SOLUTIONS

A Catalytic Converter Information Booklet And A Diagnostic Manual For Troubleshooting Catalytic Converter Problems, Replacement And Questions.

2010

Contents

Section One

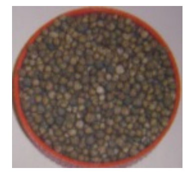
CATALYTIC CONVERTERS

A catalytic converter is a device that chemically changes the harmful components of Internal Combustion engine exhaust into harmless gasses.

A converter is made up of several parts.

1. SUBSTRATE serves as the internal structure to which the catalyst washcoat and noble metals are deposited upon. It is through this substrate that the engine exhaust flows through, or comes in contact with, to have a chemical reaction.

a. PELLET TYPE small ceramic pellets are treated with washcoat and noble metals.They are held in place inside the converter body in a cage. The exhaust gas passes over them. There could be a couple of hundred thousand pellets in the average converter. The main disadvantage of this converter is the high exhaust back pressure.



b. CERAMIC MONOLITH TYPE Also known as the honeycomb type. This ceramic type substrate has thousands of small channels through which the exhaust gas flows. This piece of ceramic is treated with the washcoat and noble metals.

c. METALLIC FOIL SUBSTRATE This type of substrate uses wound or stacked metal foil on to which the washcoat and noble metals are deposited. The exhuast gas flows through this substrate. This type has many advantages over ceramic, such as, being able to be made into shapes that cannot be easily done with ceramic.

d. CERAMIC FOAM This type of substrate is composed of ceramic solution on foam. It is then fired in a kiln to develop the mutlipore design seen in this photo. This substrate is then treated with washcoat and noble metals. As the exhaust gasses flow through it, the catalytic reaction takes place.

In addition, there are some other substrate designs that use screen, metal foam, wire wound elements, and even ceramic fiber elements. These types are currently not used in automotive applications.

2. WASHCOAT This is a chemical formulation that is comprised of high surface area alumina and other compounds, such as, cerium, zirconium, nickel, barium and lanthanum. Its purpose is to extend the physical surface area of the substrate, and to act as a surface onto which the noble metals are deposited. It also acts to store the excess oxygen in the system so it can be used when needed.

3. NOBLE METALS These are the commonly used elements; platinum, palladium and rhodium, and are deposited onto the washcoated substrate. These metals are what serve to cause the catalytic reaction.

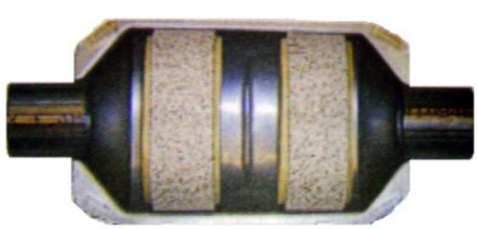
The definition of a catalyst is: a material which increases the rate of a chemical reaction while it is treated during the noble metal and washcoat process, it passes through an oven process which removes excess water and calcines in the substrate. This means it removes all traces of the chemical carriers which are used to deposit the noble metals during the preparation of the catalyst.

4. SHELL This is the stainless steel enclosure which the substrate is contained in.

5. INNERAM This is a ceramic fiber based material which is wrapped around the ceramic substrate. It acts as a vibration cushion, as a seal to prevent exhaust gas from bypassing the substrate, and as an insulator to keep the heat from the substrate from transferring into the shell. Some types of inneram can also be made of stainless wire or silica materials. Generally, as a rule, metallic type substrates do not use inneram.

6. HEAT SHIELD This is used to prevent the heat of the catalyst from causing any damage or fires to the under body or components of the vehicle.

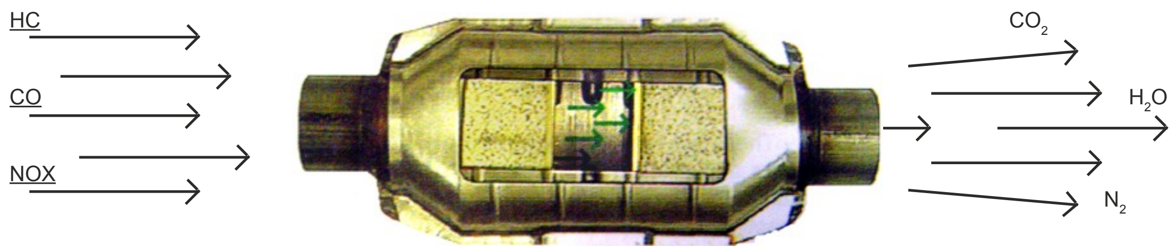
7. END PIPES The stainless steel tubes used to connect the catalytic converter to the vehicles' exhaust system.



HOW DOES THE CONVERTER WORK?

As the exhaust flows through the substrate inside the converter housing, the catalytic reaction takes place.

As the pollutants like NO_2 (nitrogen oxide), HC (hydro carbon) and CO (carbon monoxide) pass through the substrate they are converted into less harmful compounds such as CO_2 (carbon dioxide), H_2O (water) and N_2 (nitrogen). This conversion starts at temperatures around 250^0 Celsius.



RULES REGARDING THE DEVELOPMENT OF AFTERMARKET CATALYTIC CONVERTERS.

Rules for the development of converters that satisfy EPA requirements are set forth in the Federal Register. Briefly, the rules state that the converter manufacturer must submit two catalyst samples to an independent laboratory, who will accumulate 25,000 miles or its equivalent, on each of the catalysts. The catalysts are then tested for emissions performance and must convert a minimum of 70% Hydrocarbons and Carbon Monoxide and 30% NOX on a worst case vehicle. A worst case vehicle is defined as having the largest engine displacement and heaviest test vehicle weight that the converter manufacturer intends to cover with the catalyst.

Currently, the United States EPA requires the aftermarket converter manufacturer to warranty that the converter will not cause the MIl (check engine light) to illuminate within the 25,000 mile required warranty period of the substrate that has met all the prior EPA requirements.

Section Two

THE BASICS OF VEHICLE EMISSION SYSTEM TROUBLESHOOTING

A customer walks into your shop, his car is stalling and will not run above 20 mph. You check the car out and tell him the catalytic converter is bad and you replace it. Off he goes, but did you really fix his problem? Was the old converter melted down and plugged? Why had it failed? Will the customer come back with the same problem? Did replacing the converter really fix the problem or just remedy it temporarily? This booklet will try to help you answer these questions and give you some direction in diagnosing and reparing emission system failures.

CONVERTERS: WHAT DO THEY DO?

A catalytic converter is a device located in the exhaust system of all cars and most light trucks produced since 1975. It chemically changes pollutants like carbon monoxide, hydrocarbons and nitrogen oxide into harmless substances like carbon dioxide, nitrogen and water vapor. A converter uses an inside structure called a substrate that is plated with precious metals such as platinum, palladium and rhodium. These elements cause the chemical change.

TESTING OF CONVERTERS

THE THUMP TEST:
Thump the converter with your fist. If it is a monolith type and you hear pieces moving around inside the converter, chances are the substrate has come apart. If it is a pellet type, you should hear pieces moving when you hit it. If you do not, chances are the pellets have melted together.

THE VACUUM TEST:
By using a vacuum gauge, you can tell if the converter is plugged. Connect the gauge to a manifold vacuum source and quickly move the throttle to midway of its travel, then let it snap back to idle. A proper vacuum reading will be about 1520 in Hg at idle. When you quickly accelerate the engine, it will drop to zero. When you release the throttle, it will quickly return to its proper idle reading. If there is a long delay in return of the proper vacuum reading, it is a good indication of a restricted exhaust; most likely a plugged converter.

