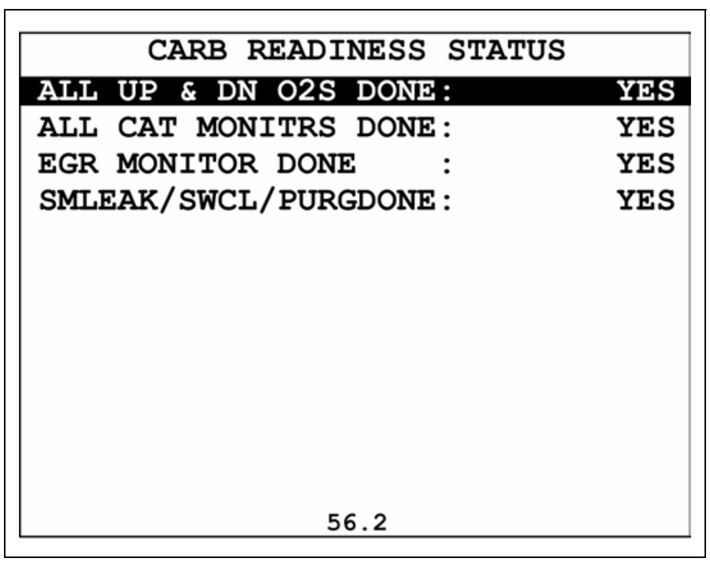


Figure 30 CARB Readiness Screen

ACTIVITY 3: SCAN TOOL ACTIVITY ON NGC EQUIPPED VEHICLE

Notes:

MODULE 8 OXYGEN SENSOR RESPONSE MONITOR

BACKGROUND

The Oxygen Sensor Response Monitor tests upstream O_2 sensor operation and its ability to respond. This Monitor is a two-trip-fault Monitor that is tested once per trip. On NGC vehicles, the Monitor runs when the vehicle is under light load at approximately 25-50 mph. On JTEC and SBEC vehicles, the Monitor runs at idle, in gear. A/C-ON does not inhibit running the Monitor.

Downstream O_2 sensors are also monitored. This Monitor will be covered in a later course.

OXYGEN SENSOR OPERATION

Oxygen Sensors provide a feedback signal that allows the PCM to maintain the desired stoichiometric air/fuel ratio of 14.7:1.

When hot, the O_2 sensor becomes a galvanic battery that typically generates a voltage signal between 0.0 - 1.0V. On NGC vehicles, a bias voltage shifts the signal voltage to fluctuate between 2.5 - 3.5V.

The voltage generated by the Oxygen Sensor is consistently high when air/fuel ratios are richer than ideal, and the voltage generated is consistently low when air/fuel ratios are leaner than ideal. The sensor signal voltage switches dramatically at stoichiometry and is relatively unchanging at all other air/fuel ratios.

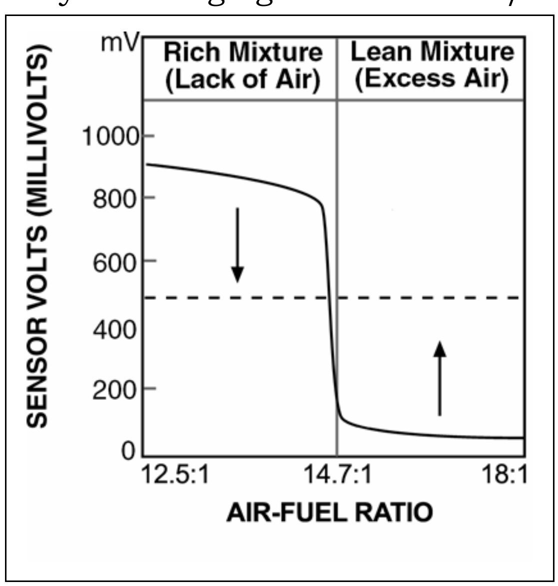


Figure 31 O_2 Sensor Signal

In closed-loop operation, the PCM attempts to keep the air/fuel ratio at stoichiometry by continuously increasing and decreasing fuel injector pulse width in response to changes in the Oxygen Sensor signal voltage.

By varying the amount of fuel injected, the PCM alternately increases and decreases the amount of oxygen in the exhaust. This drives the upstream Oxygen Sensor voltage higher and lower. This variation in air/fuel ratio and exhaust oxygen content causes the Oxygen Sensor to output a signal voltage that continuously hunts back and forth from high to low. When there is a large amount of oxygen in the exhaust caused by a lean mixture, the Oxygen Sensor produces a low voltage. When the oxygen content is lower caused by a rich mixture, the Oxygen Sensor produces a higher voltage. This produces the familiar oxygen sensor sine waveform. The waveform from a good Oxygen Sensor will swing above and below Rich and Lean Switch Points.

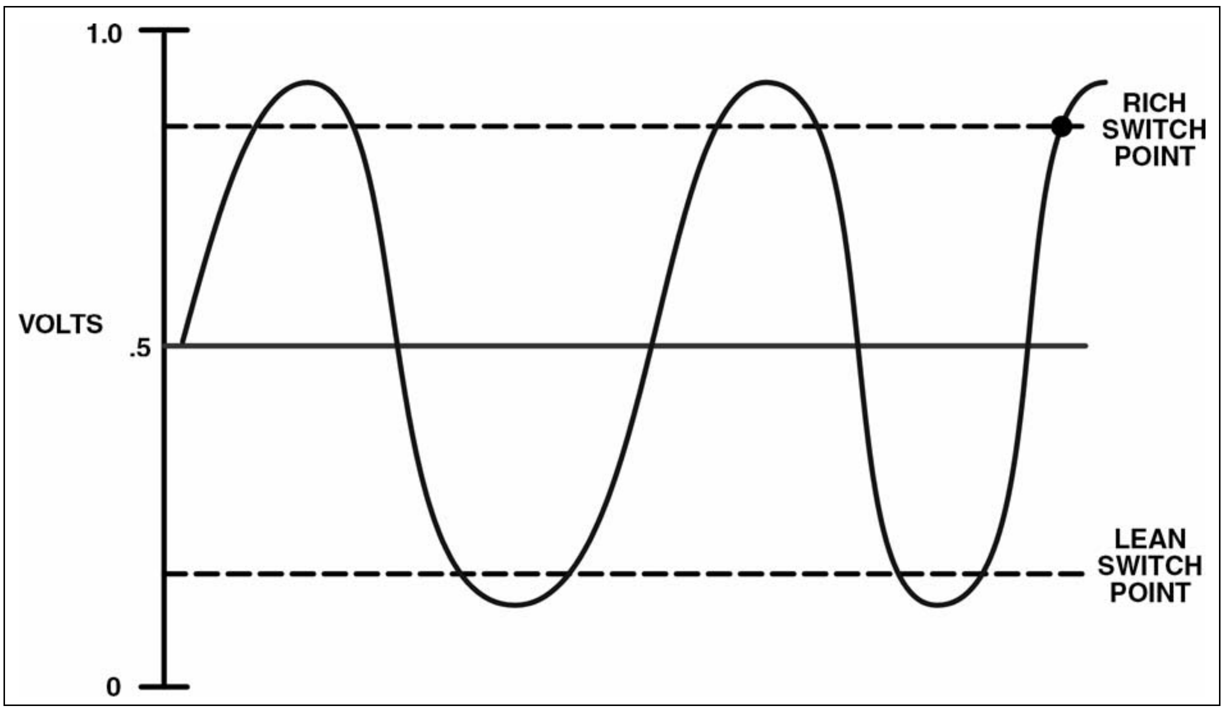


Figure 32 Oxygen Sensor Waveform and Switch Points

The sensor must detect changes in oxygen levels and output a signal voltage that reacts quickly. The Oxygen Sensor Response Monitor determines whether the sensor responds rapidly or has become lazy.

OXYGEN SENSOR MONITOR

The Oxygen Sensor Response Monitor is a two-trip fault and a once-per-trip monitor. Oxygen sensor signal voltage range for NGC vehicles is 2.5 – 3.5 V. This is higher than SBEC and JTEC vehicles.

The monitor on NGC vehicles runs when the vehicle is under light load, at approximately 20 – 50 mph. With SBEC and JTEC, the monitor runs at idle, in gear. A/C ON does not inhibit the monitor from running. The monitor takes 20 seconds to run, and there is a "fast pass mode" if the specification is met within 10 seconds. Two consecutive failures result in a DTC for OXYGEN SENSOR SLOW RESPONSE.

JTEC/SBEC Big Slope and Half Cycle Counters

On JTEC and SBEC vehicles, the Oxygen Sensor Response Monitor checks two oxygen sensor performance parameters. These parameters are called Big Slope and Half Cycles.

Big Slope refers to how rapidly the sensor signal voltage changes or swings. In other words, how steep the curves of the waveform are. This is the response rate of the sensor. A sensor that has aged will not respond as quickly as a good sensor.

Big Slope is determined by this formula:

$$\text{SLOPE} = \frac{\Delta \text{ VOLTAGE}}{\Delta \text{ TIME}} \text{ OR } \frac{\text{CHANGE IN VOLTAGE}}{\text{CHANGE IN TIME}}$$

The PCM checks O_2 Sensor voltage every few milliseconds. The waveform is a plot of these voltage values. The Monitor checks the slope of the curve by calculating the change in voltage divided by the change in time. If the slope value is not sufficient, the Monitor judges the sensor failed and sets a one-trip failure.

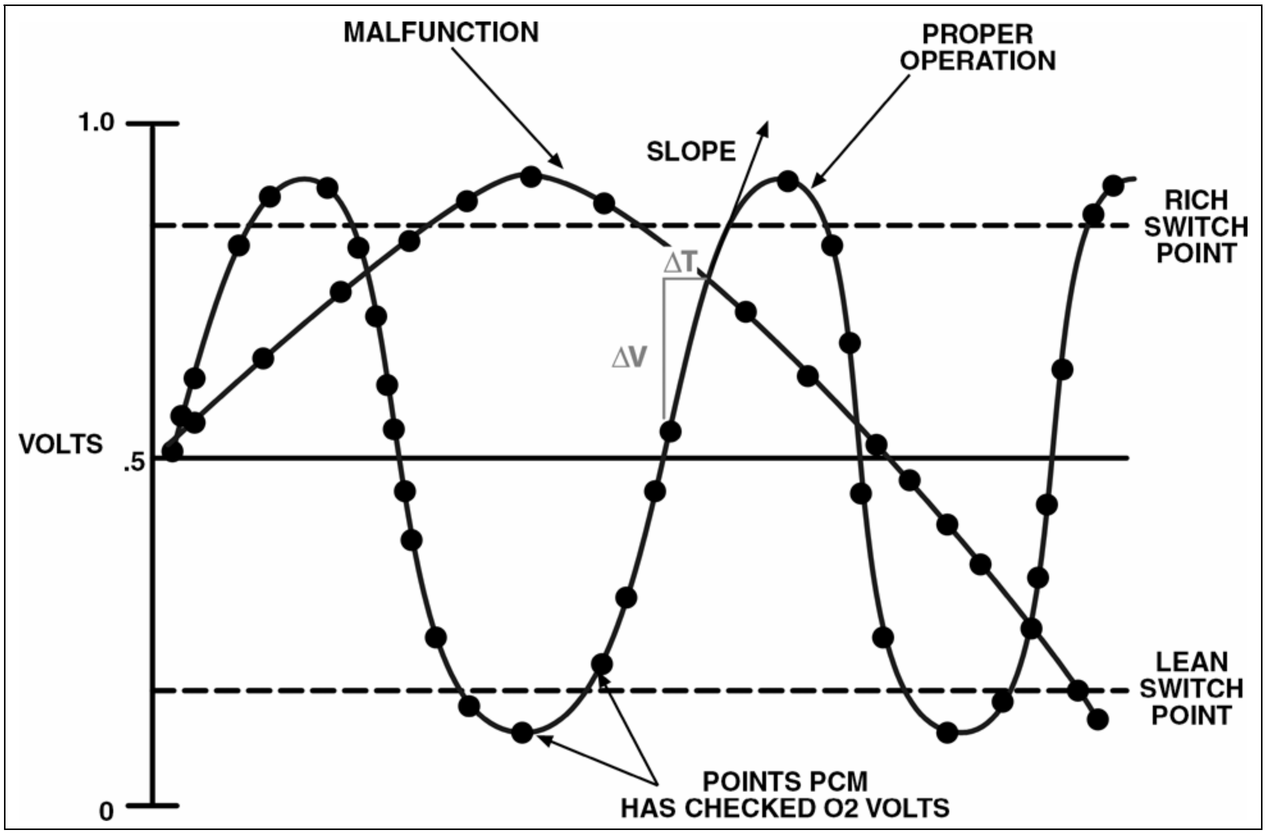


Figure 33 JTEC/SBEC Oxygen Sensor Big Slope

Half Cycles refers to the number of times that the sensor signal voltage swings exceed the upper and lower Switch Point or Threshold voltages set by the PCM. Each time the signal voltage surpasses a Switch Point, a threshold a counter increments by one. The Switch Points are calibrated voltages, typically around 0.2V and 0.8V.

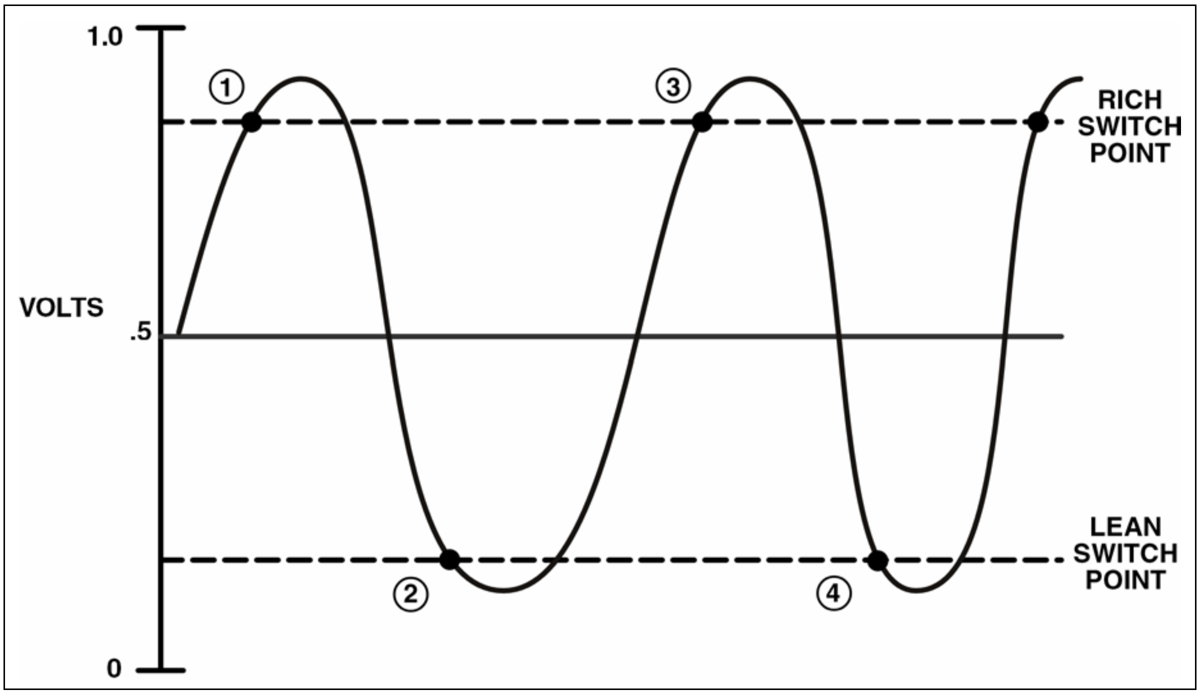


Figure 34 JTEC/SBEC Oxygen Sensor Half Cycles

Only one of the parameters (Big Slope or Half Cycles) needs to pass for the O_2 Sensor Monitor to register a pass.

NGC Switch Counter

The NGC Oxygen Sensor Switch Counter Monitor counts the number of times the sensor signal crosses calibrated high and low thresholds (Switch Points) in a calibrated time period. Each time the voltage signal goes beyond both thresholds, a counter increments by one. If the sensor is lazy and the waveform does not switch rapidly enough, or if the amplitude of the voltage swings is insufficient to cross the Switch Points, the count will be low. The counter increments only when the waveform crosses the Switch Points.

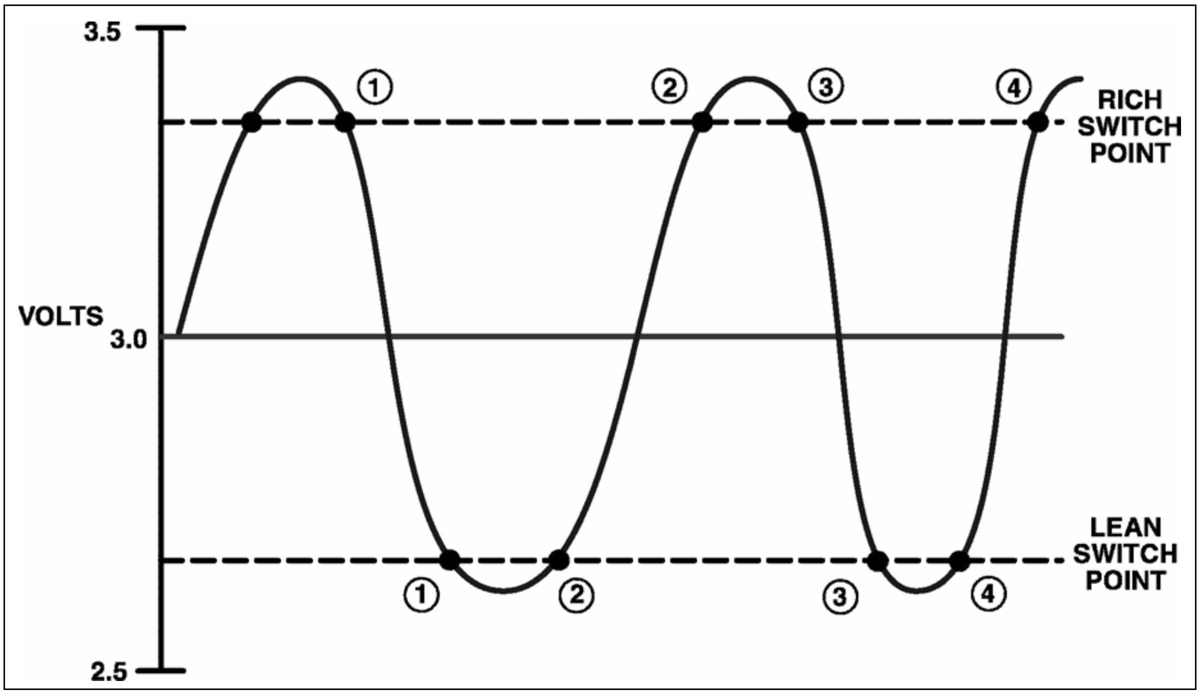


Figure 35 NGC Oxygen Sensor Switch Counts

The Oxygen Sensor Switch Counter Monitor takes 20 seconds to run. The Monitor will register a PASS if the counter reaches a calibrated value within the time period. There is a Fast Pass Mode if the calibrated count is reached within 10 seconds. The Monitor is a two trip monitor that is tested once per trip. The Monitor must fail on two consecutive trips to set DTC "P0133 - UPSTREAM HO2S RESPONSE" and to illuminate the MIL.

