TEAM A.V.I.

As Fast As Lightning Strikes...
Automotive Technology Changes.

LBT-135
USING MODE 6
IN DIAGNOSTICS

affiliate ASA member

member MACS

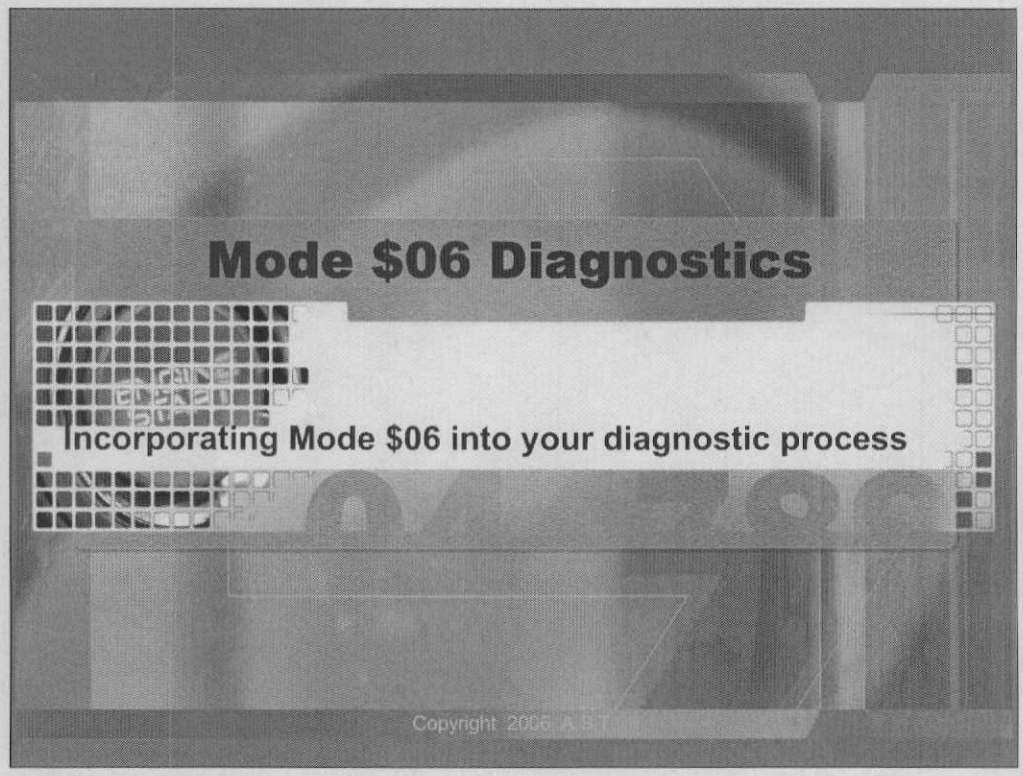
WE ENCOURAGE PROFESSIONALISM

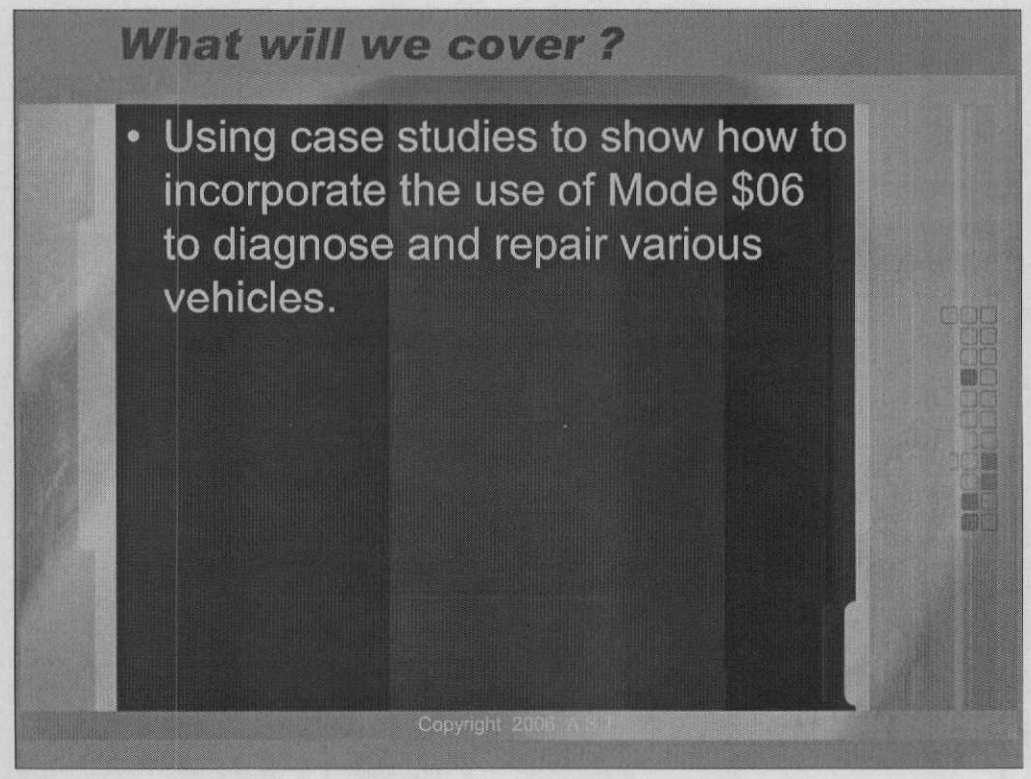
ASE CERTIFIED

THROUGH TECHNICIAN CERTIFICATION

"Before everything else, getting ready is the secret of success."