THE TEMPERATURE TEST:
For this test you will need a digital pyrometer. To commence testing, run the vehicle at a high rpm for two minutes (about 2000 rpm). This needs to be done to ensure that the converter has had time to activate. Touch the probe of the pyrometer to the front of the converter and note temperature. Touch the probe to the rear of the converter and note

temperature. There should be a noticeable difference between the two temperatures, with the rear temperature being hotter. If the rear temperature is not hotter than the front, the converter is not working properly.

THE BACK PRSSURE TEST:
This test will require a backpressure gauge. An inexpensive backpressure gauge can be made from a small pressure gauge that reads from 0 to 30 psi, a piece of vacuum tubing and a small 1/8” O.D. piece of copper tube is inserted into. A backpressure gauge may also be purchased from numerous sources, premade.

To use the backpressure gauge, drill a 1/8” hole in the exhaust pipe at the front of each converter. With the engine running, check the back pressure. The back pressure should be no more than 4 to 5 psi. This reading is with the throttle partly open at 2500 rpm. When checking exhaust back pressure, be sure to check at the inlet and outlet of each converter or exhaust component tested. A reading of 1/2 to 2 psi is normal.

By using a plug with the same thread as an oxygen sensor, you can remove the O2 sensor, install the plug into the hole and connect it to your backpressure gauge. To do this, you will need to obtain a plug with an 18mm x 1.25 thread. This plug may be purchased at any auto parts store under the name of Spark Plug Non Fouler Adapter. You can also save one out of a CATCO catalytic converter that comes with one. You will then need to fix a small piece of 1/8” O.D. tube to the back side of the plug. This will serve as a way to connect it to your gauge by the vacuum hose. If additional help is needed, call the CATCO technical hotline at (800) 2472515.

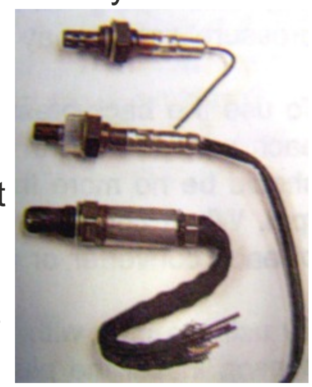
EXHAUST GAS ANALYZER TEST:
A gas analyzer will tell you if the converter is functioning properly. By checking your CO (carbon monoxide) reading, you will be able to tell if the system is operating rich. Hooking up the machine differs according to the model and brand of analyzer being used. Consult the analyzer manual for instructions. Once you have determined that the converter has failed, the next step should be to find out why it failed. As a rule of thumb, the following will usually be correct over 95% of the time: if the tail pipe reading shows that hydrocarbons (HC) are higher than 125 ppm, but less than 400 ppm and carbon monoxide (CO) is greater than 0.3% and oxygen (O2) is greater than 0.4%, the converter is most likely defective.

TESTING OF CONVERTERS

You remove a defective converter from a car and it has melted down. What could have caused the converter to melt down? A step by step approach is needed to find the answer; so let’s start at the begining:

FUEL:
Unleaded fuel must be used in vehicles with a catalytic converter. Using leaded fuel will cause the converter to become plugged and inoperative. Also, some gas additives can damage a converter. Always check the instruction label of any additive added to your fuel system to be sure that it is converter safe!

OXYGEN SENSOR:
This sensor sends information to the ECU (Electronic Control Unit) to maintain proper air/fuel mixture. It is located either in the exhaust manifold, pipe or catalytic converter. As an oxygen sensor operates, it checks to see if oxygen is present in the system. If no oxygen is detected, this would indicate a rich mixture and the oxygen sensor will read about 900mV (millivolts). when excessive amounts of oxygen are present, the sensor voltage will read about 100mV. Rich mixtures mean high readings, lean mixtures mean low readings. Please note taht the exhaust temperature must be at least 600 degrees Farenheit for the sensor to operate. The measurements should only be taken with a multimeter that has a 10 meg ohm impedance rating. Failure to follow this rule may cause you to replace the vehicles ECU. A properly functioning sensor will oscillate between 900mV and 100mV every few seconds. You can measure this with your multimeter. If the reading does not oscillate or stays fixed, the sensor is defective. Also, note that silicone, from either antifreeze or RTV (silicone) sealant, can clog an oxygen sensor and make it defective. If the vehicle has a coolant leak into the combustion chamber, the sensor should be replaced. When using a silicone sealer, make sure it is oxygen sensor safe. Consult the last pages of this catalog for wiring information on O2 sensors. Also note, there are two types of oxygen sensors. The Zirconia, the most common type, works by generating a voltage. The Titania type works by varying its resistance.

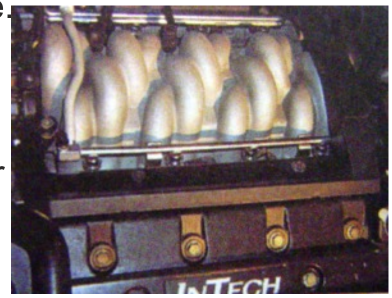


IGNITIION SYSTEM:
Many parts are used in the ignition system. This system delivers the voltage or spark to the appropriate cylinder to fire the engine. Any of the following problems can cause the converter to fail or be damaged; fouled spark plugs, bad spark plug wires or carbon tracked distributor cap. Make sure all spark plugs and wires are firing properly. A misfiring plug not only wastes gas, but it makes the mixture rich. In time this will ruin the converter. Be sure to check distributor timing and vacuum advance for proper operation.

CARBURETOR SYSTEM:
A carburetor is a device that mixes gasoline with air and delivers it into the intake manifold for the engine to burn. If a carburetor is worn or defective, it may be the cause of a converter failure. Problems such as improper float adjustments, air/fuel mixture adjustments, out of

spec or worn metering rods can cause damage to the catalyst. Also, check the choke system to make sure it is operating properly and if the carburetor is an electronic feed back modle, make sure all adjustments are made according to manufacturer specs. Also make sure all feedback sensors and electronic components, such as mixture con trol solenoids, throttle position sensors and throttle holding solenoids are operating and are within specs.

FUEL INJECTION SYSTEM:
Problems in the fuel injection system can also cause problems with the converter. Fuel injection systems differ greatly. Basically, a fuel injection system uses small electronical ly controlled solenoids that deliver or inject fuel into the throttle body, or into the intake part of the engine. These little solenoids are controlled by a computer which obtains information from various sensors located throughout the engine. These sensors help the computer to determine how much fuel to inject. If an injector is leaking internally or dribbling fuel into the engine, it may damage the converter. If the oxygen sensor is defective or the map sensor is bad, this can lead to converter damage. If the injection system uses a cold start injector (which is a small injector that is used to richen theh mixture by injecting fuel into the intake air stream when the engine is cold) and it is leaking or dripping, or if its temperature sensor is not operating properly, this too, can damage the converter. Because of the many different injection systems used, consult the proper manual when diagnosing this system.



MASS AIR FLOW SENSOR:
This sensor measures the volume of intake air. It is tested with a special tester or a computer scan tool. If it is defective, it can cause problems such as rough idles, no start and poor fuel economy.

Most of the previously talked about systems and devices can be tested with the use of a scan tool. There are many types of this tool, so please consult tool makers information for proper hookup. While some of these tools are expensive, they are well worth the cost when you realize how useful they are.

MAP SENSOR:
This sensor tells the ECU how much air is entering the engine as well as the load on the engine. It also monitors barometric pressure. When this sensor fails it can cause a rich condition which can damage the converter. Because testing of these sensors vary between make and model, consult the manual beore testing. Generally there are two types; the voltage type and the frequency type. To check the voltage type you would use a volt meter and a vacuum pump. To check the frequency type you would use a tach and a vacuum pump.

