CHRYSLER CORPORATION

ON BOARD DIAGNOSTICS II

TECHNICAL TRAINING

STUDENT WORKBOOK

SAFETY NOTICE

This publications purpose is to provide Technical training information to individuals in the automotive trade. All test and repair procedures must be performed in accordance with manufacturers service and diagnostic manuals. All ***warnings, cautions,*** and ***notes*** must be observed for safety reasons. The following is a list of general guidelines:

- Proper service and repair is critical to the safe, reliable operation of all motor vehicles.
- The information in this publication has been developed for service personnel, and can help when diagnosing and performing vehicle repairs.
- Some service procedures require the use of special tools. These special tools must be used as recommended throughout this Technical Training Publication, the diagnostic Manual, and the Service Manual.
- Special attention should be exercised when working with spring-or tension-loaded fasteners and devices such as E-Clips, Cir-clips, Snap rings, etc., careless removal may cause personal injury.
- Always wear safety goggles when working on vehicles or vehicle components.
- Improper service methods may damage the vehicle or render it unsafe.
- Observe all ***warnings*** to avoid the risk of personal injury.
- Observe all ***cautions*** to avoid damage to equipment and vehicle.
- ***Notes*** are intended to add clarity and should help make your job easier.

Cautions and ***Warnings*** cover only the situations and procedures Chrysler Corporation has encountered and recommended. Chrysler Corporation cannot know, evaluate, and advise the service trade of all conceivable ways in which service may be performed, or of the possible hazards or each. Consequently, Chrysler Corporation has not undertaken any such broad service review. Accordingly, anyone who used a service procedure or tool that is not recommended in this publication, must be certain that neither personal safety, nor vehicle safety, is jeopardized by the service methods they select.

TECHNICAL TRAINING

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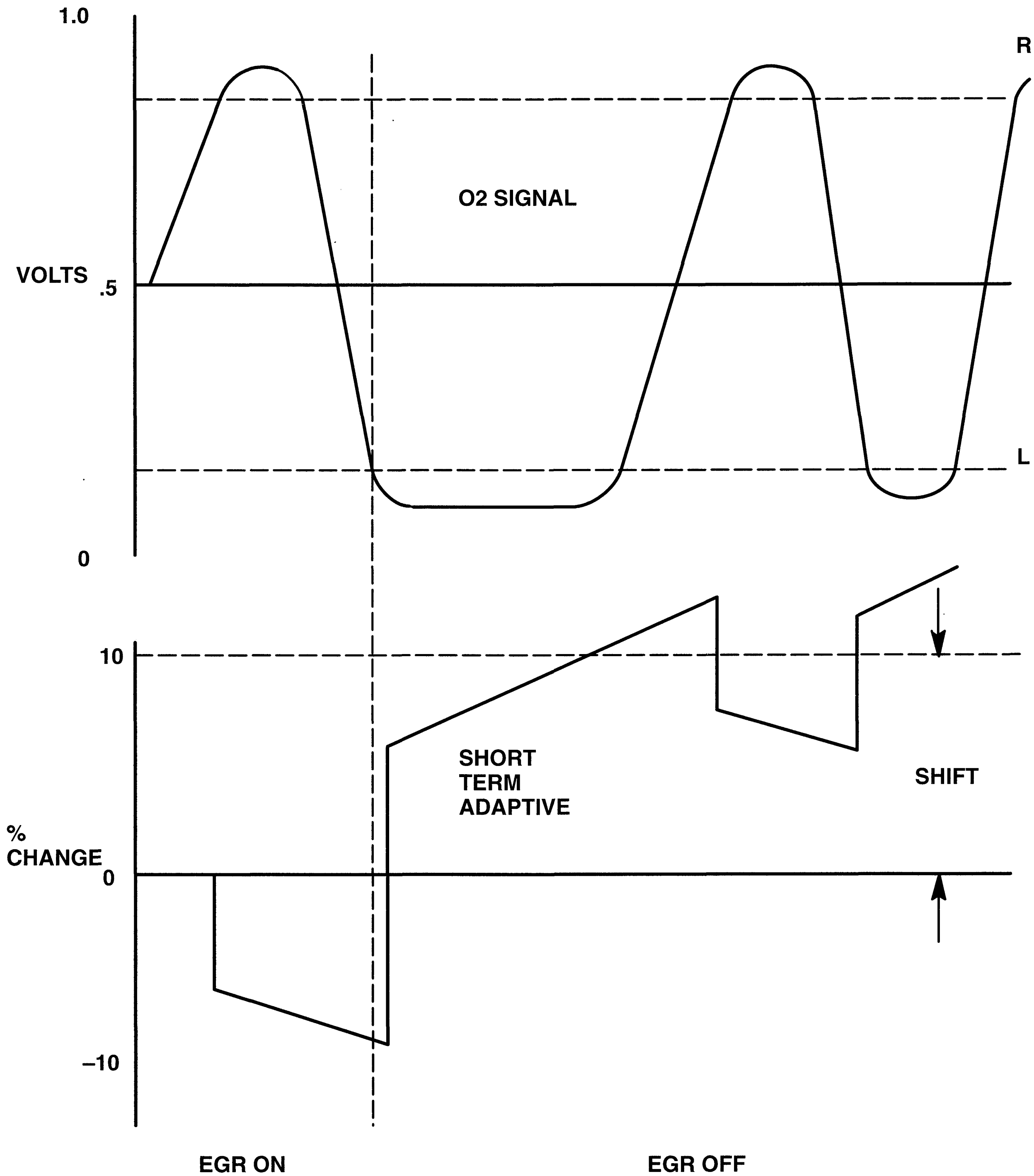
MASTER TECH


1.0
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EGR OFF

On Board Diagnostics II

On Board Diagnostics II

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On Board Diagnostics II

INTRODUCTION

The introduction of new regulations regarding emissions has brought on the second generation of On Board Diagnostics, OBD II. Vehicles are now required to monitor emissions related components to further reduce vehicle emissions. Although regulations have not required the use of many new components, software changes to vehicles controllers have brought on vast changes in diagnostics.

After completing this training course you will have the necessary knowledge and skills to perform correct, efficient, and professional OBD II system diagnosis and repair.

STUDENT LEARNING OBJECTIVES

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

- Federal Clean Air Act
- California Air Resources Board
- OBD II Regulations
- Use of Diagnostic Tools and Service Manuals
- Function of Task Manager to Control Diagnostic Systems
- Understand Operation and Function of All Monitors.

ACRONYMS

ASD	Automatic Shutdown
BARO	Barometric Pressure
CAA	Clean Air Act
CARB	California Air Resources Board
CKP	Crankshaft Position Sensor
CMP	Camshaft Position Sensor
CO	Carbon Monoxide
DLC	Data Link Connector
DRB III	Diagnostic Readout Box, Third Generation
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohm Meter
EATX II	Electronic Automatic Transmission Controller, Second Generation
ECT	Engine Coolant Temperature Sensor
EET	Electronic EGR Transducer
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
EVAP	Evaporative Emissions System
FTP	Federal Test Procedure
HC	Hydrocarbons
HO2S	Heated Oxygen Sensor
IAC	Idle Air Control
I/M	Inspection and Maintenance Testing
LDP	Leak Detection Pump
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
NO_X	Oxides of Nitrogen
OBD I	On Board Diagnostics, First Generation
OBD II	On Board Diagnostics, Second Generation
PCM	Powertrain Control Module
PFS	Purge Flow Solenoid
RPM	Revolutions Per Minute
SAE	Society of Automotive Engineers
TPS	Throttle Position Sensor

MODULE ONE - OBD II OVERVIEW

OBJECTIVES

Upon completion of this Module you should become familiar with the following subjects:

- Federal Clean Air Act (CAA)
- The role of government agencies in the implementation of OBD II
- California Air Resources Board (CARB)
- Environmental Protection Agency (EPA)
- Society of Automotive Engineers (SAE)
- Chrysler Corporation's commitment to regulatory compliance
- Evolution of OBD II
- OBD II monitoring strategies/elements
- Emission-related system/component deterioration
- Chrysler Corporation phase-in of OBD II

BASIS FOR OBD II

Federal Legislation

Over the years, the Federal Government has passed legislation in an effort to maintain air quality standards. The original Clean Air Act was brought into law in 1963. The Clean Air Act Amendments of 1970 formed the Environmental Protection Agency (EPA), and gave the agency broad authority to regulate vehicle pollution. Specific responsibilities were set for government and private industry to reduce emissions. Since then, the agency's pollution and automotive emission standards have become increasingly more stringent.

Environmental Protection Agency

The EPA dictates standards on acceptable limits of vehicle emissions. The EPA guidelines state that all vehicles must reduce the emissions of certain pollutants and potentially harmful gases to acceptable levels.

The EPA has passed legislation regulating various automotive systems over the years. Table 1 is a list of emission standards milestones since 1963.

Table 1 EPA Legislation

YEAR	LEGISLATION
1963	Original Clean Air Act passed into law
1970	Clean Air Act amendments to current policies amended
1970	Environmental Protection Agency formed
1971	Evaporative emission standards enacted
1972	First Inspection and Maintenance program introduced
1973	NO_X exhaust standards enacted
1975	First catalytic converter introduced
1989	Gasoline volatility standards enacted
1990	New Clean Air Act amended to current policies
1995	I/M 240 testing for gasoline vehicles required in non-attainment zones
1996	OBD II vehicle compliance required

The Clean Air Act Amendments of 1990 added more clout to many parts of the earlier law. Some features of the new act are:

- Stricter tailpipe emission standards for cars, trucks and buses.
- Expansion of Inspection and Maintenance (I/M) programs with more stringent testing.
- Attention to fuel technology (the development of alternate fuels).
- Study of non-road engines (e.g. boats, farm equipment, home equipment, construction equipment, lawn mowers, etc.).
- Mandatory alternative transportation programs (car-pooling) in heavily polluted cities.

California Air Resources Board

After the passage of the Clean Air Act in 1970, California created the Air Resources Board (CARB). The role of CARB is to propose tighter emission standards for vehicles sold in that state.

CARB began regulation of On Board Diagnostics (OBD) for vehicles sold in California beginning in 1988. OBD I, the first phase, required monitoring of the fuel metering system, the Exhaust Gas Recirculation (EGR) system, and additional emissions–related electrical components. A Malfunction Indicator Lamp (MIL) was required to alert the driver of a malfunction. Along with the MIL, OBD I required the storage of Diagnostic Trouble Codes (DTCs) identifying the specific area at fault.

With the passage of the Federal Clean Air Act Amendments in 1990, CARB developed regulation for the second generation of On Board Diagnostics (OBD II). These amendments also prompted the EPA to develop somewhat different On Board Diagnostic requirements. The EPA allows manufacturers to certify to CARB's OBD II regulations until 1999. All passenger cars, light duty trucks and medium duty vehicles and engines sold in the US must comply with OBD II standards by 1996.

CHRYSLER CORPORATION'S COMMITMENT

Not only is Chrysler committed to meeting OBD II requirements, the company is making strides toward environmental friendliness. From OBD II to plastic recycling, Chrysler is pushing toward saving and protecting our environment.

OBD II GUIDELINES

CONTINUED EVOLUTION OF EMISSION CONTROLS

OBD I

OBD I started with the 1988 model year. OBD I standards required monitoring of the following systems:

- Fuel Metering
- Exhaust Gas Recirculation (EGR)
- Additional Emission–Related Electrical Components

Vehicles were required to illuminate a Malfunction Indicator Lamp (MIL) to alert the driver of any malfunctions the monitoring discovered. Along with the MIL, Diagnostic Trouble Codes were required to store information identifying specific areas of failure.

OBD I systems do not detect many emission-related problems such as misfire and catalytic converter failures. By the time a component actually fails and the MIL is illuminated, the vehicle may have been producing excess emissions for quite some time. The MIL may never be illuminated because an OBD I system is not designed to detect certain failures.

OBD II

After the passage of the Clean Air Act Amendments, CARB developed guidelines for OBD II that must be met for 1996 and beyond (fig. 1 and fig. 2) . Below is a list of requirements as outlined by OBD II.

- Malfunction Indicator Lamp illumination if HC, CO, or NO_X, emissions exceed certain thresholds, typically 1.5 times the allowable Federal Test Procedure standards.
- Use of an on-board computer to monitor the condition of electronic components and to illuminate the MIL if components fail or if emission levels exceed acceptable limits.
- Standard specifications for a Data Link Connector (DLC), including location, and terminal layout, allowing access by generic scan tools.
- Implementation of standards for emissions-related Diagnostic Trouble Codes (DTCs) with standard definitions.
- Standardization of electrical systems and component terms and acronyms.
- Service, diagnostic, maintenance, and repair information availability to <u>all</u> persons engaged in vehicle service and repair.

OBD I VS. OBD II

OBD I	OBD II
• MONITORS ARE DESIGNED TO DETECT SYSTEM AND COMPONENT ELECTRICAL FAILURES	• MONITORS THE PERFORMANCE OF EMISSION SYSTEMS AND COMPONENTS AS WELL AS ELECTRICAL FAILURES
• MIL WOULD TURN OFF IF EMISSION PROBLEM CORRECTED ITSELF	• MIL STAYS ON UNTIL 3 CONSECUTIVE TRIPS HAVE PASSED WITHOUT THE PROBLEM RE-OCCURRING

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Figure 1 OBD I vs. OBD II

OBD I VS. OBD II

OBD I REQUIRED MONITORS

- OXYGEN SENSOR
- EGR SYSTEM
- FUEL DELIVERY SYSTEM
- PCM

OBD II REQUIRED MONITORS

- CATALYST EFFICIENCY
- ENGINE MISFIRE
- FUEL SYSTEM
- OXYGEN SENSOR RESPONSE
- OXYGEN SENSOR HEATER
- COMPREHENSIVE COMPONENT
- EVAPORATIVE SYSTEM
- SECONDARY AIR SYSTEM
- CFC MONITORING
- EGR SYSTEM

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Figure 2 Required Monitors

EMISSIONS DIAGNOSTIC SYSTEMS

System Monitors and Component Deterioration

OBD II requires that vehicles falling under OBD II guidelines utilize the following system monitors:

- Comprehensive Component Monitor
- Fuel Control Monitor
- HO2S/Heater Monitor
- Catalyst Monitor
- Misfire Monitor
- Evaporative Emissions Monitor
- Exhaust Gas Recirculation Monitor
- Secondary Air System Monitor

Specific OBD II requirements for monitor and component operation are discussed in Module Four.

OBD II HARDWARE AND SOFTWARE

General Industry Impact

OBD II requires the use of minimal additional monitoring hardware. Changes in regulations revise and clarify already adopted requirements. The most significant areas of impact are:

- Additional O_2 Sensors
- EVAP Leak Detection Pump
- Faster Powertrain Control Module

CHRYSLER PHASE-IN

Chrysler began phasing in OBD II compliant vehicles in 1994. Below is a list by year of Chrysler vehicles that are OBD II compliant:

1994 1/2

- PL Body - Neon (Certified as 1995 Model Year)

1995

- PL Body - Neon
- F24S Body - Eagle Talon, 2.0L Manual Transmission only
- FJ 22 Body - Sebring/Avenger, 2.0L Manual Transmission only
- JA Body - Cirrus/Stratus, 2.0L Manual Transmission only

1995 1/2

- NS Minivan

1996 All vehicles except:

- Flex Fuel (Methanol)
- CNG (OBD II For Comprehensive Components)
- Diesel

Note: *Chrysler was granted a waiver for 1995 vehicles utilizing the EATX II transmission controller. These vehicles are non–compliant, because the controller is unable to communicate at the OBD II–mandated baud rate.*

ACTIVITY ONE

CONNECTING DIAGNOSTIC EQUIPMENT

In this activity, you will be asked to connect the equipment to the classroom vehicle that will be used to demonstrate the operation of OBD II. Your instructor will guide you through the procedure. Use the spaces provided below to record any notes that you feel are important.

NOTES:

MODULE TWO - OBD II DIAGNOSTIC TOOLS

OBJECTIVES

This module is designed to give students a brief overview of tools to be used for diagnostics on OBD II vehicles. Upon completion of this module technicians should be familiar with:

- Chrysler Service Manuals
- Diagnostic Readout Box Third Generation (DRB III) Scan Tool
- Mopar Diagnostic System (MDS) Machine
- EVAP Flow Pump/Ultrasonic Leak Detector

Chrysler Service Manuals

Chrysler service manuals are designed to give the technician insight into what repairs and diagnostics need to be performed. Diagnostic Procedure Manuals serve to guide technicians to a proper diagnosis. The Service Manuals provide instruction for actual removal and replacement of components, as well as vehicle electrical schematics.

Manuals for each vehicle include the following:

- Service Manual
- Powertrain Diagnostic Procedures
- Body Electrical Diagnostic Procedures
- Electrical, Heating and A/C diagnostic Procedures

DRB III

The DRB III Scan Tool is a Chrysler-specific, completely portable computer-type vehicle analyzer (fig. 3). It enables a technician to electronically access vehicle control system data such as diagnostic trouble codes, sensor inputs/outputs, switch states and controller software levels. In addition, it can perform system tests by controlling the functions of many components. It can also be used as a digital multimeter (DVOM).

The DRB III displays all OBD II information processed by the PCM. Communicating through the Data Link Connector (DLC), the DRB III shows Freeze Frame, DTC's, Monitoring Enabling Conditions, and trip counters.

Through the use of the DRB III, technicians can also actuate many components on the vehicle to test operation. Items such as relays, motors, switches, etc., can be actuated with the DRB III.

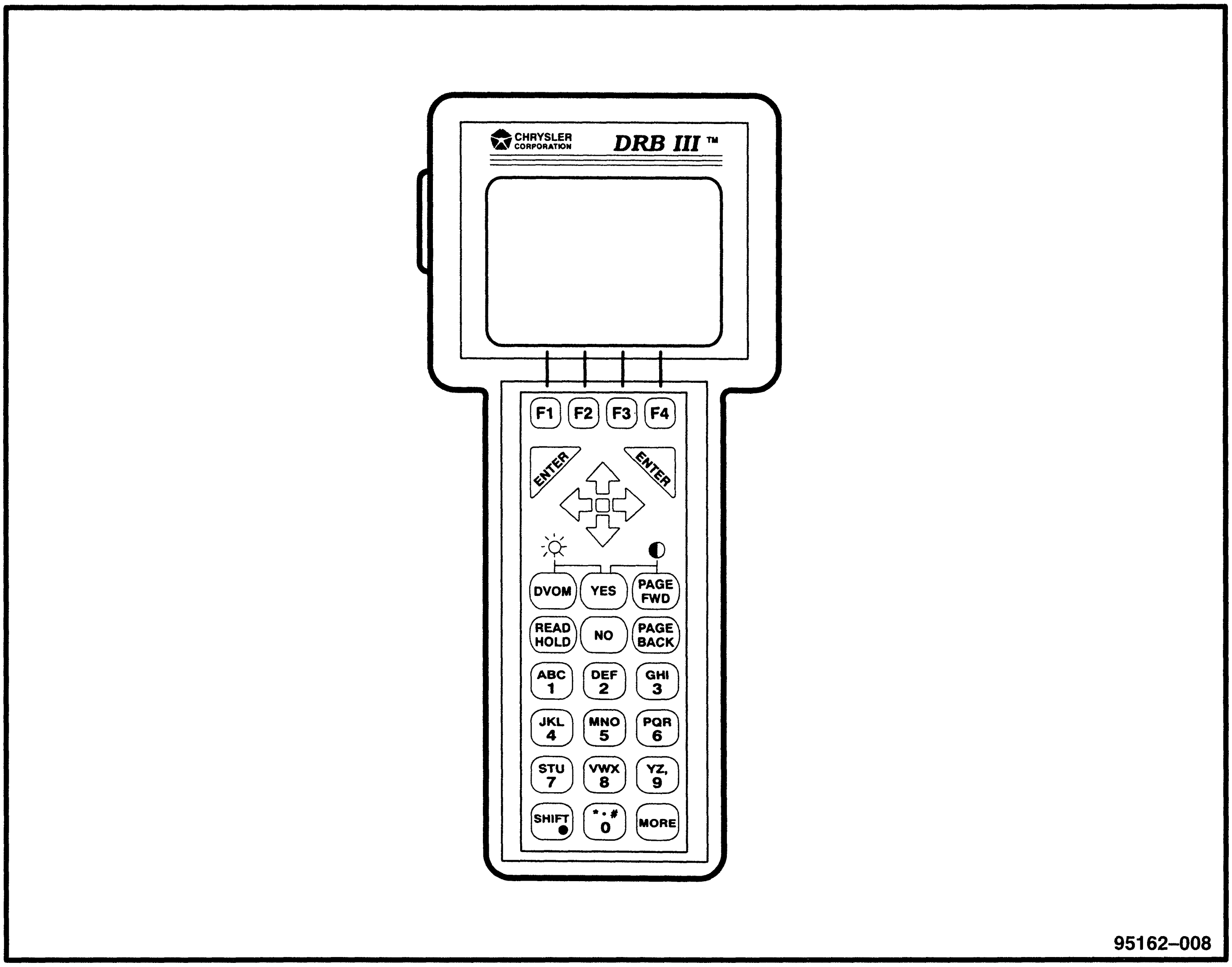

Figure 3 DRB III Scan Tool

Mopar Diagnostic System (MDS)

The Mopar Diagnostic System (MDS) can be used as a diagnostic tool (fig. 4). Several MDS functions can assist the technician in the diagnosis of an OBD II failure. One of these functions is the Dynamic Data Display.

For example, the Dynamic Data Display is helpful when diagnosing oxygen sensor-related problems, because sensor signals can be displayed. This could be useful for the Oxygen Sensor Monitor and the Catalyst Monitor. Additional component signals can be displayed as well.

Other useful functions include diagnostic procedures, service bulletins and the Big Screen function for DRB III screen display.