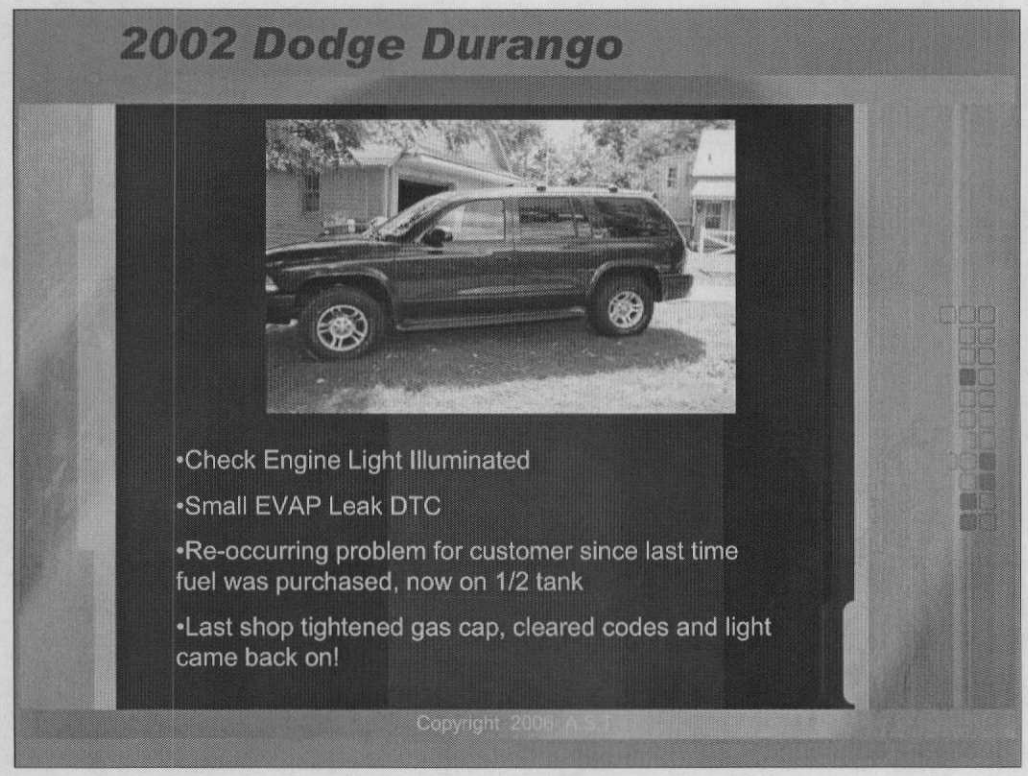
- Henry Ford


Mode $06 Diagnostics
Incorporating Mode $06 into your diagnostic process
Copyright 2006 AST



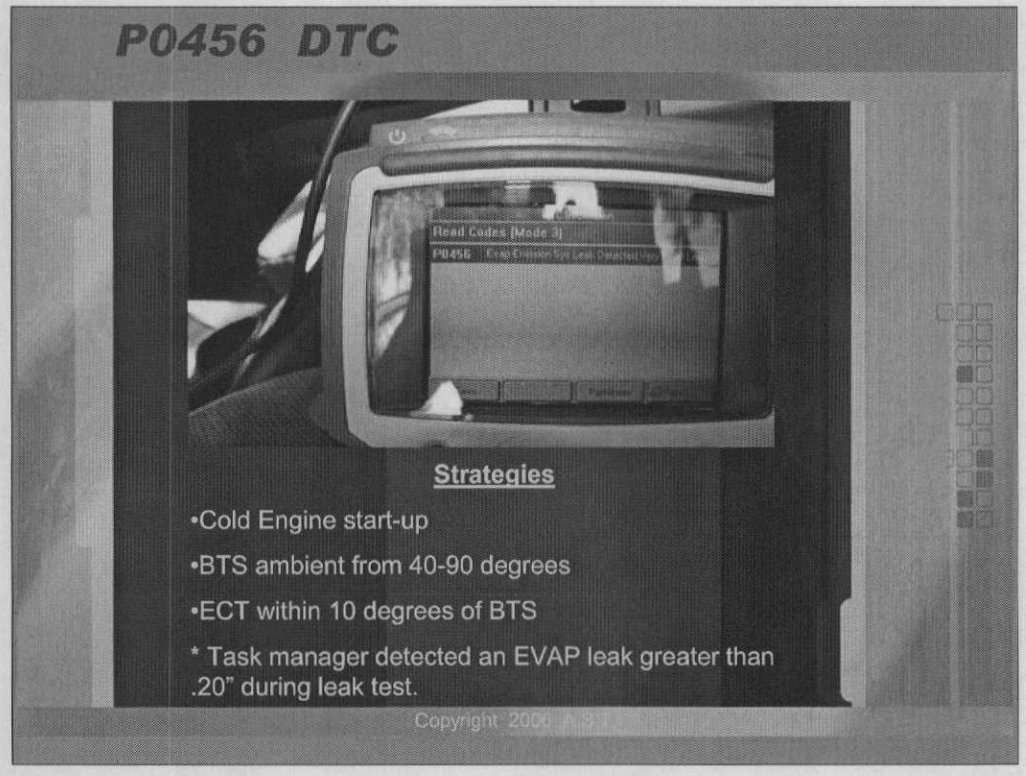
At this point Mode $06 has been available to help technicians diagnose/repair vehicles for more than 10 years! The funny thing is that no-one really started referring to its use until about 5 years ago. There are many training organizations that offer training relating to what Mode $06 is at this point including our Diagnosing and Repairing OBD II (Mode $06 Diagnostics) books and videos. All of the training materials to date have structured their curriculum to explaining what Mode $06 is and the better ones will give us TID and CID descriptors for the various car lines. For this reason, we will not re-hash any of that information in this program. If you should be interested in obtaining such information, be sure to inquire with the training vendor in which you purchased this package from.

We will pertain this program to the **actual use of Mode $06** to help you diagnose and repair these vehicles. We feel that this is the next most logical step to help technicians become more efficient when using Mode $06. We will accomplish this by showing and documenting 5 different vehicles ranging from fairly easy repairs to a little more tricky ones that we have had the pleasure to come across over the last month or so during our mobile diagnostic jobs.



Our first vehicle is a 2002 Dodge Durango. This vehicle had already been to a service shop about one week earlier for an illuminated check engine light, which turned on shortly after the owner bought fuel. The shop checked for codes and determined that the gas cap was left loose so they tightened the cap and cleared the DTC.

This vehicle belongs to a friend of the family so when the light came back on, she called me and asked if I could look at it for her. Knowing the history of the complaint I decided to attach my scan tool to retrieve the stored DTC. I also looked at the gas cap to ensure it was indeed tight!