CANISTER PURGE VALVE:

This vacuumoperated valve vents fuel vapors from the carburetor bowl to the charcoal canister. If the diaphragm becomes ruptured, the charcoal canister will flood and the mixture will become very rich and can damage the converter. To check the valve, disconnect the hoses to see if any gas comes out of the hoses or valve. If there is gas, the valve should be replaced.

AIR INJECTION SYSTEM:

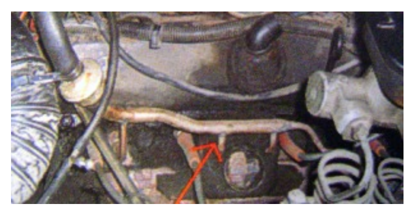
Air Pumps Air pumps operate from the vehicle engine through a belt. This pump supplies the air injection needed at the catalyst and at the air manifolds. Generally, when this component goes bad, it stops turning, breaking its belts or it just becomes very noisy. If the pump won't turn and the belt is broken off, it is defective. The air injection system as a whole aids in the control of carbon monoxide.

Air Manifolds Air manifolds direct air into the exhaust manifolds to aid in reduction of CO. When they go bad it is usually obvious due to the loud exhaust noise coming from under the hood. Check the air manifolds to make sure they are free of rust out or corrosion when cool.

High Temperature Hose This hose routes air from the air pump and diverter valve to the air manifolds and check valves. If this hose is found to be burnt, check the exhaust check valve that is in that hose; it may be defective.

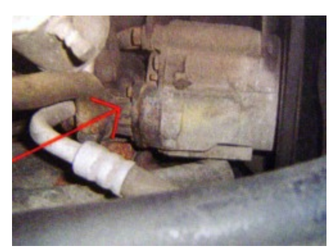
Check Valves These valves allow air to pass to the various components (ie. air manifolds, converter). They should only allow the air to pass in one direction. If air passes freely in both directions, the diaphragm is ruptured and the valve is no good. This failure can lead to damage of the air pump, diverter valve or the high temperature hose if left unchecked. If hoses are melted or components like the air pump or the diverter valve are damaged, check the exhaust check valves.

Converter Air Tubes These tubes route air into the catalyst to help aid in the oxidation process. Check to make sure it is connected and that it is not rusted through.



DIVERTER VALVE:

This valve helps to route air to the exhaust manifold or catalytic converter to assist in maintaining proper emissions. Operation should be checked and a manual should be consulted regarding proper test procedures.



EGR SYSTEM:
This system routes small amounts of exhaust gasses back to the intake manifold to reduce oxides of nitrogen or NOX. Systems vary by design, so you need to consult the proper manual for the vehicle you are working on. Some newer systems also use an EGR valve position sensor. If the exhaust system you are working on has one, it must be checked also. While a bad EGR system will not lead to a converter failure, it might be the reason why the vehicle has a NOX problem. The EGR valve should be checked according to the vehicle manufacturers procedure to determine if it and its system components are functioning properly. Make sure the valve moves when vacuum, pressure or electric signal are applied and that the passages are open and not plugged with carbon. Also, check any switches, relays or solenoids that are used. Generally, the EGR valve can be checked with a vacuum pump. However, some late 1970's Ford EGR valves worked by air pressure supplied by the air pump. some EGR valves operate with positive or negative exhaust back pressure. Also, be aware taht some EGR valves are totally electronic. Always consult a service manual for proper service and test procedures.

IDLE SPEED CONTROL MOTOR:
This device helps the computer controlled engine to maintain proper idle speed. When this device goes bad, it can cause erractic idle speed, stalling, hesitation or engine runon. This device can be checked with a 9 volt power source and an ohm meter. Consult vehicle service manual for proper wiring diagram and test procedure.

AIRTEMP SENSOR:
This sensor is sometimes called a Manifold Temperature sensor or an Air Charge Temperature sensor. It monitors the temperature of the intake air, and if defective, it causes a problem of poor overall performance, heavy black exhaust smoke and bad fuel economy. It is tested with an ohm meter.

COOLANT TEMPERATURE SENSOR:
This sensor is located on either the water outlet or the engine block. It monitors engine coolant temperature. The computer uses this information to control idle speed, timing and fuel mixture. If this sensor goes bad, it can cause heavy black exhaust smoke, surging or poor fuel economy. To test this sensor, with the engine cold, disconnect the sensor wire harness. With an ohm meter, measure the resistance across the sensor, then reconnect the sensor harness and run the engine for 3 to 5 minutes until it reaches normal operating temperature. Disconnect the wire harness and again measure resistance across sensor. If the difference between cold and hot readings is less than 200 ohms, the sensor is defective.

POSSIBLE EXHAUST EMISSION DEVICE PROBLEMS AND CAUSES

BLACK EXHUAST SMOKE
*Oxygen Sensor
*Coolant Temp Sensor
*Map Sensor
*Air Change Sensor

STRONG EXHAUST SMELLS
*Catalytic Converter
*Map Sensor
*Air Change Sensor

MELTED CONVERTER
*Oxygen Sensor
*Fuel System Problems
*Ignition Problems
*Map Sensor
*Vehicle Overload