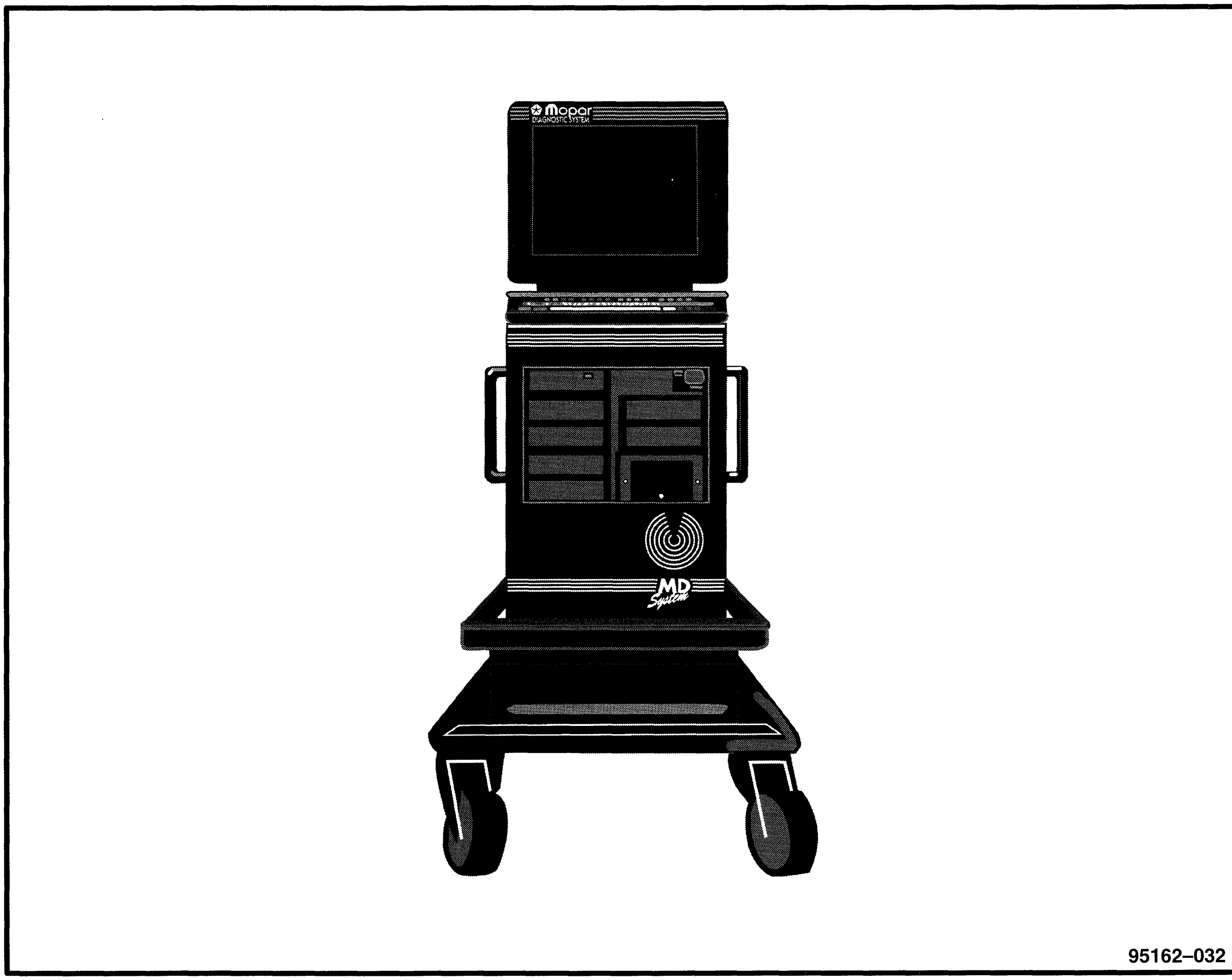

Figure 4 Mopar Diagnostic System

EVAP Flow Pump/Ultrasonic Leak Detector

The evaporative system pressure test is used to verify the integrity of the evaporative emissions system. The test is performed by pressurizing the EVAP system and monitoring for leaks. The EVAP Flow Pump is utilized to pressurize the system. Once sufficient pressure is applied, technicians can use the Ultrasonic Leak Detector to check the system for leaks.

The pump consists of two battery leads (positive and negative), a pump, an air hose, a pressure gauge and switches (fig. 5).

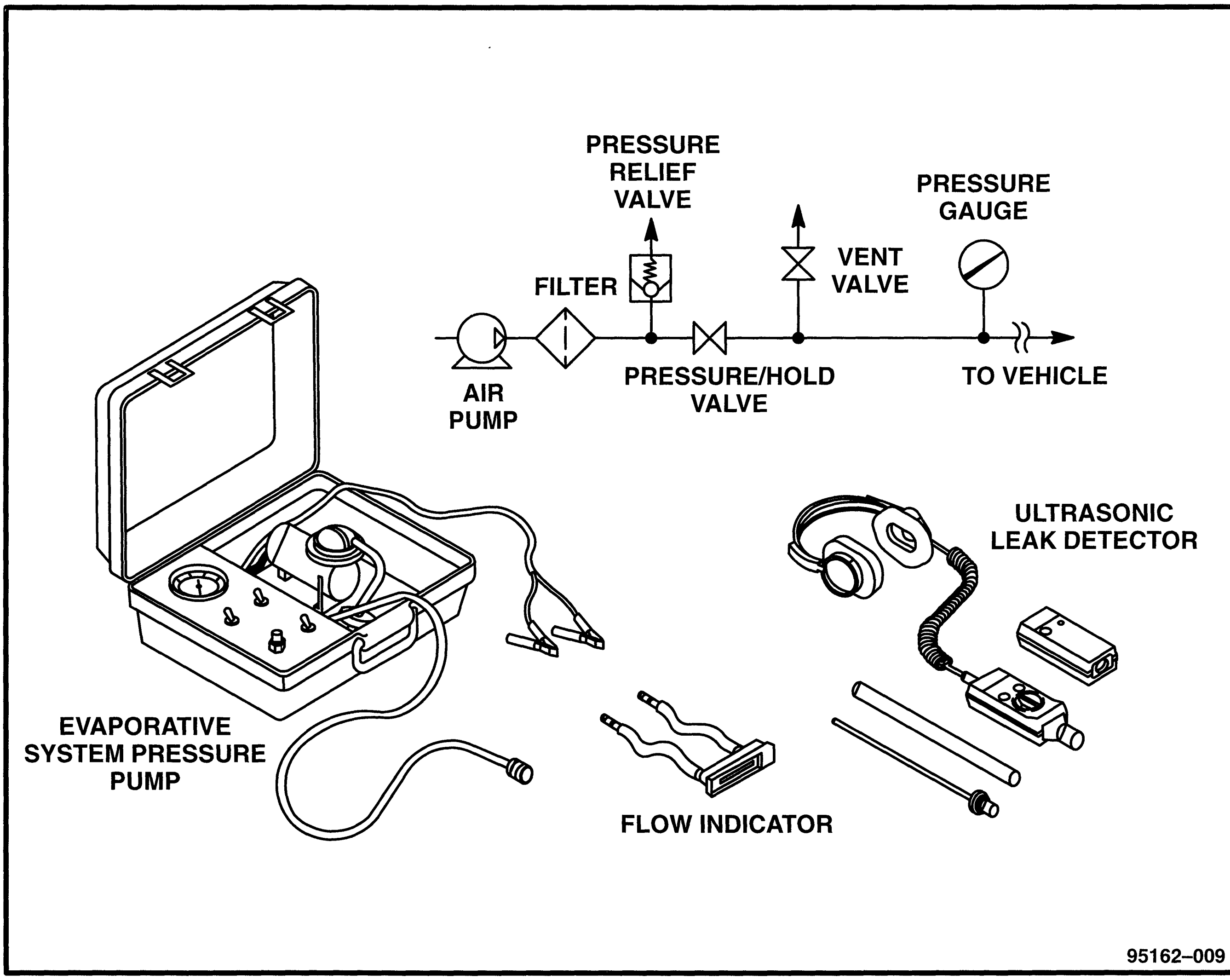

Figure 5 EVAP Flow Pump and Ultrasonic Leak Detector

NOTES:

MODULE THREE - OBD II DIAGNOSTIC SYSTEMS

OBJECTIVES

Module Three is designed to provide an understanding of Chrysler's OBD II diagnostic systems. Upon completion of this Module you should become familiar with the following subjects:

- Role of Powertrain Control Module (PCM) as "Diagnostic Executive"
- Enhancements made to PCM software to reach OBD II objectives
- Task Manager software functions and its role as "Traffic Cop" for OBD II tests
- Task Manager responsibilities
- Trip Indicator
- Readiness Indicator
- MIL Operation
- Diagnostic Trouble Codes (DTCs)
- Freeze Frames
- Warm Up Cycles
- Test Sequences

SERVICE STANDARDIZATION

OBD II requirements have prompted the standardization of several aspects of the automotive industry (fig. 6).

OBD II DIAGNOSTIC FEATURES

STANDARD TERMINOLOGY	J1930
STANDARD CODES: DTC'S	J2012
STANDARD CONNECTOR: DLC	J1962
STANDARD PROTOCOL FOR COMMUNICATION	J1850
STANDARD GENERIC SCAN TOOL	J1978
STANDARD PROTOCOL FOR DIAGNOSTIC TEST MODES	J1979
AVAILABILITY OF EMISSIONS SERVICE INFO	J2008

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Figure 6 OBD II Diagnostic Features

Terminology

The number of sophisticated electronic systems grew with the increasing requirements on emissions. The need to standardize terms, abbreviations and acronyms has increased dramatically with the new technology.

In 1991, the Society of Automotive Engineers published standards for electrical/electronic systems diagnostic terms, definitions, abbreviations and acronyms. The resulting publication, J1930, applies to the following:

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

Published in J1930 are standards for naming current systems and systems in development. Historically acceptable terminology is also listed along with the SAE standards for hundreds of components and systems.

Diagnostic Trouble Codes (DTCs)

Diagnostic Trouble Codes (DTCs) are intended to direct technicians to the proper service procedure. DTCs do not necessarily imply specific component failure. MIL illumination is manufacturer–specific, and is based on their testing of how system malfunctions affect emissions.

SAE published J2012 to describe industry wide standards for a uniform DTC format. This format allows generic scan tools to access any system. The format assigns alphanumeric codes to malfunctions, and provides guidance for uniform messages associated with these codes. Malfunctions without a code assignment may be given manufacturer–specific code assignments. DTCs consist of a three digit numeric code preceded by an alphanumeric designator defined as follows:

B0 – Body codes, SAE controlled
B1 – Body codes, Manufacturer controlled

C0 – Chassis codes, SAE controlled
C1 – Chassis codes, Manufacturer controlled

P0 – Powertrain codes, SAE controlled
P1 – Powertrain codes, Manufacturer controlled

U0 – Network Communications codes, SAE controlled
U1 – Network Communications codes, Manufacturer controlled

The third digit represents the system in which the failure occurred, such as the Ignition System, Idle/Speed Control, Transmission, etc. The fourth and fifth digit represent the specific DTC for that system.

For example, DTC P0131 is the Upstream O2 Sensor voltage shorted to ground.

P = Powertrain
0 = SAE Controlled
1 = Fuel/Air Control
31 = Sequence

This fault falls under flash code 21. This flash code contains P0131 – P0141 (fig. 7)

	FIRST DIGIT	SECOND DIGIT	THIRD DIGIT	FOURTH AND FIFTH DIGIT
PURPOSE OF EACH DIGIT	PREFIX LETTER OF DTC INDICATES DTC FUNCTION	WHO WAS RESPONSIBLE FOR DTC DEFINITION	POWERTRAIN DTC SUBGROUP	AREA INVOLVED
	P = POWERTRAIN	0 = SAE	0 = TOTAL SYSTEM	00–99
	B = BODY	1= MANUFACTURER	1= FUEL/AIR CONTROL	
	C = CHASSIS		2 = FUEL/AIR CONTROL	
			3 = IGNITION SYSTEM/MISFIRE	
			4 =AUXILIARY EMISSIONS CONTROL	
			5 = IDLE/SPEED CONTROL	
			6 = PCM AND INPUTS/OUTPUTS	
			7 =TRANSMISSION	
			8 = NON PCM POWERTRAIN	

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Figure 7 DTC Standards

Hex ID Code

The Hex ID code is the two–digit binary code read by the DRB III and MDS. The "$" sign identifies a code as a Hex code and is shown before the two digits. The DRB III deciphers this code and displays the DTC text shown in the tables. This code appears on the DRB III screen called "On Board Diagnostics Monitor", on the MDS when monitoring with the Data Recorder and in the Service and Powertrain Diagnostics Procedures manuals.

Hex code 9B is the same as P0131 which occurs under flash code 21.

Note: *Many Hex codes and DTC's can appear under the same flash code.*

Use of specific Hex codes and DTC's is required for all service documentation. Flash codes should only be used if no diagnostic tools or DTCs are available.

Diagnostic Trouble Code Text

Diagnostic Trouble Code text will appear on the DRB III and MDS when reading DTCs. This is the format most technicians will be using and is the easiest to understand.

The text format will tell the type of fault detected on the component or system being tested.

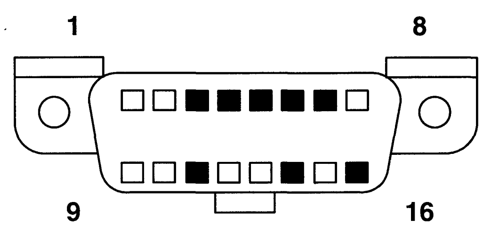
For example, MAP Voltage High would typically indicate an electrical open. MAP Voltage Low would typically indicate a short to ground. These are examples of voltage out of range faults.

The OBD II monitor Upstream O_2 Sensor Slow Response typically indicates that the sensor is not switching rich to lean as many times as it should. This is an example of a system performance fault.

More detailed information on DTC standards can be found in SAE publication J2012.

Data Link Connector

OBD II requires the use of a single diagnostic link called a Data Link Connector (DLC). The DLC and on-board diagnostics must accept generic scan tools. The DLC, according to SAE Standard J1962, must be a 16 pin connector. The DLC must be located between the left end of the instrument panel and 300 mm past vehicle centerline (fig. 8). Technicians must be able to conveniently access the DLC from a kneeling position outside of the vehicle.



P26
DATA LINK CONNECTOR (DLC)
(TERMINAL END)

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CAV.	CIRCUIT INFORMATION	FUNCTION DESCRIPTION
1	–	–
2	–	–
3	DI 20 VT/BR	CCD Bus (+)
4	Z2A 20 BK/LG	Ground
5	Z11 20 BK/WT	Ground
6	D20 20 LG	SCI Receive
7	D21 20 PK	SCI Transmit/ISO 9141K
8	–	–
9	–	–
10	–	–
11	D2 20 WT/BK	CCD Bus (–)
12	–	–
13	–	–
14	D6 20 PK/LB	SCI Receive (TCM)
15	–	–
16	M1B 22PK	Fused B (+)

Figure 8 Data Link Connector (DLC)

OBD II Scan Tool

The SAE document J1978 describes the minimum requirements for an OBD II scan tool. It covers the required capabilities of and conformance criteria for OBD II Scan Tools. Tool manufacturers may add additional capabilities at their own discretion. The basic requirements of OBD II scan tools are:

- Automatic determination of the communication interface used
- Automatic determination and display of Inspection and Maintenance readiness information
- Display of emission-related diagnostic trouble codes, current data, freeze frame data and oxygen sensor data
- Clearing the DTCs, freeze frame data and diagnostic test status
- Ability to perform Expanded Diagnostic Protocol functions described in SAE J2205

PCM DIAGNOSTICS MANAGEMENT SYSTEM

At the heart of the OBD II diagnostics system is the Powertrain Control Module (PCM). The PCM is the "Diagnostics Executive" on Chrysler vehicles. The PCM is a microprocessor–based digital computer that receives input signals from various switches and sensors that are referred to as PCM inputs. Based on the inputs, the PCM adjusts various engine and vehicle operations through devices that are referred to as outputs.

The software for the PCM was re-written to enable the PCM to carry out the responsibilities required to meet OBD II guidelines. The PCM software holds the Task Manager capabilities for OBD II diagnostics.

Task Manager

The PCM is responsible for coordinating the operation of the large number of emission–related components. It is designed to coordinate this operation as efficiently as possible. The PCM is also responsible for determining if the diagnostic systems are operating properly. The new software designed to carry out these responsibilities is called the "Task Manager".

The Task Manager can be considered a "traffic cop" at the intersection of information at the PCM. This "traffic cop" determines which tests happen when and which functions go when. Many of the diagnostic steps required by OBD II must be performed under specific operating conditions. The Task Manager software organizes and prioritizes the diagnostic procedures. In short, the job of the Task Manager is to determine if conditions are appropriate for tests to be run, monitor the parameters for a trip for each test, and record the results of the test. Listed below are the responsibilities of the Task Manager software:

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

Test Sequence

In many instances, emissions systems must fail diagnostic tests more than once before the before the PCM illuminates the MIL. These tests are known as "two trip monitors". Other tests that turn the MIL lamp on after a single failure are known as "one trip monitors".

Pending

Under some situations the Task Manager will not run a monitor if the MIL is illuminated and a fault is stored. In these situations, the Task Manager postpones monitors **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 Oxygen Sensor fault, the Task Manager does not run the Catalyst Monitor until the O_2 fault is remedied. Since the Catalyst Monitor is based on signals from the Oxygen Sensor, running the test would produce inaccurate results.

Conflict

There are also situations when the Task Manager does not run a test if another monitor is in progress. In these situations, the effects of another monitor running may have an adverse effect that could result in erroneous failure. If this **conflict** is present, the monitor is not run until the conflicting condition passes. Most likely the monitor will run later after the conflicting monitor has passed.

For example, if the EVAP Monitor is in progress, the Task Manager does not run the EGR Monitor. Since both tests monitor changes in air/fuel ratio and adaptive fuel compensation, the monitors conflict with each other.

Suspend

Occasionally the Task Manager may not allow a two trip fault to mature. The Task Manager will **suspend** the maturing of a fault if a condition exists that may induce erroneous failure. This prevents illuminating the MIL for the wrong fault and allows for more precise diagnosis.

For example, if the PCM is storing a one trip fault for the Oxygen Sensor and the EGR Monitor, the Task Manager may still run the EGR Monitor but will suspend the results until the Oxygen Sensor Monitor either passes or fails. At that point the Task Manager can determine if the EGR System is actually failing or if an Oxygen Sensor is failing.

Trip Counters

Trips are criteria used to turn OFF the MIL. The DRB III displays this information under a Tip Counter. CARB mandates that three good trips must occur to extinguish the MIL. The Good Trip Counter can be seen on the DRB III.

Good Trips

CARB's definition of a good trip is as follows:

"Vehicle operation following an engine OFF period, of duration and driving mode, such that all components are monitored at least once by the diagnostic system, except Catalyst Efficiency and Evaporative Monitoring when steady speed check is used..."

In simpler terms, all once per trip monitors must have run within the limitations of the manufacturers defined "good trip". Chrysler has defined four good trip counters. They are as follows:

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

Global Good Trips

Global Good Trips vary by vehicle and model year. To increment a Global Good Trip, all monitors that run only once per trip must have run and passed. Table 2 shows Chrysler defined Global Good Trips by vehicle and model year. The monitors that must run in order to increment a Global Good Trip are shown under Required Monitors.

Table 2 Global Good Trips

MODEL YEAR	VEHICLES	REQUIRED MONITORS
1994 1/2	Neon, Talon	Oxygen Sensor, EGR
1995	Neon, Talon Sebring/Avenger Cirrus/Stratus	Oxygen Sensor
1995 1/2 - 1996	Minivan	Oxygen Sensor Catalyst Efficiency
1996	Jeep/Truck Passenger Car	Oxygen Sensor Catalyst Efficiency

Fuel System Good Trip

To count a good trip and erase a fuel system fault, the following conditions must occur:

- Engine in Closed Loop
- Operating in Similar Conditions Window
- Short Term Multiplied by Long Term Less Than Threshold
- Less Than Threshold for Predetermined Time

If all of the previous criteria are met, the PCM will count a good trip to erase a fuel system DTC.

Misfire Good Trip

If the following conditions are met the PCM will count one good trip in order to erase a Misfire DTC:

- Operating in Similar Conditions Window
- 1000 Engine Revolutions 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 are met:

- Two Minutes of Engine Run Time
- No Other Faults Occur

The Task Manager counts an Alternate Good Trip for a 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 Cycles

Once the MIL has been extinguished by the Good Trip Counter, the PCM automatically switches to a Warm Up Cycle Counter that can be viewed on the DRB III. Warm Up Cycles are used to erase DTCs and Freeze. CARB requires that 40 Warm Up Cycles must occur in order for the engine controller to self erase a DTC and Freeze Frame. A Warm Up Cycle, as defined by CARB, is as follows:

- Engine Coolant Temperature Must Cross 160°F
- Engine Coolant Temperature Must Rise By 40°F
- No Further Faults Occur

MIL Illumination

The PCM Task Manager carries out the illumination of the MIL (fig. 9). The Task Manager triggers MIL illumination upon test failure, depending on monitor failure criteria. Failure criteria for monitor tests are discussed in the individual sections.

MIL illumination may be terminated when three good trips occur. Misfire and fuel monitors require the test to pass in a similar window of vehicle operation as when the original failure occurred. If that similar window is not present during a key cycle, if it is not considered to be a good trip.