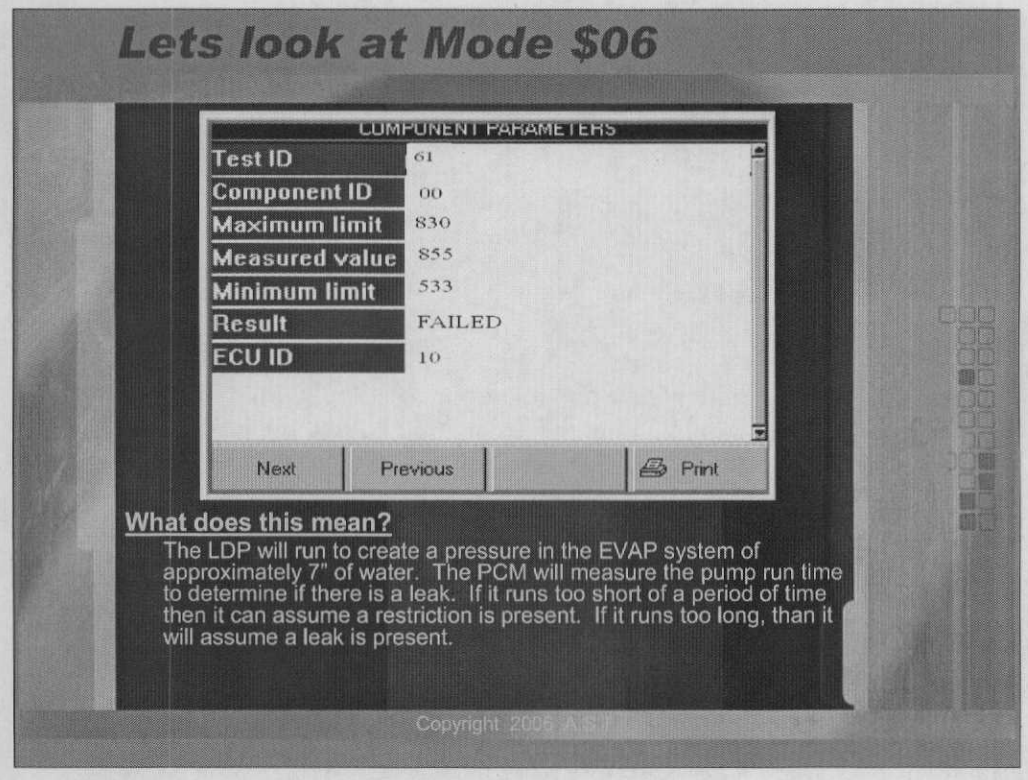
The stored DTC was a P0456, which upon looking in my Mode $06 diagnostics manual, I was able to determine that the code referred to a small leak present in the EVAP system. I also learned the code setting criteria needed to set this DTC. This may become useful information to aid in getting the monitor to run after the repair has been completed.

I also looked at the freeze frame information and was able to determine that this code had re-set itself 200 miles ago. This all makes perfectly good sense since it goes along with the story I received from the owner of the vehicle.

The code setting criteria:

1) Engine started cold
2) Battery temperature sensor reading a temperature of 40-90 degrees.
3) Coolant sensor within 10 degrees of battery temperature sensor reading.

* Then the PCM detected an EVAP leak present of greater than .20". (Small Leak)

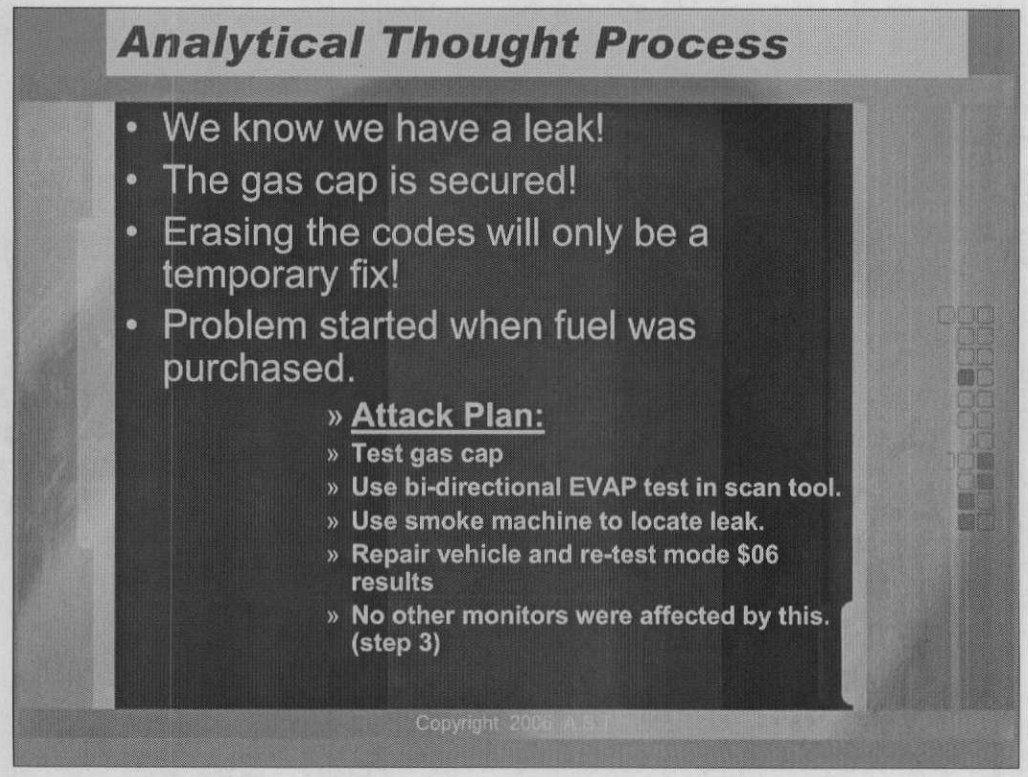


At this point I decided to view the Mode $06 information using my scan tool. Upon entering the Mode $06 screens I was able to determine that all the TID's and CID's were passing with the exception of TID $ 61 (EVAP monitor). In this monitor, Chrysler will either assign a CID of "00" maximum limit fail, or "80" minimum limit fail.

What does this mean?

The LDP will run to create a pressure in the EVAP system of approximately 7" of water. The PCM will measure the pump run time to determine if there is a leak. If it runs too short of a period of time then it can assume a restriction is present (CID 80). If it runs too long, than it will assume a leak is present (CID 00).