The MIL is extinguished when the Monitor passes on three consecutive Good Trips. The DTC is erased from memory after 40 consecutive warm-up cycles without a failure.

SCAN TOOL PRETEST SCREEN – NGC SWITCH COUNTER MONITOR

This screen allows the user to determine when the conditions have been met to run the Oxygen Sensor Switch Counter Monitor. This is a split screen. Pre-test enabling conditions are located on the top half of the screen and the conditions required to actually run the monitor are located on the bottom half of the screen.

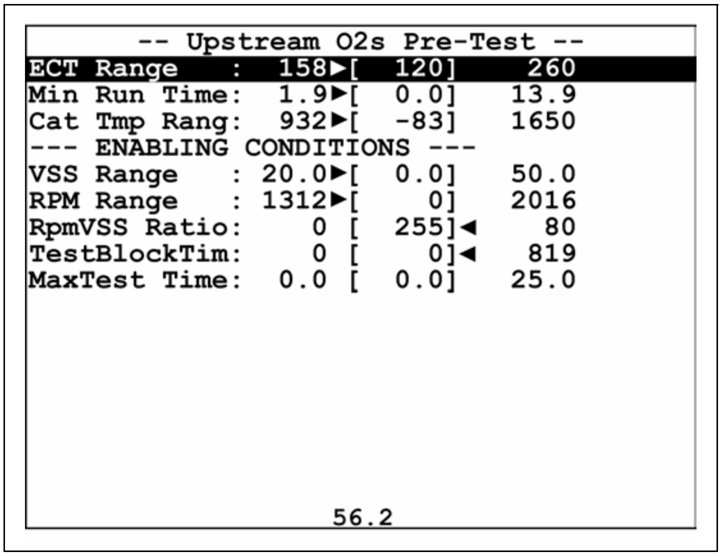


Figure 36 NGC III Oxygen Sensor Switch Counter Monitor Pretest Screen

The main objective of this and other pre-test screens is to “make the arrows go away”. When the arrows disappear, the conditions required to run the monitor have been satisfied and the monitor should run.

The vehicle can be driven, either on the road or on a lift, to satisfy the conditions of a pre-test. The parameters of this pre-test include several timers. The expiration of the timers indicates the vehicle, including the exhaust components, is hot enough to ensure accurate test results. To meet these enabling conditions, drive the vehicle until the arrows on the screen disappear. You can now ignore the arrows on the top half of the screen and begin satisfying the conditions on the bottom half of the screen.

ECT Range: Engine coolant temperature value must be within the indicated range; minimum value on the left, actual value in the middle, and maximum value to the right.

Min Run Time: Minimum amount of engine run time since start, displayed in minutes. The number right of the decimal are tenths of a minute (e.g., 1.5 is equal to 1 minute and 30 seconds)

Cat Temp Range: Catalyst temperature is a calculated value based on load, road speed, ambient temperature, short-term and long-term fuel correction, spark advance, run time, coolant temp, etc.

VSS Range: Vehicle speed must fall within this range, with minimum value on the left, actual value in the middle, and maximum value to the right.

RPM Range: Engine speed must fall within this range, with minimum value on the left, actual value in the middle, and maximum value to the right.

RPM VSS Ratio: This is a calculation of RPM divided by vehicle speed (N/V ratio). It is used to verify selected transmission gear (usually used to prevent monitor from running in 1st or 2nd gear). The ranges are displayed as a percent or ratio.

Test Block Time: Minimum amount of time in seconds where the O2 switch counts can be summed to the total counter.

This does not require a consecutive 10 second block for a fast pass; it can be over a period of time. Requires 20 seconds for a normal pass. It is possible for the minimum value to be calibrated to zero (0) (e.g., 2003 5.7L Truck). The maximum value of 819 seconds is a hard coded value, which is not possible to reach (but needed to display the range).

Max Test Time: This is the maximum time allowed during the monitor.

SCAN TOOL MONITOR DATA SCREEN – NGC SWITCH COUNTER MONITOR

This screen indicates the status of the Oxygen Sensor Switch Counter Monitor.

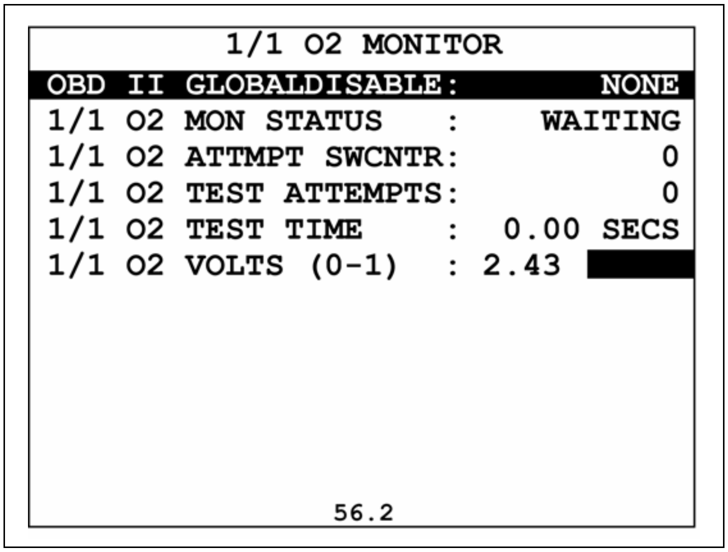


Figure 37 NGC Oxygen Sensor Switch Counter Monitor Data Screen

OBD II Global Disable: This line item is covered in Module 7 Monitors.

1/1 O2 Mon Status: Displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in the Module 7 Monitors.

1/1 O2 Attmpt Swcntr: Total number of O2 Sensor switch counts within the maximum test time period.

1/1 O2 Test Attempts: Number of tests attempted for that key cycle. Can be as many attempts as shown on Last Result screen.

1/1 O2 Test Time: Amount of time in seconds that monitor has been in progress. This number may stop and start as enable conditions are entered and exited. This timer will max out when the monitor is completed – stop at the value from the monitor pre-test screen (i.e. “MaxTest Time” 20 seconds)

1/1 O2 Volts (0-1): This is actual O_2 sensor voltage.

SCAN TOOL LAST RESULT SCREEN – NGC SWITCH COUNTER MONITOR

This screen can be used to track previous Oxygen Sensor Switch Counter Monitor results.

1/1 O2 MON LAST RESULT		
1/1 O2 CNTR RESULTS	:	VALID
1/1 O2SW CNTR RESULT	:	11
1/1 O2 SW CNTR SPEC	:	10
1/1 O2 FASTPASS SPEC	:	6
1/1 O2 TEST ATTEMPTS	:	0
1/1 O2 TEST ATMPSPEC	:	3
1/1 O2 THRESH TYPE	:	MINIMUM
1/1O2TESTFAILTHISTRP	:	NO
1/1O2TESTFAILLASTTRP	:	NO
1/1 O2LAST TEST TYPE	:	FASTPASS
56.2		

Figure 38 NGC Oxygen Sensor Switch Counter Monitor Last Result Screen

1/1 O2 Cntr Results: This tells the status of the monitor's results. "Valid" indicates monitor has completed and has passed or failed. This data is from the last time the monitor completed and does not necessarily mean that the data came from the last drive cycle. "Invalid" indicates monitor has not run since battery disconnect or clear DTCs (i.e. not Ready).

1/1 O2SW Cntr Result: Total amount of O2 switch counts within the last completed O2 Monitor test time period. Same as the "1/1 O2 Attmpt SwCntr" for the same key cycle in which the monitor has run and completed.

1/1 O2 Sw Cntr Spec: Minimum passing specification for the total amount of O2 switch counts required for the normal test period (e.g., 20 seconds)

1/1 O2 Fastpass Spec: Minimum specification which allows the monitor to pass prior to the full test period (e.g., 10 seconds rather than 20 seconds). This was done to reduce the tailpipe emissions during the O2 Monitor. Due to the shorter test time period of the Fast Pass test, the Fast Pass Spec. is less than the Normal Switch Counter Spec. A value of 255 indicates that this test is not enabled (calibrated) for this package. A fast pass will only be indicated if both O2 monitor and Catalyst monitor meet the "fast pass" criteria.

1/1 O2 Test Attempts: Number of fail attempts accumulated trying to reach a pass by exceeding the O2 Sw Cntr Spec. Not associated with the FastPass – FastPass can only be used to pass and not fail. O2 Test Attempts only increments when the monitor is incrementing toward a failure (e.g., to fail O2 monitor, it must run three (3) 20 second test attempts in the same key cycle to set a 1-trip failure).

1/1 O2 Test Atmpspec: Specification for the maximum number of soft fail attempts before setting a 1-trip failure.

1/1 O2 Thresh Type: Displayed as “minimum”. Indicates that the result must exceed the specification for the switch counter to pass.

1/1 O2 Test Fail This Trip: Indicates if the monitor has ran and failed during this trip. Results in a “Yes” or “No”.

1/1 O2 Test Fail Last Trip: Indicates if the monitor failed during the previous trip. Results in a “Yes” or “No”.

1/1 O2 Last Test Type: Indicates which threshold was compared against “1/1 O2Sw Cntr Results” to determine the Pass or Fail. Displayed as “Normal” or “FastPass”.

ACTIVITY 4: OXYGEN SENSOR SWITCH COUNTER MONITOR

Notes: ____

NGC State of Change

Beginning in 2004, 2.0L, 2.4L, and 5.7L engines with NGC III controllers use a new Oxygen Sensor Response Monitor strategy. This new method is called State of Change.

During testing, O_2 sensor signal voltage readings are taken every 10 ms.

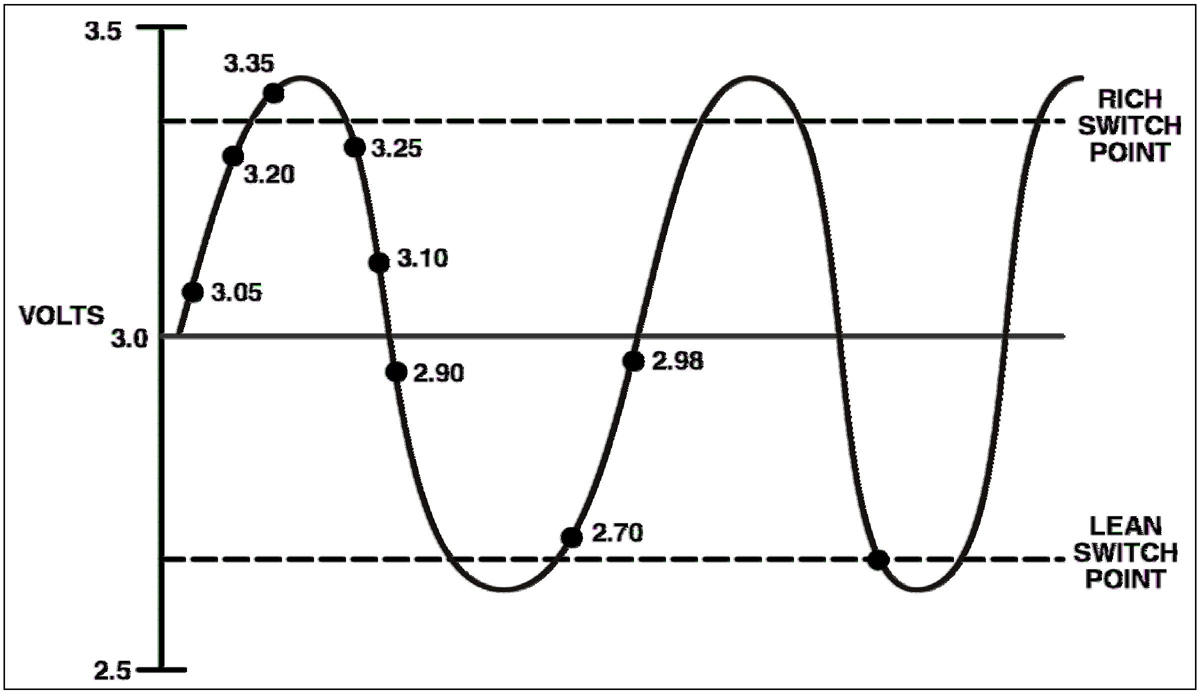


Figure 39 NGC State of Change

Each value representing the difference between consecutive 10 ms voltage readings (in other words, the change in voltage) is placed in a set of five bins. Each bin is based on a MAP and RPM matrix, similar to Long Term Adaptive memory cells.

Bin 1	Bin 2	Bin 3	Bin 4	Bin 5
.15 .10	.20		.28	

Figure 40 NGC State of Change Bins

When the total test time is completed, the bin values are added to calculate the bin total values.

Bin 1	Bin 2	Bin 3	Bin 4	Bin 5
.15 .10	.20		.28	

Sum of Bin Values at End of Test Time

.25	.20		.28	

Figure 41 Sum of NGC State of Change Bin Values

Each sum for each bin is multiplied by a weighted factor. The five weighted bin values are then added together and divided by the total test time. The result is an Average Voltage Change value. If this value exceeds a calibrated value, the monitor passes.

Sum of Bin 1 X Weighted Factor=B1Voltage

You do the same for each Bin

$$\frac{B1V + B2V + B3V + B4V + B5V}{\text{Total Test Time}} = \text{O2 Average Voltage Change}$$

Figure 42 NGC State of Change Calculation

SCAN TOOL PRETEST SCREEN – NGC STATE OF CHANGE MONITOR

This screen allows the user to determine when the conditions have been met to run the Oxygen Sensor State of Change Monitor. This is a split screen. Pre-test enabling conditions are located on the top half of the screen and the conditions required to actually run the monitor are located on the bottom half of the screen.

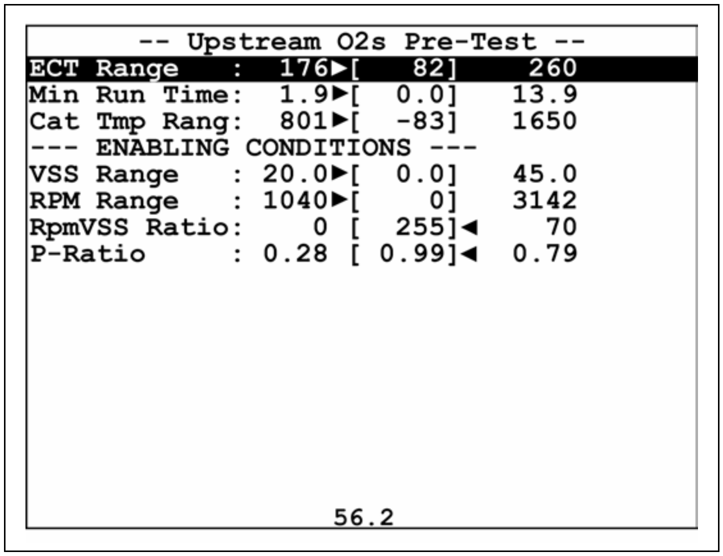


Figure 43 NGC SOC Oxygen Sensor Monitor Pretest Screen

ECT Range: Engine coolant temperature value must be within the indicated range, with minimum value on the left, actual value in the middle, and maximum value to the right.

Min Run Time: Minimum amount of engine run time since start, displayed in minutes. The number right of the decimal are tenths of a minute (e.g., 1.5 is equal to 1 minute and 30 seconds)

Cat Temp Range: Catalyst temperature is a calculated value based on load, road speed, ambient temperature, short-term and long-term fuel correction, spark advance, run time, coolant temp, etc.

VSS Range: Vehicle speed must fall within this range; minimum value on left, actual value in the middle, and maximum value to the right.

RPM Range: Engine speed must fall within this range, minimum value on left, actual value in the middle, and maximum value to the right.

RPM VSS Ratio: This is a calculation of RPM divided by vehicle speed (N/V ratio). It is used to verify selected transmission gear (usually used to prevent monitor from running in 1st or 2nd gear). The ranges are displayed as a percent or ratio.

P Ratio: This is a calculation of absolute MAP divided by barometric pressure. A sample reading is; 0.99 volts = wide open throttle (Map equal to Baro).

SCAN TOOL MONITOR DATA SCREEN – NGC STATE OF CHANGE MONITOR

This screen indicates the status of the Oxygen Sensor State of Change Monitor.

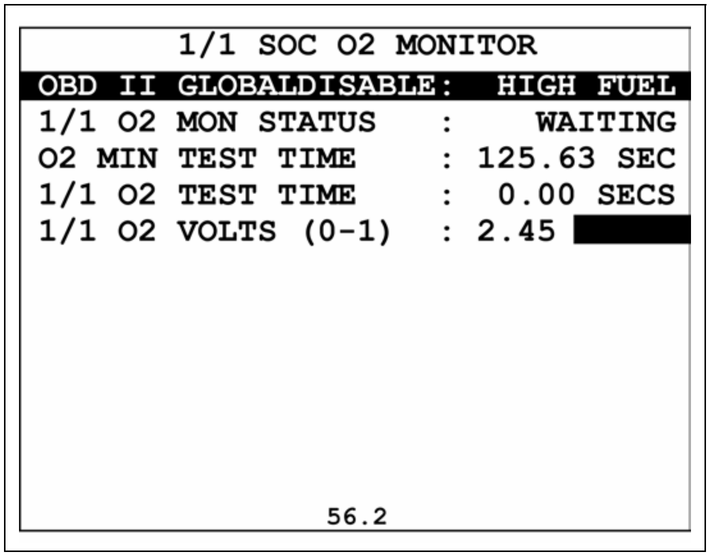


Figure 44 NGC SOC Oxygen Sensor Monitor Data Screen

OBD II Global Disable: This line item is covered in Module 7 Monitors.