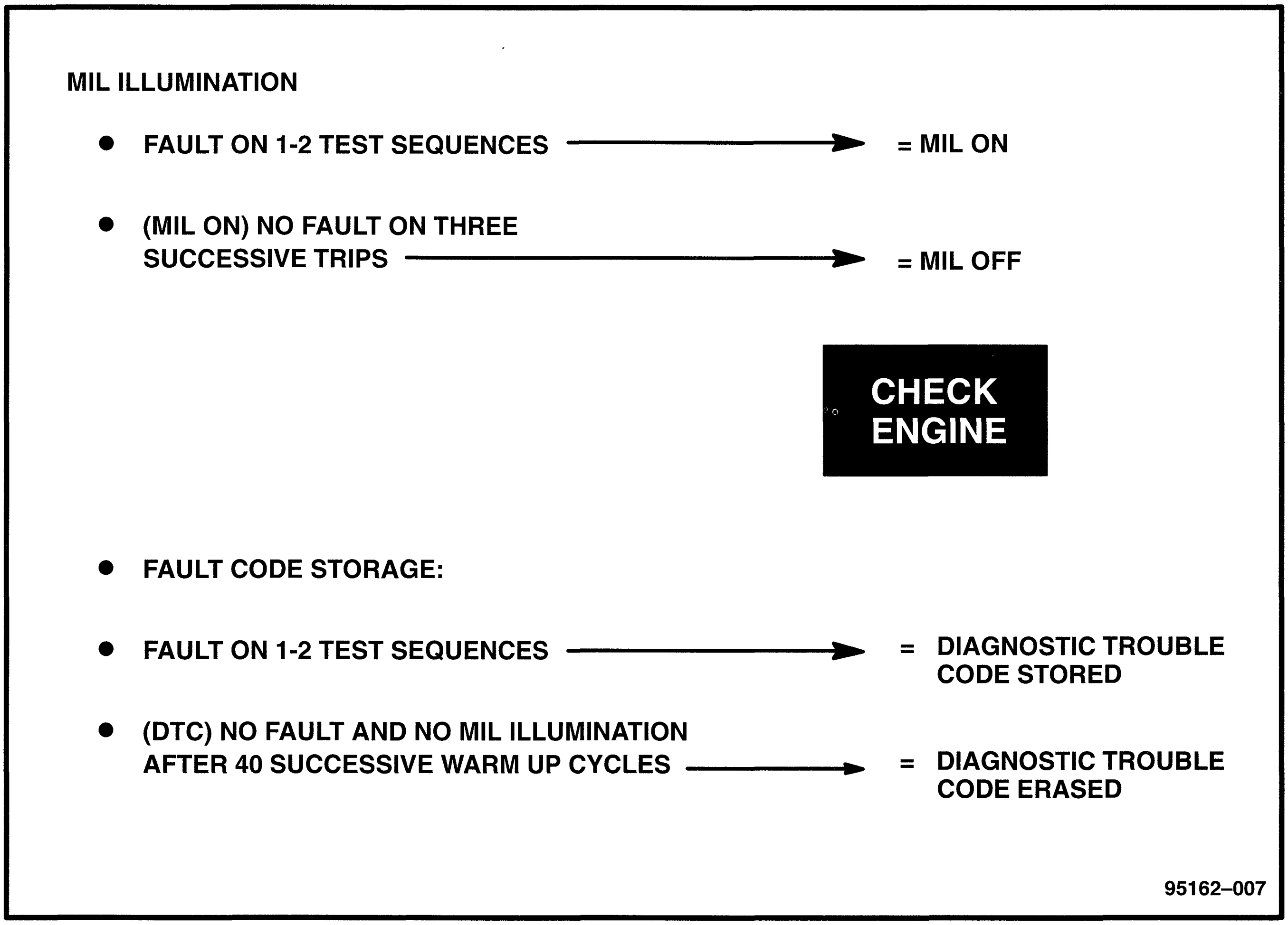

Figure 9 MIL Illumination

The DRB III shows both a Requested MIL State and an Actual MIL State. When the MIL is illuminated, upon completion of a test for a third trip, the Requested MIL State changes to OFF. The MIL continues to stay illuminated until the next key cycle. During the key cycle for the third good trip, the Requested MIL State is OFF, while the Actual MIL State is ON. After the next key cycle, the MIL is not illuminated and both MIL states read OFF.

DTC Self Erasure

With one trip components or systems, the MIL is illuminated upon test failure and DTCs are stored.

Two trip monitors are components requiring failure in two consecutive trips for MIL illumination. Upon failure of the first test, the Task Manager enters a maturing code. If the component fails the test for a second time the code "matures" and a DTC is set.

For misfire and fuel system monitors, the component must pass the test under a "similar conditions window" in order to record a good trip. A "similar conditions window" is when engine rpm is within ± 375 rpm and load is within ± 10% of when the fault occurred.

Note: *It is important to understand that a component does not have to fail under a similar window of operation to mature. It must pass the test under a similar conditions window when it failed to record a "good trip" for DTC erasure for misfire and fuel system monitors.*

After three good trips the MIL is extinguished and the Task Manager automatically switches the trip counter to a warm up cycle counter. DTCs are automatically erased following 40 warm-up cycles if the component does not fail again (fig. 10).

MIL ILLUMINATION

- ONE TRIP FAULT (ELECTRICAL)
- TWO TRIP MATURED FAULT

MIL EXTINGUISH

- THREE CONSECUTIVE GOOD TRIPS

DTC ERASURE

- 40 WARM UP CYCLES

95162–036

Figure 10 MIL Extinguish and DTC Erasure

DTCs can be erased anytime with a DRB III. Erasing the DTC with the DRB III erases all OBD II information. The DRB III automatically displays a warning that erasing the DTC will also erase all OBD II monitor data. This includes all counter information for warm up cycles, start cycles, trips, and Freeze Frame data.

CARB has also mandated that DTCs are entered according to individual priority. DTC priority is listed below. DTCs with a higher priority overwrite lower priority DTCs.

- Priority 0 - Non emission related trouble codes.
- Priority 1 - One trip failure of a two trip fault for non–fuel system and non–misfire.
- Priority 2 - One trip failure of a two trip fault for fuel or misfire.
- Priority 3 - Two trip failure or matured fault for non–fuel and non–misfire.
- Priority 4 - Two trip failure or matured fault for fuel and misfire.

In short, CARB has mandated that non-emission related failures have no priority. One trip failures of two trip faults have low priority. Two trip failure or maturation have higher priority. One and two trip failures of fuel system and misfire monitors take precedence over non–fuel system and non–misfire failures.

Freeze Frame

Once a failure occurs, the Task Manager records several engine operating conditions and stores it in a Freeze Frame. The Freeze Frame is considered one frame of information taken by an on–board data recorder. When a fault occurs, the engine controller stores the input data from various monitors (fig. 11). Technicians can determine under what vehicle operating conditions the failure occurred.

The data stored in Freeze Frame is usually recorded when a system fails the first time for two trip faults. Freeze Frame data will only be overwritten by a different fault with a higher priority.

Warning:	*Erasing DTC's, either with the DRB III or by disconnecting the battery, also clears all Freeze Frame data.*

FREEZE FRAME DATA

- OPEN/CLOSED LOOP
- CALCULATED LOAD
- ECT
- SHORT TERM ADAPTIVE
- LONG TERM ADAPTIVE
- MAP (VACUUM)
- RPM
- VEHICLE SPEED
- DTC (HEX)
- FREEZE FRAME PRIORITY

95162–037

Figure 11 Freeze Frame Data

MODULE FOUR - OBD II MAJOR MONITORS

OBJECTIVES

- To identify all of the major monitors that are required for OBD II
- To define the monitoring strategy, enabling conditions and failure conditions of each of the major monitors
- To identify MIL operation pertaining to each of the major monitors
- To discuss possible causes for failing each of the major monitors
- To identify all of the DTCs associated with each of the major monitors

MAJOR MONITORS

OBD II requires that the diagnostic system monitor all emission related components and all emission related systems. Many of these components and systems were already being monitored with OBD I for diagnostic and driveability reasons. To comply with OBD II however, additional testing procedures were added.

The components and systems that form the major monitors, per OBD II requirements, are as follows:

- Comprehensive Components
- Fuel Control Monitor
- HO2S/Heater Monitor
- Catalyst Monitor
- Misfire Monitor
- Evaporative Emissions Monitor
- EGR Monitor
- Secondary Air Monitor

For each of the above monitors, a brief background description of the system and how the monitor operates is given. The following are also included:

- Enabling conditions
- Failure conditions
- DTCs related to the monitor
- Description of MIL operation

COMPREHENSIVE COMPONENTS

Along with the major monitors, OBD II requires that the diagnostic system monitor any component that could affect emissions levels. In many cases, these components were being tested under OBD I. The OBD I requirements focused mainly on testing emission related components for electrical opens and shorts. Manufacturers added procedures that tested components that could affect driveability.

However, OBD II also requires that inputs from powertrain components to the PCM be tested for **rationality**, and that outputs to powertrain components from the PCM be tested for **functionality**. Methods for monitoring the various Comprehensive Component monitoring include:

1. Circuit Continuity
   - Open
   - Shorted High
   - Shorted to Ground
2. Rationality or Proper Functioning
   - Inputs Tested for Rationality
   - Outputs Tested for Functionality

Input Rationality

While input signals to the PCM are constantly being monitored for electrical opens and shorts, they are also tested for **rationality**. This means that the input signal is compared against other inputs and information to see if it makes sense under the current conditions.

PCM Sensor inputs that are checked for rationality include:

- Manifold Absolute Pressure (MAP) Sensor
- Oxygen Sensor
- Engine Coolant Temperature (ECT) Sensor
- Camshaft Position (CMP) Sensor
- Vehicle Speed Sensor
- CNG Fuel Temperature Sensor
- Crankshaft Position (CKP) Sensor
- Intake Air Temperature (IAT Sensor)
- Throttle Position (TPS) Sensor
- Ambient/Battery Temperature Sensors
- Power Steering Switch
- Oxygen Sensor Heater
- Engine Controller
- Brake Switch
- Leak Detection Pump Switch
- P/N Switch
- Trans Controls

Output Functionality

PCM outputs are now being tested for **functionality** in addition to testing for opens and shorts. When the PCM provides 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 a specific position under certain operating conditions, it expects to see a specific (target) idle speed (RPM). If it does not, it stores a DTC.

PCM outputs monitored for functionality include:

- Fuel Injectors
- Ignition Coils
- Torque Converter Clutch Solenoid
- Idle Air Control
- Purge Solenoid
- EGR Solenoid
- Aspirator
- Electric Air Pump
- LDP Solenoid
- Radiator Fan Control
- Trans Control

ACTIVITY TWO
COMPREHENSIVE COMPONENTS

In this activity you will identify the similarities and differences between OBD I and OBD II. You will also discuss trips, drive cycles and priorities. Complete the following questions and statements as you perform the activity.

1. What is a rationality check?

____

____

2. Has Chrysler Corporation ever performed rationality checks under OBD I?

____

If yes, what was the rationality check?

____

3. How does the PCM know if the throttle is actually in the position the TPS is indicating?

____

4. What priority is the DTC set for TPS voltage High or Low?

____

5. How many "trips" does it take to illuminate the MIL for a Comprehensive Component DTC?

____

How is this different than the OBD II requirements?

____

____

6. Once the MIL is illuminated for a "TPS Does Not Agree With MAP" fault, what priority is the DTC?

____

7. What is a functionality check?

8. After erasing all DTCs and storing the "Target Idle Speed Not Reached" DTC (one trip) again, what is its priority?

NOTES:

FUEL CONTROL MONITOR

The primary function of the fuel control system is to optimize the air/fuel ratio. Improper air/fuel ratio can be one of the largest contributors to unwanted exhaust emissions. The PCM tries to maintain the air/fuel ratio at its stoichiometric value: 14.7:1. The stoichiometric ratio produces the best balance between the production of harmful emissions. Catalytic conversion of the three emissions is most efficient at the stoichiometric ratio. The three main emissions are:

- HC
- CO
- NO_X

When the air/fuel ratio becomes lean (greater than 14.7:1, high oxygen content), the emission of NO_X increases (fig. 12). When the air/fuel ratio becomes rich (less than 14.7:1, low oxygen content), the emission of HC and CO increases. Therefore, the PCM tries to maintain the air/fuel ratio at the stoichiometric value to produce the optimum results, based on the inputs that it receives from the various engine sensors.

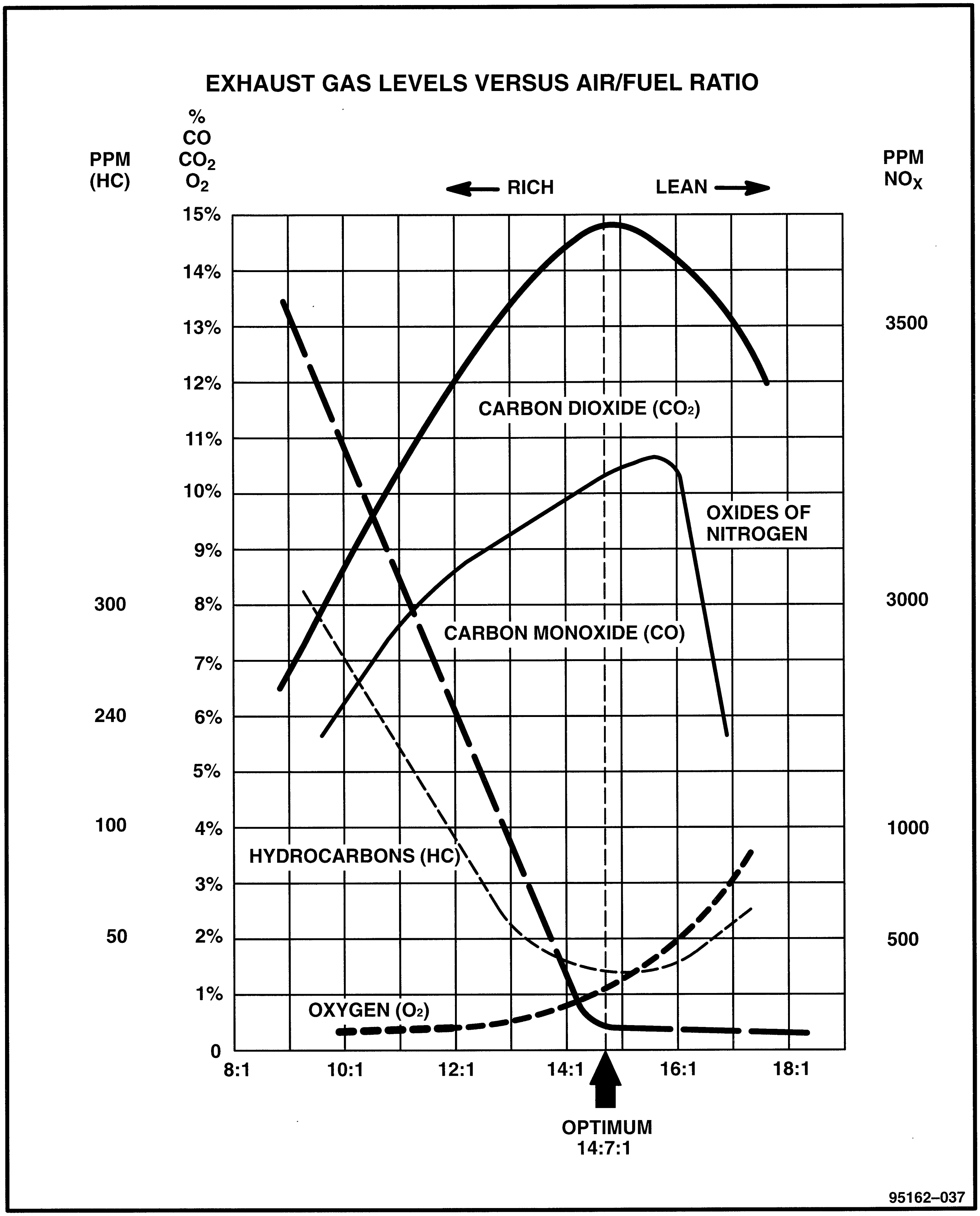

Figure 12 Exhaust Emissions vs. Air/Fuel Ratio

NOTES:

Operation

The PCM utilizes engine information to calculate fuel injector pulse width. As pulse width increases, the time the injector is energized, and the amount of fuel injected both increase. A shorter pulse width decreases the amount of fuel injected. As RPM, load, TPS, engine temperature and various other inputs to the PCM change, the injector pulse width needs to change accordingly. The PCM utilizes an equation to calculate pulse width. A simplified version of this equation is shown below:

$$PW = \frac{RPM \times MAP}{BARO} \times TPS \times ECT \times IAT \times Batt.\ Volts \times O_2\ (Short\ Term \times Long\ Term)$$

During Open Loop operation the values for Short Term Adaptive Memory are valued at 1, or zero percent change (see section on Short Term and Long Term Adaptive Memory). Long Term Adaptive is the value that is currently in that cell. Long Term Adaptive is always used under both closed and open loop operation.

Short Term Adaptive

In Open Loop, the PCM changes pulse width without feedback from the oxygen sensors. Once the engine warms up to approximately 70 to 80 degrees Fahrenheit, the PCM goes into closed loop operation and utilizes feedback from the oxygen sensors. Closed loop operation is maintained above 70 to 80 degrees Fahrenheit unless the PCM senses wide open throttle. At that time the PCM returns to Open Loop operation.

In an effort to maintain the stoichiometric ratio, the PCM monitors the exhaust with an oxygen sensor. Based on oxygen content in the exhaust, the PCM can detect if the air/fuel mixture is rich or lean. When the air/fuel ratio is rich, excessive amounts of unburned fuel enter the exhaust and oxygen content decreases. When the air/fuel ratio is lean, more oxygen is present in the exhaust.

The amount of pulse width correction is measured in percent of change. As the PCM recognizes the percent change required, it changes the short term adaptive value in the Pulse Width equation. Table 3 shows the correspondence between percent change and the number used in the calculation.

Table 3 Percent Change vs. Short Term Adaptive Value

PERCENT CHANGE	VALUE
0%	1
+ 25%	1.25
– 25%	.75

Short term adaptive is based on upstream oxygen sensor voltage only. The short term adaptive strives to maintain the stoichiometric ratio, thus giving the oxygen sensor its range of authority. As O_2 signal voltage increases, indicating a rich mixture, the Short Term Adaptive decreases (shortens pulse width). As shown on a graph over time, the two are inversely proportional (fig. 13).

Short Term Adaptive reacts when Oxygen Sensor voltage crosses a threshold. These thresholds act as rich and lean switch points. Once the Oxygen Sensor voltage signal crosses a threshold Short Term Adaptive ramps quickly to adjust pulse width and stays steady until the O_2 signal crosses the threshold again. Although the percentage of change required is converted into a numeric value for the Pulse Width equation, it is still displayed as a percent value on the DRB III.

NOTES:

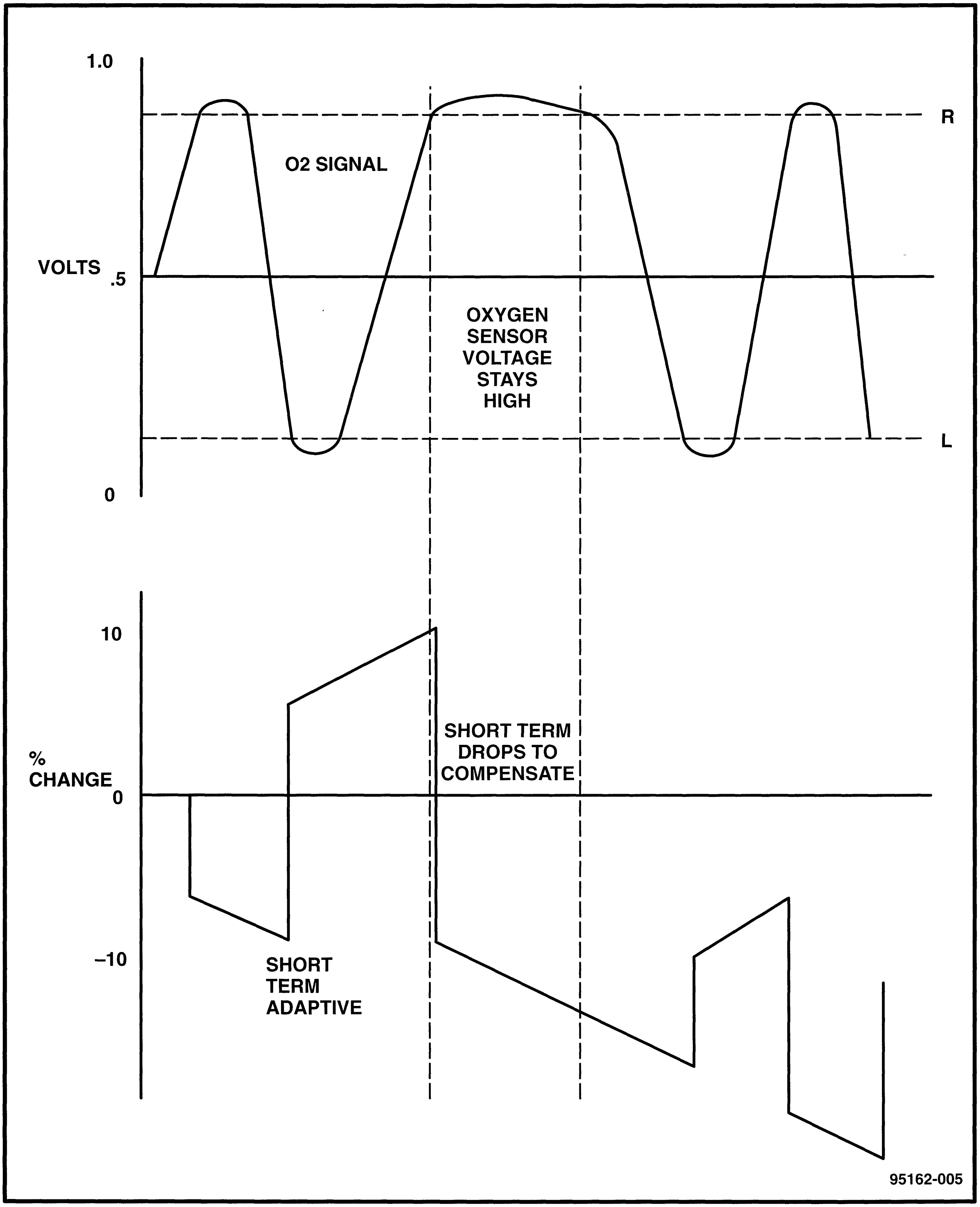

Figure 13 Short Term Adaptive vs. O_2 Sensor Voltage

Long Term Adaptive

After the engine has reached an operating temperature of approximately 170 to 180 degrees Fahrenheit, the PCM starts to update Long Term Adaptive. Engine operating conditions are divided into 13 to 15 cells. One example is shown in Figure 14. The cells are based on engine RPM and load. If, at any time, the Short Term Adaptive remains high (for example ± 3%) for an extended period, the PCM updates the Long Term Adaptive cell in which the engine is operating.