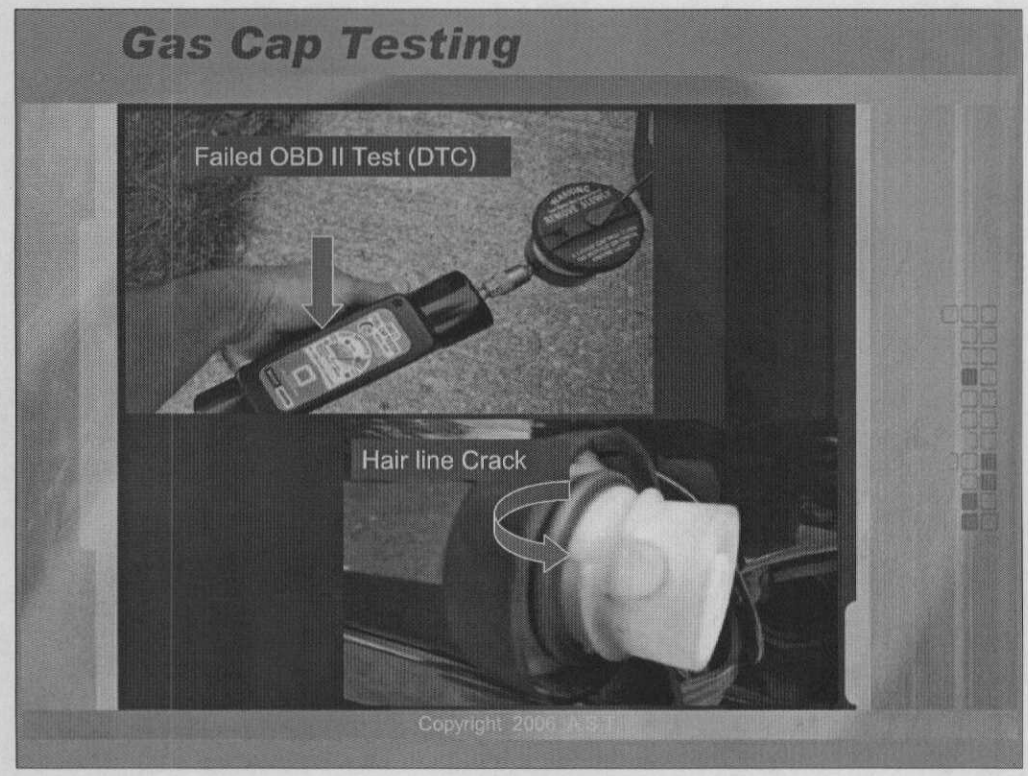
Since Mode $06 information has the ability to update, we can safely assume that the leak is indeed present! This is better than just seeing a DTC and not knowing if it was an old code or a hard DTC.



At this point we would want to decide what our next course of action will be. We know that we currently have a leak present thanks to viewing the Mode $06 data. We also know that the gas cap is secure since we have already verified that. We know that erasing the codes would only turn off the light for a short period of time. Finally , we were told that all this started after she had bought fuel.

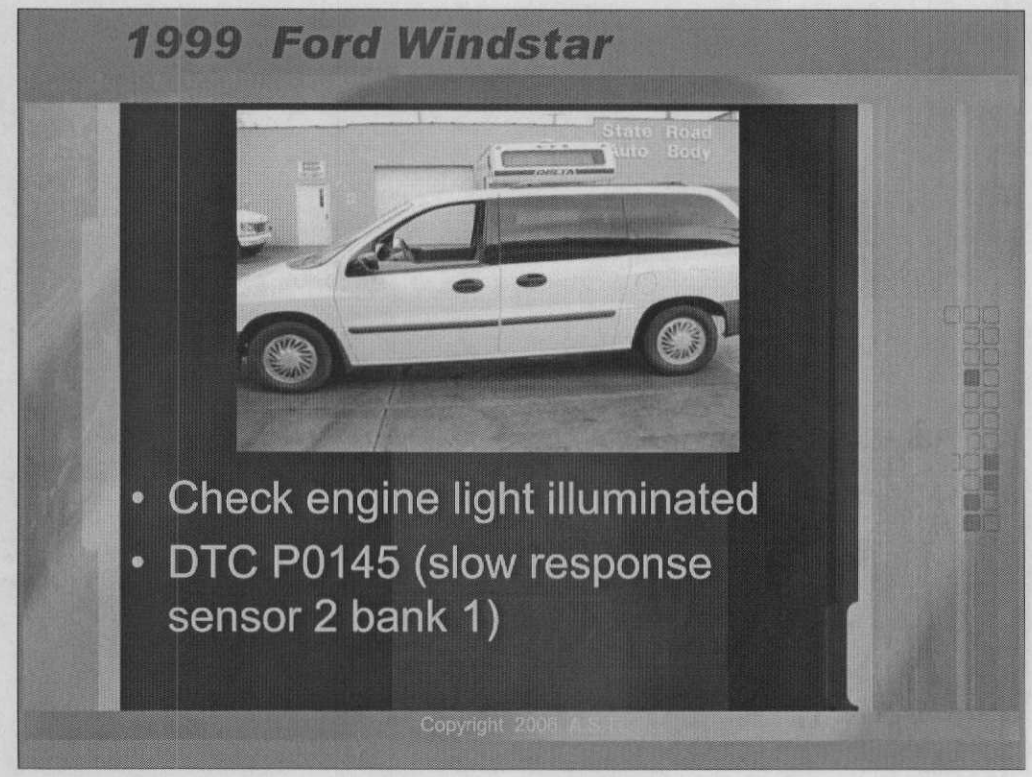
Given all the information listed above, I decided to test/inspect the gas cap first. Step two would be to use my scan tool to perform a system leak test. I would then use my smoke machine to help locate the leak. The other nice thing we can do with mode $06 is inspect other monitors that were possibly shut down as a result of setting this trouble code. We were fortunate in that no other monitors were shut down as a result of this DTC being set.

Remember after we have successfully repaired the vehicle we can then use mode $06 again to see if the testing criteria is now passing! Refer back to the previous slide showing the min and max limits.