1/1 O2 Mon Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in Module 7 Monitors.

O2 Min Test Time: The amount of time necessary to complete the State of Change Monitor.

1/1 O2 Test Time: This is the live reading of the time that the vehicle has been driven within the 5 MAP/RPM bins. This timer will start and stop as the vehicle is driven in and out of the MAP/RPM based bins. The total time must equal the O2 Min Test Time before the monitor will complete.

1/1 O2 Volts (0-1): This is the live reading of the 1/1 O2 sensor. This reading is displayed in the 0v to 1v range.

SCAN TOOL LAST RESULT SCREEN – NGC STATE OF CHANGE MONITOR

This screen can be used to track previous Oxygen Sensor State of Change Monitor results.

```
   1/1 SOC O2 MON LAST RESULT
1/1 O2 Mon Results  :      VALID
1/1 O2 RATIO        :    186.42%
1/1 O2 RATIO SPEC   :    111.54%
1/1 O2 THRESH TYPE  :    MINIMUM
1/1O2TESTFAILTHISTRP:         NO
1/1O2TESTFAILLASTTRP:         NO
1/1 O2LAST TEST TYPE:     NORMAL

             56.2
```

Figure 45 NGC SOC Oxygen Sensor Monitor Last Result Screen

1/1 O2 Mon Results: This tells the status of the monitor's results. "Valid" indicates monitor has completed and has passed or failed. This data is from the last time the monitor completed and does not necessarily mean that the data came from last drive cycle. "Invalid" indicates monitor has not run since battery disconnect or clear DTCs (i.e. not Ready).

1/1 O2 Ratio: The O2 sensor voltage is read every 10ms. The difference between each reading provides a delta voltage. The sum of the accumulated O2 delta voltage readings which are gathered during the O2 Test Time is then divided by the Total Test Time. The total will be expressed as a ratio. The accumulated voltage is typically higher than the accumulated time, which results in the ratio being greater than 100%. Example: a lazy O2 sensor will generate less voltage change over time, resulting in a ratio below 100%.

1/1 O2 Ratio Spec: The percentage of accumulated volts divided by test time. Below this percentage, the monitor will fail.

1/1 O2 Thresh Type: Displayed as "minimum". Indicates that the result must exceed the specification for the switch counter to pass

1/1 O2 Test Fail This Trip: Indicates if the monitor has run and failed during this trip. Results in a "Yes" or "No".

1/1 O2 Test Fail Last Trip: Indicates if the monitor failed during the previous trip. Results in a "Yes" or "No".

1/1 O2 Last Test Type: For the State of Change Monitor this will display "Normal" all the time. "Fast Pass" is currently not necessary on the SOC Monitor.

ACTIVITY 5: OXYGEN SENSOR STATE OF CHANGE MONITOR

Notes:

SCAN TOOL PRETEST SCREEN – JTEC/SBEC

SBEC

```
        Upstream O2S Pre-Test
ECT Range     :  120    [95]     260
Min Run Time  :  1.0    [3.0]    13.9
VSS MPH Range:   14.0   [0]      100
Open Thr Time:   1.0    [0.0]    13.9
Cat Tmp Range:   0.0    [145]    2500
          ENABLING CONDITIONS
VSS Range     :  0.0    [0.0]    1
Target RPM    :  -192   [-816]   320
Exhst Time    :  1.1    [0.0]    13.9
Cat Tmp Range:   0      [145]    2500
```

JTEC

```
        Upstream O2S Pre-Test
ECT Range     :  147    [68]     260
Bat Tmp Range:   21     [66]     130
VSS MPH Range:   10     [0]      100
Open Thr Time:   1.9    [0.0]    13.9
          ENABLING CONDITIONS
VSS Range     :  0.0    [0.0]     5.0
RPM Range     :  448    [0]       992
Exhst Time    :  1.9    [0.0]     13.9
MaxTestTime   :  0.0    [0.0]     1.6
Adap Cell ID  :  0.0    [21.0]    20.0
```

Figure 46 JTEC/SBEC Oxygen Sensor Response Monitor Pretest Screen

Adap Cell ID: The vehicle must be in the indicated adaptive cell before the monitor runs.

SCAN TOOL MONITOR DATA SCREEN – JTEC/SBEC

SBEC

```
             1/1 O2S MONITOR
1/1 O2S MON DATA             : 80
1/1 O2S MON IN PROGRESS      : NO
1/1 O2S MON DONE THIS TRP:     NO
1/1 O2S MON FAIL 1 TRIP      : NO
1/1 O2S MON FAIL DTC SET     : NO
1/1 O2S MON STOP TESTING     : NO
1/1 O2S MON TEST TIME        : 0.00 SECS
1/1 O2S HALF CYCLE CNTR      : 0
1/1 O2S BIG SLOPE CNTR       : 0
1/1 O2S VOLTS                : 0.47 VOLTS
```

JTEC

```
             1/1 O2S MONITOR
1/1 O2S MON DATA              : 00
1/1 O2S MON IN PROGRESS       : NO
1/1 O2S MON DONE THIS TRP     : NO
1/1 O2S MON FAIL THIS TRIP:     NO
1/1 O2S MON STOP TESTING      : NO
1/1 O2S MON TEST TIME         : 0.00 SECS
1/1 O2S HALF CYCLE CNTR       : 0
1/1 O2S BIG SLOPE CNTR        : 0
1/1 O2S VOLTS                 : 5.00 VOLTS
```

Figure 47 JTEC/SBEC Oxygen Sensor Response Monitor Data Screen

1/1 O2 Half-Cycle Counter: The counter records the activity of the O2 sensor during the monitor by counting the number of times the O2 voltage exceeds the upper switch point (0.80 volts) and falls below the lower switch point (0.20 volts).

1/1 O2 Big Slope Counter: This is an indicator of O2 sensor response time. The counter increments every time the O2 sensor responds quickly. Big slope is defined as a change in voltage over a change in time.

SCAN TOOL LAST RESULT SCREEN – JTEC/SBEC

SBEC

```
      1/1 O2S MON LAST RESULT
1/1 O2 HALF CYCLE STATUS : C0
1/1 HALF CY LAST RESULT  : MIN
1/1 HALF CY FAIL THIS TST: NO
1/1 HALF CY FAIL PREV TST: NO
LAST 1/1 O2 HALF CY CNTR : 255
1/1 O2 HALF CY CNTR SPEC : 18
1/1 O2 BIG SLOPE STATUS  : C0
1/1 BIG SLOPE LAST RESULT: MIN
1/1 BIG SLP FAIL THIS TST: NO
1/1 BIG SLP FAIL PREV TST: NO
LAST 1/1 O2 BIG SLP CNTR : 53
1/1 O2 BIG SLP CNTR SPEC : 20
```

JTEC

```
      1/1 O2S MON LAST RESULT
LAST 1/1 O2 HALF CY CNTR: 0
1/1 O2 HALF CY CNTR SPEC: 56
LAST 1/1 O2 BIG SLP CNTR: 0
1/1 O2 BIG SLP CNTR SPEC: 10
```

Figure 48 JTEC/SBEC Oxygen Sensor Response Monitor Last Result Screen

1/1 O2 Half-Cycle Status: The value represented on this line is a data byte.

1/1 Half-Cycle Last Result: The term “min”, when seen on the DRBIII®, indicates the PCM is looking for a minimum value to be exceeded during the monitor. The term “max” indicates the PCM is looking for a maximum value not to be exceeded during the monitor. In this example, the PCM was looking for a minimum value to be exceeded during the monitor.

1/1 Half-Cycle Failed Prev Test: The monitor result from the trip previous to the last trip is recorded on this line.

1/1 Half-Cycle Failed This Test: The monitor result from the previous trip is recorded on this line.

Last 1/1 O2 Half-Cycle Counter: The number of half-cycles that occurred during the previous trip is recorded on this line.

1/1 O2 Half-Cycle Counter Spec: The number of half-cycle counts that needed to be exceeded to pass the monitor is specified here.

1/1 O2 Big Slope Status: The value represented on this line is a data byte.

1/1 Big Slope Last Result: The term “min”, when seen on an OBD DRBIII®, indicates the PCM is looking for a minimum value to be exceeded. The term “max” indicates the PCM is looking for a maximum value not to be exceeded. In this example, the PCM was looking for a minimum value to be exceeded during the trip.

1/1 Big Slope Failed This Test: The monitor result from the previous trip is recorded on this line.

1/1 Big Slope Failed Previous Test: The monitor result from the trip previous to this trip is recorded on this line.

Last 1/1 O2 Big Slope Counter: The number of big slopes during the previous test is recorded on this line.

1/1 O2 Big Slope Counter Spec: The number of big slope counts that needed to be exceeded to pass the monitor is specified here.

Note: **The monitor pass is based on which counter first satisfies the requirements, the half-cycle counter or the big slope counter.**

Notes: ____

MODULE 9 MISFIRE MONITOR

BACKGROUND

Misfire is the lack of combustion in a cylinder during a power stroke. When misfire occurs, raw, unburned fuel and excess oxygen enter the exhaust stream. Two things happen that adversely affect emissions. First, the unburned fuel (hydrocarbons) in the exhaust continues to burn in the catalytic converter. This elevates catalytic converter temperatures and increases tailpipe HC emissions. Second, the oxygen sensors detect increased oxygen levels and the PCM incorrectly assumes that this is due to a lean mixture condition. The PCM increases fuel injector pulse width and more raw fuel enters the exhaust. Prolonged misfire may overheat the catalytic converter and cause permanent damage.

OBD II rules require that the vehicle diagnostic system monitors engine misfire and identifies specific cylinders with misfire. A separate DTC must be stored if multiple cylinders misfire. When multiple cylinders misfire, identifying specific misfiring cylinders is optional.

CKP SENSOR

Misfire is not directly sensed in the engine, but is indirectly detected by monitoring crankshaft acceleration. Each power stroke causes the crankshaft to accelerate. In an eight-cylinder engine, a power stroke occurs and the crankshaft receives a kick every 90° of rotation. Between power strokes, the crankshaft coasts and slows down. When a cylinder misfires, the crankshaft slows down more than normal. The Crankshaft Position Sensor (CKP) signal is monitored to detect this deviation.

ADAPTIVE NUMERATOR

To accurately detect misfire, the Misfire Monitor needs to take into account variations due to component wear, machining tolerances and sensor fatigue. The PCM compares the CKP signal for the crankshaft in the vehicle with ideal data and determines a variance value, or Adaptive Numerator.

The Adaptive Numerator is learned during fuel-cutoff deceleration, when there are no power strokes to affect crankshaft speed of rotation. To calculate the variance, the PCM uses the first group of crank signal slots as a reference. The PCM then compares the position of the second group of slots against the stored ideal data and calculates the difference or variance. This value is the Adaptive Numerator.

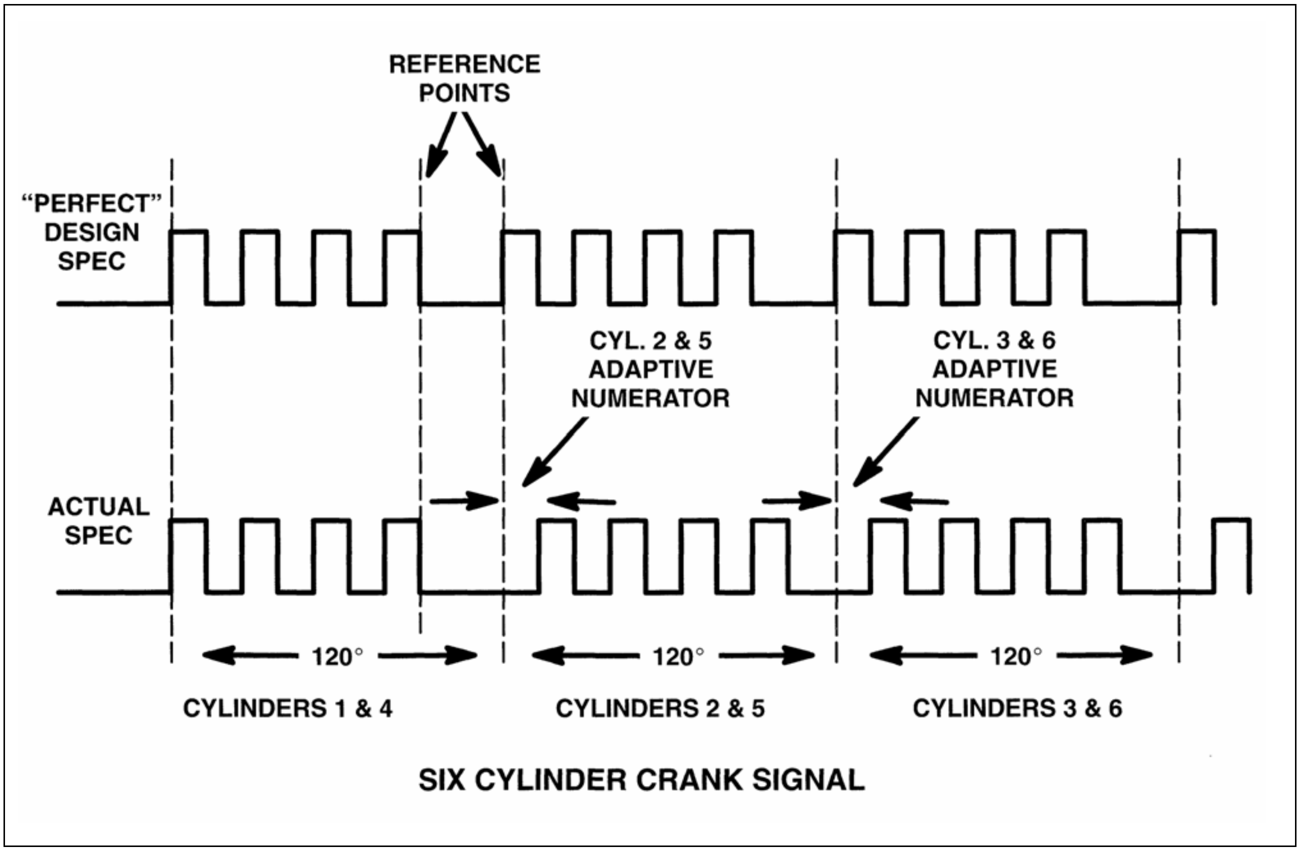


Figure 49 Adaptive Numerator

The PCM updates the Adaptive Numerator at every key-ON, and is relearned after battery disconnect. The Misfire Monitor will not run until the Adaptive Numerator has updated since the last battery disconnect. If the Adaptive Numerator is equal to the default value then the PCM knows that the Adaptive Numerator has not been learned and does not permit the Misfire Monitor to run. On NGC, if the Adaptive Numerator exceeds a calibrated percentage, the PCM sets a DTC for CKP NOT LEARNED and illuminates the MIL. Previously, this DTC was MISFIRE ADAPTIVE NUMERATOR AT LIMIT failure.

Note: Normal engine operation is necessary for proper PCM update. If misfire is present when a PCM is replaced or when battery power is reconnected, the PCM will consider the misfire normal.

The PCM also checks the machining tolerances for the CKP sensor slots. The PCM calculates engine rpm by monitoring crankshaft speed from the first slot to the last slot in a group. Variance between groups of slots is called RPM Error. RPM Error must be less than approximately 5% for the Misfire Monitor to run.

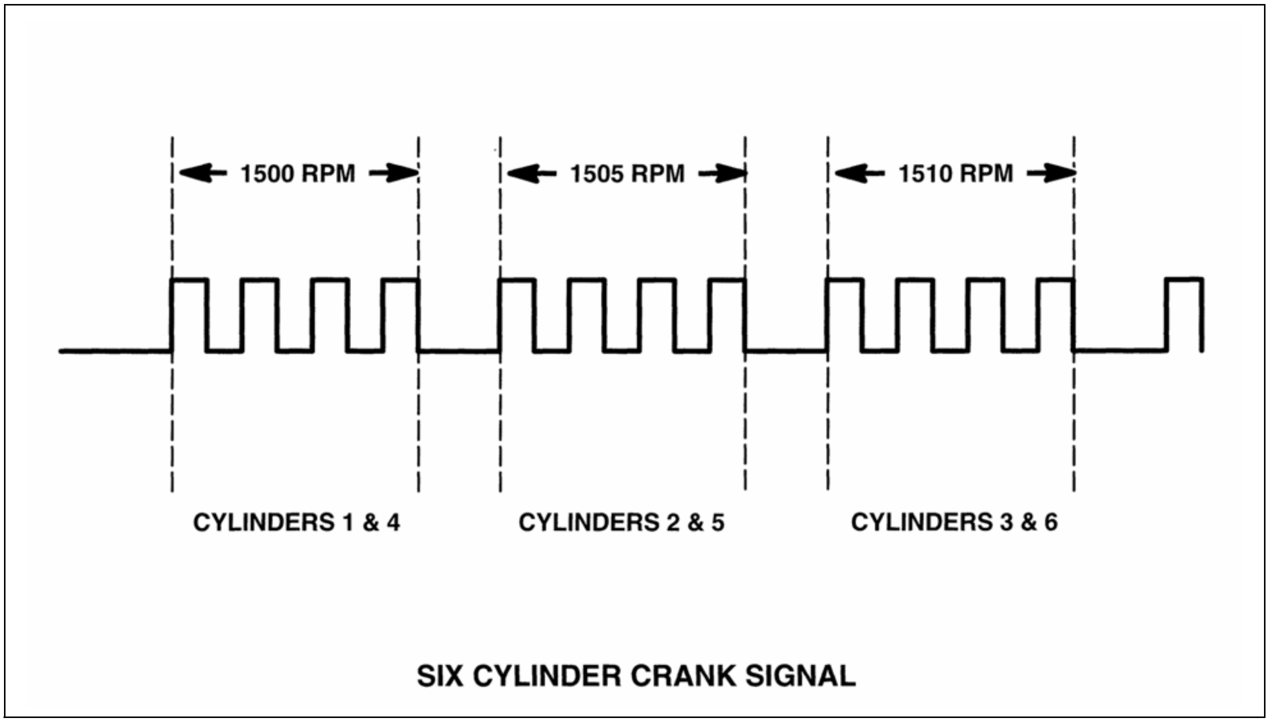


Figure 50 RPM Error

NGC MISFIRE MONITOR

The NGC Misfire Monitor is a continuous two-trip monitor. The monitor uses two different tests/counters:

- 200 Revolution Counter - Looks for misfire that can cause immediate catalyst damage.
- 1000 Revolution Counter - Looks for misfire that can cause emissions to increase 1.5 times the Federal Test Procedure (FTP) standards. This test must also identify misfire percentages that might cause a "durability demonstration vehicle" to fail an Inspection and Maintenance Program tailpipe emissions test.