ADAPTIVE MEMORY CELLS

1	3	5	7	9	11	13	15
0	+7	+2	-1	0	+3	-4	+1
+2	+11	+3	-11	-1	-5	0	+1
0	2	4	6	8	10	12	14

95162–012

Figure 14 Long Term Adaptive Memory Cells

Figure 15 shows actual traces from an MDS Dynamic Data Display. When a fuel system runs rich for an extended period, oxygen sensor voltage stays high (Stage I). The PCM recognizes the rich mixture and Short Term Adaptive updates to –17%. Short term adaptive is taking away fuel by decreasing the pulse width 17%. Long Term Adaptive then starts to decrease the amount of fuel delivered by changing the pulse width in incremental steps. Long Term Adaptive Memory Cells are updated, and the Short Term Adaptive change required becomes less (Stage II). Long Term Adaptive drives Short Term Adaptive back to zero percent change, giving Short Term Adaptive a wider range of authority (Stage III).

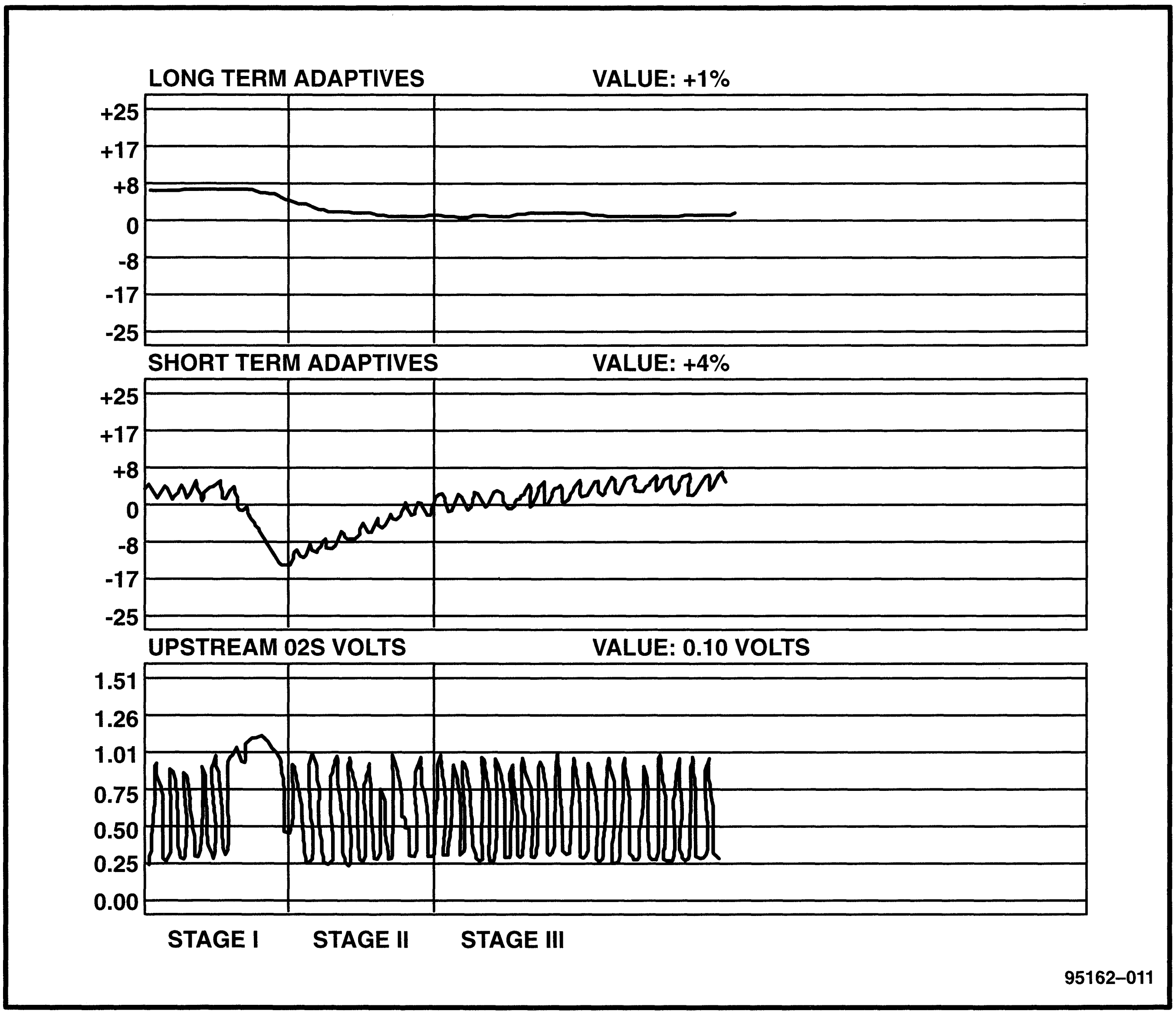

Figure 15 Short/Long Term Fuel Control

The Long Term Adaptive Memory works to bring Short Term to zero percent pulse width correction for each cell. The Long Term Adaptive Memory returns to this level of compensation the next time the PCM enters a cell. In this way, the PCM is continuously relearning the most appropriate fuel mixture, even as the engine ages.

Note: *Whenever components are replaced that have any affect on engine operation, the Adaptive Memory should be reset. If not, when the engine returns to open loop on initial start up, it utilizes the Long Term Adaptive that was stored when the component was malfunctioning. This could lead to rough engine running on warm up after repairs.*

Monitor Operation

The PCM constantly monitors Short Term and Long Term Adaptive Memory. If at anytime during a lean engine operation Short Term multiplied by Long Term Adaptive exceed a certain percentage for an extended period, the PCM sets a Fuel System Lean Fault for that trip and a Freeze Frame is entered. If at anytime during a rich operation Short Term multiplied by Long Term Adaptive is less than a predetermined value, the PCM checks the Purge Free Cells.

Purge Free Cells are values placed in Adaptive Memory cells when the EVAP Purge Solenoid is OFF. Two Purge Free cells are used. One corresponds to an Adaptive Memory cell at idle, the other to a cell that is off–idle. For example, if a Purge Free cell is labeled PFC1, it would hold the value for Adaptive Memory cell C1 under non–purge conditions.

If all Purge Free Cells are less than a certain percentage, and the Adaptive Memory factor is less than a certain percentage, the PCM sets a Fuel System Rich fault for that trip and a Freeze Frame is entered.

The Fuel Monitor is a two trip monitor. The PCM records engine data in Freeze Frame upon setting of the first fault, or maturing code. When the fuel monitor fails on a second consecutive trip, the code is matured and the MIL is illuminated. The Freeze Frame data stored is still from the first fault.

The messages on the scan tool appears as follows:

FUEL SYSTEM RICH
J2012 CODE – P0172

FUEL SYSTEM LEAN
J2012 CODE – P0171

In order for the PCM to extinguish the MIL, the Fuel Monitor must pass in a similar condition window. The similar conditions relate to rpm and load. The engine must be within a predetermined percentage of both rpm and load when the monitor runs to count a good trip. 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.

Enabling Conditions

The following conditions must be met to operate the fuel control monitor:

- The PCM not in fuel crank mode (engine running)
- PCM in Closed Loop fuel control
- Fuel system updating Long Term Adaptive
- Fuel Level above 15% of capacity

Pending

The Fuel Control Monitor does not operate if the MIL is illuminated for any of the following:

- Misfire Monitor
- Upstream HO2S
- EVAP Purge Solenoid Electrical
- PCM Self-test Fault
- Camshaft or Crankshaft Position Sensor
- Fuel Injectors
- Ignition Coil
- Throttle Position (TPS) Sensor
- Engine Coolant Temperature (ECT) Sensor
- Manifold Absolute Pressure (MAP) Sensor
- Idle Air Control (IAC)
- 5V Output Too Low
- EGR Monitor
- EGR Solenoid Circuit
- Vehicle Speed Sensor
- Oxygen Sensor Monitor
- Oxygen Sensor Heater Monitor
- Oxygen Sensor Electrical
- Idle Speed Rationality
- Charge Temperature

Suspend

The Task Manager will suspend maturing a Fuel System fault if any of the following are present:

- O_2 Sensor Response, Priority 1
- O_2 Heater, Priority 1
- Misfire Monitor, Priority 2

NOTES:

ACTIVITY THREE
FUEL SYSTEM MONITOR

This is an instructor lead activity/demonstration and is designed to demonstrate the operation of the fuel system. You will go though exercises for short term and long term adaptive memory, the setting of faults and Freeze Frames. Answer the following questions as you complete the activity.

1. At idle what is the short term adaptive value on the classroom vehicle.

    ____

2. What immediate effect does the decrease in fuel pressure have on injector pulse width?

    ____

3. What effect does the decrease in fuel pressure have on air/fuel ratio?

    ____

4. What happens to short term adaptive when fuel pressure is decreased?

    ____

    ____

5. When the fuel pressure is decreased, what effect does the short term adaptive have on injector pulse width?

    ____

    ____

6. How does the PCM determine that the fuel monitor has failed?

    a. Short and long term adaptives cannot compensate to maintain air/fuel mixture.

    b. PCM checks purge free idle cells against operating cells.

    c. O2 voltage stays low, PCM recognizes stoichiometric ratio cannot be maintained.

    d. All of the above.

NOTES:

HEATED OXYGEN SENSOR MONITOR

OBD II regulations require that the on-board computer monitor the condition of electronic components that could lead to an emissions increase of 1.5 times the allowable Federal Test Procedure (FTP) levels. Because Oxygen (O_2) Sensors are used to directly monitor catalyst efficiency and air/fuel ratio, they too must be tested for proper operation. The PCM runs two monitor tests on oxygen sensors. One monitors the O_2 Sensor operation. The other monitors the heater element in the sensors. For both monitors, upstream and downstream oxygen sensors are tested.

Sensor Monitor

The PCM is responsible for effective control of the air/fuel ratio entering the engine. The PCM monitors oxygen sensor feedback to adjust the air/fuel ratio to 14.7:1 (stoichiometric). The three-way catalyst is most efficient at the stoichiometric ratio. As this air/fuel ratio directly affects emissions, OBD II regulations have prompted testing for sluggish or marginal O_2 Sensors.

Oxygen sensors act like a battery. By means of a chemical reaction, a low voltage output is created. Oxygen in the exhaust and oxygen in the atmosphere cause a chemical reaction within the oxygen sensor that produces voltage. Oxygen sensors must be able to produce a voltage output between zero and one volt depending on the oxygen content in the exhaust. The sensor must also be able to detect changes quickly. Table 4 shows the oxygen sensor voltage outputs.

Table 4 Oxygen Sensor Voltage Output

FUEL MIXTURE	OXYGEN CONTENT	OXYGEN SENSOR OUTPUT
Rich	Low	Above 450 mV
Ideal	Ideal	450 mV
Lean	High	Below 450 mV

When there is a large amount of oxygen in the exhaust caused by a lean mixture, the sensor produces a low voltage. When the oxygen content is lower, caused by a rich mixture, the sensor produces a higher voltage. In closed loop operation, the PCM monitors the upstream sensor input to adjust the fuel injector pulse width. During normal operation, the sensor reads changes in O_2 content as the PCM is adjusting the air/fuel ratio. In this way, the O_2 sensor acts as a rich to lean switch (fig. 16).

For the PCM to detect a shift in the air/fuel ratio, the voltage input from the oxygen sensor must change beyond a threshold. The threshold may vary from engine to engine. These thresholds are the lean and rich switch points. As the voltage signal crosses a threshold, the PCM changes the air/fuel ratio accordingly. A sensor that does not change voltage output beyond this threshold is considered to be malfunctioning.

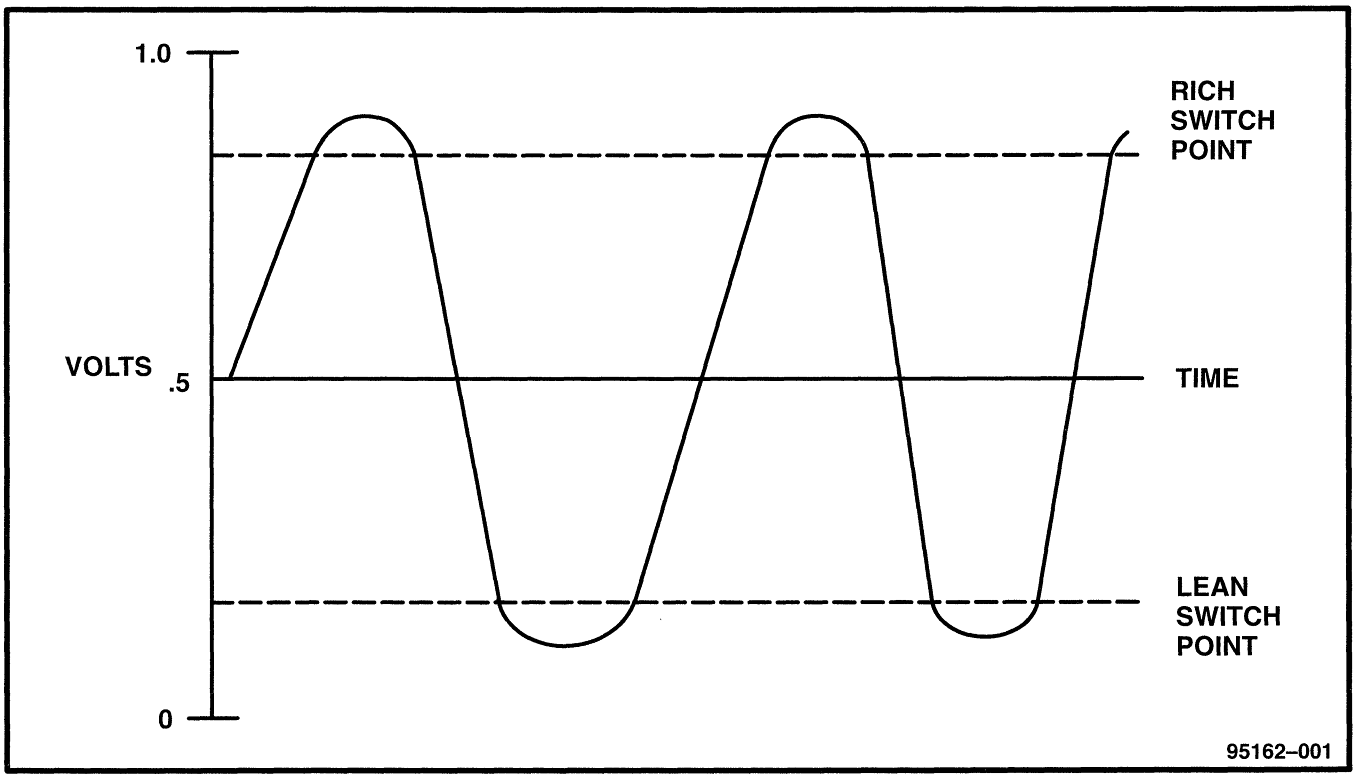

Figure 16 Oxygen Sensor Thresholds

Oxygen sensors can fail a test for any of the following reasons:

- Response Rate
- Reduced Output
- Dynamic Shift
- Shorted or Open Circuits

Big Slope

Response rate is the time required for the oxygen sensor to switch from a lean to rich signal output. As the PCM adjust the air/fuel ratio, the sensor must be able to rapidly detect the change. As a sensor ages, its ability to detect these changes weakens. The rate of change that an oxygen sensor experiences is called "big slope". The rate of change is determined by the following formula:

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

The PCM checks the O_2 sensor voltage in increments of a few milliseconds. When the voltage signal from an oxygen sensor is printed out over time, it looks similar to a sine wave. The slope of the curve is actually the change in voltage divided by the change in time (fig. 17).

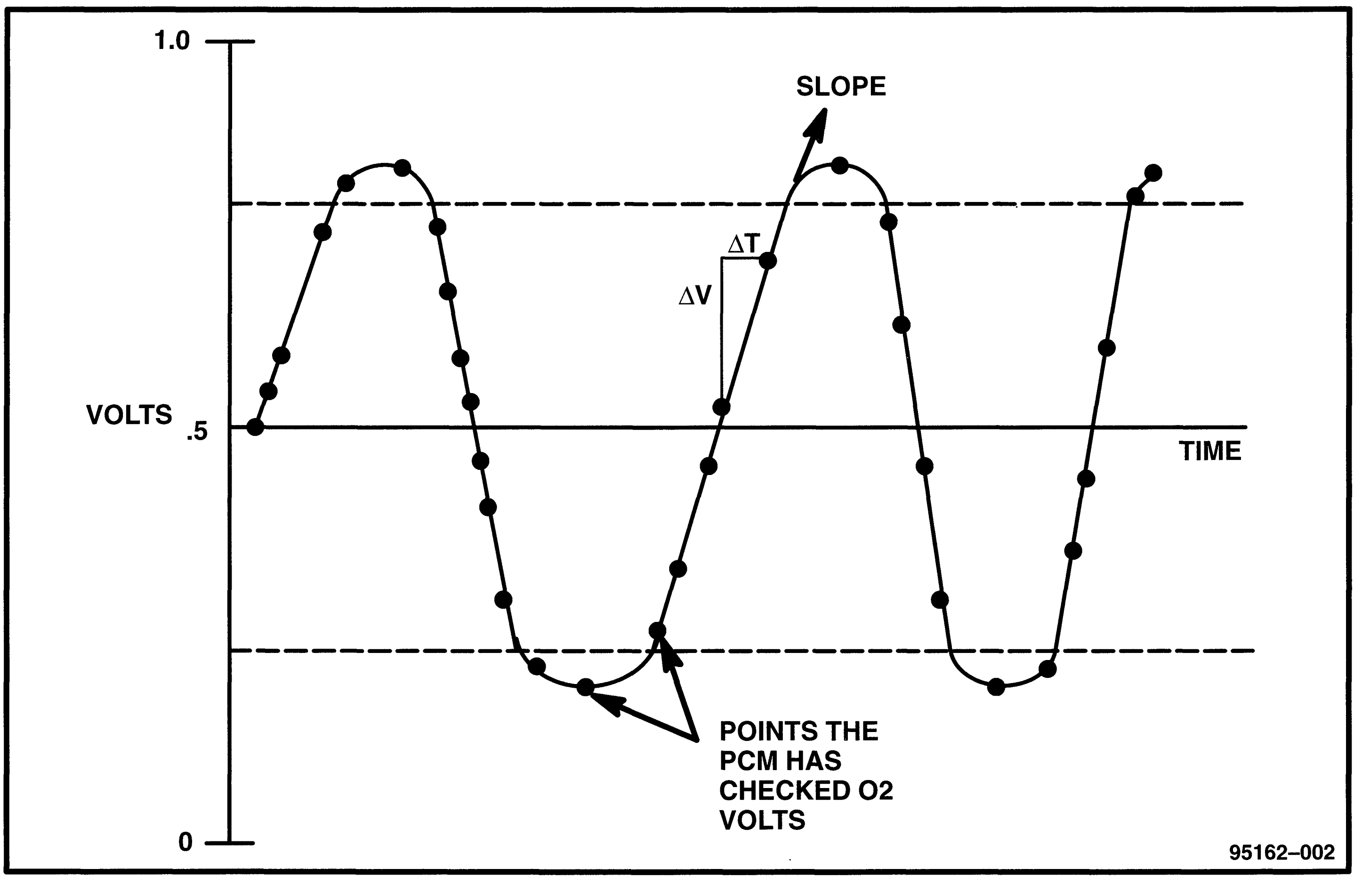

Figure 17 Oxygen Sensor Big Slope

Half Cycle

The PCM also monitors the number of times the oxygen sensor signal goes beyond predetermined thresholds. The graphic in Figure 18 shows thresholds of approximately .2 and .8 volts. Each time the voltage signal surpasses the threshold, a counter is incremented by one. This is called the Half Cycle Counter.