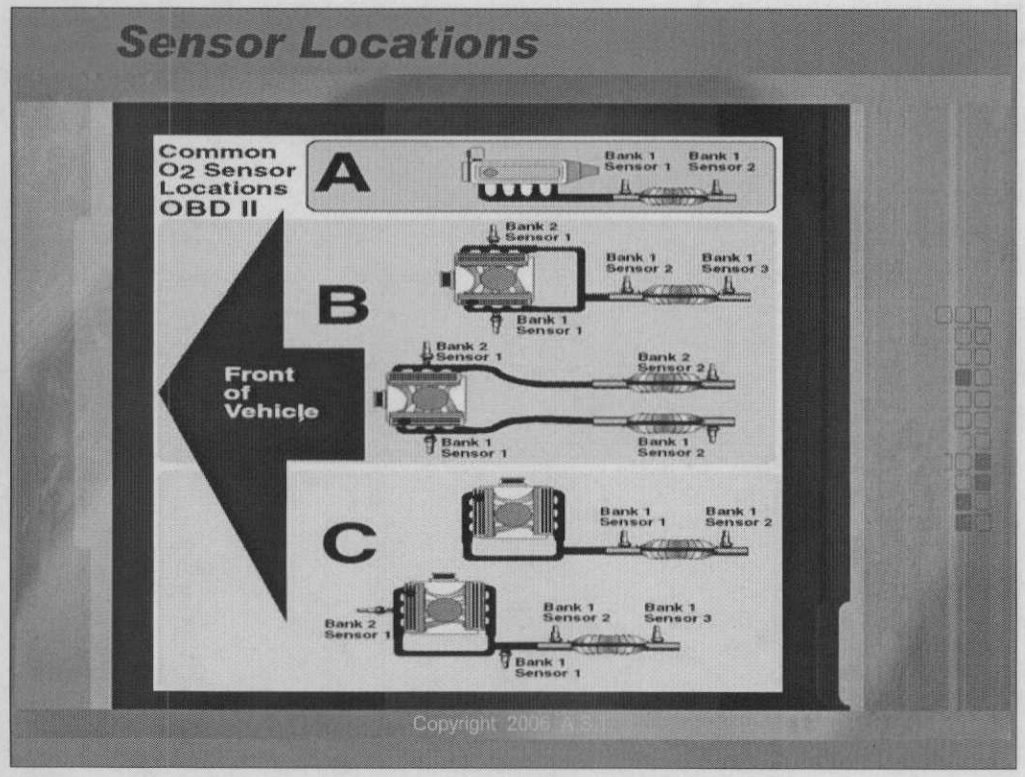


We got lucky on this one! The first thing we decided to test was the failed component with the vehicle. Sweeeeeet! We attached our gas cap tester to the vehicle's gas cap and followed the appropriate steps needed to test the gas cap. This tool has the ability to tell us if we pass, if we fail for an IM reason, or if we fail for an OBD II reason (these are the ones that set the DTC). We could quickly see that we were failing this test for an OBD II reason due to the light being illuminated on the far left side of the tool.

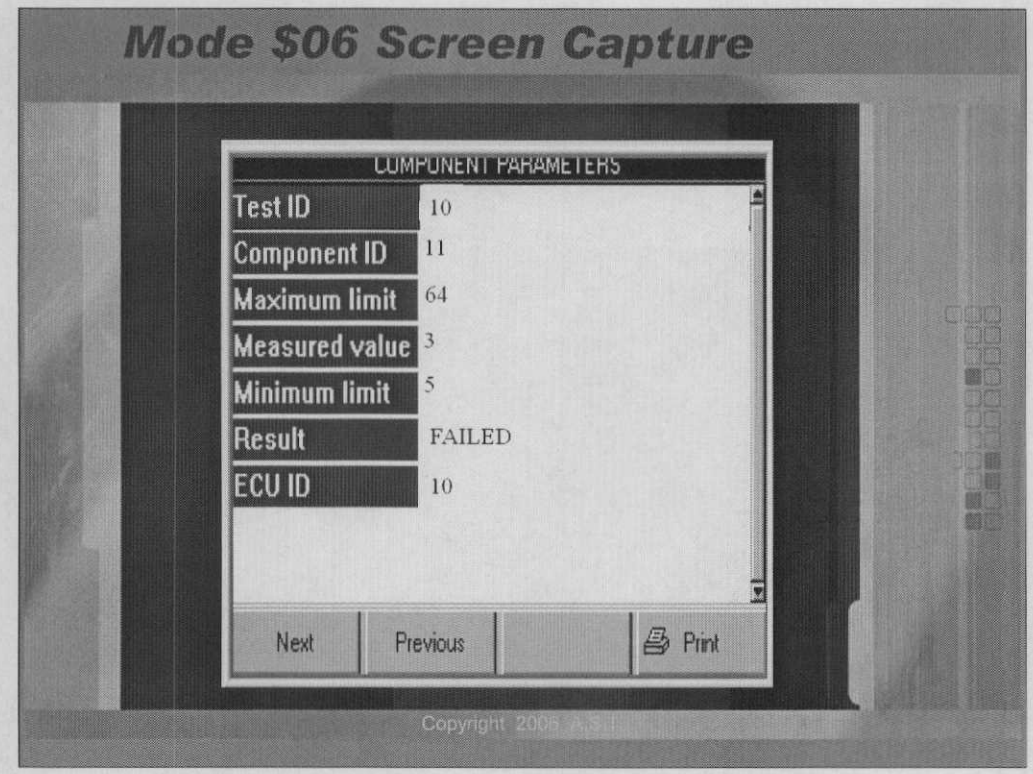
Upon closer inspection of the gas cap, we were able to see that the cap was actually cracked! This was most likely caused by improper installation procedures over the years. We quickly replaced the gas cap and used mode $06 to verify that the current levels were now comfortably between the min and max testing criteria.



Our next vehicle is a 1999 Windstar. This vehicle was at a local body shop with the check engine light illuminated and a stored P0145 DTC for a slow switching catalyst sensor. No work had been done to this vehicle as of yet.

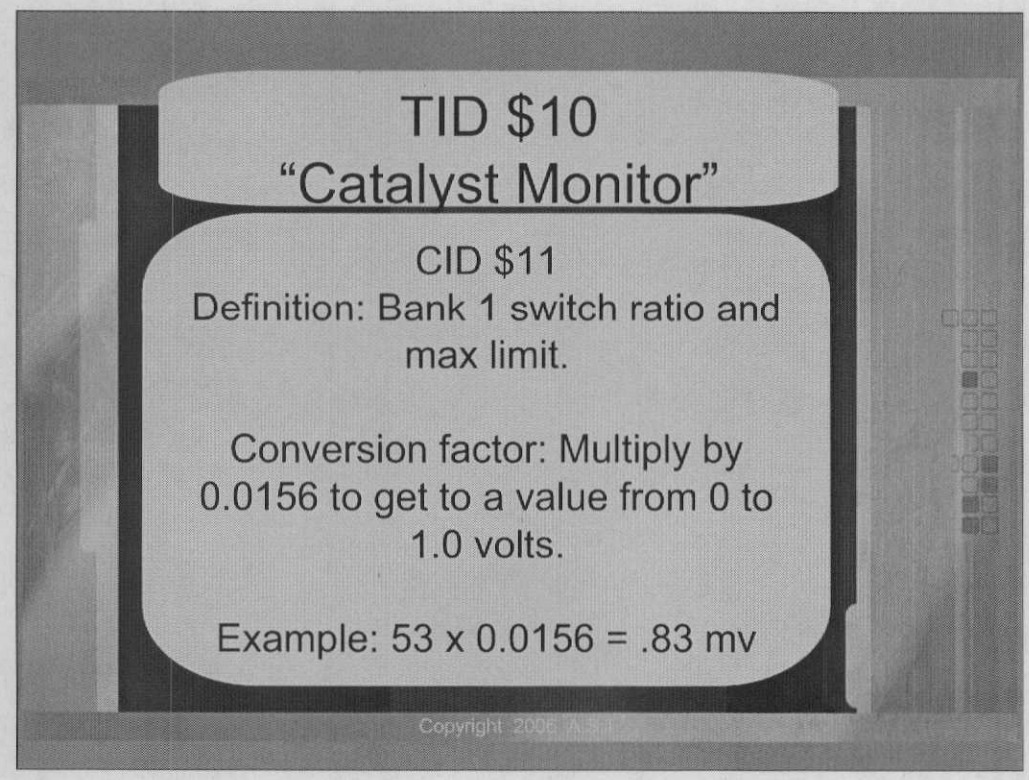


We should start by identifying the oxygen sensor locations. We have supplied you with a graphic showing the various locations of each of the sensors located on various engine designs. Our DTC relates to the sensor located by the catalytic converter.