Note: The percentage of misfire for failure in each test is calibrated by the manufacturer. The percentage of misfire for failure varies with engine speed and load. As engine speed increases or load decreases, the effects of misfire decrease due to crankshaft momentum.

200 Rev Counter - NGC

Once the enabling conditions are met, the Misfire Monitor is enabled and the PCM counts the number of misfires during every 200 revolutions of the crankshaft. If during five 200 rev counters, the misfire percentage exceeds a calibrated value, a Maturing Code is set and a Freeze Frame is entered. Freeze Frame Data is recorded during the last 200 revolutions of the 1000 rev period. A failure on the second consecutive trip matures the code and a DTC is set.

The percentage of misfire to set a fault varies with rpm and load. As engine speed increases and load decreases, crankshaft inertia reduces the effects of misfire. The values also vary with different engine packages.

If misfire continues during the initial trip, the MIL is not illuminated. However, when the percentage of misfire exceeds the malfunction percentage in any 200 revolution period that would cause permanent catalyst damage, the MIL will flash, a DTC and Freeze Frame Data are stored. The engine defaults to open loop operation to prevent increased fuel flow to the cylinders. If misfire drops below the calibrated percentage, the MIL stops flashing but remains illuminated.

If the engine is under 3000 rpm, failure in a group of three 200 revolution blocks is required to set a one-trip failure. If the engine is over 3000 rpm, one failure in one 200 revolution block will set a one-trip failure. A second consecutive trip with misfire is required to set a DTC. When the DTC will set depends on rpm, so it is possible to have a flashing MIL without a DTC set.

1000 Rev Counter - NGC

The 1000 revolution counter for FTP failure is a two-trip monitor. Freeze Frame Data is stored after the first occurrence of the fault. Every 1000 revolution counter contains five 200 revolution counters. The PCM counts misfires for each 200 revolution counter and carries the value over to the 1000 revolution counter. The 1000 revolution counter increments a count of one for each 200 revolution period where the misfire percentage exceeds the threshold for a FTP or I/M failure. Beginning with all 2004 NGC III controllers, the 200 rev counter does not count up, it counts down to zero.

A misfire that is present upon start-up will set a one-trip failure after one set of 1000 revolutions. A misfire that occurs after the engine has run at least 1000 revolutions without misfire requires four blocks of 1000 revolutions to set a one-trip failure. The DTC will set after misfire is detected during two-consecutive trips. On the second trip it will only take one block of 1000 revolutions to set a misfire DTC, whether the misfire was present on start-up or not.

Number of Misfire Events

200 REVS	400 REVS	600 REVS	800 REVS	1000 REVS	
5	0	10	10	5	200 REV COUNTERS
5	5	15	25	30	1000 REV COUNTERS

Figure 51 Misfire Events and Counters

600 and 4000 Rev Counters

Starting with 1999 models, if catalyst-damaging misfire does not occur in the first 200 revolutions, but does occur after the first 200 revolutions, then the 600 revolution counter detects the misfire. This new counter counts from 0 to 3 (3 x 200) to equal 600 revolutions.

DIAGNOSTICS

When misfire occurs, these DTCs may be stored: P0300 MULTIPLE CYLINDER MISFIRE, or P030# CYLINDER # MISFIRE.

Misfire may occur and may not be caused by component failure. Be sure to eliminate these possible causes:

- Moisture on ignition system components
- Insufficient fuel
- Low quality fuel
- Manual transmission bog
- Towing overload

SCAN TOOL PRETEST SCREEN - NGC

This screen allows the user to determine when the conditions have been met to run the Misfire Monitor. This is a split screen. Pre-test enabling conditions are located on the top half of the screen and the conditions required to actually run the monitor are located on the bottom half of the screen.

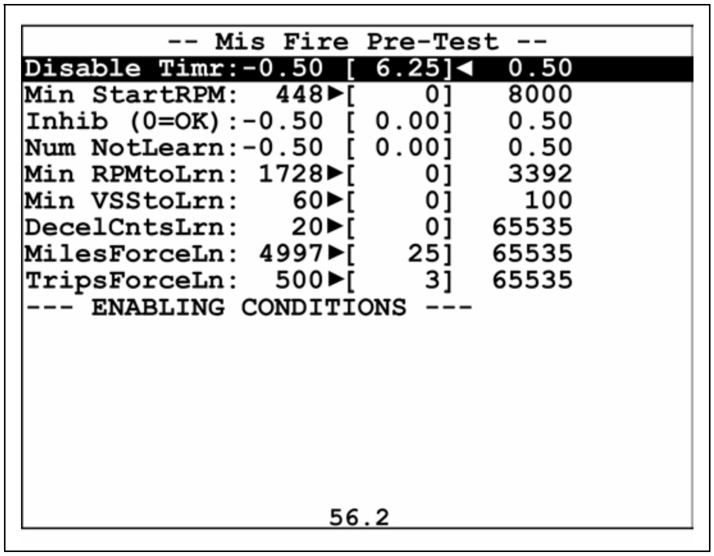


Figure 52 NGC Misfire Monitor Pretest Screen

The main objective of this and other pre-test screens is to “make the arrows go away”. When the arrows disappear, the conditions required to run the monitor have been satisfied and the monitor should run.

The vehicle can be driven, either on the road or on a lift, to satisfy the conditions of a pre-test. The parameters of this pre-test include several timers. The expiration of the timers indicates the vehicle, including the exhaust components, is hot enough to ensure accurate test results. To meet these enabling conditions, drive the vehicle until the arrows on the screen disappear. You can now ignore the arrows on the top half of the screen and begin satisfying the conditions on the bottom half of the screen. Once these conditions have been satisfied and the vehicle is at a stop, the monitor should run within 15-30 seconds.

Disable Time: This represents the amount of time, in seconds, that the Misfire Monitor will be disabled after a start up.

Min Start RPM: The minimum amount of engine RPM required before the PCM will begin to monitor for misfires.

Inhib (0=OK): If the Misfire Monitor is disabled for any reason, this bit will be equal to something other than 0.

Num Not Learn: This 0 or 1 value represents the state of the Adaptive Numerator learned bit. A 0 in this case represents the Numerator being learned.

Min RPM To Lrn: The required Engine RPM for the PCM to go into the necessary Full Fuel Shut Off Decel to learn the Adaptive Numerator.

Min VSS To Lrn: The required VSS for the PCM to go into the necessary Full Fuel Shut Off Decel to learn the Adaptive Numerator.

Decel Cnts Lrn: Number of Full Fuel Shutoff decal counts required before the PCM will begin to count misfires.

Miles Force Lrn: If the vehicle has traveled more than the specified mileage, the PCM will attempt to relearn the Adaptive Numerator. The PCM will widen the specified ranges normally necessary to learn the Adaptive Numerator. This method insures the PCM will go no more than the specified mileage without updating the Adaptive Numerator.

Trips Force Lrn: If the vehicle has had the minimum number of starts (stable run time), the PCM will attempt to relearn the Adaptive Numerator. The PCM will widen the specified ranges normally necessary to learn the Adaptive Numerator. This method insures the PCM will go no more than the specified number of trips without updating the Adaptive Numerator.

SCAN TOOL MONITOR DATA SCREEN - NGC

To confirm that the Adaptive Numerator is learned, view the 200/1000 rev screen. This screen indicates the status of the Misfire Monitor.

MIS FIRE MON 200/1000		
MISFIRE MON STATUS	:	WAITING
MISFIRE DISABLED	:	NONE
ADAP NUMERATOR	:	LEARNED
200 REV COUNTER	:	2
1000 REV COUNTER	:	0
MIS-FIRE 200 REV CTR	:	0
MIS-FIRE 1000REV CTR	:	0
MIS-FIRE 600 REV CTR	:	0
MIS-FIRE 4000REV CTR	:	0
56.2		

Figure 53 NGC Misfire Monitor Data Screen

Misfire Mon Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in Module 7 Monitors.

Misfire Disabled: The data displayed here tells what may be preventing the Misfire Monitor from running. Examples are Adap Num, Torque.

Adap Numerator: Tells the state of the Adaptive Numerator, learned or not learned

200 Rev Counter: Once the Adaptive Numerator is learned, this counter will begin counting the number of crankshaft revolutions. It will reset to 0 every 200 revs.

1000 Rev Counter: This counter represents the number of 200 Rev counters that have gone by. This counter will display 0-3 for the number of 1000 rev counters completed

Mis-Fire 200 Rev Counter: Number of misfires being counted in 200 revolutions.

Mis-Fire 1000 Rev Counter: Number of misfires being counted in 1000 revolutions.

Mis-Fire 600 Rev Counter: Number of misfires being counted in 600 revolutions.

Mis-Fire 4000 Rev Counter: Number of misfires being counted in 4000 revolutions.

SCAN TOOL SIMILAR CONDITIONS WINDOW SCREEN - NGC

The Misfire Monitor is a continuous monitor and must pass in a Similar Conditions Window in order for the PCM to extinguish the MIL. The Similar Conditions Window allows the user to operate the vehicle in the same load and temperature state as it was when the monitor failed. The Similar Conditions Window occurs when engine rpm and MAP vacuum are within a calibrated range of engine rpm and MAP vacuum when the fault occurred. The vehicle must also be in the same warm-up state, with engine temperature above or below a threshold value, as it was when the fault occurred.

As with all DTCs, three good trips are required to extinguish the MIL, and 40 warm up cycles are required to erase the DTC. If the engine does not run in a Similar Conditions Window, the Task Manager extinguishes the MIL after 80 good trips.

With this screen, the user can compare present operating conditions with the operating conditions that occurred at the time of the failure. To re-test the monitor, drive the vehicle until the Similar Conditions Window value changes from “no” to “yes”. Once in the window, maintain a steady load until the PCM reports that it is “done this trip” or increments a Good Trip.

Note: Some failures create a Similar Conditions Window that cannot be duplicated after the vehicle is repaired. For example, a misfire condition may drop manifold vacuum to a value that cannot be achieved once the vehicle is repaired. When this occurs, use the live “Which Cylinder is Misfiring” screen while operating the vehicle under all load conditions.

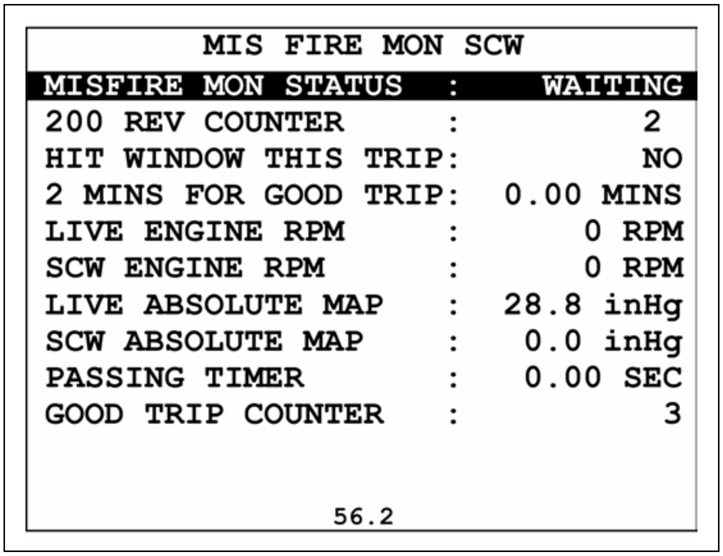


Figure 54 NGC Misfire SCW Screen

Misfire Mon Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in Module 7 Monitors.

200 Rev Counter: Once the Adaptive Numerator is learned, this counter will begin counting the number of crankshaft revolutions. It will reset to 0 every 200 revs.

Hit Window This Trip: Indicates if the vehicle has been driven in the SCW during this key cycle.

2 Mins For Good Trip: On NGC vehicles it is necessary to run for 2 minutes with out a failure reoccurring.

Live Engine RPM: Live reading of actual engine RPM

SCW Engine RPM: Engine RPM at the time of failure

Live Absolute MAP: Live reading of actual engine MAP

SCW Absolute MAP: Engine MAP at the time of failure

Passing Timer: The length of time that the vehicle is running in the SCW.

Good Trip Counter: Number of good trips completed to clear this failure.

ACTIVITY 6: MISFIRE MONITOR

Notes:

200 Rev Counter – JTEC/SBEC

On 1999 and earlier SBEC and JTEC vehicles, misfire is a one-trip monitor. The first occurrence of the fault based on a 200 revolution counter will set a MIL-illuminating DTC.

In later vehicles, misfire is a two-trip monitor. Two consecutive occurrences of a failure based on a 600 revolution counter are required to set a MIL-illuminating DTC. The 600 revolution counter records three cycles of the 200 revolution counter.

1000 Rev Counter – JTEC/SBEC

FTP misfire detection on SBEC and JTEC vehicles may be based on the 1000 revolution counter or the 4000 revolution counter. The 1000 revolution test requires information from five cycles of the 200 revolution counter. On vehicles using the 4000 revolution counter, this counter is supplied four cycles of the 1000 revolution counter.

SCAN TOOL PRETEST SCREEN – JTEC/SBEC

SBEC

```
       MIS-FIRE MON PRE-TEST
MIS-FIRE EPP DISABLED 0=OK: 0
MIS-FIRE DISABLED     0=OK: 0
ADAP NUMERATOR LEARNED    : YES
MIS-FIRE DETECTION ENABLED: YES
200  REV CNTR(Counting=OK): 0
ADAP NUM CYL 2&5 (2625)   : 2624
ADAP NUM CYL 2&5 (A000)   : 0703
AVG RPM ERROR CYL 2&5     : -0.01
ADAP NUM CYL 3&6 (2625)   : 261A
ADAP NUM CYL 3&6 (A000)   : 4177
AVG RPM ERROR CYL 3&6     : -0.01
```

JTEC

```
       MIS-FIRE MON PRE-TEST
MIS-FIRE DISABLED 0=OK     : 0
ADAP NUMERATOR LEARNED     : NO
REVS TO LEARN ADAPNUMERATR: 32
AVERAGE RPM ERROR TOO LARG: Y
200  REV CNTR(Counting=OK): 0
LO ADP NUM. CYL 2&3(1C9C) : 1C9C
LO ADP NUM. CYL 2&3(3800) : 3800
HI ADP NUM. CYL 2&3(3938) : 3938
HI ADP NUM. CYL 2&3(7000) : 7000
AVERAGE RPM ERROR CYL 2&3 : +0.00
LO ADP NUM. CYL 4&7(1C9C) : 1C9C
LO ADP NUM. CYL 4&7(3800) : 3800
HI ADP NUM. CYL 4&7(3938) : 3938
HI ADP NUM. CYL 4&7(7000) : 7000
LO ADP NUM. CYL 5&8(1C9C) : 1C9C
LO ADP NUM. CYL 5&8(3800) : 3800
HI ADP NUM. CYL 5&8(3938) : 3938
HI ADP NUM. CYL 5&8(7000) : 7000
AVERAGE RPM ERROR CYL 5&8 : +0.00
AVERAGE RPM ERROR CYL 4&7 : +0.00
```

Figure 55 JTEC/SBEC Misfire Monitor Pretest Screen

- **Misfire EPP Disabled:** The PCM counts down from a predetermined number of engine position pulses on start up, to allow the engine to stabilize prior to performing misfire detection.
- **Misfire Disabled:** Any number other than zero indicates something is disabling misfire detection.

200 Rev Counter: The 200 rev counter begins incrementing when the PCM is performing misfire detection.

SCAN TOOL MONITOR DATA SCREEN – JTEC/SBEC

SBEC

```
         MIS-FIRE MON 200/1000
MIS-FIRE EPP DISABLED 0=OK: 0
MIS-FIRE DISABLED     0=OK: 0
200  REV CNTR(Counting=OK): 0
1000 REV CNTR(Counting=OK): 0
MIS-FIRE CNTR CAT  200 REV: 0
MIS-FIRE CNTR CAT  600 REV: 0
MIS-FIRE CNTR FTP 1000 REV: 0
MIS-FIRE CNTR FTP 4000 REV: 0
ENGINE RPM                : 0 RPM
MIS-FIRE MON DATA         : 80
MIS-FIRE MON FAIL 1 TRIP  : NO
MIS-FIRE MON FAIL DTC SET : NO
```

JTEC

```
         MIS-FIRE MON 200/1000
MIS-FIRE DISABLED 0=OK     : 0
AVERAGE RPM ERROR TOO LARG : Y
200  REV CNTR(Counting=OK) : 0 1000
REV CNTR(Counting=OK)      : 0
MIS-FIRE CNTR CAT  200 REV : 0
MIS-FIRE CNTR CAT  600 REV : 0
MIS-FIRE CNTR FTP 1000 REV : 0
MIS-FIRE CNTR FTP 4000 REV : 0
ENGINE RPM                 : 0 RPM
MIS-FIRE MON DATA          : 00
MIS-FIRE MON FAIL THIS TRIP: NO
```

Figure 56 JTEC/SBEC Misfire Monitor Data Screen

- **Catalyst Damaging Misfire:** This value is based on the percentage of misfire within three 200 revolution counts. When a misfire percentage exceeds a predetermined value, a 1-trip failure is declared, unless the percentage of misfire is above a predetermined threshold within the first 200 revolutions. The MIL flashes while the misfire is severe enough to cause imminent catalyst damage.
- **FTP or I/M Misfire:** This value is based on the percentage of misfire within four counts of 1000 revolutions. When the percentage of misfire exceeds a predetermined value and causes an emissions increase, based on either FTP or I/M (smog test no longer used), the PCM increments a 1-trip failure.
- **Misfire Counter Cat 200 Rev:** This line indicates the PCM is counting misfires within a 200 rpm block.
- **Misfire Counter Cat 600 Rev (Cat Damage):** Misfires are counted in 200 rpm blocks. The 600 revolution counter increments a count of one for each 200 revolution period where misfire percentage exceeds the threshold for a catalyst damaging misfire.
- **Misfire Counter FTP 1000 Rev (FTP Emissions):** Misfires are counted in 200 rpm blocks. The 1000 revolution counter increments a count of one for each

  200 revolution period where misfire percentage exceeds the threshold for a FTP or I/M failure.