CONVERTER PROBLEM FLOW CHART

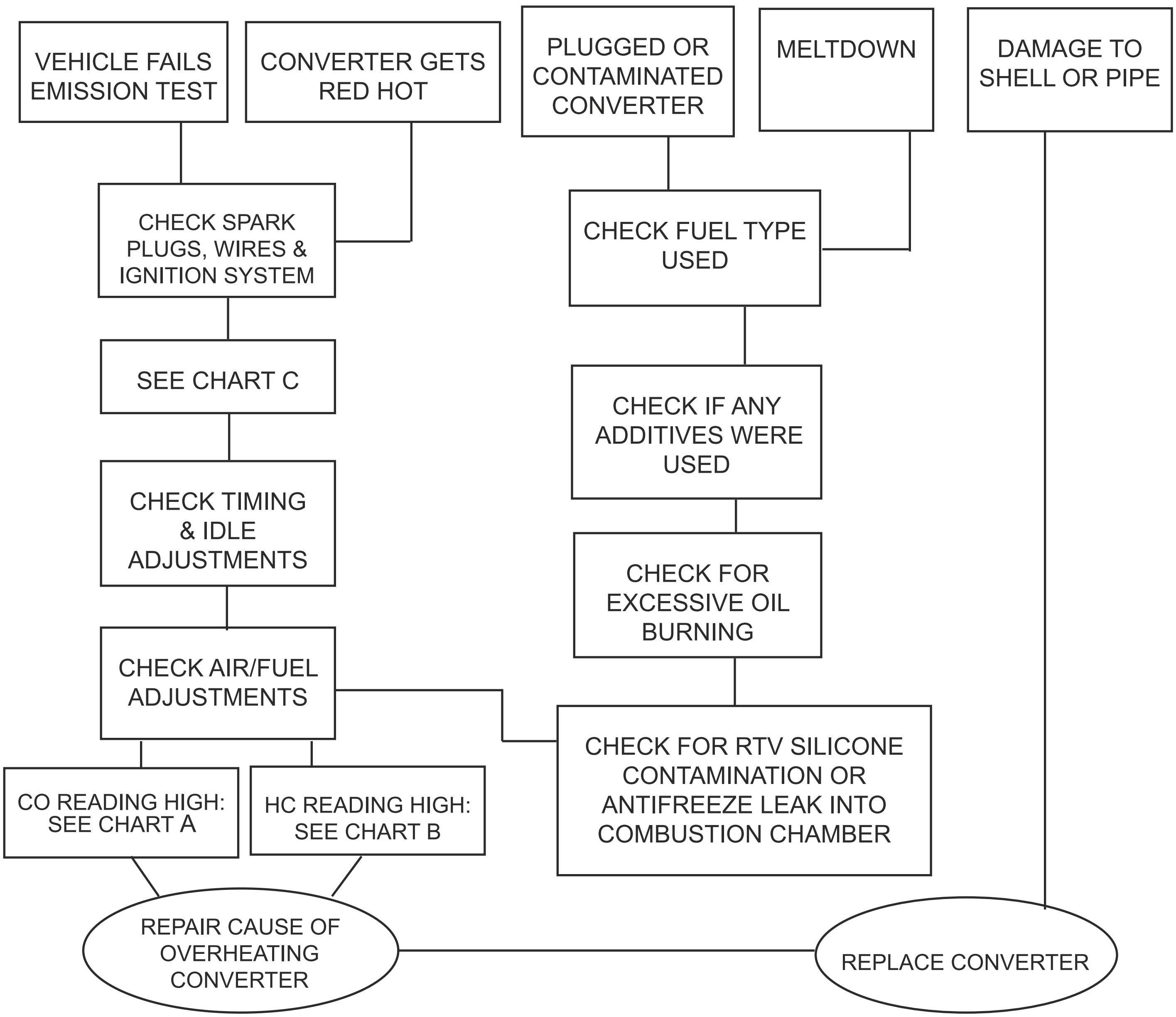


CHART A

POSSIBLE HIGH CO READING CAUSES

- ~ Improper idle speed or mixture
- ~ Inoperative air pump or air injection
- ~ Inoperative choke
- ~ Faulty PVC
- ~ Improper timing
- ~ Faulty gas check valve
- ~ Faulty
- ~ Faulty O^2 sensor
- ~ Fuel system malfunction
- ~ Faulty converter

CHART B

POSSIBLE HIGH HC READING CAUSES

- ~ Ignition system malfunction
- ~ Vacuum leak
- ~ Fuel system malfunction
- ~ Engine mechanical damage worn rings or burnt valves
- ~ Faulty o^2 sensor
- ~ Faulty canister purge valve
- ~ Overly rich fuel mixture
- ~ Faulty converter
- ~ Faulty PVC valve

CHART C

FAULTY IGNITION COMPONENTS THAT CAN DAMAGE A CONVERTER

- ~ Cracked distributor cap
- ~ Faulty coil
- ~ Faulty spark plug wires
- ~ Fouled plugs
- ~ Faulty rotor

Section Three

OBD II: WHAT IS IT?

OBD II refers to the On Board Diagnostics generation two. This is a system that has the ability to test its various components and systems and tell the driver when a fault has been detected that will cause the vehicle to put out excessive emissions. This system first became available on passenger cars in the 1995 model year and 1996 for light trucks with a gross vehicle weight of under 8500lbs.

WHAT CAN THE SYSTEM DETECT?

The system has the ability to detect malfunctions in many engine systems that can cause excessive emissions. Let’s look at the individual system checks or monitors and how they work. The OBD II system uses different monitors. These monitors are divided into three types:

1. Comprehensive Component Monitor
2. Continuous Monitor
3. Non Continuous Monitor

The Comprehensive Component Monitor runs electrical tests on all of the sensors to ensure that they perform. It tests the sensor range and also does rationality tests. This test ensures that the sensor output makes sense or are rational when compared to each other.

NTK Sensor Shown

Gray Wire, Sensor Ground
Black Wire, Sensor Signal
White Wire, Heater Circuit

OXYGEN SENSOR SYSTEM MONITOR

The O2 sensors are monitored or checked for proper reference signals and to make sure that the heater circuit is functioning. O2 sensors that are located before the catalyt ic converter are tested for high and low voltage thresholds and for switching frequency. the switching frequency test will count the number of times that the signal voltage goes beyond the mid point of 450 millivolts during a specified time frame and compares this figure with the information stored in the vehicles computer. The system will also count the rich to lean transition and the lean to rich transition. This, again, is checked against the time stored in the vehicles computer. For universal O2 wiring information, please see the O2 sensor section of this catalog.

THE CATALYTIC CONVERTER MONITOR

The vehicles O2 sensors are used to determine catalytic converter efficiency. All the ox ygen sensors located before the catalytic converter show a voltage pattern on an oscillo scope of a wave form having many peaks and valleys. These peaks and valleys are the varying voltages of the oxygen sensor signaling rich and lean air/fuel ratios. This type of wave form is proper for the O2 sensors that are located before the catalytic converter.

EXAMPLE
PATTERN

The voltage is generated by a sensor that has a probe assembly which contacts the ex haust stream. This probe assembly is made up of a compound called zirconium dioxide, which is an electrically conductive material that can generate small voltages when in contact with oxygen. The probe tip is also coated with platinum to aid in this process.

The downstream, or after converter, oxygen sensors measure the amount of oxygen present in the exhaust after the converter. Generally, the wave form of a system with a properly operating catalyst will show little or no voltage fluctuation on an oscilloscope.

EXAMPLE
PATTERN

The catalytic converter is comprised of an internal substrate onto which a chemical washcoat is placed. It extends the geometric surface area of the substrate and also acts as an absorbing or storing material for oxygen in the exhaust. On to this substrate the precious metals are impregnated that cause the catalytic reactions with the pollutants.

Ceramic Monotlith
Substrate shown

When the engine burns a lean air/fuel mixture, high amounts of oxygen from the exhaust stream flow through the substrate of the catalytic converter. The washcoat on the sub strate absorbs this excess O2 and stores it for use during rich air/fuel mixtures when it is released to help in the oxidation process.

A proper functioning catalytic converters downstream, or after converter oxygen sen sor, will show little or no fluctuation in voltage. If catalytic converter degredation occurs affecting the oxygen storage capacity of the washcoat, a fluctuating voltage signal will be sent to the vehicles computer which will in turn illuminate the (MIL) Malfunction Il lumination Light. This will notify the driver of a problem. The vehicles computer has an algorithm stored in it which allows the computer to determine converter efficiency by the amount of oxygen obsorbed. The catalyst monitor is a Non Continuous Monitor. This type runs one time per drive trip.

THE FUEL SYSTEM MONITOR

The fuel system monitor controls fuel trim to the engine. The vehicles computer allows for fine tuning of the air/fuel ratio. The computer actually stores information on fuel trim and compares this to a preprogrammed based fuel calculation. Fuel trim can be divided into two types; Long Term fuel trim and Short Term fuel trim. The Short Term fuel trim applies to the function of temporary or short term changing of the fuel deliver. Short Term fuel trim can only happen in closed loop operation. Long Term fuel trim ap plies to the long term effects of the Short Term fuel trim corrections. In simple terms, the vehicles computer will add or subtract fuel from the programmed based calculation in accordance withe the signals received from the vehicles oxygen senors. The computer tries to maintain the air/fuel ratio at 14.7:1. This is the air/fuel ratio referred to as teh Stoichiometric Ratio. Fuel trim information can be monitored through the Data Link with a scan tool. The scan tool will monitor fuel trim in terms of percentage from 1100.

THE EVAPORATIVE EMISSIONS SYSTEM

The EVAP system monitors tests for leaks in the Evaporative Emissions System. The vehicles computer checks the EVAP, which is the system where hydrocarbon vapors emitted from the gasoline, or the fuel system, are stored into a canister that is loaded with activated charcoal. The system monitor is generally comprised of two components; a purge valve and a fuel tank pressure sensor. In most applications the monitor system will close the EVAP system off from the atmospheric pressure and will open the purge valve during vehicle cruise down. The fuel pressure sensor in the fuel tank then checks the rate at which a vacuum increases in the EVAP system. This information is then used by the vehicles computer to determine purge flow rate or volume. Remember, the func tion of this system is to store hydrocarbon vapors into the charcoal canister and then purge them into the engine, generally through the intake manifold, via a hose that con nects the two points. The purge valve opens at the proper time to allow this to happen. The EVAP monitor also checks the system for fuel leaks. It does this by closing the purge valve completely which in turn causes the system to be completely closed. The pressure sensor in the fuel tank then checks the leak down rate. If the rate is greater than the value stored in the vehicles computer, a leak is determined to exist, and the MIL will be illuminated. The EVAP monitor is another Non Continuous Monitor.