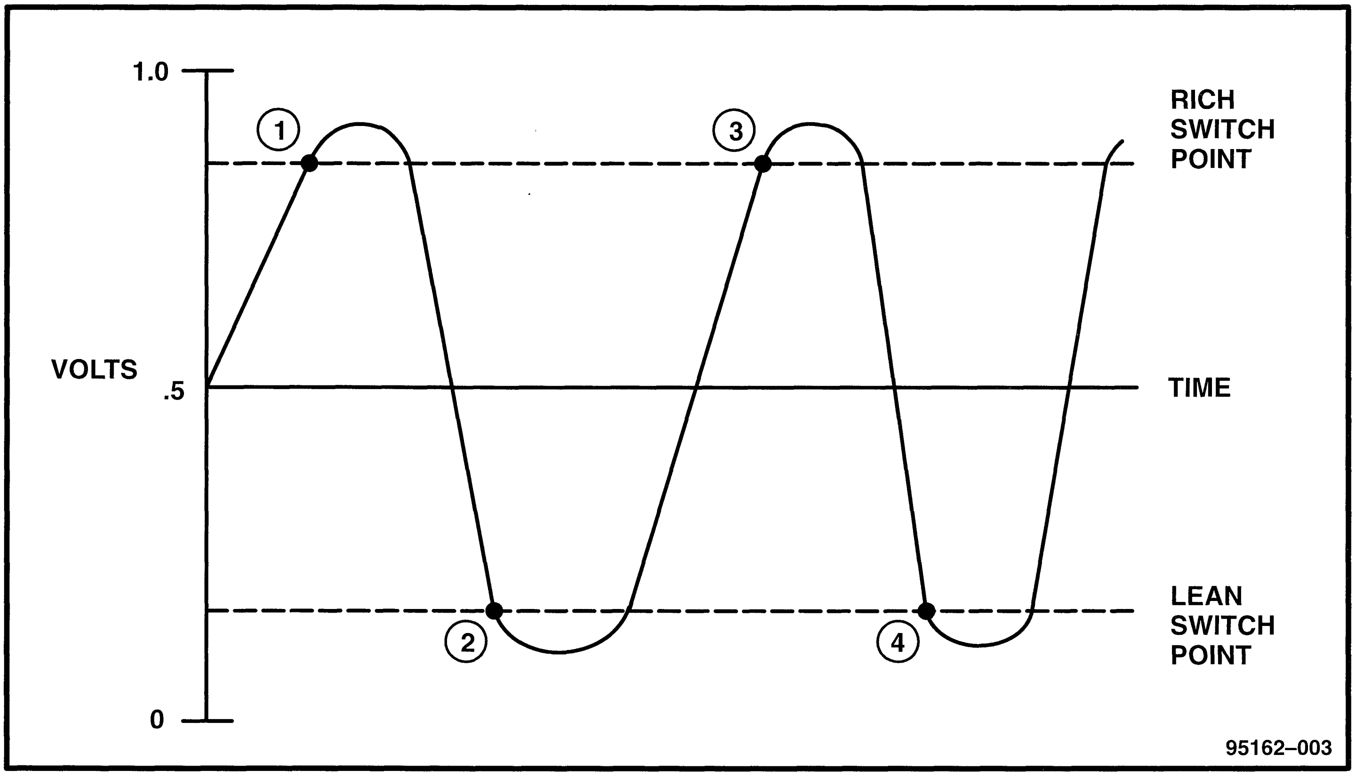

Figure 18 Oxygen Sensor Half Cycle Counter

As the O_2 Sensor signal switches, the PCM monitors the half cycle and big slope signals from the O_2 Sensor. If during the test neither counter reaches a predetermined value, a malfunction is entered and a freeze frame is stored. Only one counter reaching its predetermined valve is needed for the monitor to pass.

Monitor Operation

The Oxygen Sensor Monitor is a two trip monitor that is tested only once per trip. When the oxygen sensor fails the test in two consecutive trips, the message on the scan tool screen appears as follows:

UPSTREAM H02S RESPONSE
J2012 – P0133

The MIL is extinguished when the O_2 monitor passes in three consecutive trips. The DTC is erased from memory after 40 consecutive warm-up cycles without test failure.

Enabling Conditions

The following conditions must be met for the PCM to run the oxygen sensor monitor:

- Battery Voltage
- Engine Temperature
- Engine Run Time
- Engine Run Time at Predetermined Speed
- Engine Run Time at Predetermined Speed and Throttle Open
- Transmission in Gear (automatic only)
- Fuel System in Closed Loop
- Long Term Adaptive
- Power Steering Switch in Low PSI (no load)
- Engine at Idle
- Fuel Level Above 15%
- Ambient Air Temperature
- Barometric Pressure
- Engine RPM Within Acceptable Range of Desired Idle
- Closed Throttle Speed

Pending

The Task Manager does not run the O_2 Monitor if the MIL is illuminated for any of the following:

- Misfire Monitor
- Front O_2 Sensor and Heater Monitor
- MAP Sensor
- Vehicle Speed Sensor
- Coolant Temperature Sensor
- Throttle Position Sensor
- Engine Controller Self Test Faults
- Cam or Crank Sensor
- Injector and Coil
- Idle Air Control Motor
- EVAP Electrical
- EGR Solenoid Electrical
- Charge Temperature
- 5 Volt Feed

Conflict

The Task Manager does not run the O_2 Monitor if any of the following conditions are present:

- A/C OFF (A/C clutch cycling temporarily suspends monitor)
- Purge Flow In Progress

Suspend

The Task Manager suspends maturing a fault for the O_2 Monitor if any of the following are present:

- Oxygen Sensor Heater Monitor, Priority 1
- Misfire Monitor, Priority 2

NOTES:

Heater Monitor

Oxygen sensors are most accurate when they are hot. For them to function properly they must be heated to approximately 572° – 662°F (300° – 350°C). OBD II regulations state that the diagnostic system shall monitor all Heated Oxygen Sensors for proper heating. Regulations require the system to illuminate the MIL when a detected failure would cause an emission increase of 1.5 times any applicable FTP standard.

To maintain an ideal operating temperature, oxygen sensors contain heating elements that are Positive Thermal Coefficient (PTC) devices. PTCs in both oxygen sensors are fed battery voltage by the PCM. They are grounded through external grounds routed through the oxygen sensor connector. As PTCs receive voltage, their internal structure changes and the temperature increases. PTCs combined with engine exhaust maintain oxygen sensor temperature at approximately 1200°F.

The heater element itself is not tested. The resistance in oxygen sensors output circuits is tested to determine heater operation. The resistance is normally between 100 ohms and 4.5 megaohms. When oxygen sensor temperature increases, the resistance in the internal circuit decreases. The PCM sends a 5 volt biased signal through the oxygen sensors to ground this monitoring circuit (fig. 19) As the temperature increases, resistance decrease and the PCM detects a lower voltage at the reference signal. Inversely, as the temperature decreases, the resistance increases and the PCM detects a higher voltage at the reference signal.

Heater monitors are run at either key ON or key OFF depending on the vehicle. Refer to the Powertrain Diagnostic Procedures Manual for your vehicle to verify test parameters.

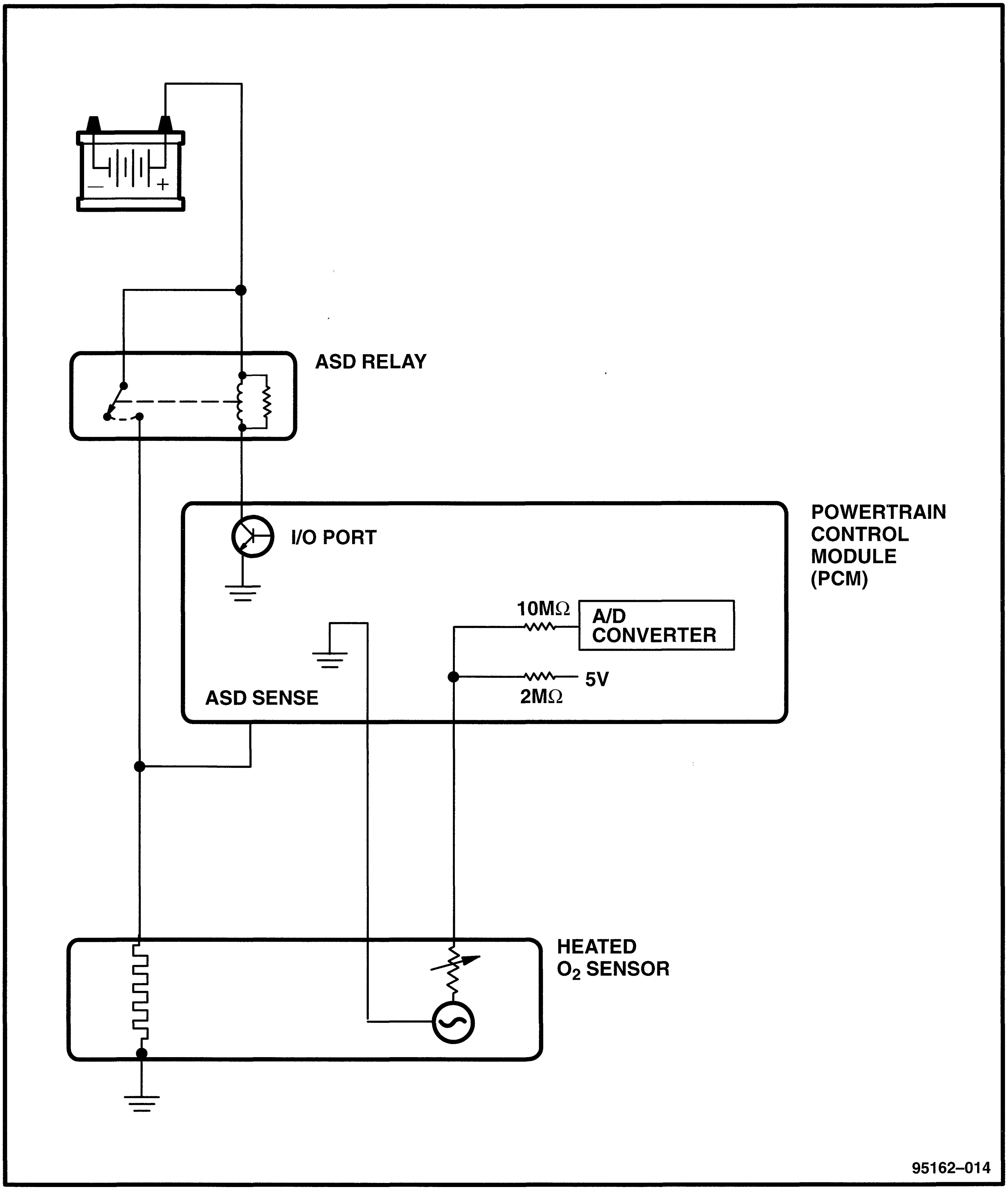

Figure 19 Heated Oxygen Sensor Schematic

Ignition OFF (After Engine Run)

The O_2 Sensor Heater Monitor begins after the ignition has been turned OFF and the O_2 Sensors have cooled. The PCM sends a 5 volt bias to the oxygen sensor every 1.6 seconds. The PCM keeps it biased for 35 ms each time . As the sensor cools down, the resistance increases and the PCM reads the increase in voltage. Once voltage has increased to a predetermined amount, higher than when the test started, the oxygen sensor is cool enough to test heater operation.

When the oxygen sensor is cool enough, the PCM energizes the ASD relay. Voltage to the PTC begins to increase the temperature. As the sensor temperature increases the internal resistance decreases. The PCM continues biasing the 5 volt signal to the sensor. Each time the signal is biased the PCM reads a voltage decrease. When the PCM detects a voltage decrease of a predetermined value for several biased pulses, the test passes.

The heater elements are tested each time the engine is turned OFF if all the enabling conditions are met. If the monitor fails, the PCM stores a maturing fault and Freeze Frame is entered. If two consecutive tests fail, a DTC is stored. Because the ignition is OFF, the MIL is illuminated at the beginning of the next key cycle.

Enabling Conditions

The following conditions must be met for the PCM to run the oxygen sensor heater test:

- Engine run time of at least 5.1 minutes
- Key Off Power-down
- Battery voltage of at least 10 volts
- Sufficient O_2 Sensor Cool-down

Pending Conditions

There are no conditions or situations that prompt conflict or suspension of testing. The oxygen sensor heater test is not run pending resolution of MIL illumination due to oxygen sensor failure.

Once the DTC is entered, the message on the scan tool appears as follows:

UPSTREAM HO2S HEATER FAILURE
J2012 CODE — P0135

DOWNSTREAM HO2S HEATER FAILURE
J2012 CODE — P0141

The MIL is extinguished if the conditions causing it to illuminate are not repeated for three consecutive trips. The DTC is erased from memory if the monitor passes for 40 consecutive warm-up cycles.

A malfunction in the O_2 sensor's heater could possibly be caused by problems with any of the following components:

- Upstream or downstream O_2 sensor (heater element)
- O_2 sensor related wiring or connectors (heater circuit)

The fault trees in the Powertrain Diagnostic Procedures Manual can help you isolate the source of the problem.

Suspend

There are no conditions which exist for suspending the Heater Monitor.

Ignition On (On Start Up)

The O_2 Sensor Heater Monitor for the JTEC operates similar to the SBEC III only at a different time. The JTEC also biases 5 volts to the O_2 Sensor to measure voltage decrease when the sensor is heating up. The monitor, though, runs at key–on or start up.

If the outside air temperature is within ten degrees of engine coolant temperature, the PCM recognizes that the engine has experienced a cold soak. Once these conditions are met, the PCM tests heater operation on start up. To test heater operation, the PCM monitors the decrease in O_2 Sensor Heater voltage. From a cold start, if the voltage signal drops to 3 volts or less during a predetermined time frame the monitor is said to have passed. The time duration of the monitor is dependent on outside ambient air temperature. At – 20°F the test duration may be up to one minute or more. When the temperature is 100°F the monitor may run for only 40 seconds.

Enabling Conditions

- Ambient Air Temperature
- Engine Coolant Temperature
- Engine Running

ACTIVITY FOUR
OXYGEN SENSOR AND HEATER MONITORS

This activity runs the Oxygen Sensor Monitor. Answer the following questions while running the monitor on the classroom vehicle

O_2 MONITOR

1. Using the General Information Section of the Powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the Response Monitor on the classroom vehicle.

   Engine Coolant Temperature ______________________________

   Park/Neutral Position ______________________________

   Engine Run Time ______________________________

   TPS Percent______________________________

   Vehicle Speed ______________________________

2. Connect the DRB III to the classroom vehicle and start the engine.

3. Access the O_2 Monitor Pre–test screen on the DRB III. Run the engine long enough to enable the monitor.

4. Once the enabling conditions are met, access the O_2 Monitor screen.

5. Observe the O_2 Monitor screen while the test is running. Which O_2 signal is cycling faster?

   ____

   What is the PCM monitoring for oxygen sensor operation?

   ____

   ____

6. What are the values the for each counter the PCM is monitoring?

   ____

   ____

7. Does the test pass or fail?

   a. Pass　　　　b. Fail

8. Based on the duration of the test, is the BCM counting the number of big slopes or the rate of change of the oxygen sensor?

____

9. Cycle the Ignition OFF then ON and access the Pre–test Menu on the DRB III.

10. Run the engine again to enable the monitor.

11. Once the enabling conditions are met, access the O_2 Monitor Screen.

12. Jump the downstream O_2 signal to the upstream signal at the Breakout Box and let the engine run the monitor.

13. Which O_2 signal is cycling faster.

____

14. Allow the monitor to run. Does the monitor run roughly the same amount of time as when it passed?

____

Why or why not?

____

____

15. Once the monitor has failed is the MIL illuminated and why?

____

16. Access the Freeze Frame data and Read DTC's screen. Which DTC is stored?

____

____

17. Cycle the key OFF and then back ON.

18. Access the O_2 Monitor Pre–test screen, what is the code listed for status and what does it mean?

____

O_2 HEATER MONITOR

1. Using the General Information Section of the powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the Heater Monitor on the classroom vehicle

   Engine Coolant Temperature ______________________________

   Engine Run Time ______________________________

   Vehicle Speed ______________________________

   Conditions after key OFF ______________________________

2. Connect the DRB III to the classroom vehicle and start the engine.

3. Access the O_2 Heater Monitor Pre–test Screen on the DRB III. Run the engine long enough to enable the monitor.

4. Once enabling conditions are met, access the O_2 Heater Monitor Pre–test screen on the DRB III. Turn the ignition OFF .

5. What functions does the PCM perform in the initial minutes after turning the ignition OFF?

   ____

   ____

6. How can you tell the monitor is running once it starts?

   ____

   ____

7. Observing the voltmeter, what is the PCM doing while the monitor is running?

   ____

   ____

8. As the monitor is running, record the voltage readings from the O_2 Sensor below:

   Beginning of Test: ______________________________

   End of Test: ______________________________

CATALYST MONITOR

The latest technology provides the use of a three way catalytic converter on most automobiles. The three way catalyst simultaneously converts three harmful exhaust emissions into harmless gases. Specifically, HC and CO emissions are converted into water (H_2O) and carbon dioxide (CO_2). Oxides of Nitrogen (NO_X) are converted into elemental Nitrogen (N) and water. The three way catalyst is most efficient in converting HC, CO and NO_x at the stoichiometric air fuel ratio of 14.7:1 (fig. 20).

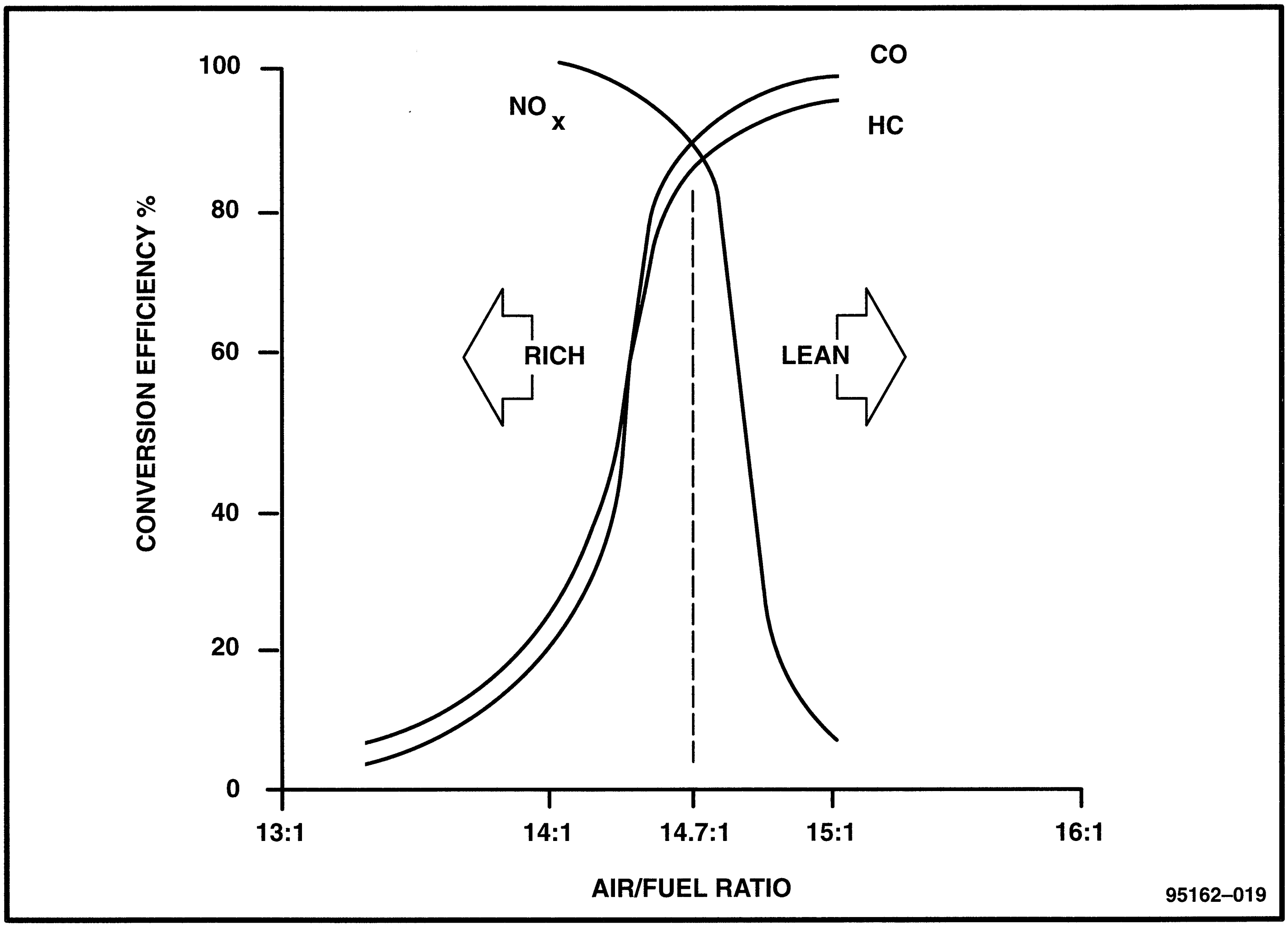

Figure 20 Conversion Efficiencies of a Three–Way Catalyst

OBD II regulation requires monitoring the functionality of the catalyst. When the catalyst system has deteriorated to the point that vehicle emissions increase by more than 1.5 times the standard, OBD II requires MIL illumination.

The oxygen content in a catalyst is important for efficient conversion of exhaust gases. When a lean air/fuel ratio is present for an extended period, oxygen content in a catalyst can reach a maximum. When a rich air/fuel ratio is present for an extended period, the oxygen content in the catalyst can become totally depleted. When this occurs, the catalyst fails to convert the harmful gases. This is known as catalyst "**punch through.**"

Catalyst operation is dependent on its ability to store and release the oxygen needed to complete the emissions-reducing chemical reactions. As a catalyst deteriorates, its ability to store oxygen is reduced. Since the catalyst's ability to store oxygen is directly proportional to proper operation, oxygen storage can be used as an indicator of catalyst performance. To accomplish this, two oxygen sensors are now required (fig. 21). By utilizing an oxygen sensor upstream from the catalytic converter, and a second sensor located downstream, oxygen storage can be determined by comparing the two voltage signals.