- **Misfire Counter FTP 4000 Rev (FTP Emissions):** Due to a change in the EPA standards, all '98 and newer vehicles count FTP misfires based on a percentage of misfire within 4000 revolutions. Each time the percentage of misfire based on 1000 revolutions exceeds the threshold, the 1000 revolution counter increments a count of one. When it counts to four, a 1-trip failure is recorded.

Average RPM Error Too Large: This is determined by comparing the high adaptive numerator specification to the low adaptive numerator specification.

SCAN TOOL SIMILAR CONDITIONS WINDOW SCREEN – JTEC/SBEC

SBEC

```
            MIS-FIRE MON SCW
MIS-FIRE SAME WARMUP STATE: NO
MIS-FIRE IN SIM WINDOW    : NO
MIS-FIRE ABSOLUTE MAP     : 7.9 in Hg
ABSOLUTE MAP              : 29.3 in Hg
MIS-FIRE ENGINE RPM       : 1440 RPM
ENGINE RPM                : 0 RPM
200  REV CNTR(Counting=OK): 0
SCW CAT  200 REV CNTR     : 0
MIS-FIRE GOOD TRIP CNTR   : 0
MIS-FIRE MON DATA         : 80
```

JTEC

```
            MIS-FIRE MON SCW
MIS-FIRE IN SIM WINDOW     : NO
MIS-FIRE ABSOLUTE MAP      : 0.0 in Hg
ABSOLUTE MAP               : 29.5 in Hg
MIS-FIRE ENGINE RPM        : 0 RPM
ENGINE RPM                 : 0 RPM
200  REV CNTR(Counting=OK) : 0
SCW FTP 1000 REV COUNTER   : 0
MIS-FIRE GOOD TRIP CNTR    : 0
MIS-FIRE MON DATA          : 00
```

Figure 57 JTEC/SBEC Misfire SCW Screen

Misfire Same Warm-up State: There are two warm-up states, above 160°F or below 160°F. You must be in the same warm-up state as the failed trip to enter the similar conditions window.

200 Rev Counter: The counter increments if the PCM is performing misfire detection.

SCW Cat 200 Rev Counter: The counter increments if the PCM is detecting catalyst damaging misfire while in the similar conditions window.

SCW FTP 1000 Rev Counter: The counter increments if the PCM is detecting an emissions (FTP) misfire while in the similar conditions window.

Misfire Good Trip Counter: If the monitor passes, it increments the good trip counter. Three good trips extinguish the MIL, and 40 warm-up cycles erase the DTC and Freeze Frame.

SCAN TOOL WHICH CYLINDER IS MISFIRING SCREEN – JTEC/SBEC

SBEC

```
      WHICH CYL IS MIS-FIRING
CYL 1 MIS-FIRE 200 REVS: 0
CYL 2 MIS-FIRE 200 REVS: 0
CYL 3 MIS-FIRE 200 REVS: 0
CYL 4 MIS-FIRE 200 REVS: 0
CYL 5 MIS-FIRE 200 REVS: 0
CYL 6 MIS-FIRE 200 REVS: 0
```

JTEC

```
   WHICH CYL IS MIS-FIRING-8 CYL
CYL 1 MIS-FIRE COUNTER: 0
CYL 8 MIS FIRE COUNTER: 0
CYL 4 MIS FIRE COUNTER: 0
CYL 3 MIS FIRE COUNTER: 0
CYL 6 MIS FIRE COUNTER: 0
CYL 5 MIS FIRE COUNTER: 0
CYL 7 MIS FIRE COUNTER: 0
CYL 2 MIS-FIRE COUNTER: 0
```

Figure 58 JTEC/SBEC Which Cylinder is Misfiring Screen

SCAN TOOL LAST RESULT SCREEN – JTEC/SBEC

SBEC

```
MIS-FIRE MON LAST RESULT
RUNTIME AT MIS-FIRE        : 0.00 MINs
RATE WHICH CAUSED MIS-FIRE: 0
MIS-FIRE ABSOLUTE MAP      : 7.9 in Hg
MIS-FIRE ENGINE RPM        : 1440 RPM
DTC TYPE - CAT MIS-FIRE    : NO
DTC TYPE - FTP MIS-FIRE    : NO
DTC TYPE - I/M MIS-FIRE    : NO
FAULT TYPE - 1 TRIP CAT MF: NO
FAULT TYPE - 1 TRIP FTP MF: NO
FAULT TYPE - 1 TRIP I/M MF: NO
```

JTEC

```
MIS FIRE MON LAST RESULT
DTC TYPE – CAT DAMAGE MF   : NO
DTC TYPE – FTP MIS-FIRE    : NO
DTC TYPE - I/M MIS-FIRE    : NO
FAULT TYPE - 1 TRIP CAT MF: NO
FAULT TYPE - 1 TRIP FTP MF: NO
FAULT TYPE - 1 TRIP I/M MF: NO
```

Figure 59 JTEC/SBEC Last Result Screen

Notes:

Notes:

MODULE 10 EVAP LEAK MONITOR

BACKGROUND

Current engine management technology does an excellent job of maintaining low tailpipe emissions. However, a large percentage of hydrocarbon (HC) emissions results from evaporating fuel, not from tailpipe emissions.

The current California Air resources Board (CARB) regulations require detection of leaks equivalent to a hole 0.020 in. (0.5 mm) diameter. Testing has shown that a leak of this size can cause HC emissions of around 1.35 grams HC per mile. This is more than 30 times the allowable standard. This is why EVAP systems must be monitored.

OBD II regulations require that the diagnostic system:

- Verify Airflow
- Monitor For HC Loss

NGC vehicles use a new evaporative emissions leak detection system that can dependably detect 0.020 in. (0.5 mm) leaks. The new system is called Natural Vacuum Leak Detection (NVLD), and it replaces the leak detection pump system previously used on SBEC and JTEC vehicles.

NGC vehicles can perform two types of EVAP system leak tests. The first type of test is a passive test, called Natural Vacuum Leak Detection. This is a small leak (0.020 in. (0.5 mm)) test, and is run after enabling conditions are met and the vehicle is turned OFF. The second type of test is an intrusive test and checks the EVAP system for medium or large leaks (0.040 – 0.090 in. (1.02 – 2.29 mm)) during a cold start. This second test is only conducted if the small leak test results are "inconclusive." If the small leak test passes, obviously there is no medium or large leak.

NVLD PRINCIPLES

The NVLD system relies on the "Gas Law" principle, which states that "the pressure of a gas in a sealed vessel will change with changes in the temperature of the gas." This principle applies only if the vessel is sealed. Any leak, even a small leak in the system will allow the pressure to equalize with ambient atmospheric pressure.

A vent valve seals the charcoal canister vent during engine-OFF conditions. If the EVAP system does not have a leak larger than the failure threshold, the system pressure will drop when ambient temperatures drop at night. When vacuum in the system exceeds approximately 1 in. H_2O (0.25 kPa), a vacuum switch closes. When the PCM detects that this switch has closed, the Small Leak Monitor Test will record a "pass" on the next start. If the switch state does not change, either the system has a leak, or the required temperature change did not occur. In either case, the test results at this point are inconclusive.

See example below of the Natural Vacuum principle at work. This tanker had been steam cleaned and the tank vents were not open while it cooled.

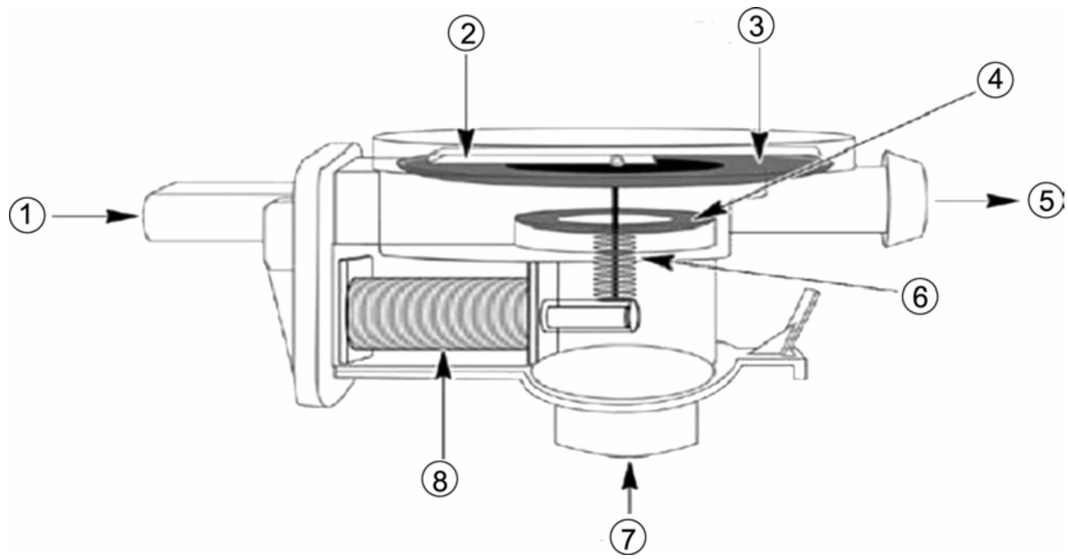
Figure 60 Natural Vacuum Principle Demonstrated

NGC NVLD OPERATION

The NVLD assembly is located on the atmospheric vent side of the charcoal canister. The NVLD assembly is designed with a normally open vacuum switch, a normally closed (de-energized) solenoid, and a pressure/vacuum relief valve, which is actuated by both the solenoid and a diaphragm. The normally open vacuum switch will close when about 1 in. H_2O (0.25 kPa) vacuum lifts the diaphragm. The normally closed pressure/vacuum relief valve in the NVLD is intended to maintain the seal on the evaporative system during engine off conditions.

If vacuum in the evaporative system exceeds 3 – 6 in. H_2O (0.75 – 1.5 kPa), the valve will be pulled off the seat, opening the seal. This protects the system from excessive vacuum and allows sufficient purge flow if the solenoid is inoperative. A noise may be heard if this happens.

The solenoid actuates the valve to unseal the canister vent while the engine is running. The solenoid is de-energized to close the vent during the medium and large leak tests and during the purge flow check. Pressure in the EVAP system exceeding 0.5 in. H_2O (0.12 kPa) will open the seal. This will vent pressure from the evaporative system to permit the venting of vapors, via the canister, during refueling. This also allows the tank to "breathe" during increasing temperatures, thus limiting the pressure in the tank to a low level. Limiting pressure build-up allows vacuum to be achieved sooner than if the tank had to decay this pressure with declining temperatures after shutdown.



1	Electrical Connector	5	To Remote Filter
2	Vacuum Switch	6	Spring and Plunger
3	Diaphragm	7	To Canister
4	Pressure/Vacuum Relief Valve	8	Solenoid

Figure 61 NVLD Assembly

NGC NVLD SMALL LEAK MONITOR

The NVLD Small Leak Monitor used on all NGC vehicles is a non-intrusive switch test. A special circuit in the NGC PCM stays alive after the vehicle is turned OFF to monitor for NVLD switch closure for up to 1050 minutes (17.5 hours) after key-OFF. This circuit consumes very little power.

The NGC controller uses key-ON (engine at stable idle, no min run time) followed by key-OFF, to complete a small leak test. Results depend on what the switch does and when the vehicle is restarted. A temperature drop of 3°F (1.7°C) reduces pressure enough to cause switch closure.

Specific milestones must be met for switch closure to be a "SMALL LEAK PASS" or for no switch closure to accumulate time toward a failure. Here are the milestones:

Table 1 Small Leak Test Time Thresholds

0 to 1050 minutes	This is the total available test time allowed during KEY OFF
0 to 10 minutes	This is the time that the NGC will IGNORE anything the NVLD switch does
10 to 1050 minutes	During this time, if the NVLD switch closes, the Small Leak test will "PASS"
0 to 60 minutes	If the switch does not close during this time, the PCM will NOT accumulate this time towards a failure
60 to 1050 minutes	This is the time that will be stored towards a failure if the NGC does not see switch closure before the vehicle is restarted
4200 minutes TOTAL	TO RECORD A FAILURE, this is the total number of minutes of vehicle OFF time to be accumulated without seeing switch closure.
1050 minutes	This is the maximum number of minutes that can be accumulated without switch closure in one "Key OFF" period toward the total of 4200 min.
100 minutes TOTAL	TO RECORD A FAILURE, this is the total number of minutes to be accumulated in the "Key ON, Engine Running" state, in between the 4200 minutes of accumulated "OFF" time.
25 minutes	This is the maximum number of minutes that can be accumulated per drive cycle (key on engine running) towards the total of 100 minutes.

The timer starts counting as soon as the key is turned OFF, but the PCM IGNORES ANYTHING that the NVLD switch does for the first 10 minutes.

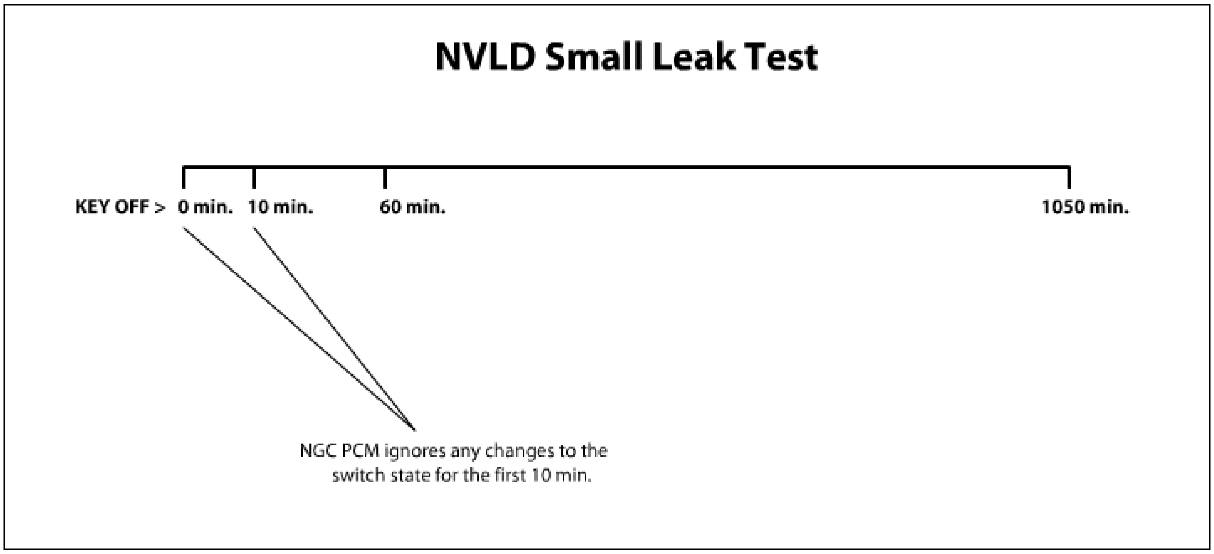


Figure 62 Small Leak Test Main Time Thresholds

The PCM will record a SMALL LEAK PASS if the NVLD switch contacts CLOSE any time between 10 - 1050 minutes after the vehicle is turned OFF. The switch contacts may have been open or closed during the first 10 minutes, but the PCM ignores the switch state until after the first 10 minutes. AS LONG AS the NVLD switch closes sometime between 10 - 1050 minutes, the system registers a SMALL LEAK PASS.

If the NVLD switch contacts DO NOT CLOSE within the first 60 minutes after key OFF, the PCM ignores the switch state until after 60 minutes.

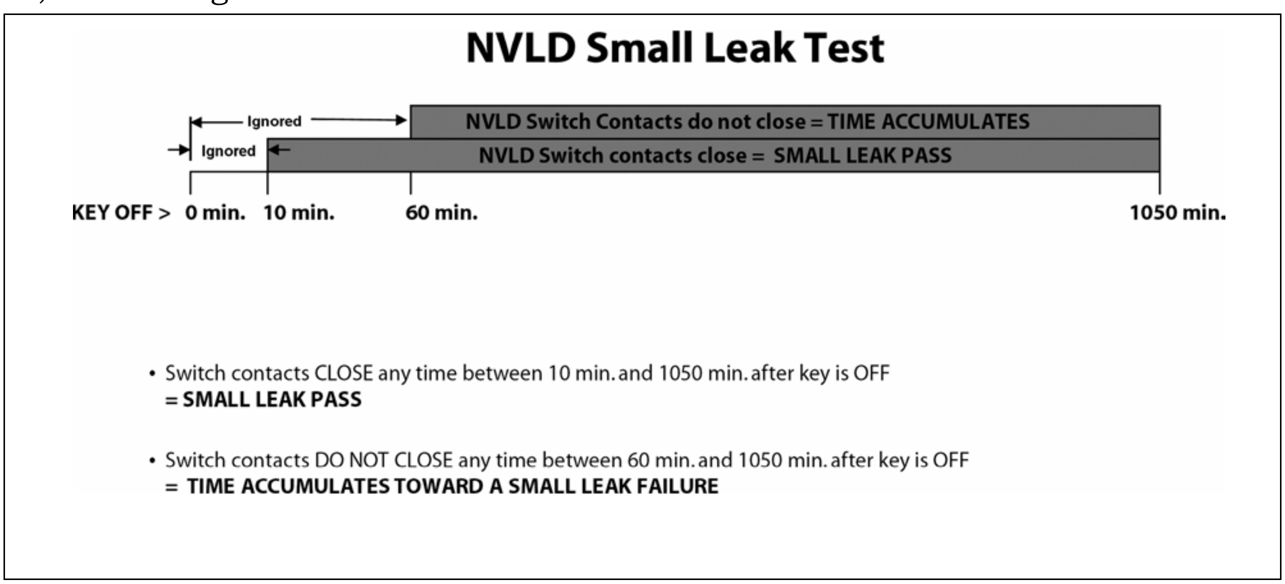


Figure 63 Small Leak Pass or Fail

If the NVLD switch contacts DO NOT CLOSE any time between 60 - 1050 minutes after the vehicle is turned OFF, the time is recorded for a possible SMALL LEAK FAIL. A failure is not immediately recorded. Several time thresholds must be met.