THE EGR SYSTEM MONITOR

The EGR monitor works by performing tests which open and close the EGR valve and measure the voltage signal sent by the EGR valves position sensor. The computer com pares these signals to the ones that are stored in the computer, and uses these figures to determine exhaust gas flow an efficiency. If a problem is detected, the MIL will illumi nate.

SECONDARY AIR INJECTION MONITOR

This system checks the function of the secondary air injection system components. The diverter valve and bypass valve are checked for proper function. If the system uses an electronically drive air pump, instead of the common engine belt driven type, it checks this also. The before converter oxygen sensors are used to check the exhaust to detect the excess oxygen that will be present in the exhaust. This will determine if there is air flow from the air pump. If a malfunction is indicated, the MIL will illuminate.

MISFIRE MONITOR SYSTEM

This system monitors and detects misfire on a cylinder by cylinder basis. The system does this by using the crankshaft position sensor to detect a slowdown in crankshaft speed caused by a misfiring cylinder. Not only can the system detect a misfire, it can also isolate and determine which cylinder misfired. This is done through the vehicles computer monitoring sensor signals; not only from the crankshaft position sensor, but also the camshaft position sensor. If a misfire occurs, excess hydrocarbons can be released into the exhaust gas which can damage the catalytic converter. When the computer detects a misfire it will illuminate the MIL. The Misfire Monitor is a Continuous Monitor type. It monitors a system constantly and is very important to the OBD II sys tem.

HOW CAN THE OBD II SYSTEM BE USED TO DIAGNOSE EMISSION PROBLEMS?

The OBD II vehicle computer can be invaluable in diagnosing what is causing a vehicle to have emission problems and MIL illumination. This system was designed with SAE (Society of Automotive Engineers) guidelines that make the system economical and easy for all technicians to use. It uses a data connector or link in which all of the pins or connections are the same, no matter who the vehicle manufacturer is. This enables a technician to purchase one OBD II reader or scan tool and be able to use this tool on all vehicles. Another guideline called for easy access to the location of this data connector. The guidelines also called out for a standardized system of fault code identifications. This way, all vehicle manufacturers would use the same codes to show MIL illuminating DTCs (Diagnostic Trouble Codes).

HOW DO YOU USE THE DATA LINK TO DIAGNOSE PROBLEMS?

First you will need a scan tool to be able to decode or read DTCs. CATCO® offers an in expensive scan tool, part # T9035, and there are many others offered by a wide variety of sources. When you connect the scan tool to the data link and turn it on, it will display or read the stored DTCs. These codes appear as such:

P0123

The first character in the display code identifies which system the code relates to:
B is used for body codes
C is used for chasis codes
P is used for powertrain codes

The second character denotes what type of code it is:
0 OBD II
1 Manufacturer

2 or 3 SAE

The third character denotes what system the code refers to:
1 or 2 denotes fuel or air
3 denotes ignition
4 denotes emission control
5 denotes speed control
6 denotes vehicle computer or output
7 or 8 denotes transmission
9 or 0 denotes SAE

The fourth and fifth characters denote the part or condition that caused the problem. The scan tools manual will identify the measuring of all displayed codes. This explana tion is in a simple or abbreviated form and the scan tool manual, vehicle service manual or competent diagnostic manual should be consulted for complete explanation of the OBD II system. The system may also have capabilitites to display enhanced DTC as opposed to just generic codes. So again, it is important to have not only proper tools, but service manuals, if you truly want to get to understand OBD II inside and out. The DTCs are broken down into 4 types.
Type 1 or type A indicates a DTC that is an emission related failure, and illuminates the MIL after one trip in which the fault is detected.

Type 2 or type B indicates a DTC that is an emission related failure, and illuminates the MIL after two trips in which the fault is detected.

Type 3 or type C indicates a DTC that is a non emission related failure, and illuminates the MIL after one trip in which the fault is detected.

Type 4 or type D indicates a DTC that is a non emission related failure, and illuminates the MIL after two consective trips in which the fault is detected.

See end of section for a list of emission related DTCs.

I FIXED THE PROBLEM, WHY WON'T THE MIL GO OFF?

Once the MIL has come on, it can be turned off with a scan tool. The CATCO® tool, part # T9035, will do this job easily. The MIL should only be turned off after the problem that caused it is corrected. Never disconnect the vehicles battery to try to shut the light off; doing so can cause a host of new problems for the car owner and you. Disconnect ing the battery can cause simple but aggravating problems; such as a radio that will not work unless you know the security code to reenable it; or a possible major problem, like disconnecting and reconnecting the battery that causes a voltage surge which can dam age the vehicles computer. The OBD II system will reset and shut the MIL off, if after three consecutive trips the fault does not occur again. Also, make sure that the MIL bulb is good. An ECM that shows the MIL to be commanded on, but not illuminating the check engine light due to a bad bulb, will fail an emission test even if everything else is correct. Bulb replacement can be time consuming, but it is necessary. Consider the MIL bulb to be just another emission control and offer this service.

WHAT MAKES THE OBD II CATALYTIC CONVERTER DIFFERENT THAN A NORMAL OR NON OBD II CATALYTIC CONVERTER?

The main difference between the two is the oxygen storage capacity of the catalytic con verter. The catalyst is comprised of three distinct parts.

1) SUBSTRATE The structure onto which the catalytic reactants are deposited. This structure is placed in contact with the exhaust gases. The substrate can be in the form of pellets or a monolithic honeycomb. It can also be metallic or ceramic.

2) WASHCOAT This is a solution made up of alumina and other chemicals that stabi lize and promote a good catalytic reaction. This coating of chemicals also extends the geometric surface area of the substrate. This extending of the surface area is important because, as this area is increased, it allows for more space or sites in which a reaction can take place. The more areas in which a reaction can take place, the better the cata lytic reaction, and the better the converter efficiency. The catalytic washcoat also stores excess oxygen from lean operating cycles and releases it for use during rich cycles.

3) NOBLE or PRECIOUS METALS LOADING These materials, commonly Platinum, Palladium and Rhodium, are the elements that make the catalytic reaction to reduce pollutants. The definition of the word “catalyst” means that something causes a reaction without itself being consumed or changed in that reaction. The metals can be used to gether or by themselves. It should be noted that OEM OBD II catalysts contain an aver age of about twice the precious metal loading of their non OBD II counterparts.

Now that you know what comprises a catalytic converter, you can see a very important difference between OBD II and Non OBD II catalytic converters. OBD II catalytic con verters <u>must</u> have excellent oxygen storage capacity. Other chemicals and compounds are added into the washcoat of OBD II converters to aid in this oxygen storage capacity. If the oxygen storage capacity is not good, the MIL will illuminate. Please refer back to the Catalyst Monitor section of this publication.

WHAT ARE THE PARTS OF AN OBD II SYSTEM AND HOW CAN I FIND THEM?

CRANKSHAFT POSITION SENSOR:

The purpose of this sensor is to give the engine speed to the vehicles computer so that it can send spark at the appropriate time to the right cylinder. There are three types of CKP’s (crankshaft position sensors) used. The first is the Hall Effect which works by using a slotted wheel and a magnetic field, and this information is sent to the computer. The second, is the Magnetic Pulse

Generator which generates its own signal through magnetic induction. The third is the Optical Sensor. This type uses a spinning wheel or rotor, a light beam and a photo transistor. As the wheel rotates and cuts through the light beam, a signal is sent.

CAMSHAFT POSITION SENSOR:

This sensor signals camshaft position and speed and sends the signal back to the vehicles computer. This sensor is of the same type that is used for crankshaft position.