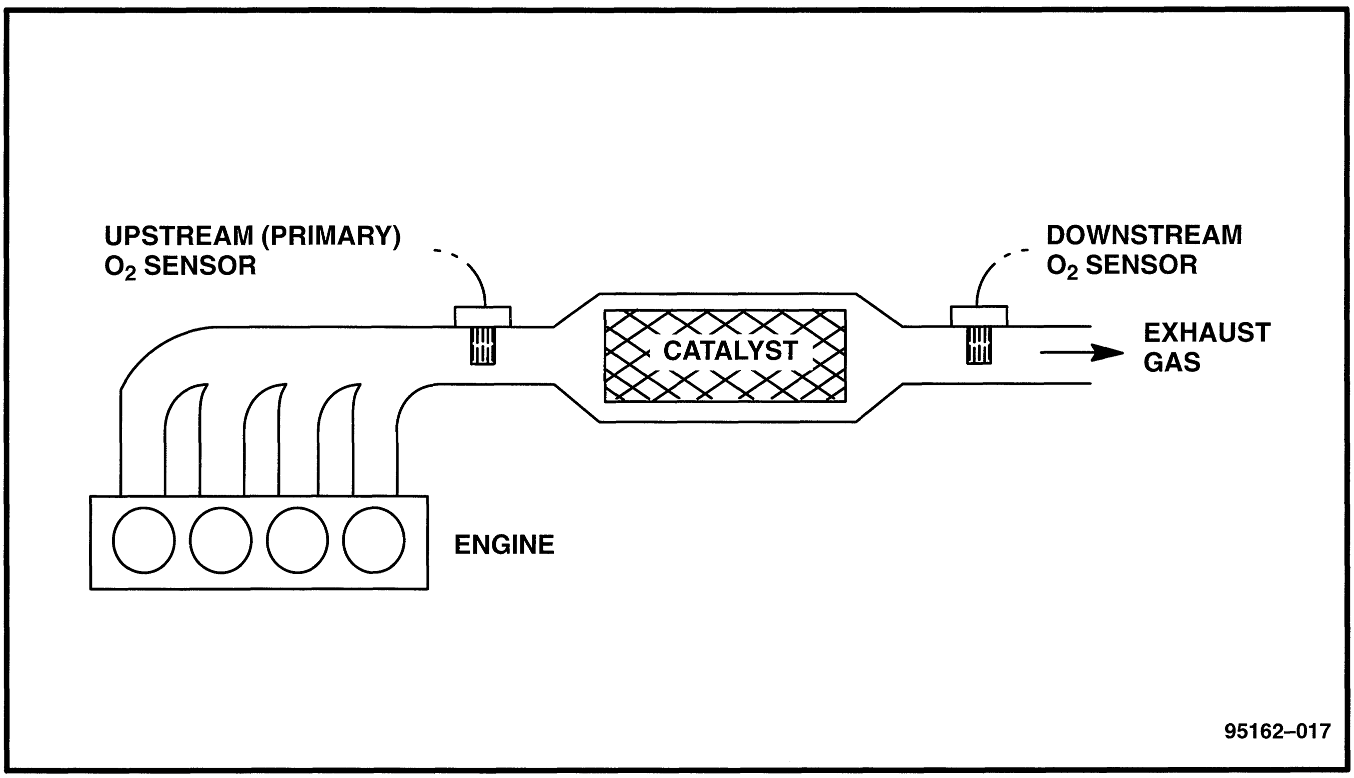

Figure 21 Oxygen Sensor Locations

As the PCM constantly adjusts the air/fuel mixture to maintain a stoichiometric ratio, the change in oxygen content is less noticeable downstream from the converter. The upstream sensor switches voltage more rapidly than the downstream sensor. Due to the effects of the converter, the oxygen content at the downstream sensor should be stable. Hence the voltage output from the downstream sensor changes less rapidly (fig. 22).

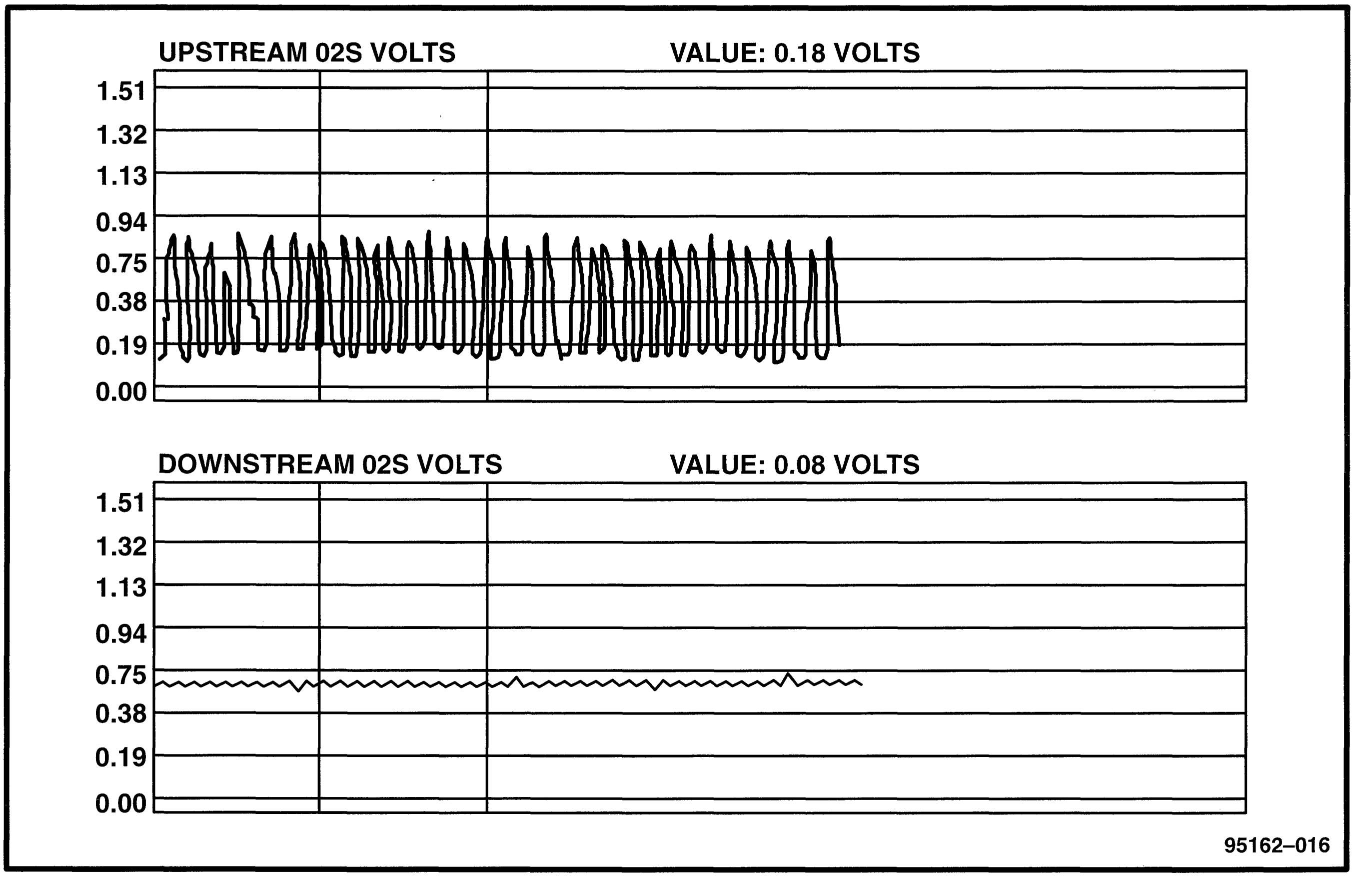

Figure 22 Oxygen Sensor Signals

To monitor catalyst efficiency, the PCM expands the rich and lean switch points of O_2 sensor. With extended switch points, the air/fuel mixture runs richer and leaner to overburden the catalytic converter. Once the test is started, the air/fuel mixture runs rich and lean and the O_2 switches are counted. A switch is counted when an oxygen sensor signal goes from below the lean threshold to above the rich threshold. The number of Rear O_2 Sensor switches is divided by the number of Front O_2 Sensor switches to determine the switching ratio.

$$\textbf{Switching Ratio} = \frac{\text{Number of Rear Sensor Switches}}{\text{Number of Front Sensor Switches}}$$

The test runs for 20 seconds. As catalyst efficiency deteriorates over the life of the vehicle, the switch rate at the downstream sensor approaches that of the upstream sensor. If at any point during the test period the switch ratio reaches a predetermined value, a counter is incremented by one. The monitor is enabled to run another test during that trip. When the test fails three times: the counter increments to three, a malfunction is entered, and a Freeze Frame is stored. When the counter increments to three during the next trip, the code is matured and the MIL is illuminated. If the test passes the first time, no further testing is conducted during that trip.

The monitor runs once per trip. When the test fails for the first time, a Freeze Frame is stored and a maturing code is set. However, the MIL is not illuminated. When the test fails on a second consecutive trip, the code matures, a DTC is entered and the MIL is illuminated.

The MIL is extinguished after three consecutive good trips. The good trip criteria for the catalyst monitor is more stringent than the failure criteria. In order to pass the test and increment one good trip, the downstream sensor switch rate must be less than 80 % of the upstream rate (60% for manual transmissions). The failure percentages are 90% and 70% respectively. The criteria for pass/fail percentages is listed in Table 5.

Table 5 Downstream Switch Rate

TRANSMISSION TYPE	FAIL RATE (SWITCH RATE OF UPSTREAM SENSOR)	PASS RATE (SWITCH RATE OF UPSTREAM SENSOR)
Automatic	90%	80%
Manual	70%	60%

The message on the scan tool screen for the catalyst monitor appears as follows:

CATALYTIC CONVERTER EFFICIENCY FAILURE

J2012 CODE - P0422

There are several factors that can adversely affect the monitoring of catalyst efficiency. They are:

- Exhaust leaks. Allowing excess amounts of oxygen to enter the exhaust system can mask a faulty converter.
- Fuel contaminants such as engine oil, coolant, phosphorus, lead, silica and sulfur can interfere with the converter's chemical reaction, affecting the catalyst's oxygen storage capacity.

Enabling Conditions

The conditions listed below must be met before the PCM runs the catalyst monitor. Specific times for each parameter may be different from engine to engine.

- Accumulated Drive Time
- Enable Time
- Ambient Air Temperature
- Barometric Pressure
- Catalyst Warm-up Counter
- Engine Coolant Temperature
- Accumulated Throttle Position Sensor
- Vehicle Speed
- MAP
- RPM
- Engine in Closed Loop
- Fuel Level

Pending

The catalyst monitor is not conducted if a one trip fault is set or if the MIL is illuminated for any of the following:

- Misfire DTC
- Front O_2 Sensor Response
- Front O_2 Heater Monitor
- Front O_2 Sensor Electrical
- Rear O_2 Sensor Rationality (middle check)
- Rear O_2 Heater Monitor
- Rear O_2 Sensor Electrical
- Fuel System Monitor
- All TPS Faults
- All MAP Faults
- All Coolant Temperature Sensor Faults
- Purge Flow Solenoid Functionality
- Purge Flow Solenoid Electrical
- All Engine Controller Self–test Faults
- All Cam and Crankshaft Sensor Faults
- All Injector and Ignition Electrical Faults
- Idle Air Control Motor Functionality
- Vehicle Speed Sensor
- Brake Switch
- Charge Temperature

Conflict

The catalyst monitor does not run if any of the following are conditions are present:

- EGR monitor in progress
- Fuel system rich intrusive test in progress
- EVAP Monitor in progress
- Time since start is less than 60 seconds
- Low Fuel Level
- Low Ambient Air Temperature

Suspend

The Task Manager does not mature a catalyst fault if any of the following are present:

- Oxygen Sensor Monitor,Priority 1
- Oxygen Sensor Heater Monitor, Priority 1
- EGR Monitor, Priority 1
- EVAP Monitor, Priority 1
- Fuel System Monitor, Priority2
- Misfire Monitor, Priority2

ACTIVITY FIVE
CATALYST MONITOR

This activity runs the Catalyst Monitor. Answer the following questions while running the monitor on the classroom vehicle.

1. Using the General Information Section of the Powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the EGR Monitor on the classroom vehicle

   Engine Coolant Temperature ______________________

   Time From Start ______________________

   TPS Percent ______________________

   Vehicle Speed ______________________

   MAP Vacuum ______________________

2. Connect the DRB III to the classroom vehicle and start the engine.

3. Access the Catalyst Monitor Pre–Test screen. Have either the instructor or a student make adjustments to the break out box to meet the enabling criteria.

   When the MAP voltage is simulating load, what happens to the injector pulse width?

   ____

Note: *While adjusting MAP and Fuel pressure you need to observe an adaptive memory screen, i.e., Fuel Lean/Rich Pre–test, Evap Purge Flow Pre–test, or Adaptive Memory under Engine Systems.*

4. To decrease the amount of fuel entering the engine, slowly adjust the fuel pump voltage to allow the engine to run smoothly. Note what fuel pressure is required to maintain smooth operation in the window the monitor runs. The fuel pressure may have to be constantly adjusted during run time to maintain smooth performance. If the pressure drops too low, RPM may decrease and the engine may begin to operate in a different memory cell.

5. Access the Purge Flow Pre–test screen. What cell are you operating in?

   ____

6. If the RPM starts to drop, and the engine enters a lower cell, what is the fuel trim in that cell?

___

7. Why does this affect engine performance?

___

___

___

8. Access the Catalyst Monitor screen and observe the monitor as it runs.

9. After the monitor has passed, leave all break out adjustments in place. Allow the throttle to close.

10. Run a jumper wire from the downstream O_2 Sensor to the Upstream O_2 Sensor on the Breakout Box. What input does the PCM receive by doing this?

___

11. Restart the engine and re–install the throttle position adjuster (feeler gauge).

12. Access the Catalyst Monitor Pretest Screen. Allow the engine to run to meet the enabling criteria.

13. Once enabling conditions are met, access the Catalyst Monitor Screen.

14. Once the monitor fails the test, does the PCM immediately store a freeze frame for the maturing code and why?

___

15 Allow the engine to run in the enabling conditions window to fail the monitor.

16. Once the monitor fails, what is the code that is stored in Freeze Frame?

___

17. Turn the ignition key OFF.

NOTES:

MISFIRE MONITOR

Misfire is the lack of combustion in a cylinder. When a misfire occurs, raw fuel and excess oxygen are dumped into the exhaust stream. Two things happen that adversely effect emissions. First, the unburned fuel (HCs) in the exhaust continues to burn at the catalytic converter, raising the temperature of the catalyst and increasing tailpipe HC emissions. Secondly, oxygen sensors detect excess amounts of unburned oxygen, and the PCM incorrectly reads a lean condition. The PCM increases the pulse width to the injectors and more raw fuel enters the exhaust. Prolonged misfire may overheat the catalyst causing permanent damage.

OBD II regulation requires that the diagnostic system monitors engine misfire and identifies specific cylinders experiencing misfire. Systems also must identify and store a separate code to indicate multiple cylinder misfires. Identifying the specific misfiring cylinders is optional under a multiple cylinder misfire.

OBD II regulations for misfire monitoring require three different tests for misfire. The three tests are listed in Figure 23.

MISFIRE DETECTION

TYPE A:

- % OF MISFIRE IN 200 REVOLUTIONS
- INDICATING PENDING CATALYST DAMAGE
- FLASHING MIL

TYPE B:

- % OF MISFIRE IN 1000 REVOLUTIONS
- INDICATING EMISSIONS GREATER THAN 1.5 X FTP STANDARDS
- MIL ON STEADY AFTER 2 TRIPS

TYPE C:

- % OF MISFIRE IN 1000 REVOLUTIONS
- INDICATING FAILURE OF CALIFORNIA I/M TEST
- MIL ON STEADY AFTER 2 TRIPS

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Figure 23 Misfire Monitors

The tests are monitored by two different counters. These counters are:

- 200 revolution increments for immediate catalyst damage
- 1000 revolution increments for emissions violation and I/M test failure

200 Revolution Counter (Type A)

Diagnostic systems must be able to monitor a percent of misfire, during a 200 revolution test, that would cause permanent catalyst damage. Manufacturers must predetermine a percentage of misfire that would cause permanent catalyst damage and enter a malfunction.

Note: *The percentage of misfire for each test is predetermined by manufacturers during testing. The percent of misfire for malfunction criteria varies due to RPM and load. As the engine speed increases or load decreases, the effects of a misfire diminishes due to crankshaft momentum. Failure percentages also vary from engine to engine.*

1000 Revolution Counter (Type B & C)

The diagnostic system must also be capable of identifying a misfire percentage that would lead to an increase of 1.5 times the FTP standard. This test must be run in 1000 revolution increments. The 1000 revolution checks are two trip monitors.

Also during 1000 revolution increments, systems must identify misfire percentages that would cause a "durability demonstration vehicle" to fail an I/M test. Under these conditions, manufacturers must determine a misfire percentage that would cause a future Inspection and Maintenance program failure of a tail pipe emissions test.

Monitor Operation

The PCM utilizes the Crankshaft Speed Fluctuation method to monitor for misfire. The misfire monitor utilizes a crankshaft position sensor to determine engine RPM. The sensor can detect slight variations in engine speed due to misfire. Misfire is continuously monitored once the enabling conditions are met.

The Adaptive Numerator

The misfire monitor takes into account component wear, sensor fatigue, and machining tolerances. The PCM compares the crankshaft in the vehicle to data on an ideal crank and uses this as a basis to determine variance. To do this, the crankshaft sensor monitors the reference notches in the crank. The PCM uses the first signal set as a point of reference. It then measures where the second set of signals is, compared to where engineering data has determined it should be. This variance is the Adaptive Numerator.

For example, in calculating variance on a six cylinder engine, the PCM uses the first group of slots as a reference (fig. 24). It then compares the position of the latter groups of slots to predetermined data and enters a variance. This is the Adaptive Numerator. The PCM calculates the numerator on engine decel where crank speed is not affected by cylinder firing. The PCM updates the Adaptive Numerator at every key-ON and will not run the monitor until it has updated at least once since the last battery disconnect.

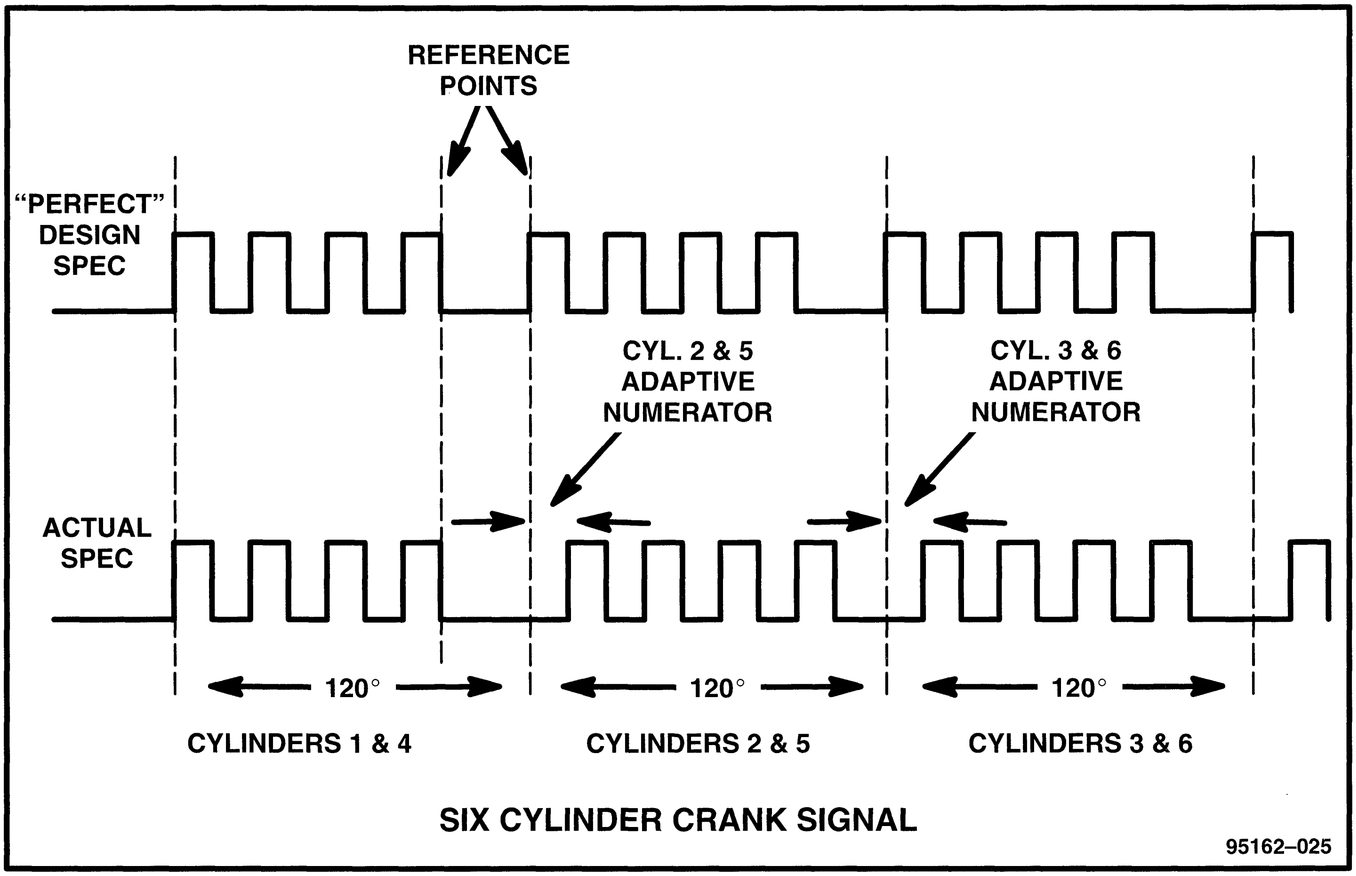

Figure 24 Adaptive Numerator

The Adaptive Numerator is relearned after battery disconnect to the PCM. If the Adaptive Numerator is equal to the default value, the Adaptive Numerator has not been learned and the Misfire Monitor does not run. The Adaptive Numerator is learned on deceleration, when crankspeed is not likely to fluctuate. If the Adaptive Numerator exceeds its limits, the PCM sets a DTC for Adaptive Numerator and illuminates the MIL.