If the vehicle is restarted before 60 minutes without switch closure, this is considered a NO-TEST. If the vehicle is restarted between 60 – 1050 minutes without switch closure, this test is INCONCLUSIVE.

4200 minutes KEY OFF time + 100 minutes KEY ON ENGINE RUNNING time are required without switch contact closure to record a SMALL LEAK FAILURE.

1050 minutes is the maximum KEY OFF time that can be stored in any one KEY OFF period toward the 4200 minute total.

25 minutes is the maximum time that can be stored in any drive cycle toward the 100 minute total.

Whenever Small Leak Test results are inconclusive, the PCM will attempt to run the MEDIUM/LARGE LEAK AND PURGE MONITOR to determine whether the reason for no switch closure is a larger leak.

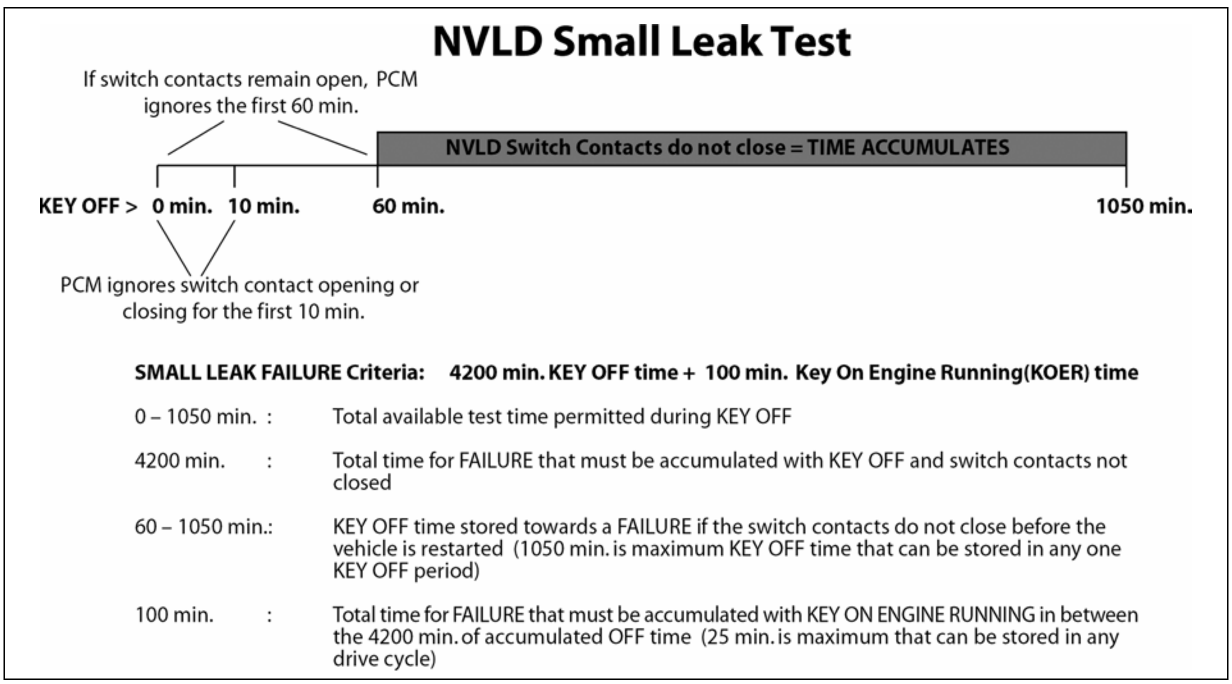


Figure 64 Small Leak Failure Time Thresholds

This diagnostic test can take a week or longer to mature a leak fault. This time period has been chosen to allow the vehicle to be exposed to the largest possible number of drive scenarios before a leak decision is made. This also satisfies CARB's stated goal of getting three MIL illuminations within a month for 0.020 in. (0.5 mm) leak detection. The diagnostics will log engine OFF and RUN time to determine when a week has elapsed. There is a limit on the total amount of run time that is applied to the one-week timer. There is also a limit on the total soak time that will be allowed to be applied to the one-week timer and a limit on the amount of accrued run time during one specific drive that can be applied to the one-week timer.

NVLD SWITCH AND SOLENOID RATIONALITY TESTS

- At key-ON, the NVLD solenoid will be energized to vent any vacuum that may be trapped in the evaporative system from the previous soak. This should result in an open switch condition. If the switch state does not indicate an open condition, the DTC "NVLD Pressure Switch Stuck Closed" will be set.
- The solenoid will be de-energized (to seal the system) and purge will be ramped-on. The system/NVLD component rationality passes for that drive cycle if the switch closes after purge begins.
- The solenoid is then re-energized for the remainder of the drive cycle. If the switch events are not seen within two trips, the rationality test will fail.
- This rationality check is considered sufficient to confirm proper purge solenoid operation.

NGC MEDIUM AND LARGE LEAK TEST

This intrusive test will only be run if the Small Leak test is inconclusive (the switch does not close). The intrusive Medium and Large leak are conducted as follows:

- The NVLD solenoid is de-energized to seal the canister vent.
- Purge is activated shortly after closed loop. A vacuum builds in the EVAP system that is greater than the NVLD vacuum switch point value of 1 in. H_2O (0.25 kPa), for a specified time.
- Purge is then turned off and a determination is made on how long it takes for the tank vacuum to decay and the switch to reopen. This is also known as the “vacuum decay” method.

Leak size is determined by the time it takes for the switch to reopen. Medium or Large leak DTCs will be set if the switch closes, and then re-opens before the calibrated time. If the switch does not close, a more aggressive purge flow will be applied to determine whether a very large leak is present, a missing fuel cap, a problem with the NVLD assembly, a purge flow problem, etc. If the switch never closes, a "General EVAP System Failure" DTC will be set.

ACTIVITY 7: NVLD

Notes: ______________________________

ACTIVITY 8: NVLD FORCED MONITOR TEST

Notes:

NGC PURGE FLOW MONITOR

On NGC vehicles with NVLD, if the vehicle passes the small leak test, the PCM will run a two-stage Purge Flow Monitor. During Stage One, the NGC PCM monitors purge vapor ratio. If the ratio is above the calibrated specification, the monitor passes. Stage One is passive and non-intrusive.

If the purge vapor ratio is not above the specification, Stage Two runs. During this test, the PCM commands the purge solenoid to flow at a specified rate to force the purge vapor ratio to update. The vapor ratio is compared to the calibrated specification and if it is below, a one-trip failure is recorded. Stage Two is an active intrusive test.

ACTIVITY 9: PURGE FLOW ACTIVITY

Notes:

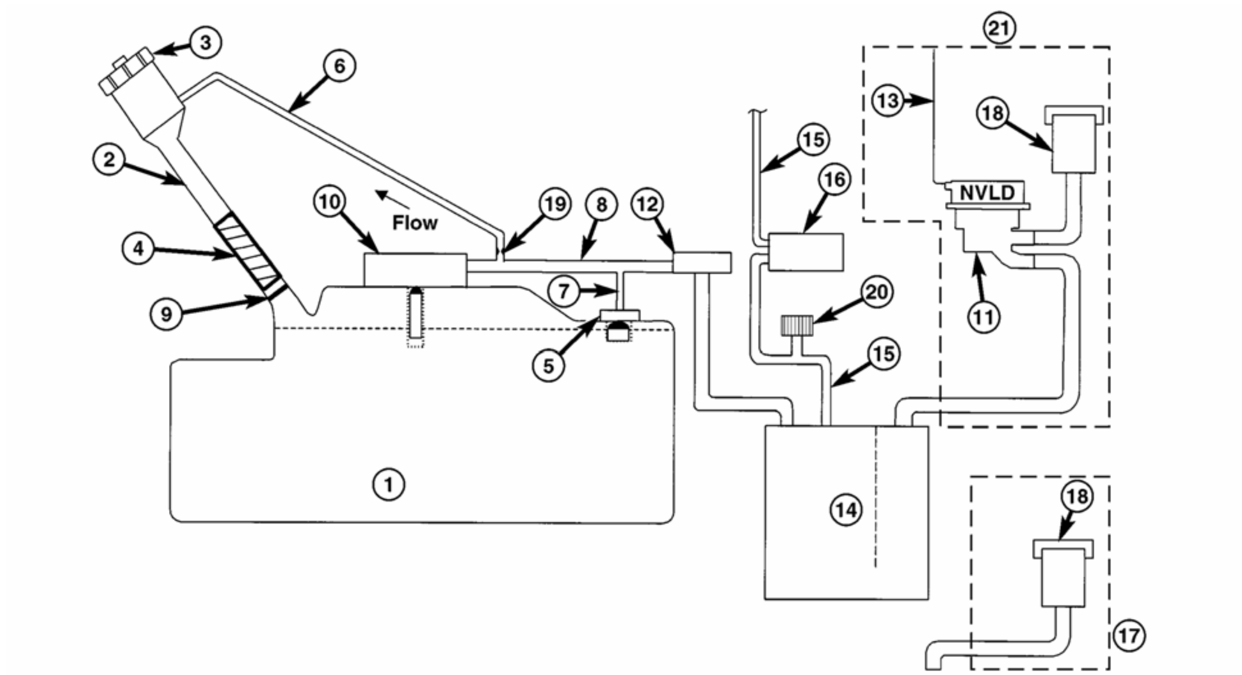
ONBOARD REFUELING VAPOR RECOVERY

The Onboard Refueling Vapor Recovery (ORVR) system was first introduced on some 1998 passenger vehicles. Previous EVAP systems vented fuel vapor (HC) emissions during refueling. ORVR greatly reduces these HC emissions.

Fuel flowing into the tank filler tube (approx. 1 in. I.D.) creates an aspiration effect which draws air into the fill tube. During refueling, the fuel tank is vented to the charcoal canister to capture HC vapors. With air flowing into the filler tube, no fuel vapors escape to the atmosphere.

As fuel starts to flow through the fill tube, it opens a normally closed check valve and enters the fuel tank. Vapor and air is expelled from the tank through the control valve to the vapor canister. Vapor is absorbed by the charcoal in the canister until vapor flow in the lines stops, either following shut-off or by having the fuel level in the tank rise high enough to close the control valve. The control valve contains a float that rises to seal the large diameter vent path to the canister. At this point in the fueling of the vehicle, the tank pressure increase, the check valve closes (preventing tank fuel from spiting back at the operator), and fuel then rises up the filler tube to shut-off the dispensing nozzle.

Once the HC vapors from refueling are captured by the canister, the vehicle's computer controlled purge system draws the HC out of the canister for the engine to burn. The vapor flow is metered by the purge solenoid so that there is minimal impact on driveability or on tailpipe emissions.



1	Fuel Tank (Plastic)	12	Liquid Separator (If Equipped)
2	Fuel Filler Tube	13	Engine Wiring Harness to NVLD
3	Fuel Cap (Pressure/Relief)	14	Vapor Canister
4	Fill Tube to Fuel Tank Connector (Elastomeric)	15	Purge Line
5	Tank Vent/Rollover Valve(s)	16	Purge Device
6	Vapor Recirculation Line	17	Without NVLD
7	Tank Vapor Line	18	Breather Element
8	Vapor Line to Canister	19	Flow Control Orifice
9	Check Valve (N/C)	20	Service Port
10	Control Valve	21	With NVLD
11	Natural Vacuum Leak Detection (NVLD)		

Figure 65 ORVR System Schematic

SCAN TOOL SMALL LEAK PRETEST SCREEN - NGC

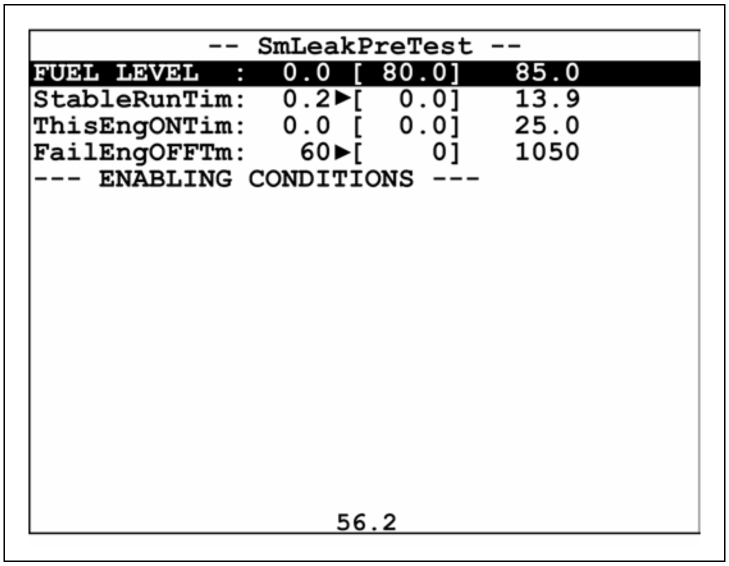


Figure 66 NGC Small Leak Monitor Pretest Screen

Fuel Level: Fuel level in the tank is displayed in percentage (100% = full tank; 0% = empty). Upper limit exists (e.g., 85%) for Small Leak Monitor to ensure a large enough vapor dome in the fuel tank in which a vacuum can be created to close the NVLD Switch during the Engine OFF test.

Stable Run Tim: Used by NGC before processing any of the Small Leak values. This ensures that the engine has started, is running and has not stalled (the NVLD Small Leak timers will not be updated with data from previous shutdown until this 10 second threshold is met).

This Eng ON Tim: This is live data indicating the length of engine run time for the current trip in minutes (e.g. 1.5 is equal to 1 minute and 30 seconds)

Fail Eng OFF Tm: This Fail Engine OFF Time is the stored amount of Engine OFF time without an NVLD Switch closure during the last Engine OFF cycle (tending toward a failure; but not yet failed). The “FailEngOFFTm” data will only update if at the last Engine off event, there was no NVLD Switch closure (for at least 61 minutes of Engine Off time and for a maximum of 1051 minutes per Engine Off event); and at the next Engine start-up, the minimum “StableRunTim” of 10 seconds has been met or exceeded.

SCAN TOOL SMALL LEAK MONITOR DATA SCREEN - NGC

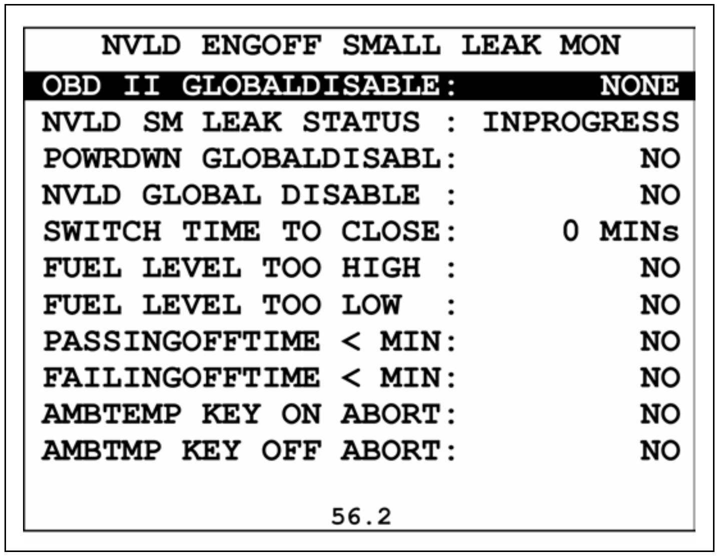


Figure 67 NGC Small Leak Monitor Data Screen

OBD II Global Disable: This line item is covered in Module 7 Monitors.

NVLD Sm Leak Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in Module 7 Monitors.

Powrdwn Global Disabl: Powerdown Global Disable will display a “Yes” if any of the bits (indicators) of the TM_GLOBAL_DIS_REG (see below) are set at powerdown. If this were the case, then the NVLD Small Leak Monitor would not have run the last Engine OFF cycle.

Flag to indicate the status of disable green catalyst2 (PCM Miles below the minimum calibration)
Flag to indicate the status of disable green catalyst1 (PCM Miles below the minimum calibration)
Flag to indicate the status of disable very low battery voltage
Flag to indicate the status of disable high Flex Fuel Level
Flag to indicate the status of disable power takeoff
Flag to indicate the status of disable low fuel level
Flag to indicate the status of disable high fuel level

Flag to indicate the status of disable high altitude
Flag to indicate the status of disable low battery voltage
Flag to indicate the status of disable high battery voltage
Flag to indicate the status of disable low ambient temperature
Flag to indicate the status of disable very low ambient temperature

NVLD Global Disable: NVLD Global Disable will display a “Yes” if any of the bits (indicators) of the TM_GLOBAL_DIS_REG (see above) are set at while the Engine is running. If this is the case, the NVLD Small Leak Monitor will not run the next Engine OFF cycle.

Switch Time To Close: The Switch Time to Close is the time in minutes that the NVLD Switch took to close the last Engine OFF cycle. 10 minutes is the minimum time that will be displayed, regardless of when the NVLD Switch really closed (e.g., 2 minutes to close NVLD Switch will not be displayed, only 10 minutes will be displayed if the Key was left OFF for 10 minutes or longer). This is the time that the NGC will ignore the NVLD Switch (which is called the “PassingOFFTime < Min” which is calibrated to 10 minutes). The maximum per Engine OFF time this display can read is 1051 minutes; thereby making sure that at least 4 tests are need to fail the Engine OFF Small Leak Monitor (4200 accumulated Minutes Max OFF Time to fail).

Fuel Level Too High: This display will go to “Yes” if the fuel level in the Fuel Tank goes above the maximum calibration (e.g., 85%). If this display shows “Yes”, then the NVLD Small Leak Monitor will not run the next Engine OFF cycle.