OXYGEN SENSOR:

This sensor sends information to the ECU (Electronic Control Unit) to maintain proper air/fuel mixture. It is located either in the exhaust manifold pipe or catalytic converter. As an oxygen sensor operates, it checks to see if oxygen is present in the system. If no oxygen is detected, this would indicate a rich mixture. The oxygen sensor will read about 900mV. When excessive amounts of oxygen are present, the sensor voltage will read about 100mV. Rich mixture means high readings, lean mixture means low readings. Please note the exhaust temperature must be at least 600 degrees Farenheit for the sensor to operate. The measurements should only be taken with a multimeter that has a 10 meg ohm impedence rating. Failure to follow this rule may cause you to replace the vehicles ECU. A properly functioning sensor will oscillate between 900mV and 100mV every few seconds.

You can measure this with your multimeter. The reading does not oscillate, or stays fixed, the sensor is defective. Note that silicone from either antifreeze or RTV (silicone) sealant can clog an oxygen sensor and make it defective. If the car has a coolant leak into the combustion chamber, the sensor should be replaced. When using a silicone sealer, make sure it is oxygen sensor safe. Also note, there are two types of oxygen sensors. The Zirconia (the most common type) works by generating a voltage. The Titania works by varying its resistance. Remember how many things are monitored by the oxygen sensor in the OBD II system. This is the most important part in catalyst monitoring.

NOTE: When using a universal converter in place of a direct fit, make sure the post converter O2 sensor is in the same position on the replacement, as it was on the original converter. Measure the distance from the outlet end of the converter substrate on the original unit to the O2 sensor port location. When installing the new universal converter make sure to install it so that the O2 sensor will be at the same distance in relation to the outlet end of the new substrate as the original unit was. Keep in mind that not all oxygen sensors operate the same. Consult the catalog on proper replacement sensor applications. Removal of insulation or change to the pipe (exc. insulated pipes) can cause codes pointing to a converter malfunction that is not the fault of the converter. If you are using a universal converter, please keep this in mind. If in doubt use the direct fit. Catco engineers their direct fits so that any isulation is included with the direct fit assembly.

IGNITION SYSTEM:

Many parts are used in the ignition system. This system delivers the voltage or spark to the appropriate cylinder to fire the engine. Any of the following problems can cause the converter to fail or be damaged: fouled spark plugs, bad spark plug wires or carbon tracked distributor cap. Make sure all spark plugs and wires are firing properly. A misfiring plug not only wastes gas, but it makes the mixture rich, and in time, will ruin the converter. Be sure to check distributor timing and vacuum advance for proper operation. Some cars also use a system called Distributerless or Coil Pack, where the ignition coil is connected right to the spark plug and the coil is fired through the computer.

FUEL INJECTION SYSTEM:

Problems in the fuel injection system can also cause problems with the converter. Fuel injection systems differ greatly. Basically, a fuel injection system uses small electrically controlled solenoids that deliver or inject fuel into the throttle body or into the intake part of the engine. These little solenoids are controlled by a computer which obtains information from various sensors located throughout the engine. This sensor helps the computer determine how much fuel to inject. If an injector is leaking internally or dribbling fuel into the engine, it may damage the converter. If the oxygen sensor is defective or the map sensor is bad, this too can lead to converter damage. If the injection system uses a cold start injector (which is a small injector used to richen the mixture by injecting fuel into the intake air stream when the engine is cold) better the converter efficiency. The catalytic washcoat also stores excess oxygen from lean operating cycles and releases it for use during rich cycles. If this injector is leaking or dripping, or if its temperature sensor is not operating properly, this too, can damage the converter. Because of the many different injection systems used, consult the proper manual when diagnosing this system. the Fuel Injection System is monitored by the Fuel Monitor, another continuous monitor.

MASS AIR FLOW SENSOR:

This sensor measures the volume of intake air. It is tested with a special tester or a computer scan tool. If it is defective it can cause problems from rough idles to no start and poor fuel economy.

Most of the previously talked about systems and devices can be tested with the use of a scan tool. There are many types of this tool, so please consult tool maker's informa tion for proper hookup. While some of these tools are expensive, they are well worth the cost when you realize how useful they are. For the OBD II system you should consider the CATCO® #T9035; its help to you will certainly outweigh its cost.

MAP SENSOR:

This sensor tells the ECU how much air is entering the engine as well as the load on the engine. It also monitors barometric pressure. When this sensor fails, it can cause a rich condition which can damage the converter.

Because testing of these sensors vary between make and model, consult the manual before testing. Generally, there are two types; the Voltage Type you would use a volt meter and a vacuum pump. To check the Frequency Type you would use a tach and a vacuum pump.

CHARCOAL CANISTER AND PURGE VALVE:
This valve vents fuel vapors from the charcoal canister into the engine. The vapors are collected into the charcoal canister from the fuel tank. The cansister is located by the tank or under the hood.

AIR INJECTION SYSTEM:
Air Pumps Air pumps operate from the vehicle engine through a belt. This pump supplies the air injection needed at the catalyst and at the air manifolds. Generally, when this component goes bad, it stops turning, breaking its belts or it just becomes very noisy. If the pump won't turn and the belt is broken off, it is defective. The air injection system as a whole aids in the control of carbon monoxide.
Air Manifolds Air manifolds direct air into the exhaust manifolds to aid in reduction of CO. When they go bad it is usually obvious due to the loud exhaust noise coming from under the hood. Check the air manifolds to make sure they are free of rust out or corrosion when cool.
High Temperature Hose This hose routes air from the air pump and diverter valve to the air manifolds and check valves. If this hose is found to be burnt, check the exhaust check valve that is in that hose; it may be defective.
Check Valves These valves allow air to pass to the various components (ie. air manifolds, converter). They should only allow the air to pass in one direction. If air passes freely in both directions, the diaphragm is ruptured and the valve is no good. This failure can lead to damage of the air pump, diverter valve or the high temperature hose if left unchecked. If hoses are melted or components like the air pump or the diverter valve are damaged, check the exhaust check valves.
Converter Air Tubes These tubes route air into the catalyst to help aid in the oxidation process. Check to make sure it is connected and that it is not rusted through.

DIVERTER VALVE:
This valve helps to route air to the exhaust manifold or catalytic converter to assist in maintaining proper emissions. Operation should be checked and a manual should be consulted regarding proper test procedures.

EGR SYSTEM:
This system routes small amounts of exhaust gases back to the intake manifold to reduce oxides of nitrogen or NOX. Systems vary by design so you need to consult the proper manual for the vehicle you are working on.

Some newer systems also use an EGR valve position sensor. If the exhaust system you are working on has one, it must be checked also. While a bad EGR system will not lead to a converter failure, it might be the reason why the vehicle has a NOX problem.

IDLE SPEED CONTROL:

This device helps the computer controlled engine to maintain proper idle speed. When this device goes bad, it can cause erratic idle speed, stalling, hesitation or engine runon. This device can be checked with a 9 volt power source and an ohm meter. Consult the vehicle service manual for proper wiring diagram and test procedure.

AIRTEMP SENSOR:

This sensor is sometimes called a Manifold Temperature sensor or an Air Charge Temperature sensor. It monitors the temperature of the intake air, and if defective, it causes a problem of poor overall performance, heavy black exhaust smoke and bad fuel economy. It is tested with an ohm meter.

COOLANT TEMPERATURE SENSOR:

This sensor is located on either the water outlet or the engine block. It monitors engine coolant temperature. The computer uses this information to control idle speed, timing and fuel mixture. If this sensor goes bad, it can cause heavy black exhaust smoke, surging or poor fuel economy. To test this sensor, with the engine cold, disconnect the sensor wire harness. With an ohm meter, measure the resistance across the sensor, then reconnect the sensor harness and run the engine for 3 to 5 minutes until it reaches normal operating temperature. Disconnect the wire harness and again measure resistance across sensor. If the difference between cold and hot readings is less than 200 ohms, the sensor is defective.