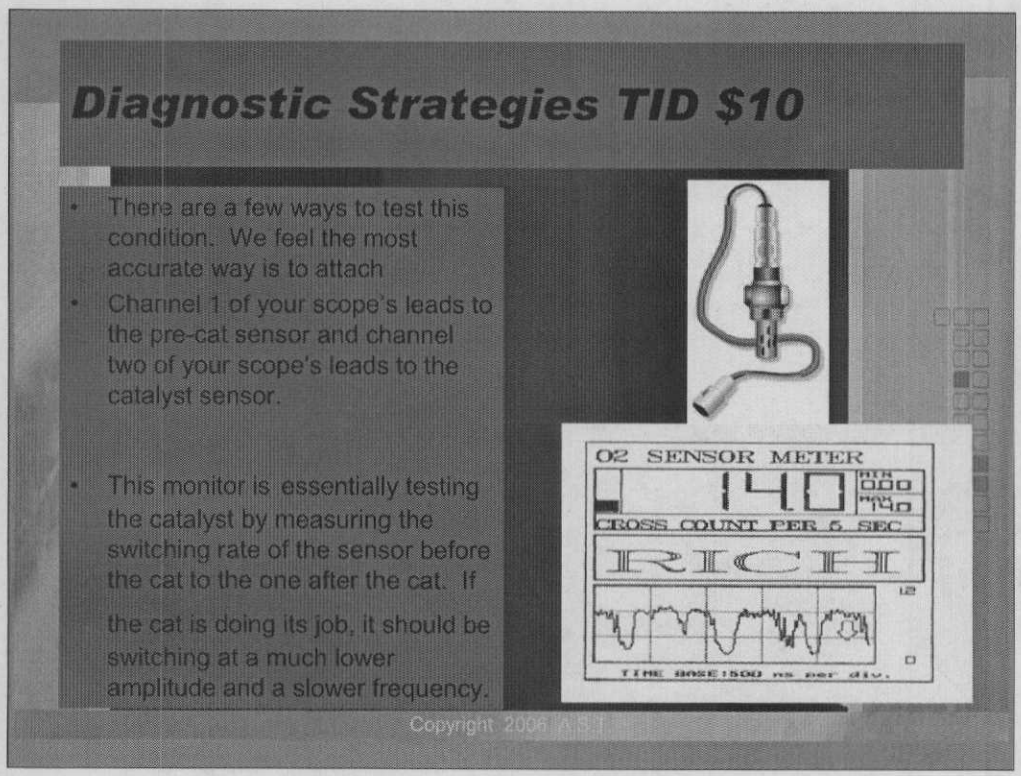
We then decided to view the Mode $06 information and we see that the TID $ 10 and CID $ 11 has failed. Upon looking in our Mode $06 diagnostics manual we also see that once this code sets, the PCM will stop running the EVAP test so we will have to be sure that once the vehicle is completed, not only does the catalyst monitor pass, but the EVAP monitor passes as well.

We are failing this test due to the fact that the measured limit does not fall between the min and max values stored in the PCM. This verifies that the sensor is not only displaying very low amplitude but is also switching at a very low rate of speed.



The above slide refers to the conversion factor that we must use with Ford vehicles that are not C.A.N. compliant. In order for us to get a voltage value from our Mode $06 screen we must take the measured value of 3 and multiply that by 0.0156, which gives us a voltage value of 0.0468 millivolts. Remember, C.A.N. vehicles will have no conversion factor.

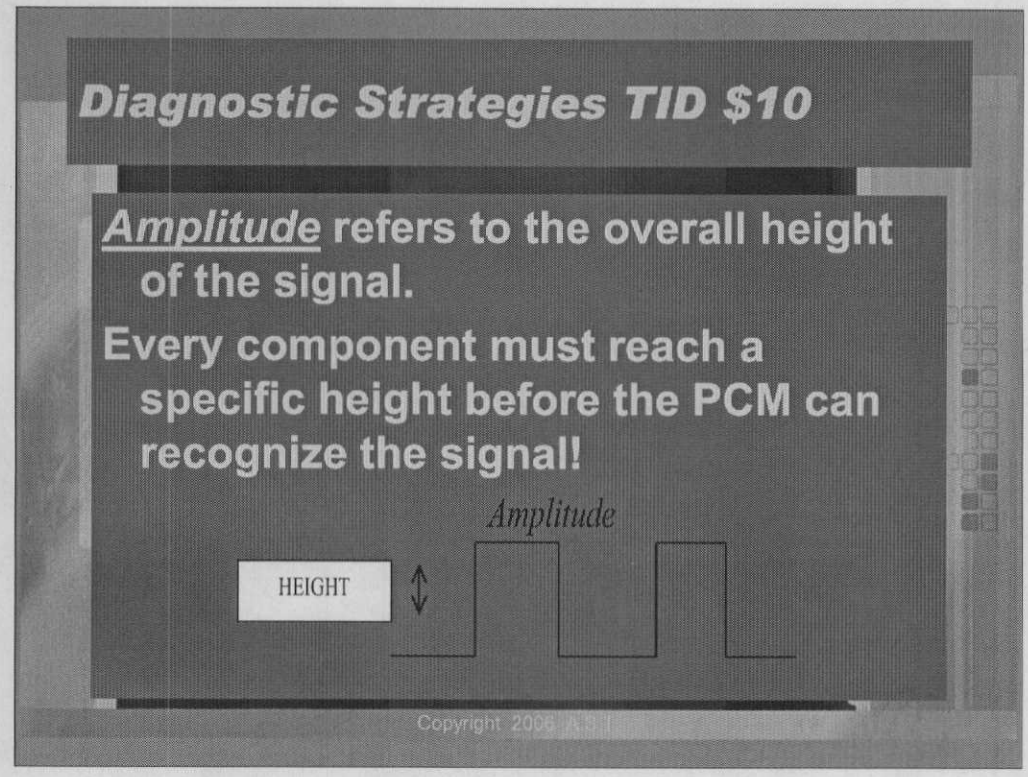
This information is very valuable by itself! We can now start formulating an attack plan based on possible causes that would keep the sensor's voltage at a low amplitude and switching rate. Examples: exhaust leak, bad sensor, vacuum leak, weak fuel pressure etc…



There are a few ways to test this condition. We feel the most accurate way is to attach

Channel 1 of your scope's leads to the pre-cat sensor and channel two of your scope's leads to the catalyst sensor.