To detect misfire, the PCM monitors the crankshaft speed. For example, when an engine is running, the PCM monitors the speed of the crankshaft. When a misfire occurs, the PCM detects a decrease in crank speed and counts a misfire.

Note: *Normal engine operation is required for proper PCM memory update. If misfire is present when a PCM is replaced or power is reconnected, it considers the misfire normal operation.*

RPM Error

The PCM also checks the machining tolerances for each group of slots. By monitoring the speed of the crank from the first slot to the last slot in a group, the PCM can calculate engine RPM. The variance between groups of slots is known as the RPM error (fig. 24). In order for the PCM to run the Misfire Monitor, RPM error must be less than approximately 5%.

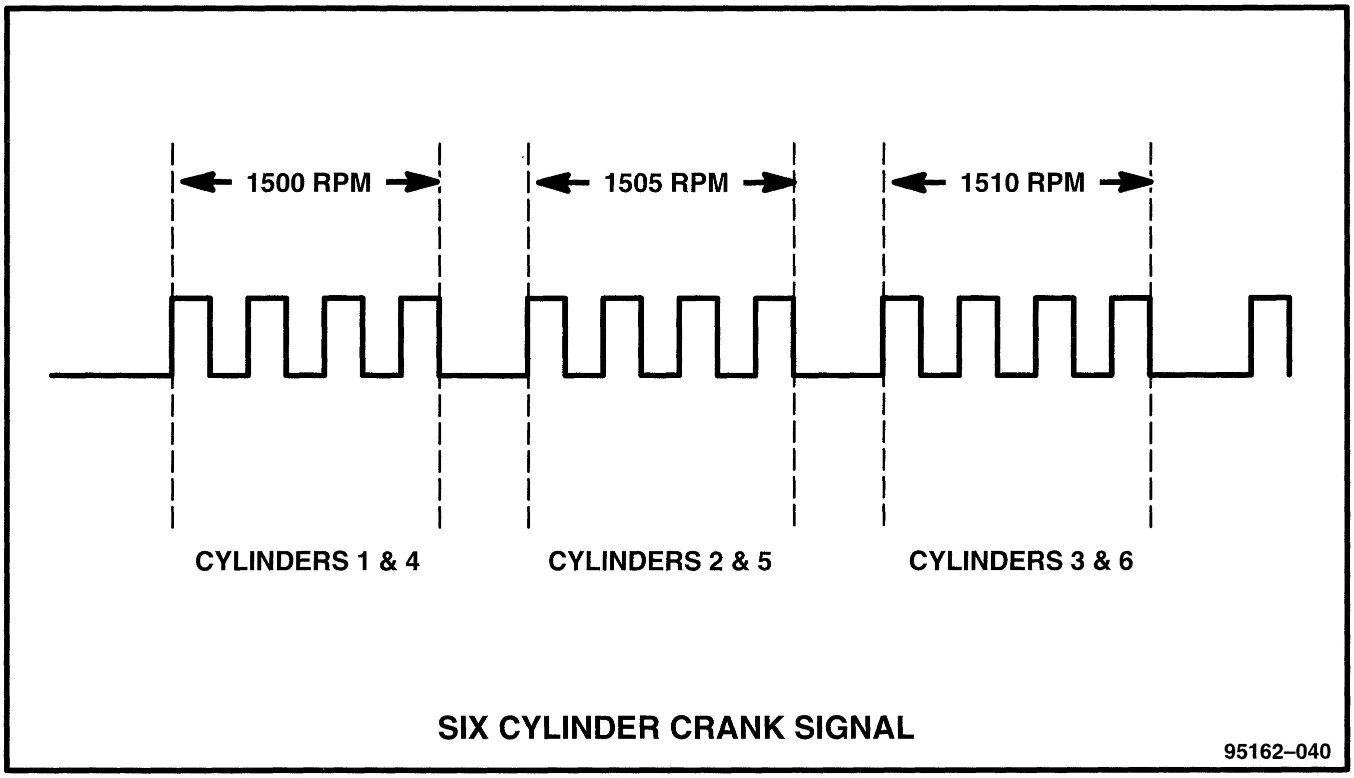

Figure 25 RPM Error

Once enabling conditions are met, the PCM counts the number of misfires in every 200 revolutions of the crank. If, during **five** 200 counters, the misfire percentage exceeds a predetermined 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 revolution period. A failure on the second consecutive trip matures the code and a DTC is set.

If misfire continues during the initial trip, the MIL is not illuminated. However, the MIL flashes when the misfire percentage exceeds the malfunction percentage, in any 200 rev. period, that would cause permanent catalyst damage. This is a one trip monitor. Now, misfire has reached a point in which catalyst damage is likely to occur. The MIL flashes and a DTC is stored in a Freeze Frame. The engine defaults to open loop operation to prevent increased fuel flow to the cylinders. Once misfire is below the predetermined percentage, the MIL stops flashing but remains illuminated.

Figure 26 shows how the misfire counters work. Every 1000 revolution window contains five 200 revolution windows. The PCM counts misfires for each 200 window and carries that value over for the 1000 revolution window.

Note: It is not recommended that vehicles be driven if the MIL is flashing.

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

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Figure 26 Revolution Counters

The 1000 revolution counters are two trip monitors. As with the fuel system monitor, Freeze Frame data is from the original fault, and MIL extinguishing requires the monitor to pass under similar conditions.

When a misfire occurs, a DTC is stored and the message on the scan tool appears as follows:

MULTIPLE CYLINDER MISFIRE
J2012 CODE - P0300

CYLINDER # MISFIRE
J2012 CODE - P030#

Some misfires occur that are not due to component failure. Make sure that misfire is not due to any one of the following:

- Moisture on Ignition System Components
- Insufficient Fuel Level
- Low Quality Fuel
- Manual Transmission Bog Down
- Towing Overload

Enabling Conditions

The following conditions must be met before the PCM runs the Misfire Monitor:

- RPM
- Engine Coolant Temperature
- Barometric Pressure
- Fuel Level
- Ambient Air Temperature

Pending

The Misfire Monitor does not run when the MIL is illuminated for any of the following:

- Limp in Mode for:
    - MAP
    - TPS
    - Crankshaft Sensor
    - Engine Coolant Temperature Sensor
- Speed Sensor DTC
- EGR Electrical
- EVAP Electrical
- Idle Speed Faults
- Charge Temperature
- Oxygen Sensor Monitor
- Oxygen Sensor Electrical

Conflict

If any of the following conditions conflict with the Misfire Monitor, the monitor will not run:

- Low Fuel Level
- MAP Voltage Rapidly Changing
- Severe Engine Decel
- TPS Toggling OPEN/CLOSED
- Engine RPM Too Low
- Engine RPM Too High
- Full Lean or Decel Fuel Shut-Off
- Cold Start

ACTIVITY SIX
MISFIRE MONITOR

This activity demonstrates the misfire enabling conditions, including the misfire numerator, and activation of the misfire monitor. Answer the following questions as you run the monitor on the classroom–vehicle.

1. Using the General Information Section of the Powertrain Diagnostics Procedures manual for your vehicle, list the enabling criteria to run the EGR Monitor on the classroom vehicle.

   Engine Coolant Temperature ____________________

   Engine Run Time ____________________

   Fuel System Status ____________________

   MAP Volts ____________________

   TPS Percent ____________________

   Engine RPM ____________________

   Vehicle Speed ____________________

2. What are the enabling conditions for the PCM to calculate the misfire Numerator?

   ____

   ____

Warning:	*Make sure the transmission is in Park (Automatic Transmissions) or Neutral (manual transmissions) and the Parking Brake is ON.*

3. Connect the DRB III to the classroom vehicle and access the Misfire Pre Test Screen. Start the engine and observe the Misfire Numerator. What is the numerator value on start up?

   ____

4. What value did the PCM input for the misfire numerator after it is calculated?

   ____

5. Insert spark plug wire adaptors between two spark plug wires and the ignition module.

6. Referring back to the Procedures Manual what is the allowable percentage of misfire for the classroom vehicle?

____

____

7. Allowable engine misfire percentages vary with RPM and Load.

   a. True

   b. False

8. Access the Misfire Monitor.

9. With the engine idling, observe the 200 and 1000 misfire counters. What value ranges are displayed for each counter?

   200 Counter _______________________________________

   1000 Counter ______________________________________

10. Use an insulated tool to short cross the spark plug wire adapters (ie. grounded test light).

> **Warning:** *Make sure the transmission is in Park (Automatic Transmissions) or Neutral (manual transmissions) and the Parking Brake is ON.*

11. Have a student sit in the drivers seat and slightly press the accelerator to keep engine RPM in the window for enabling conditions.

12. Observe the misfire counter as the spark plug wires are being shorted together.

13. When the misfire percentage surpasses limits for 1000 revolution counter, what happens?

   a. PCM stores a Freeze Frame

   b. PCM sets a maturing DTC.

   c. The MIL is illuminated

   d. a and b

14. On which DRB III menu(s) can you determine which cylinders were misfiring?

____

15. Cycle the key OFF and ON, and run the monitor a second and third time.

16. Allow the monitor to pass.
17. Once the monitor has passed, what happens to the Freeze Frame?

    ____

18. Cycle the ignition OFF then back ON.
19. What happened to the Freeze Frame Data?

    ____

    ____

NOTES:

EVAP MONITOR

The evaporative control system prevents fuel tank vapors from entering the atmosphere. Fuel evaporation emits Hydrocarbons (HC) directly into the atmosphere. As fuel evaporates in the fuel tank, vapors are routed into a charcoal canister. Through the use of a purge solenoid, manifold vacuum draws these vapors into the combustion chamber.

Emissions testing has determined that EVAP systems with a .020 inch diameter leak can yield an average of about 1.35 grams of HC per mile. This is over 30 times the allowable exhaust emissions standard. For this reason, OBD II regulations require monitoring of EVAP systems.

OBD II regulations require that the diagnostic system:

- Verify Airflow
- Monitor For HC Loss

With current technology, a .040 inch diameter leak is the smallest leak that can be detected on a regular basis. OBD II regulations, therefore, require systems to detect leaks greater than or equal to .040 inches in diameter. Vacuum tubing and connections between the purge valve and the intake manifold are excluded from these regulations.

Regulations also require that: "the MIL shall illuminate and a fault code shall be stored no later than the end of the next driving cycle". This means the EVAP monitor can be a two trip monitor. Manufacturers may employ a second warning indicator (other than the MIL) for a leak caused by a missing or loose fuel cap.

There are two ways in which Chrysler vehicles monitor the EVAP System:

- EVAP Leak Detection Pump (LDP)
- Stricter EVAP (Non LDP Vehicles)

EVAP Leak Detection Pump

The Leak Detection Pump must perform two primary functions:

- Pressurize the EVAP system
- Seal the Charcoal Canister

The Leak Detection Pump system contains the following components (fig. 27):

- Three-port solenoid that activates the two primary functions of the system
- Vacuum driven pump that contains a reed switch, check valves, and a spring loaded diaphragm
- Canister Vent Valve that contains a spring loaded vent seal valve

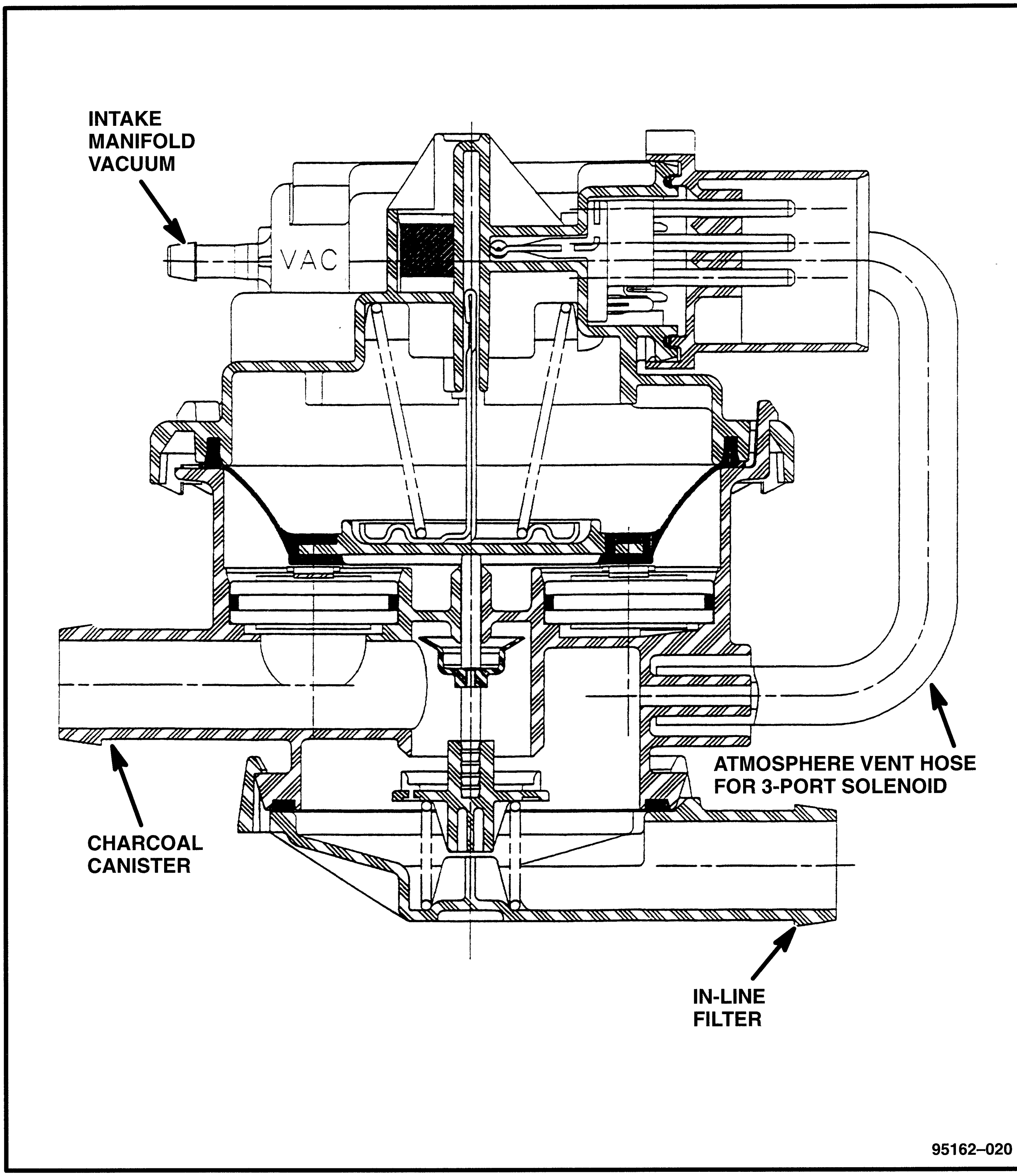

Figure 27 EVAP Leak Detection Pump

When the outside ambient air temperature is within predetermined parameters, the leak detection portion of the monitor is run immediately after a cold start. The three-port solenoid is energized, allowing vacuum to pull the pump diaphragm up. This draws air from the atmosphere into the pump. When the solenoid is de-energized, the pump is sealed, spring pressure drives the diaphragm down, and air is pumped into the system (fig. 28).

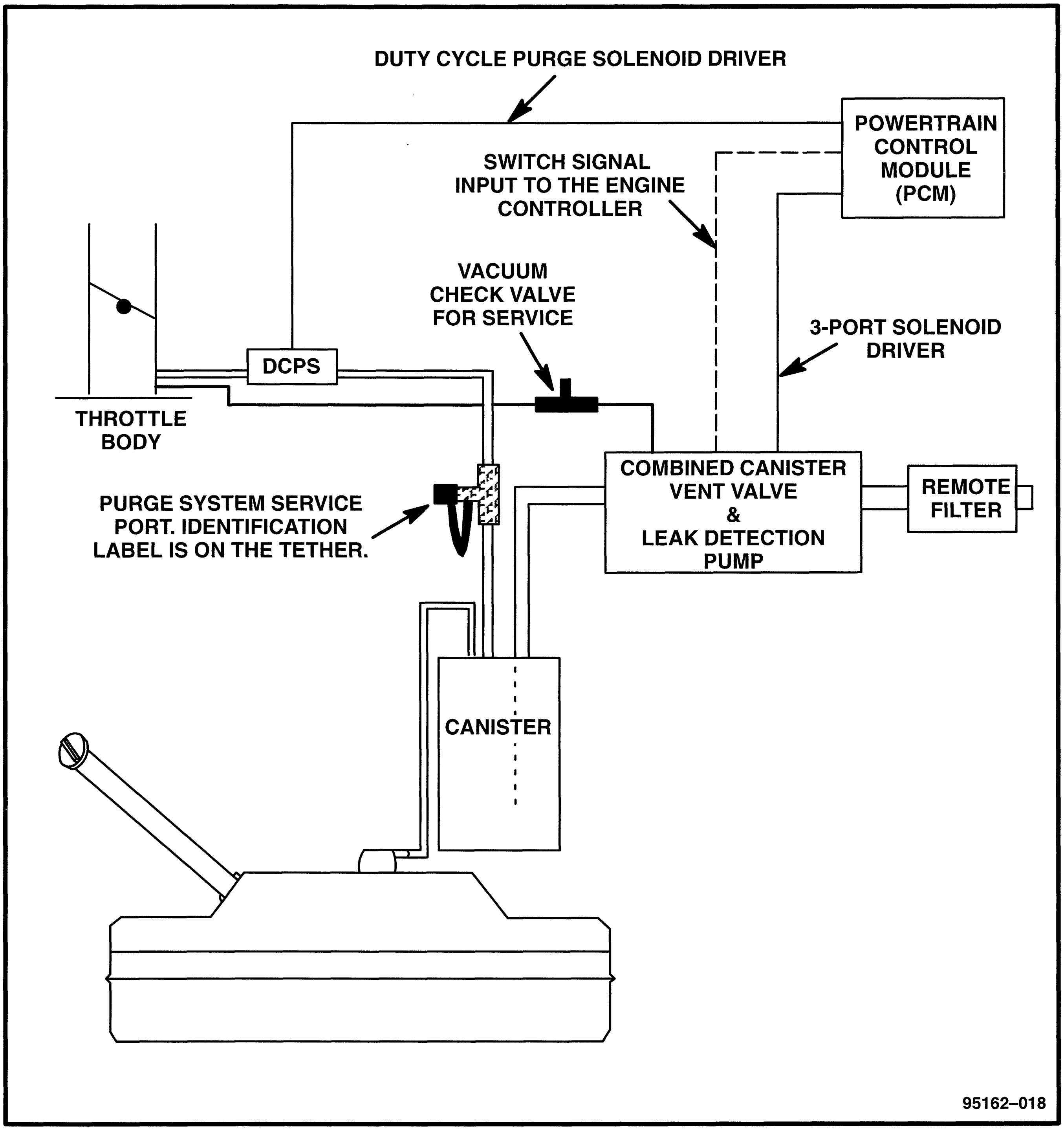

Figure 28 EVAP LDP System

The solenoid and diagram pump cycles to pressurize the EVAP system. The spring on the diaphragm is calibrated to 7.5 inches of water. If no leaks are present, pressure equalizes and the pump cycle rate falls to zero.

The first portion of the test determines whether or not a line is pinched in the system. If the pump rate falls to zero too rapidly, the PCM determines that there is not enough space to pressurize, this indicates a possible pinched line. When this portion of the test passes, the pump is stopped when the rate falls to zero. Figure 29 shows a typical monitor of the EVAP system with pressure versus time.

When there is a leak present in the EVAP system, the cycle rate falls to a rate proportional to the size of the leak. By monitoring the cycle rate of the pump, the PCM is able to calculate the size of the leak. When calculations reveal the presence of a hole .040 inches in diameter or greater, the MIL is illuminated and a Freeze Frame is stored.

When the leak test portions of the monitor are completed and test parameters are met, EVAP operation is monitored during a warm idle. The pump is again actuated to 7.5 inches of water pressure. Once the system is pressurized, the purge system is activated. The purge pump is cycled at a constant rate by the PCM. Once the purge is activated, the PCM watches for changes in short term adaptive. When the PCM detects short term adaptive shift, the system passes. When the short term adaptive shift is insufficient, the system fails the monitor.

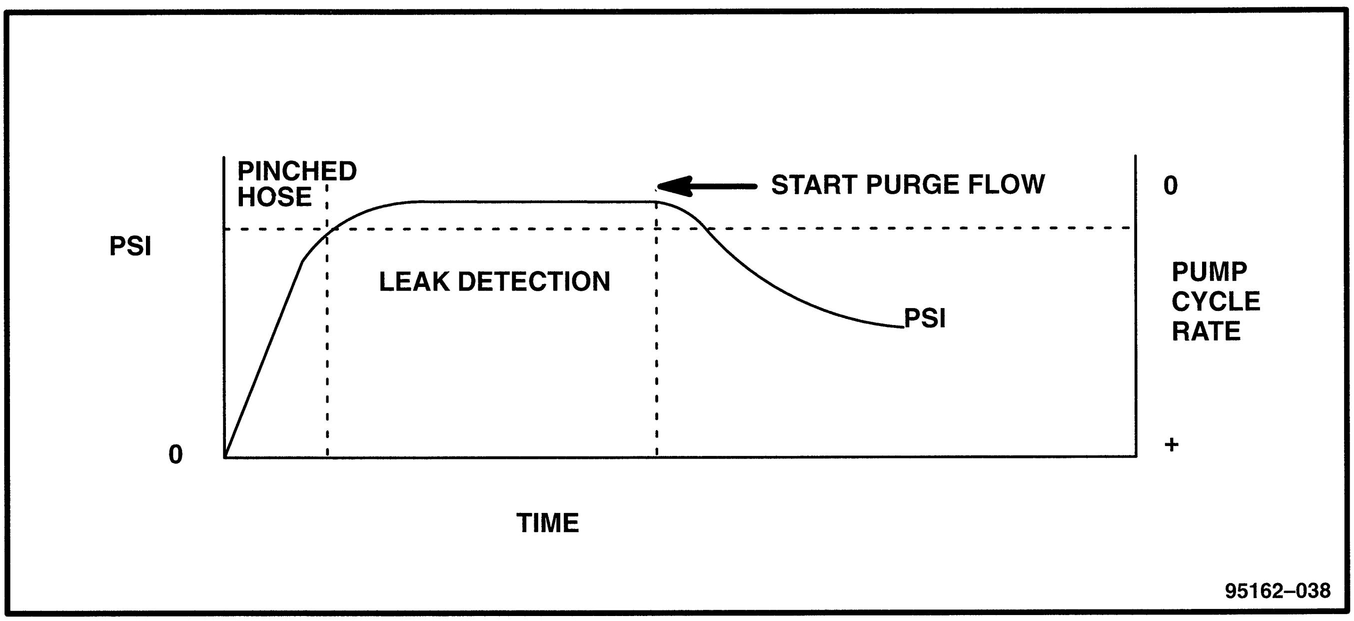

Figure 29 Leak Detection Operation

Stricter EVAP (Non–LDP Vehicles)

On a vehicle without an EVAP leak detection pump system, changes in short term adaptive memory, movement in target IAC at idle or idle speed change, are used to monitor the system. There are two stages for this test.