ENGINE COMPUTER:

ECS (Engine Control System) PCM (Powertrain Control Module) This is the unit that controls all the functions of the engine/powertrain. Everything from how much fuel, to the when a cylinder fires, to max engine speed, and timing, are controlled by this unit. All the signals from the various sensors are sent to this part and all commands back to the various systems come from it.

There are many other sensors used in modern vehicles such as; Detonation Sensors, Power Steering Cut Off Sensor Switches, Throttle Position Sensors, Vehicle Speed Sen sors and sensors used to turn cooling fans on. Make sure you have the proper manual for the system you are working on. This booklet has only covered the main parts and systems that make the engine operate.

This booklet is intended to give you background and insight on how the OBD II system works and how to repair it. Only the proper repair manual and experience can answer all questions.

EMISSION TESTING AND OBD II:
Since most states have gone to some form of enhanced emissions testing (ie. I/M 240) let's discuss the OBD II system and how it relates to the emission test process.

The I/M 240 test is an enhanced procedure that was designed to demonstrate "real world" driving conditions. Prior to this test procedure, most states used a Static or Un loaded test where the emissions were sampled out of the tail pipe without the vehicle being under any load. The I/M 240 procedure measures vehicle emissions for HC, CO and NOX under a loaded condition. The I/M 240 is run on a Dynamometer. It takes 240 seconds. This procedure can show which vehicles are not meeting the emissions stan dards in a real and reliable way.

HOW OBD II EFFECTS I/M 240 TESTING:
The OBD II system monitors emissions through its use of dedicated monitors to check for deteriorated or nonfunctioning systems or controls. It is very important that any vehicle taht comes into your shop under the following conditions gets its OBD II system checked thoroughly before the system is repaired and the vehicle is emission tested.

A. Vehicle comes in with MIL illuminated
B. Vehicle comes in with a catalytic converter that is broken up internally
C. Vehicle has failed a State required emissions test
D. MIL commanded to be on through ECR, but light is not illuminated

After all repairs have been made, trouble codes have been erased, and the MIL has been turned off, you will need to drive the vehicle before any emission tests can be performed. The OBD II system conducts the tests under certain conditions or enabling criteria. These conditions are comprised of various information; a few examples:

1. Elapsed time since vehicle engine start up
2. Throttle position
3. Engine speed
4. Vehicle speed
5. Engine temperature

Most of the various systems tested by the different monitors are only conducted after the engine has reached normal operating temperature.

The computer runs three types of tests:
1. PASSIVE TEST This test monitors a system component without affecting its opera tion.
2. ACTIVE TEST The computer has the monitor produce a test signal so that its re sponse can be checked against stored information
3. INTRUSIVE TEST The computer performs system checks that affect vehicle perfor mance and emissions.

After a passive test is run and it fails, the computer then performs active test procedures on the system. If, after this test, a failure is found, the computer will run an intrusive test. If, after the intrusive test produces a failure, the computer may not store a trouble code and/or illuminate the MIL unit after the failure appears in two consecutive tests. Because of this, it is suggested that you perform the drive cycle or I/M Readiness Drive Cycle to be sure that all systems have been checked and that all I/M Flags are set. These are benchmarks or messages that the OBD II system uses to show that all emis sion monitors have been run. It is important that all of these I/M Flags are set before the vehicle goes through an I/M 240 test.

I/M READINESS CYCLE:
A. Vehicle should be started with the engine cold

B. Let vehicle idle until the engine is at normal operating temperature (the engine cool ant temperature sensor should read 180^0 F or higher); generally 5 to 10 minutes

C. Put vehicle in gear and idle for 45 seconds

D. Accelerate to 45mph with no more than a 1/4 throttle for 10 seconds

E. Decelerate to 3540mph and run at steady throttle for 1 minute

F. Drive between 2045mph for 4 minutes, but do not operate under open throttle

G. Decelerate and idle for 10 seconds

H. Accelerate to 55mph using no more than 1/2 throttle for 10 seconds

I. Drive 4055mph using steady throttle for 1 1/2 minutes

Shut the vehicle off when you return to the shop. If time permits, run the cycle again afte the vehicle has cooled off. Doing so will ensure that all Flags have been set, all problems have been repaired and the vehicle will pass an I/M 240 test.

OTHER OBD II INFORMATION:
The OBD II system can perform other tests and store other information that cannont be fully detailed in this booklet. Among some of the other information stored when the vehicles MIL is illuminated showing air/fuel ratio, fuel trim, fuel injector base pulse width, loop status, mass airflow rate, engine speed, engine load, vehicle speed, map sensor signal and engine cooling temperature. This information is very helpful in fixing OBD II system faults.

For more information on OBD II systems, consult the vehicles manufacturers service manual or a service publication like Mitchell, Motor or ALLDATA.

ENGINE RELATED DTCs

PO400	Exhaust Gas Recirculation Flow Malfunction
PO401	Exhaust Gas Recirculation Flow Insufficient
PO402	Exhaust Gas Recirculation Flow Excessive
PO403	Exhaust Gas Recirculation Circuit Malfunction
PO404	Exhaust Gas Recirculation Circuit Range/Performance
PO405	Exhaust Gas Recirculation Sensor A Circuit Low
PO406	Exhaust Gas Recirculation Sensor A Circuit High
PO407	Exhaust Gas Recirculation Sensor B Circuit Low
PO408	Exhaust Gas Recirculation Sensor B Circuit High
PO410	Secondary Air Injection System Malfunction
PO411	Secondary Air Injection System Incorrect Flow
PO412	Secondary Air Injection System Switching Valve A Circuit Malfunction
PO413	Secondary Air Injection System Switching Valve A Circuit Open
PO414	Secondary Air Injection System Switching Valve A Circuit Shorted
PO415	Secondary Air Injection System Switching Valve B Circuit Malfunction
PO416	Secondary Air Injection System Switching Valve B Circuit Open
PO417	Secondary Air Injection System Switching Valve B Circuit Shorted
PO420	Catalyst System Efficiency Below Threshold (Bank 1)
PO421	Warm Up Catalyst Efficiency Below Threshold (Bank 1)
PO422	Main Catalyst Efficiency Below Threshold (Bank 1)
PO423	Heated Catalyst Efficiency Below Threshold (Bank 1)
PO424	Heated Catalyst Temperature Below Threshold (Bank 1)
PO430	Catalyst System Efficiency Below Threshold (Bank 2)
PO431	Warm Up Catalyst Efficiency Below Threshold (Bank 2)
PO432	Main Catalyst Efficiency Below Threshold (Bank 2)
PO433	Heated Catalyst Efficiency Below Threshold (Bank 2)
PO434	Heated Catalyst Temperature Below Threshold (Bank 2)
PO440	Evaporative Emission Control System Malfunction
PO441	Evaporative Emission Control System Incorrect Purge Flow
PO442	Evaporative Emission Control System Leak Detected (Small Leak)
PO443	Evaporative Emission Control System Purge Control Valve Circuit Malfunction
PO444	Evaporative Emission Control System Purge Control Valve Circuit Open
PO445	Evaporative Emission Control System Purge Control Valve Circuit Shorted
PO450	Evaporative Emission Control System Pressure Sensor Malfunction
PO451	Evaporative Emission Control System Pressure Sensor Range/Malfunction
PO452	Evaporative Emission Control System Pressure Sensor Low Input
PO453	Evaporative Emission Control System Pressure Sensor High Input
PO454	Evaporative Emission Control System Pressure Sensor Intermittent
PO455	Evaporative Emission Control System Leak Detected (Large Leak)
PO460	Fuel Level Sensor Circuit Malfunction
PO461	Fuel Level Sensor Circuit Range/Performance
PO462	Fuel Level Sensor Circuit Low Input
PO463	Fuel Level Sensor Circuit High Input
PO464	Fuel Level Sensor Circuit Intermittent
PO465	Purge Flow Sensor Circuit Malfunction