This monitor is essentially testing the catalyst by measuring the switching rate of the sensor before the cat, to the one after the cat. If the cat is doing its job, it should be switching at a much lower amplitude and a slower frequency.

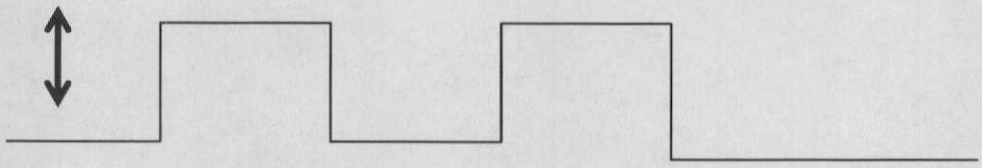


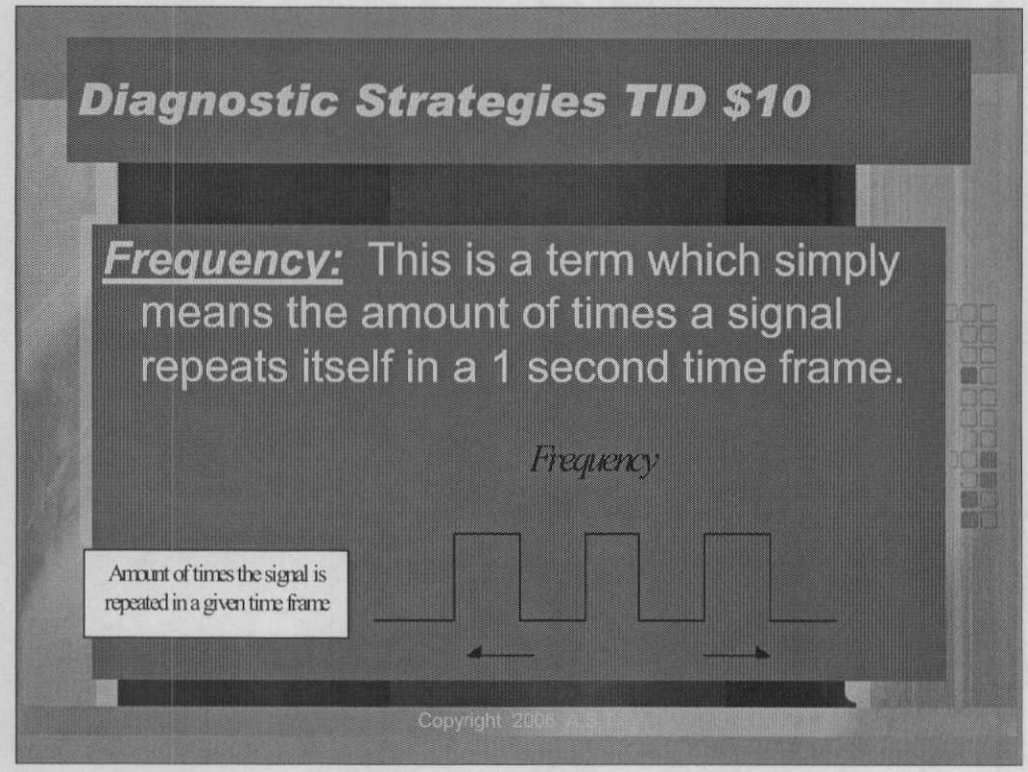
I guess we should quickly define ***Amplitude.***

Amplitude **refers to the overall height of the signal.**

Every component must reach a specific height before the PCM can recognize the signal!