Stage one is a non-intrusive test. The PCM compares adaptive memory values between purge and purge free cells. The PCM uses these values to determine the amount of fuel vapors entering the system. If the differences between the cells exceeds a predetermined value, the test passes. If not, then the monitor advances to stage two.

Stage Two

Once the enabling conditions are met, the PCM de–energizes the DCP solenoid. The PCM then waits until engine rpm, Short Term Adaptive, and Idle Air Control have all stabilized. Once stable, the PCM increments the DCP solenoid cycle rate approximately 6% every 8 engine revolutions. If during the test any one of three conditions occur before the DCP cycle reaches 100%, the EVAP system is considered to be operational and the test passes. These conditions are as follows:

- RPM Rises By Predetermined Amount
- Short Term Drops By Predetermined Amount
- Idle Air Control Closes By Predetermined Amount

When neither of the previous conditions occur, the test fails and the PCM increments a counter by one. When the PCM runs the test three times during a trip, and the counter has been incremented to three, the monitor fails and Freeze Frame is stored.

Enabling Conditions (Stage Two)

The following conditions must be met in order for the second stage of the EVAP Monitor to run:

- Ambient Air Temperature
- Barometric Pressure
- Fuel Level

Enabling Conditions

The following conditions must be met to enable the EVAP Monitor:

- Ambient Air Temperature
- Barometric Pressure
- Fuel Level
- Engine Temperature
- Engine Run Time
- RPM Stable
- MAP
- Generator, Radiator Fans, A/C Clutch

Pending

The EVAP Monitor is suspended and does not run, when the MIL is illuminated due to any of the following faults:

- Misfire
- O_2 Monitor
- Fuel System Rich
- Fuel System Lean
- EGR Monitor
- MAP
- TPS
- ECT
- DCP Solenoid

Conflict

The EVAP Monitor does not run if any of the following test are in progress:

- Catalyst
- EGR
- Fuel System
- Misfire

ACTIVITY SEVEN
EVAP SYSTEM MONITOR

This activity runs the EVAP Monitor. Answer the following questions while running the monitor on the classroom vehicle. This activity is divided into two tasks that correspond to the individual Evap systems. For systems without Leak Detection Pumps complete Task One only. For systems with Leak Detection Pumps complete Task Two only.

Task One

1. How does the PCM test the EVAP system for your classroom vehicle.

   a. It increases the purge valve duty cycle while looking for a short term adaptive memory shift due to increased fuel vapors

   b. It pressurizes the tank for leaks to atmosphere, sets purge solenoid to fixed duty cycle, and then looks for shift in adaptive memory.

2. Using the General Information Section of the Powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the EVAP Monitor on the classroom vehicle

   MAP Vacuum ______________________________

   Engine RPM ______________________________

   Fuel System Status ______________________________

   Engine Coolant Temperature ______________________________

   Engine Run Time ______________________________

3. Connect the DRB III to the classroom vehicle and start the engine.

4. Access the EVAP Monitor Pretest Screen on the DRB II to view enabling conditions. What does the PCM do to update the Purge free idle cell?

   ____

5. In what cell does the engine have to be operating to run the EVAP monitor?

   ____

6. Allow the engine to warm up to meet the enabling conditions. Once enabling temperature is met, access the EVAP Monitor Screen. Engage the Parking brake and place the transmission in drive.

7. While the monitor is running observe the DRB III EVAP Monitor Screen. Does the monitor pass or fail?

   a. Pass

   b. Fail

8. How did the PCM determine that the monitor passed or failed?

   a. PCM de–energizes EVAP solenoid and then checks for increase in short term adaptive.

   b. PCM check solenoid frequency for proper operation, then checks long term adaptive.

   c. PCM measures the vacuum at the EVAP solenoid, then checks short term adaptive.

   d. None of the above.

9. Cycle the ignition OFF and then back ON. Access the EVAP Monitor Pre–test.

10. Plug the hose from the purge solenoid to the manifold

11. Make any necessary adjustments to meet the enabling criteria and the monitor again.

12. Access the EVAP Monitor screen while the test is running. Does the monitor fail after the first test?

    ____

13. What is the reason for your response to the previous question?

    ____

    ____

14. After the monitor fails, access Freeze Frame and Read DTCs. What is the fault code for the failure?

    ____

15. Is the MIL illuminated and why?

    ____

Task Two

1. How does the PCM test the EVAP system for your classroom vehicle.

   a. It increases the purge valve duty cycle while looking for a short term adaptive memory shift due to increased fuel vapors

   b. It pressurizes the tank for leaks to atmosphere, sets purge solenoid to fixed duty cycle, and then looks for shift in adaptive memory.

2. Using the General Information Section of the Powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the EVAP Monitor on the classroom vehicle

   Ambient Air Temperature ______________________________

   Engine Coolant Temperature ______________________________

   Engine Run Time ______________________________

   MAP Volts ______________________________

   TPS Percent ______________________________

   Engine RPM ______________________________

   Vehicle Speed ______________________________

4. Connect the DRB III to the classroom vehicle.

5. Access the EVAP Monitor Pretest Screen on the DRB III to view enabling conditions. Start the engine.

   What does the PCM do to update the purge free idle cell?

   ____

6. Access the EVAP Monitor Screen to observe the monitor running.

7. Does the monitor pass or fail?

   a. Pass

   b. Fail

8. Cycle the ignition OFF and then back ON. Access the EVAP Monitor Pre–test.

9. Plug the hose from the purge solenoid to the manifold.

10. Make any necessary adjustments to meet the enabling criteria and have the monitor run again.

11. Access the EVAP Monitor screen while the test is running. Does the monitor fail after the first test?

____

12. What is the reason for your response to the previous question?

____

____

13. After the monitor fails, access Freeze Frame. What is the fault code for the failure?

____

14. Is the MIL illuminated and why?

____

NOTES:

EGR MONITOR

Normal engine cylinder operating temperatures can reach 3000°F. Emissions of NO_X increase proportionally with engine temperature. EGR systems recirculate non-combustible exhaust gases into the manifold to dilute the air/fuel mixture. In this way, EGR systems lower the cylinder temperature and reduce NO_X emissions and pre-detonation (engine knock).

OBD II regulations require that vehicles equipped with EGR must monitor the EGR system for high and low flow rates. Malfunctions must be indicated when:

- Any component in the system fails to perform within specifications.
- EGR flow rate exceeds the manufacturers high and low limits that would cause an emissions increase of 1.5 times the FTP standard.

Diagnostic systems are required to illuminate the MIL no later than subsequent failure on the next trip.

EGR systems operate using the following main components:

- EGR Valve
- EGR Tube
- Electronic EGR Transducer (EET)
- Connecting Hoses

The PCM activates the solenoid during predetermined operating conditions. When the solenoid is activated, the manifold vacuum is applied to the transducer. When exhaust back pressure is negative, the manifold vacuum is vented to the atmosphere. Positive exhaust back pressure causes the transducer to modulate. This allows the manifold vacuum to reach the EGR valve. Vacuum is applied to one side of the diaphragm and exhaust back pressure is applied to the other. This allows exhaust gases to be routed to the intake manifold.

An EGR valve stuck closed prevents the system from routing exhaust to the manifold, increasing NO_X emissions. EGR valves that are stuck open increase HC emissions, fuel consumption, and lead to rough engine operation.

To run the EGR monitor, the PCM performs the following functions in this order:

- EGR solenoid is turned OFF
- O_2 compensation control is monitored

When the EGR system is functioning properly, deactivation of the EGR shifts the air fuel mixture to lean (fig. 30). Oxygen sensor voltage then indicates increased oxygen in the exhaust. Consequently, short term adaptive memory shifts to rich (increased pulse width). By monitoring the shift, the PCM can indirectly monitor the EGR system.

If the PCM does not detect a change in short term memory within in a given percentage range, the monitor fails and a maturing code is set with a Freeze Frame. When the monitor fails on the second consecutive trip, the MIL is illuminated and a DTC is set with Freeze Frame. The message on the scan tool reads as follows:

EGR SYSTEM FAILURE

J2012 CODE - P0401

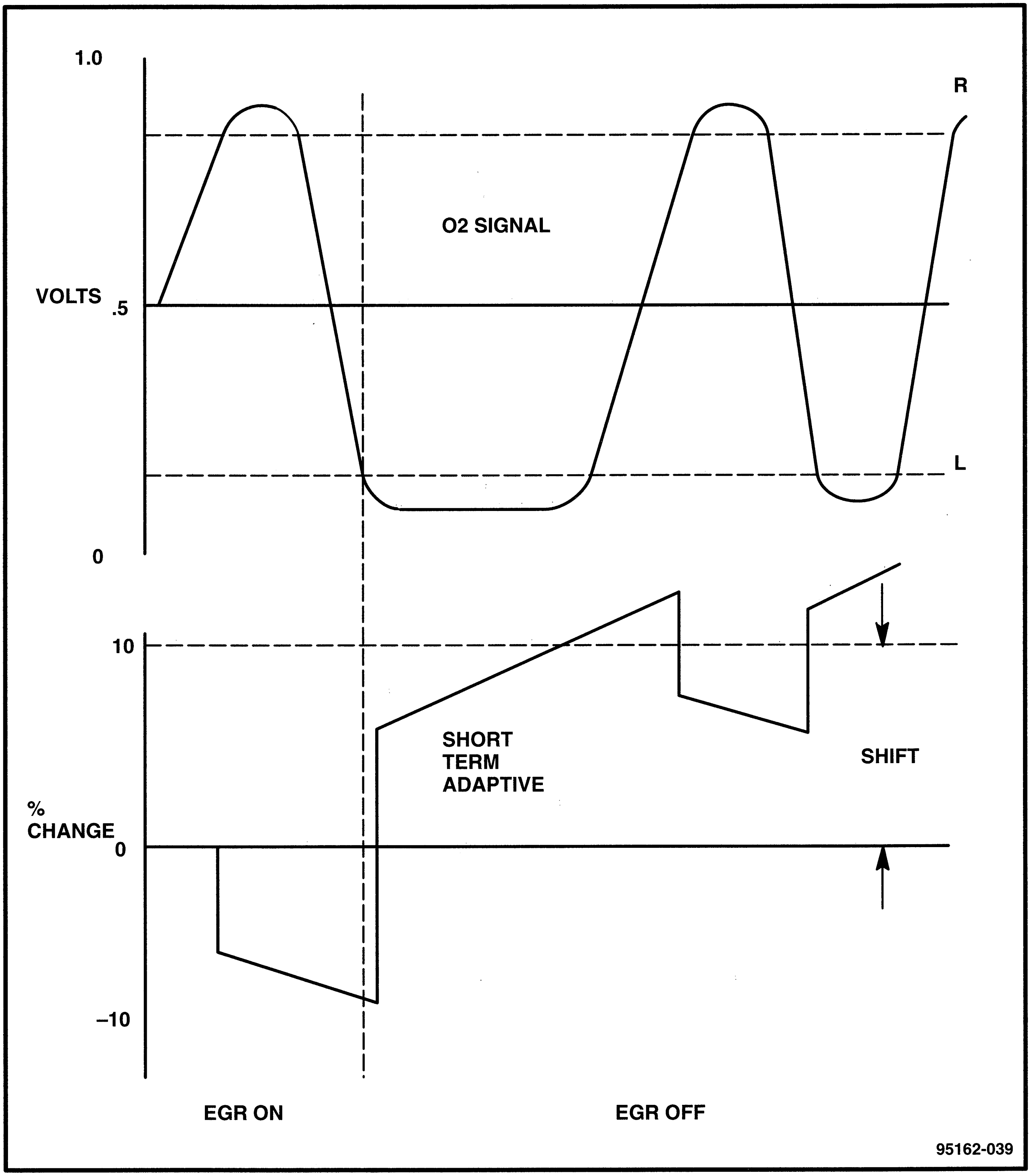

Figure 30 Fuel System Compensation Shift

Enabling Conditions

- Engine Temperature
- Engine Run Time
- Engine RPM
- MAP
- TPS
- Vehicle Speed
- Short Term Adaptive

Pending

The EGR Monitor does not run when any of the following faults have illuminated the MIL:

- Misfire
- O_2 Monitor
- O_2 Heater Monitor
- Fuel System Rich/Lean
- Limp In for MAP< TPS or ECT
- Vehicle Speed Sensor
- Cam or Crank Sensor
- EGR Electrical
- EVAP Electrical
- Fuel Injector
- Ignition Coil
- Idle Speed
- Engine Coolant Temperature (ECT) Sensor
- MAP Sensor
- Charge Temperature

Conflict

The EGR Monitor does not run if any of the following conditions are present:

- Fuel System Monitor
- Purge Monitor
- Catalyst Monitor
- Low Fuel Level
- High Altitude
- Low Ambient Air Temperature

The EGR Monitor does not run if any of the following codes are present:

- Misfire Monitor, Priority 2
- Upstream O_2 Heater, Priority 1
- Fuel System, Priority 2
- O_2 Sensor, Priority 1

ACTIVITY EIGHT
EGR MONITOR

This activity demonstrates the enabling conditions and activation of the EGR monitor. Answer the following questions as you run the monitor on the classroom vehicle.

1. Using the General Information Section of the Powertrain Diagnostics Procedures Manual for your vehicle, list the enabling criteria to run the EGR Monitor on the classroom vehicle

   Vehicle Speed Sensor ____________________

   Fuel System Status ____________________

   Time From Start/Run ____________________

   Purge Duty Cycle ____________________

   Engine Coolant Temp. ____________________

   MAP Vacuum ____________________

   Engine RPM ____________________

   TPS Volts ____________________

2. Connect the DRB III to the classroom vehicle.

3. Access the EGR Monitor Pre–test screen on the DRB III. Make the necessary adjustments to meet enabling conditions.

4. Once the enabling conditions are met, access the EGR Monitor Pre–test screen. Which adaptive memory cell is the engine operating in?

   Actual cell vehicle is operating in: ____________________

5. Access the EGR Monitor Screen on the DRB III.

6 Did the monitor pass or fail?

   a. Pass

   b. Fail

7. What is the reason for your response to the previous question?

____

____

____

8. How does the monitor actually run the test?

____

____

____

9. Record the maximum value for the fuel trim compensation when the test is running?

____

10. Access Freeze Frame to view operating conditions when the test failed. List the operating conditions below.

____

____

____

____

11. Cycle the key OFF and then back ON.

12. Access the EGR Pretest menu to run the monitor again.

13. Put the engine under actual load to create back pressure and meet the enabling criteria.

14. Does the engine have to be operating in the same cell to clear the code?

    a. Yes

    b. No

15. Access the EGR Monitor Pre–test screen. Make the proper adjustments to meet the enabling criteria. Once in the window of operation, exit out and access the EGR monitor screen.

16. Once the monitor runs, does it pass or fail?

    a. Pass

    b. Fail

17. Cycle the key OFF and then back ON.

18. Access the Pretest screen and run the monitor again.

19. Run the monitor and continue to view the Pre–test screen. Apply the load to the engine and run the monitor again. As the monitor runs, what is the change in the O_2 compensation as the test runs.

    ____

20. Cycle the key OFF and then back ON.

21 Are there any DTCs stored at this time?

    ____

    What are the requirements to extinguish the MIL and erase the DTC?

    ____

    ____

22. Access Freeze Frame. List the fault code and its description below:

    ____

    ____

GLOSSARY

Air/Fuel Ratio – The ratio, by weight, of air to gasoline entering the intake in a gasoline engine. The ideal ratio for complete combustion is 14.7 parts of gasoline to 1 part of fuel.

Baud Rate – The rate at which a controller is able to transfer and receive data. Baud rate is measure in bits per second.

Barometric Pressure (Baro) – The pressure created by the atmosphere which changes with altitude.

Big Slope – Term associated with oxygen sensor signals. The rate of input signal voltage change over time.

Carbon Dioxide – A relatively harmless gas which is a by product of complete combustion. Chemical composition CO.

Carbon Monoxide – A poisonous gas which is a result of incomplete combustion due to lack of oxygen. Chemical composition CO.

Catalyst – A material that promotes a chemical reaction without itself being changed by the reaction. The noble metals Platinum, Palladium, and Rhodium are used as catalyst in catalytic converters.

Closed Loop – A state in which the engine controller controls and adjusts the air/fuel mixture based on input from the upstream oxygen sensor.

Comprehensive Components – Any component, other than a major monitor, that has any effect on vehicle emissions.

Diagnostic Trouble Codes (DTCs) – Codes associated with engine controller fault messages that can be retrieved using a diagnostic scan tool.

Dynamic Data Display – The Mopar Diagnostic Systems software in which Input signals from various components plotted over time.

Evaporative Emissions – Emission of hydrocarbons produced by the evaporation of raw fuel.

Exhaust Gas Recirculation –. Routing exhaust gas into the intake manifold to dilute the air/fuel mixture thus lowering combustion chamber temperature. The reduction of operating temperature reduces the emissions of NOX.

Federal Test Procedure – A transient–speed mass emissions test conducted on a loaded dynamometer. This is the test which, by law, car manufacturers use to certify that new vehicles are in compliance for hydrocarbon, carbon monoxide, and oxides of nitrogen emissions.

Flex Fuel – Term pertaining to vehicles flexible in fuel requirements, ie. Natural Gas.

Freeze Frame – A "snapshot" of engine operating conditions taken when a fault occurs. Normally containing such information as engine RPM, Throttle Position, load, vehicle speed, temperature, and open or closed loop status.

Fuel Metering – Any means of controlling the air/fuel mixture entering the combustion chamber.

Functionality – Term associated with comprehensive component testing in which outputs from the engine controller can be verified by monitoring specific input signals from other components for expected change.

Good Trip – Trip counters in which various monitors have passed testing under predetermined conditions. The fulfillment of specific test parameters during a drive cycle. Good Trip are counted for MIL extinguishing and DTC erasure.

Half Cycle – When the voltage signal from an oxygen sensor crosses over a predetermined threshold. The predetermined thresholds are the rich to lean switch points.

Hydrocarbons (HC) – A family of organic fuels containing only hydrogen and carbon. Gasoline consists of almost entirely of a hydrocarbon mixture. Unburned hydrocarbons in the atmosphere are considered pollutants.

Long Term Adaptive – Long Term fuel injector pulse width compensation the engine controller has stored to maintain minimum emissions output. Long Term Adaptive drives Short Term Adaptive to maximum operating efficiency.

Misfire – The lack of complete combustion in an engine cylinder.

Nitrogen (N) – The gas which makes up 78 percent of the air we breathe. Under conditions of high temperature and pressure in the combustion chamber, Nitrogen can combine with Oxygen to form harmful Oxides of Nitrogen (NOX). Oxides of nitrogen contribute to the formation of ground–level ozone and photochemical smog..

Open Loop – A state in which the air/fuel mixture is being controlled by the engine computer according to a standard program and not in response to signals from the oxygen sensor. Normally encountered during the first few minutes o operation after a cold start.

Oxides of Nitrogen (NOX) – Harmful gases which form when Nitrogen from the air is combined with Oxygen under conditions of high temperature and pressure in the combustion chamber. Oxides of Nitrogen contribute the formation of ground–level ozone and photochemical smog. Chemical composition NOX

Positive Thermal Coefficient Device (PTC) – Electrical components in which the molecular structure changes with temperature. Voltage through PTCs creates heat changing the molecular structure. The resistance through a PTC is proportional to the heat generated. PTC are used as self–resetting circuit breaker and component heaters.

Pulse Width – The time duration of voltage pulse activating a component. The amount of time a signal is ON.

Purge – The act of transferring fuel vapors from the vapor canister to the intake system by drawing fresh air into the canister.

Rationality – Term associated with comprehensive component testing in which signal inputs from components are compared to inputs from other components to verify conditions coincide.

Similar Window – Pertaining to engine operation in which RPM and load are within predetermined percentages. Conditions in which certain monitors must pass to extinguish the MIL and erase DTCs.

Short Term Adaptive – The short term compensation made by the engine controller to vary injector pulse width. Based on oxygen sensor inputs the PCM changes injector pulse width by a percentage to maintain minimal emissions output.

Stoichiometric – Term most often used to describe the ideal air/fuel mixture entering the intake. The point at which the production of emissions is at a minimum and catalyst conversion of emissions is most efficient. The stoichiometric air/fuel ratio is 14.7 to 1, measure in parts by weight.

Task Manager – PCM software designed to manage, regulate and perform various monitor testing.

Trip – Ignition cycle and engine run sequence in which the PCM runs emission control monitors.

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