Fuel Level Too Low: This display will go to “Yes” if the fuel level in the Fuel Tank goes below the minimum calibration. Currently, all NVLD Small Leak Monitor calibrations are set to 0% as the minimum disable point, which means that this monitor will never be disabled by this calibration; however, we have to protect for the calibrators setting this to some value above 0 (zero), hence the reason for leaving it on the DRB 3 screen. If this display shows “Yes”, then the NVLD Small Leak Monitor will not run the next Engine OFF cycle. If this was calibrated on for this monitor, you will need to go above the calibration (e.g., 15%) and then accumulate 16.384 miles to clear the Fuel Level Too Low indicator.

Passing OFF Time < Min: The “Passing Off Time less than the Minimum” display (NVLD_ENG_OFFTIME_LESSTHAN_IGNORE), will be set to “Yes” if the Engine was shut down for less than 10 minutes and restarted. The 10 minute time is required by engineering to make sure that the fuel has stopped sloshing in the tank and that everything else associated with NVLD Small Leak has been stabilized before they ‘believe’ the state of the NVLD Switch.

No decision will be made before this 10 minute Engine Off period has elapsed (passing or failing). The NGC will always wait the 10 minutes before making any decision.

Failing OFF Time < Min: The "Failing Off Time less than the Minimum" display (NVLD_ENG_OFF_TIME_LESS_THAN_MIN), will be set to "Yes" if the Engine was shut down for less than 60 minutes without an NVLD Switch closure and the Engine was restarted. The 60 minute time is required by engineering to make sure that enough time has elapsed to potentially create a vacuum and close the NVLD Switch:

- Either allowing the fuel to cool over time (creating a vacuum),
- Or for a weather front (Baro change) to lower the pressure that the Fuel Tank 'sees' thus allowing the Fuel Tank to expand and creating a vacuum, etc.

After 60 minutes without an NVLD Switch closure, this time is valid to be counted "towards a failure" (has not yet failed); because either fuel cooling or the Baro change should have created enough vacuum to cause the NVLD Switch to close.

Amb Temp Key On Abort: The Ambient Temperature Key ON Abort display will be set to "Yes" if the Key ON ambient temperature is outside the calibration (e.g., 39.2° F – 109.4° F). If this is the case, the NGC will NOT be counting the last Engine OFF time without an NVLD Switch closure because you're out of the enable conditions.

Amb Temp Key Off Abort: The Ambient Temperature Key OFF Abort display will be set to "Yes" if the Key OFF ambient temperature is outside the calibration (e.g., 39.2° F – 109.4° F) thus disabling the Engine Off NVLD Small Leak Monitor for that Engine OFF period.

SMALL LEAK LAST RESULT MONITOR DATA SCREEN - NGC

```
-NVLD Eng OFF Switch Time Last Results-
 LstOffTm: xxxx M     LastOnTm: xxxx M
 SWCITime: xxxx M     ThisOnTm: xxxx M
  LAST OFF TIME        LAST  ON TIME
 LAST OFF:   10 M     LAST  ON:    3 M
 2ND  OFF:  135 M     LAST  ON:   25 M
 3RD  OFF: FAIL M     LAST  ON: FAIL M
 4TH  OFF:   14 M     LAST  ON:   26 M
 5TH  OFF:   10 M     LAST  ON:   10 M
 6TH  OFF:   35 M     LAST  ON:    7 M
 7TH  OFF:   10 M     LAST  ON:   17 M
 8TH  OFF:   15 M     LAST  ON:   24 M
 9TH  OFF:   43 M     LAST  ON:   26 M
 10TH OFF:   31 M     LAST  ON:   25 M

-NVLD EngOFF SwOpenFailTimes LastResult-
AccumOFF:       0 M     Accum ON:    0 M
LastFail:    4365 M     LastFail:  127 M
                   56.2
```

Figure 68 NGC Small Leak Last Result Monitor Data Screen

LstOffTm: This is the amount of time the key was turned off during the last small leak test attempt. This value will be the actual time. If the vehicle was only shutdown for 58 minutes with no switch closure, it will display 58 minutes, even though the monitor was aborted. If the test is a true pass or fail, this time will be stored in the Last OFF Time section or the SwOpenFailTimes section after the next key ON with 10 seconds of engine run time.

LastOnTm: This is the amount of time the Engine was running before the last small leak test attempt. This value will stop at 25 minutes. If the test is a true pass or fail, this time will be stored in the Last ON Time section or the SwOpenFailTimes section after the next key ON with 10 seconds of engine run time.

ThisOnTm: This is a live data read of the current engine run time.

Last OFF Time: This is a listing of the last 10 small leak monitors. The times listed represent the number of minutes required to see a switch closure. This time will never be less than 10 minutes. If a MIL is set this will register as a Fail. The Fail will stay listed for 10 passing tests.

Last ON Time: The length of time the vehicle was running before the monitor was attempted and passed.

Accum Off: the number of key off minutes accrued without seeing a switch closure. This number will go to 0 once a failure occurs, or the small leak monitor passes.

Accum On: Number of Key On minutes between key off tests without seeing a switch closure. This number will go to 0 once a failure occurs, or the small leak monitor passes.

Last Fail: (under OFF) This is the number of key off minutes which were accumulated for that vehicle to set a failure.

Last Fail: (under ON) This is the number of Key on minutes accumulated when the monitor failed.

Max OFF: This is the specification for the total number of Key OFF minutes required to set a DTC.

Max ON: This is the specification for the total number of Key ON minutes required to set a DTC.

SCAN TOOL EVAP SWITCH LAST RESULT DATA SCREEN - NGC

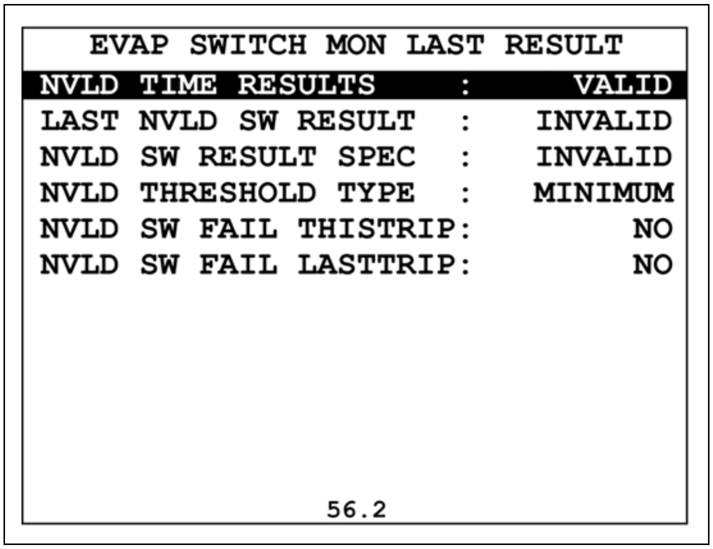


Figure 69 NGC EVAP Switch Monitor Last Result Screen

NVLD Time Results: This tells the status of the monitor's results. "Valid" indicates monitor has completed and has passed or failed. This data is from the last time the monitor completed and does not necessarily mean that the data came from last drive cycle. "Invalid" indicates monitor has not run since battery disconnect or clear DTCs (i.e., not Ready).

Last NVLD Sw Result: This will indicate the state of the switch the last time the NVLD Switch was tested. 0= open, 255=closed. This test may run with the Medium/Large Leak test or if the switch is stuck closed (solenoid turned on at start up and switch does not change state to open).

NVLD Sw Result Spec: The specification for this monitor is 128, which is the half way point between 0 and 255. This represents the switch point that the NVLD Switch must cross.

NVLD Threshold Type: This specification is set to Min. This is because all the PCM needs to see is the NVLD Switch change from open (0) to closed (255).

NVLD Sw Fail This Trip: Indicates if the monitor has ran and failed during this trip. Results in a "Yes" or "No"

NVLD Sw Fail Last Trip: Indicates if the monitor failed during the previous trip. Results in a "Yes" or "No".

SCAN TOOL MED/LARGE LEAK PRETEST SCREEN - NGC

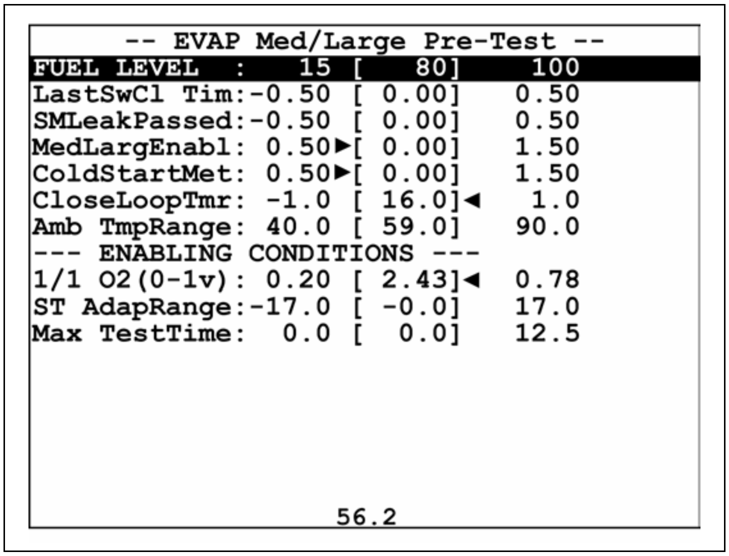


Figure 70 NGC Med/Large Leak Monitor Pretest Screen

Fuel LEVEL: Fuel level in the tank is displayed in percentage (100% = full tank; 0% = empty).

Last Sw Cl Tim: to be removed, redundant of sm leak passed

Sm Leak Passed: This Small Leak Passed indicator (bit) is displayed so that you will know that the Medium/Large Leak Monitors will not run because Small Leak passed the previous Key OFF (if Small Leak passed, you cannot have a Medium or Large Leak and therefore do not run the test). "1.00" (one) in the center column means Yes, the Small Leak Monitor passed the last Key OFF (and therefore Medium/Large are "declared" to be passed, even though they never ran this Key ON). "0.00" (zero) in the center column means No, the Small Leak Monitor has not passed the last Key OFF, and therefore run the Medium/Large Leak Monitor (if the enable conditions are met).

Med Large Enabl: This Medium/Large Leak Monitors enable indicator (bit) will display "1.00" (one) in the center column which means Yes, the monitors are enabled to run this trip.

Cold Start Met: This ColdStartMet indicator (bit) will display "1.00" (one) in the center column which means Yes, the cold start conditions have been met for the Medium/Large Leak Monitors.

Close Loop Tmr: The PCM need to ensure the engine is in Closed Loop. When Purge comes on for the monitor the PCM needs to make sure the it will not overcome the engine with purge vapors. Any non-zero value (e.g., 4.00) indicates that the fuel system is in open loop now (there is time left on the closed loop delay timer).

Amb Tmp Range: Range which is allowable for the monitor to run.

1/1 O2 (0-1V): Live O2 sensor reading

ST Adap Range: Live Short term adaptive range.

Max Test Time: This is the maximum allowable test time after a cold start.

SCAN TOOL MED/LARGE LEAK MONITOR DATA SCREEN - NGC

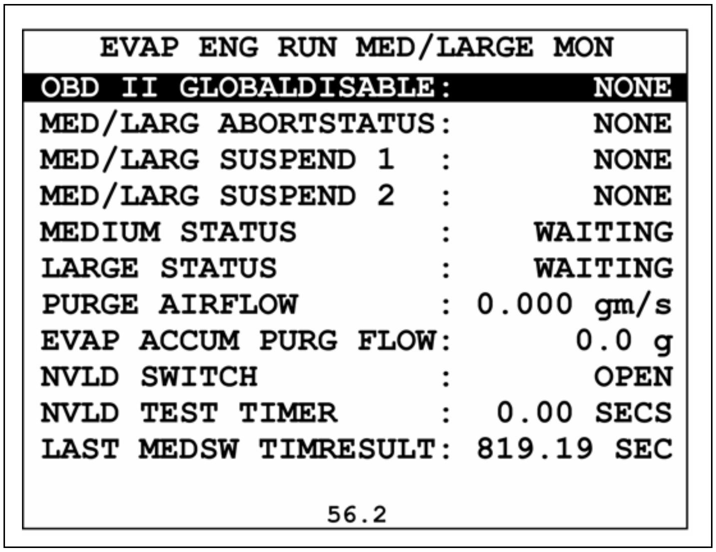


Figure 71 NGC Med/Large Leak Monitor Data Screen

OBD II Global Disable: This line item is covered in Module 7 Monitors.

1/2 O2S Mon Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in the Module 7 Monitors.

Med/Large Abort Status: The monitor can be aborted based upon a list of calibratable information. This is similar to the Global Disable status line, except these items are specific to the Medium/Large Leak Monitor.

Med/Large Suspend 1: The monitor can be suspended based upon a list of calibratable information. This is similar to the Global Disable status line, except these items are specific to the Medium/Large Leak Monitor.

Med/Large Suspend 2: This is a continuation of the Suspend 1 list.

Medium Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in Module 7 Monitors.

Large Status: The monitor status displays the current status of the monitor. There are multiple states of a monitor and they will be ranked by the DRB 3. This is covered in the Module 7 Monitors.

Purge Airflow: Calculated amount of purge airflow. Measured in Grams per Second.

EVAP Accum Purg Flow: This represents the amount of accumulated purge vapor that has flowed into the engine during the monitor. This value is only valid during the monitor.

NVLD Switch: Actual NVLD Switch state.

NVLD Test Timer: Current length of time the Med leak monitor has been testing.

Last Med Sw Tim Result: Length of time before the Switch reopened the last time the monitor was able to complete.

SCAN TOOL MED/LARGE LEAK LAST RESULT DATA SCREEN - NGC

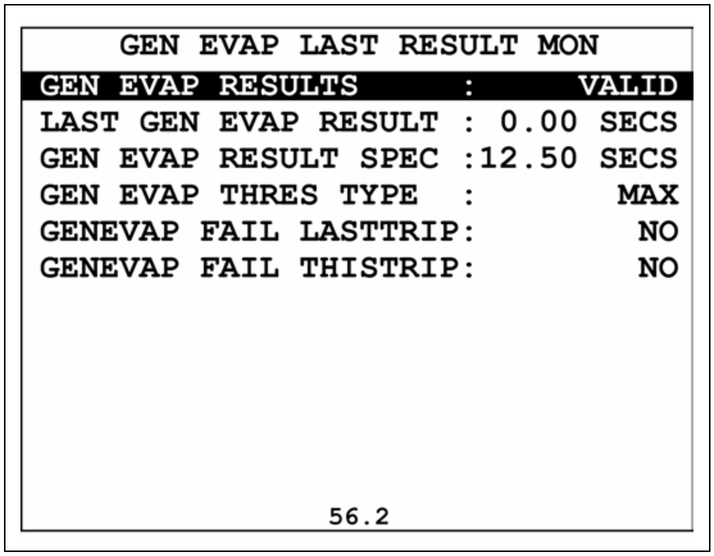


Figure 72 NGC General EVAP Monitor Last Result Screen

Gen EVAP Results: This tells the status of the monitor's results. "Valid" indicates monitor has completed and has passed or failed. This data is from the last time the monitor completed and does not necessarily mean that the data came from last drive cycle. "Invalid" indicates monitor has not run since battery disconnect or clear DTCs (i.e. not Ready).

Last Gen EVAP Result: The amount of time required to make the NVLD switch close. If the switch closes this value is substituted with a dummy value of 0.

Gen EVAP Result Spec: This is the maximum amount of time allowable for the purge vacuum to make the NVLD switch close. This purge vacuum is created during the Med/Large leak monitor "draw down" time.

Gen EVAP Thres Type: This is normally set to "MAX" due to the nature of the monitor. The length of time to cause a switch change must not exceed the specification.

Gen EVAP Fail Last Trip: Indicates if the monitor has ran and failed during this trip. Results in a "Yes" or "No".

Gen EVAP Fail This Trip: Indicates if the monitor failed during the previous trip. Results in a "Yes" or "No".

JTEC/SBEC LEAK DETECTION PUMP (LDP)

On JTEC and SBEC vehicles, the Leak Detection Pump pressurizes the EVAP system to detect leaks. It was first used in 1996 on vehicles with California emissions, and on all Federal packages starting in the 2001 model year.

Enabling Conditions Required to Run LDP Monitor

The following conditions must be met for the EVAP System LDP Leak Monitor to run:

- Fuel Level 15 - 85%
- ECT and IAT within 10°F (5.56°C)
- Ambient temperature 40 - 90°F (4 - 32°C)

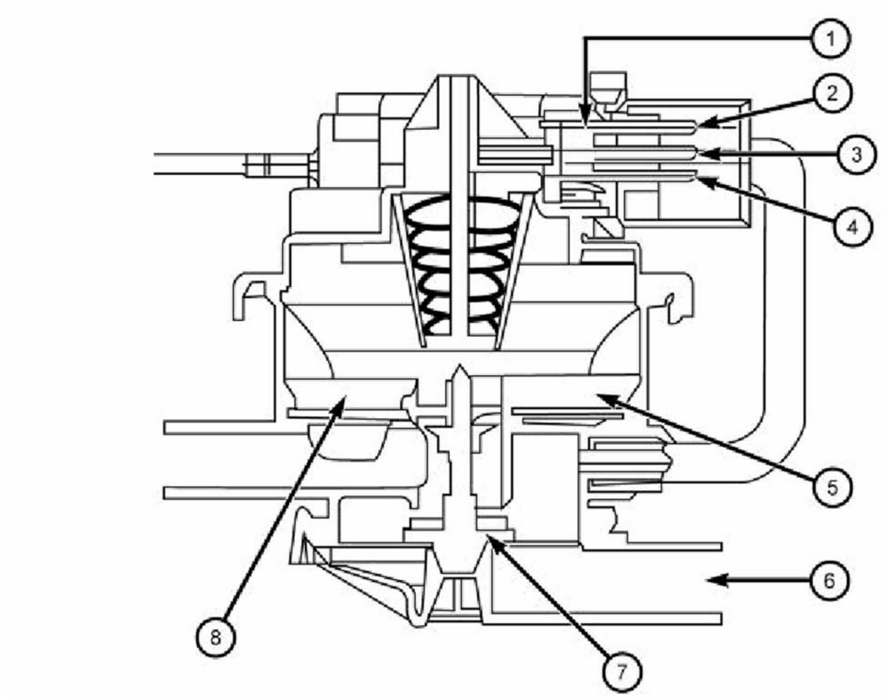
Leak Detection Pump Operation

The Leak Detection Pump contains a solenoid, a diaphragm, an atmospheric vent valve, two check valves, and a reed switch. The solenoid is cycled ON and OFF during EVAP system leak testing. This allows engine vacuum to be applied to the Leak Detection Pump diaphragm to pressurize the EVAP system. The reed switch state is used to monitor the position of the diaphragm.