PO466	Purge Flow Sensor Circuit Range/Performance
PO467	Purge Flow Sensor Circuit Low Input
PO468	Purge Flow Sensor Circuit High Input
PO469	Exhaust Pressure Sensor Malfunction
PO470	Purge Flow Sensor Circuit Intermittent
PO471	Exhaust Pressure Sensor Range/Performance
PO472	Exhaust Pressure Sensor Low
PO473	Exhaust Pressure Sensor High
PO474	Exhaust Pressure Sensor Intermittent
PO475	Exhaust Pressure Control Valve Malfunction
PO476	Exhaust Pressure Control Valve Range/Performance
PO477	Exhaust Pressure Control Valve Low
PO478	Exhaust Pressure Control Valve High
PO479	Exhaust Pressure Control Valve Intermittent

Section Four

Enhanced Testing

IM 240 An enhanced testing procedure that lasts a total of 240 seconds. The vehicle is tested on a roller or dynamometer. This allows the car to be tested under varying loads and speeds. This testing requires that the total exhaust produced during the test be analyzed instead of just a small sample as used in other tests.

The IM program that is administered by the state is intended to detect and repair inuse vehicles with excessive emissions by encouraging the vehicles owner to properly maintain and use their vehicle. The IM programs will encompass more areas as time goes on and will definately help to increase replacement of catalytic converters for shops doing exhaust and emissions work.

What does testing tell us?

The test paper that the IM 240 station gives the customer has some other information other than just HC, CO and NOX. You will also find O2 (oxygen) and CO2 (carbon dioxide) listed. Generally, O2 has an inverse relationship to CO, meaning if one goes up or increases, the other goes down or decreases. Too little O2 during the combustion process will cause CO to increase. The normal reading out of the tail pipe of O2 will be 1.5% or less. If the car has a secondary air injection system, the reading will be 3% to 4% with the injection system activated. If the O2 reading that the oxygen sensor picks up is incorrect, air/fuel ratio will be affected. For CO2, you should consider that it is an excellent indicator of com plete engine combustion. It is also produced by a functioning converter. Usually the CO2 level before the catalytic converter will be about 11% to 12%. If the con verter is functioning properly, it will be 15% or higher out of the tail pipe.

Points to check when a vehicle fails testing

1. Was the vehicle running at operating temperature (properly warmed up)?

2. Was the vehicle running at manufacturers specs?

3. Is the vehicles cooling system operating properly?

4. Is the vehicles EGR system functional?

5. Does the vehicle have high mileage on the odometer?

6. Has the vehicles engine or exhaust been modified?

7. Make sure the vehicle is IM ready. (See the IM readiness cycle in the OBD II section)

Causes of test failure

HC (hydrocarbon) failure Iginition misfire, fuel system malfunction, bad O2 senosr or other feedback sensor, worn piston rings/burned valves, bad canister purge valve or system, defect in PCV system, inoperative converter

CO (carbon monoxide) failure Improper air/fuel mixture, inoperative air injection sys tem, inoperative choke/cold idle enrichment device, faulty O2 sensor or other feedback sensor, incorrect timing, inoperative converter

NOX (oxides of nitrogen) failure Mechanical engine problems: stuck engine thermostat, corroded radiator internally, air flow to radiator plugged, blocked or corroded cool ing passages, carbon deposits

System component problems

Inoperative EGR valve or system
Plugged EGR passages
Bad air diverter valve
Extremely lean air/fuel ratio
Bad heat riser valve
Malfunctioning radiator fan motor or switch
Advanced ignition timing
Bad feedback sensor

Usually if a converter passes HC and CO but fails NOX, the problem is not the convert er. Use this rule for determing a nonfunctioning converter. (It will be accurate 95% of the time or better)

If the tail pipe reading shows the:
*CO is greater than 0.3%
*O2 is greater than 0.4%
*HC is higher than 125 ppm but not less than 400 ppm
the converter is most likely defective.

Exhaust emission effects due to engine problems

	HC	CO	NOX
Ignition System Malfunction	Increase	Decrease	Decrease
Retard Timing	Little Change	Generally no change	Decrease
Advance Timing	Small Increase	Little Change	Increase
Inoperative Air Injection	Increase	Increase	No change
Faulty EGR	Little Change	Generally No change	Increase
Fuel System Rich	Increase	Increase	Decrease
Fuel System Lean	Increase	Decrease	Increase

Section Five

For the most part, the rules or guidelines for aftermarket converters are quite clear and concise. It is permissable to install an aftermarket converter in the following situation:

A. The vehicle is over 5 years old or has more than 50,000 miles. This applies to vehicles produced in, or before, 1994. For vehicles 1995 or newer, the period of 8 years or 80,000 miles applies.

B. A state sponsored inspection program has determined that the current converter has been damaged or poisoned.

C. Any situation where the need for converter replacement has been documented.

It is possible to use an aftermarket converter in a situation where the vehicle is less than 5 years old (1994 or older) or has less than 50,000 miles. These situations are:

A. The catalytic converter is already missing from the vehicle and it has been properly documented.

B. A state inspection program has determined that the current converter is damaged or inoperable.

The following are examples of situations where original equipment converters <u>must</u> be installed:

A. Vehicles O.E. converter is covered under a warranty or recall.

B. Vehicle has been returned from overseas use and the catalytic converter is missing.

Some frequently asked questions regarding catalytic converters:

Q. Can a good catalytic converter be removed from a vehicle?

A. No. A good or functioning converter may never be removed from a vehicle. It is a violation that can cost the technician who does so a $2500 fine for each occurance.

Q. Can precatalysts be removed from a vehicle?

A. No. Precats are treated like any other catalytic converter and should not be re moved unless they are defective. Precat elimination converters can only be used when the precat and main converters are bad. They must be approved for this type of use, and should be used in accordance with the aftermarket catalytic converter manufacturers instructions.

Q. Can I replace two converters with one aftermarket converter? (example: 1993 Ford F Series Pickup)

A. Yes, but only if the replacement unit has been approved for this and it is used in accordance with the aftermarket converter manufacturers instructions.

Q. Can I install dual exhaust or dual catalysts on a vehicle?

A. No. This should not be done unless the vehicle originally came with a dual exhaust or dual catalyst configuration from the vehicle manufacturer. It has been allowed by the EPA, however, to dual on exhaust system behind the existing catalytic converter. If in doubt, it is best to check with the EPA or your local inspection program director.

Q. The vehicle has an engine that is older or newer than the vehicle or a larger engine has been installed. What type of converter, or does a converter need to be installed on this vehicle?

A. The guidelines say that a motor vehicle has to conform to its originally certified engine chassis configuration. If an engine is switched, it must be identical to the original one being replaced. It would be best to consult the local inspection station or EPA before attempting any exhaust system work.

Q. Can I replace a twoway converter with a threeway converter?

A. Yes, provided it has been tested for this type catalyst by the manufacturer in compliance with EPA aftermarket converter procedures.

Remember:

*Fill out the warranty card and mail it to the manufacturer.
*Keep all invoices for six (6) months.
*Keep all replaced converters for a period of fifteen (15) days. Use the pink copy of the CATCO® four part warranty to tag the converter for easy identification.
*Follow the CATCO® catalog and technical hotline advice.
*If in doubt, contact EPA, your local state inspector or the CATCO® technical hotline at (800) 2472515 for assistance.