When enabling conditions are met, the Leak Detection Pump Monitor runs immediately after a cold start. The LDP Solenoid is briefly energized, allowing engine vacuum to lift the diaphragm. When the diaphragm is up, the atmospheric vent is closed and the normally-closed reed switch contacts are open. This initializes the LDP.

After initialization, the PCM cycles the solenoid. The diaphragm is pulled up, drawing outside air into the pump body through the inlet check valve. When the solenoid is de-energized, the spring, which is rated at 7.5 in. H_2O, pushes the diaphragm down, closing the inlet check valve and opening the outlet check valve. This pumps air into the EVAP system and increases EVAP system pressure.

The pump continues to cycle. The increasing EVAP system pressure exerts a force on the bottom of the diaphragm and opposes spring tension on the top of the diaphragm. This slows down the pump. The PCM measures how long it takes for the diaphragm to drop down far enough for the reed switch to change state from open to closed. If the switch state changes too quickly, a leak is assumed. If the system pressurizes too quickly and the switch state changes too slowly, there may be a restriction.



1	Normally Closed Reed Switch	5	Inlet Check Valve
2	PCM Sense Circuit	6	To Inlet Air Filter Fuel Tank Vent: Pres and Vacuum
3	Solenoid Control from PCM	7	Atmospheric Vent Valve
4	12-volt Supply (SBEC-Ignition / JTEC-ASD via the PCM)	8	Outlet Check Valve

Figure 73 Leak Detection Pump

JTEC/SBEC PURGE FLOW MONITOR

The Purge Flow Monitor on SBEC and JTEC vehicles with LDP is a two-stage monitor. During Stage One, the PCM looks for a difference between purge and purge-free adaptive values. Stage One is passive and non-intrusive.

If the difference between purge and purge-free adaptive values in Stage One are not great enough, Stage Two runs. During this test, the PCM ramps open the purge solenoid and looks for Short Term Adaptive shift. If Short Term Adaptive shifts downward, the PCM determines that HC from the canister is purging. If Short Term Adaptive shifts upward, the PCM determines that the solenoid is allowing purge flow and there is no HC in the canister. In either case, the system passes. Stage Two is an active intrusive test.

SCAN TOOL PRETEST SCREEN – JTEC/SBEC

SBEC

```
LDP Pre-Test
Bat Tmp Range: 39.2    [69.8]    89.6
ECT/Bat Range: 0.0     [25.2]    19.8
     ENABLING CONDITIONS
Volts Range  : 9.0     [12.1]    15.8
Vacuum Range : 3.9     [0.0]     31.0
```

JTEC

```
LDP Pre-Test
Amb Tmp Range: 39.2    [68.0]    89.6
Bat Tmp Range: 21      [66]      130
Baro Range   : 22.1    [29.5]    31.0
ECT/Bat Range: 0.0     [1.8]     18.0
FUEL LEVEL   : 2.6     [1.1]     5.0
     ENABLING CONDITIONS
VSS Range    : 0.0     [0.0]     10.0
Volts Range  : 10.5    [12.2]    15.2
Vacuum Range : 4.9     [29.5]    31.0
```

Figure 74 JTEC/SBEC LDP Monitor Pretest Screen

SCAN TOOL MONITOR DATA SCREEN – JTEC/SBEC

SBEC

```
EVAP LEAK DETECT MONITOR
LDP SWITCH STATUS     : 80
LDP SWITCH TEST       : Test Pend
PINCHED LINE STATUS   : 80
PINCHED LINE TEST     : Test Pend
GROSS LEAK STATUS     : 80
GROSS LEAK TEST       : Test Pend
.040 LEAK STATUS      : 80
.040 LEAK TEST        : Test Pend
.020 LEAK STATUS      : 00
020 LEAK TEST         : Comp/Stop
LDP ABORT STATUS      : NONE
LDP MON STATE         : 0-Test Ini
LDP MON AVG PUMP TIME: 25.60 SEC
LEAK DETECT PUMP SW   : CLOSED(DN
DES LDP SOLENOID      : BLOCK
PURGE SOLENOID FLOW   : 0 %
```

JTEC

```
EVAP LEAK DETECT MONITOR
LDP MONITOR DATA          : 00
LDP MON IN PROGRESS       : NO
LDP MON DONE THIS TRIP    : NO
LDP MON FAIL THIS TRIP    : NO
LDP MON DONE/STOP TESTING: NO
LDP ABORT STATUS          : Pending
LDP MON STATE             : 9-Comp/Sto
LDP MON AVG PUMP TIME     : 0.00 SEC
LEAK DETECT PUMP SW       : OPEN (UP)
DES LDP SOLENOID          : VACBLOCKED
PURGE DUTY CYCLE          : 0 %
```

Figure 75 JTEC/SBEC LDP Monitor Data Screen

SCAN TOOL MONITOR LAST RESULT SCREEN – JTEC/SBEC

SBEC

```
        LDP MON LAST RESULT
LAST LDP MON STATUS       : CO
LDP MON LAST RESULT       : MIN
LDP MON FAIL THIS TEST    : NO
LDP MON FAIL PREV TEST    : NO
LDP MON AVG PUMP TIME     : 25.60 SEC
LDP MON AVGPUMP TIME SPEC: 1.91
LDP MON PUMP TIME RESULT : VALID
LDP MON FAILURE           : None
```

JTEC

```
        LDP MON LAST RESULT
LDP MON AVG PUMP TIME       : 0.00 SEC
LDP MON AVGPUMP TIME SPEC  : 1.58
LDP AVG PUMP TIME           : VALID
LDP .020 AVG PUMP TIME      : 0.00 SEC
LDP .020 AVG PUMP TIME SPEC: 1.8
LDP AVG PUMP TIME           : VALID
```

Figure 76 JTEC/SBEC LDP Monitor Last Result Screen

Notes:

GLOSSARY

Adaptive Memory Factor	Short Term Fuel Trim value and Long Term Fuel Trim values combined. This provides a maximum total correction of ±66% (NGC and JTEC) or ±50% (SBEC) from the base fuel injector pulse width calculation.
Adaptive Numerator	Learned variance in ideal and actual CKP signal. Also called the Target Linear Compensation or Target Learning Coefficient. Takes into account variations in machining of the trigger wheel and CKP sensor response.
Air Injection Reaction System	AIR systems reduce hydrocarbon and carbon monoxide emissions by injecting air directly into the exhaust and/or the catalytic converter.
Alternate Good Trip	Used in place of Global Good Trips for Comprehensive Components and Major Monitors. If a Global Good Trip cannot be run, the Task Manager will count an Alternate Good Trip after two minutes of engine run time where no other faults occur. The Task Manager counts an Alternate Good Trip for a specific Major Monitor when the monitor runs and passes.
CARB Readiness Status	A scan tool screen indicating whether or not CARB mandated once-per-trip monitors have run.
Catalyst	A substance that enhances a chemical reaction while not being changed or used up in that reaction.
Catalytic Converter	Used in exhaust systems to convert pollutants into harmless substances such as water and CO_2. The three-way Catalytic Converter oxidizes HC and CO, and reduces oxides of nitrogen (NOx).
Closed Loop	When the PCM uses input from the O_2 sensors to make feedback corrections to the speed density equation. Also see Open Loop.
Comprehensive Components	All input and output components that can affect emissions. These components are monitored for electrical faults such as opens and shorts, and may also monitored for rationality and functionality.
Conflict	A condition where a monitor may not be run because it would interfere with or be affected by another currently running monitor. The Task Manager will prevent the second monitor from running until the first monitor has finished.

Drive Cycle A Federal emissions procedure to drive a vehicle and allow most monitors to run and perform their tests. Drive Cycles can specify calibrated values for engine temperature increase, vehicle speed, time, and other parameters.

Enabling Conditions Operating parameters or conditions that must be met for a monitor to run. The list of conditions that may permit a monitor to run or prevent or suspend monitor operation is calibrated and varies for each package.

Evaporative Emissions System Fuel vapors from evaporating fuel in the tank and from refueling is absorbed and stored in the EVAP charcoal canister. Engine vacuum causes air flow through the canister during engine operation. This flow purges HC and meters it into the intake manifold.

Exhaust Gas Recirculation EGR systems dilute the air/fuel mixture with inert exhaust gases. Recycling some inert exhaust gases back into the intake mixture can lower combustion temperatures and reduce the quantity of Oxides of Nitrogen (NOx) formed. EGR also improves fuel economy, since less air and fuel enter the cylinders, and it reduces engine knocking.

Freeze Frame Data stored from various sensors describing the engine operating conditions at the time a fault is detected.

Fuel System Good Trip Counted when engine is in closed loop, operating in similar conditions window, and total Adaptive Memory Factor (Short Term Adaptive value and Long Term Adaptive value combined) does not exceed the threshold for a calibrated time. If these conditions are met, the PCM will count a Good Trip toward erasing a fuel system monitor (rich/lean) DTC.

Functionality OBD II systems test PCM outputs for functionality as well as circuit continuity. When the PCM supplies a voltage to an output component, it can verify that the command was carried out by monitoring specific input signals for expected changes.

Global Disable On NGC vehicles, Monitors can be Globally Disabled if certain conditions occur. If there is more than one condition, the DRB III will display only the highest-ranked one. Not every condition affects every monitor. For example, Global Disable can display "High Fuel" and the monitor status can indicate "Waiting". The "High Fuel" condition is not calibrated to prevent that monitor from running, so the monitor can run and complete its test.

Global Good Trip	When all Monitors that run once-per-trip have run and have passed. The definition varies by vehicle and model year. Typically, the Oxygen Sensor and Catalyst Efficiency Monitors must run in order to increment a Global Good Trip.
Good Trip	An indication that the vehicle was operated under a specific set of operating conditions and no fault was detected. There are different types of Good Trips depending upon what the PCM is trying to verify.
Intrusive	An active Monitor test that actively changes operating conditions to run its test. Also see Non-Intrusive.
Leak Detection Pump	A Leak Detection Pump pressurizes the EVAP system to detect leaks. Used on JTEC and SBEC vehicles.
Long Term Adaptive	See Long Term Fuel Trim
Long Term Fuel Trim	After the vehicle has reached full operating temperature, the fuel injector pulse width correction factors generated by Short Term Adaptive will be stored in Long Term Adaptive or Long Term Fuel Trim memory cells. Once stored, it will be used under all operating conditions. Also see Short Term Fuel Trim.
Misfire	Lack of combustion in a cylinder during the power stroke.
Misfire Good Trip	Counted when operating in Similar Conditions Window (SBEC/JTEC only) and 1000 engine revolutions occur with no misfire.
Monitor	Software in the PCM that checks and verifies the performance of various emission-related systems and components.
Natural Vacuum Leak Detection	NGC vehicles use the Natural Vacuum Leak Detection (NVLD) method to dependably detect 0.020 in. (0.5 mm) leaks in the EVAP system. NVLD replaces the leak detection pump previously used on SBEC and JTEC vehicles. NVLD seals the EVAP system and monitors for a slight pressure drop as the system cools.
Non-Intrusive	A passive Monitor test that does not actively change any operating condition to run its test. Also see Intrusive.
Onboard Refueling Vapor Recovery	ORVR systems greatly reduce HC emissions during refueling by capturing vapors in the EVAP canister. Previous EVAP systems vented fuel vapor (HC) emissions during refueling.

One-Trip Monitor An emissions system test that will set a DTC and illuminate the MIL the first time a failure is detected. Also see Two-Trip Monitor.

Oxygen Sensor Oxygen Sensors provide a signal to the PCM for oxygen content in the exhaust and make the closed-loop feedback engine management system possible. The PCM infers air/fuel ratio from the sensor signal for oxygen content and adjusts the quantity of fuel injected to keep the air/fuel ratio at stoichiometry (14.7:1).

Open Loop When the PCM ignores O_2 sensor feedback and only uses pre-programmed values to perform air/fuel ratio adjustments. Also see Closed Loop.

Pending A Monitor may not be run if the MIL is illuminated and a fault is stored. The Monitor will not be run until the problem is no longer present.

Priority CARB mandated DTCs are entered and ranked according to priority. In earlier vehicles with limited memory storage, DTCs with higher priority overwrite lower priority DTCs. Later vehicles can store as many as eight DTCs before overwriting.

Purge The process of taking stored hydrocarbon vapors from the charcoal canister and adding them to the intake mixture.

Purge Vapor Ratio The proportion or concentration of fuel (Hydrocarbon) vapors in the EVAP system purge flow. If purge flow contains a high ratio of HC vapors, less fuel from the injectors is required.

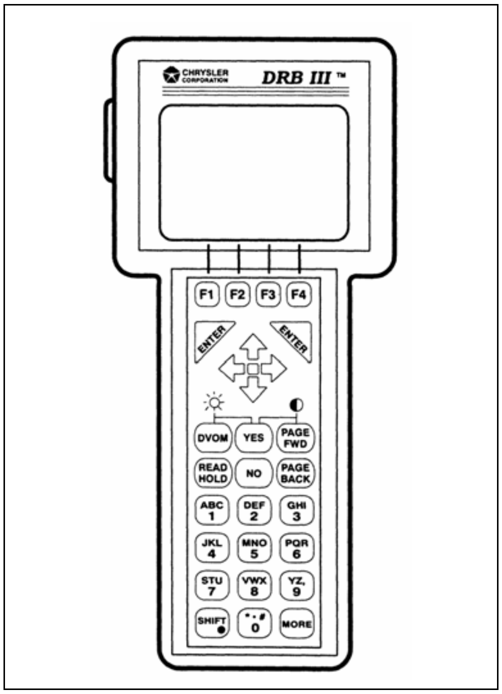
Rationality OBD II systems compare input signals against other inputs and stored information to see they make sense under the current conditions.

Short Term Adaptive See Short Term Fuel Trim.

Short Term Fuel Trim An immediate correction to fuel injector pulse width. An immediate response to an O_2 sensor signal that is not switching or is consistently high or low. Short Term Fuel Trim (also called Short Term Adaptive) begins functioning shortly after the vehicle has started, as soon as the oxygen sensor is heated to operating temperature. Short Term Adaptive values change very quickly and are not stored when the ignition is OFF. Also see Long Term Fuel Trim.

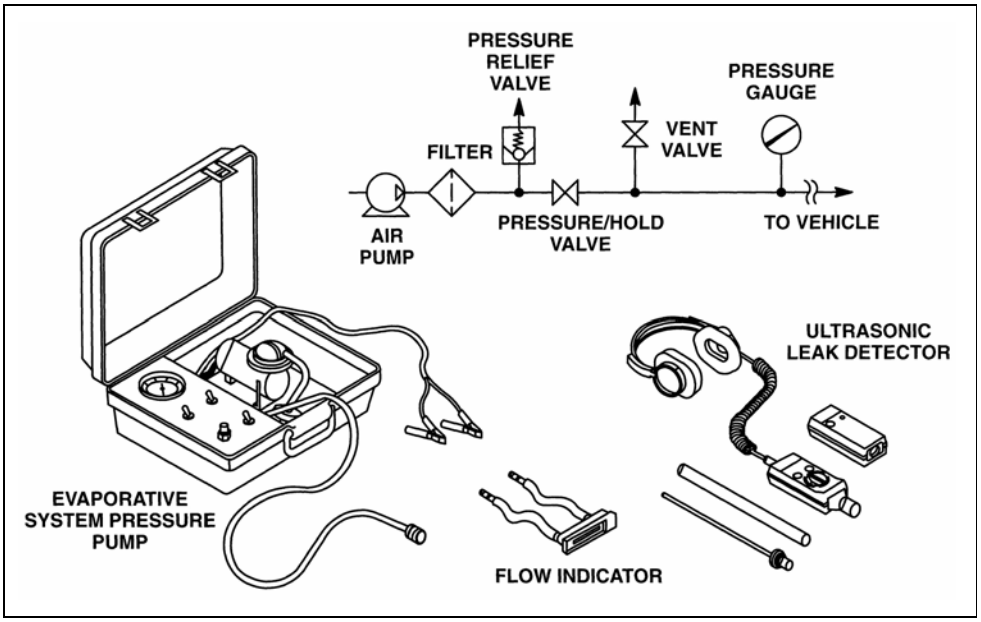
Similar Conditions Window	Displayed on the scan tool, allows the user to operate the vehicle under operating conditions similar to when the fault occurred.
Speed Density Fuel Control	A fuel control systems that changes fuel injection quantity largely based on changes in engine speed and load. Most Chrysler Group vehicle use the Speed Density system.
Stoichiometry	The ideal air/fuel ratio. For gasoline, it is 14.7 parts air to 1 part fuel. Other fuels have different ratios.
StarSCAN	Can-bus compatible scan tool replacing the DRB III.
Suspend	The Task Manager may not allow a two-trip fault to mature if conditions might lead to erroneous results. This reduces the chances of the MIL illuminating for the wrong fault.
Task Manager	Software in the PCM that determines whether enabling conditions have been met to run appropriate tests, monitors parameters during tests, and records test results.
Trip Counter	Criteria used by the PCM to turn OFF the MIL. A trip is defined as "starting the vehicle and operating it to meet the criteria necessary to run a given diagnostic test". CARB requires three good trips to extinguish the MIL.
Two-Trip Monitor	Some diagnostic tests must fail more than one time before the PCM sets a DTC and illuminates the MIL. These tests are "Two-Trip Monitors". Also see One-Trip Monitor.
Warm-Up Cycle	A Warm-Up Cycle occurs when engine coolant temperature starts below and rises above 160°F (71°C), and increases at least 40°F (22.2°C), while no other faults occur. Counted by the PCM and used to erase DTCs and Freeze Frames.

TOOL APPENDIX



DRB III Scan Tool

StarSCAN Scan Tool



EVAP System Pressure Tester and Ultrasonic Leak Detector

EELD Tester