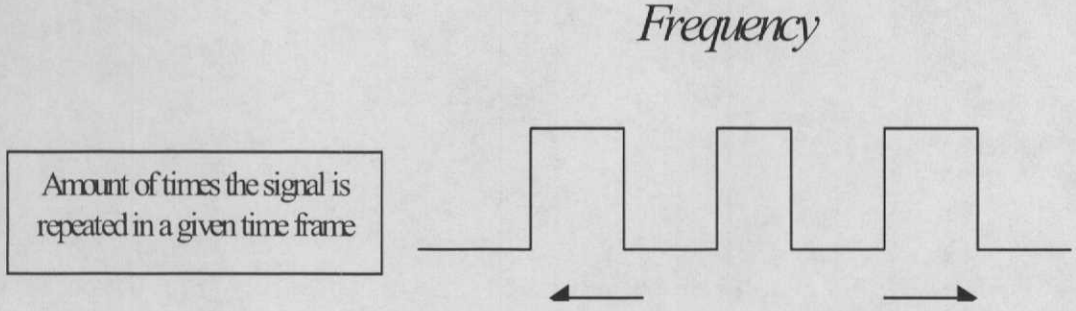
Amplitude = HEIGHT

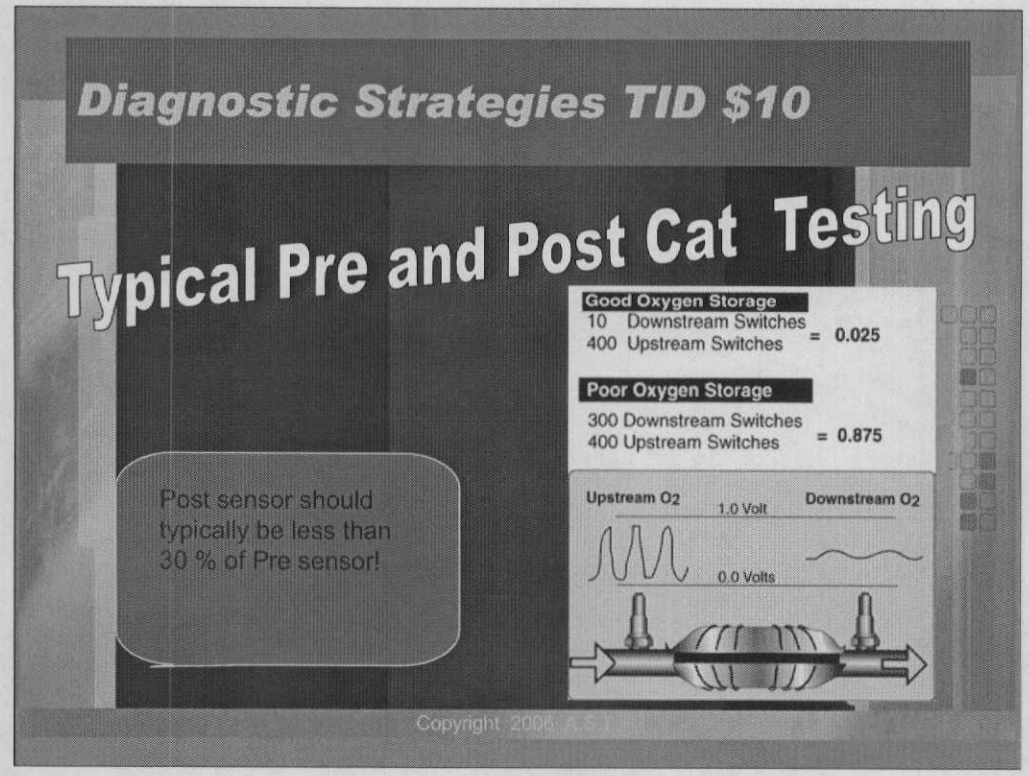




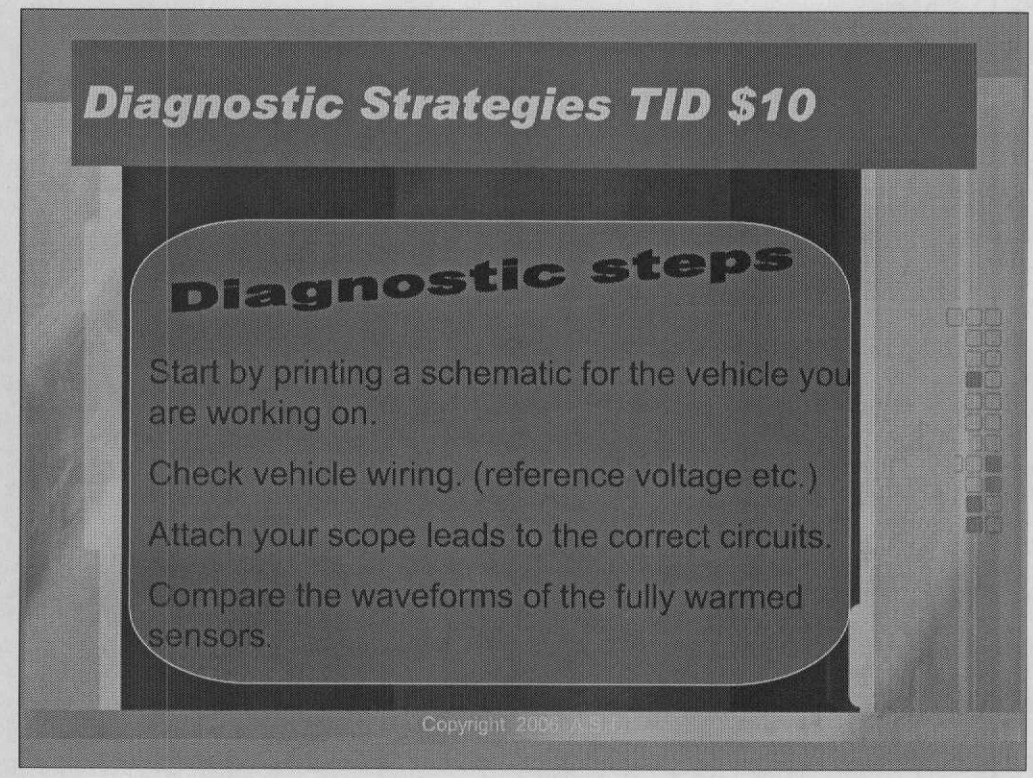
Now lets define the term ***Frequency.***

Frequency: This is a term which simply means the amount of times a signal repeats itself in a 1 second time frame.

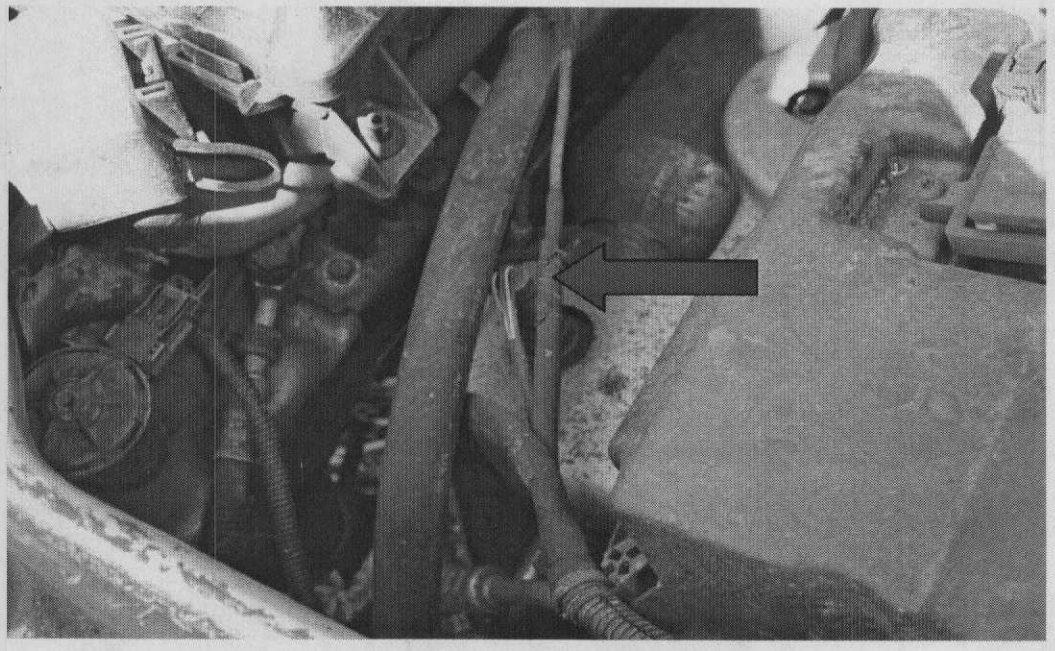


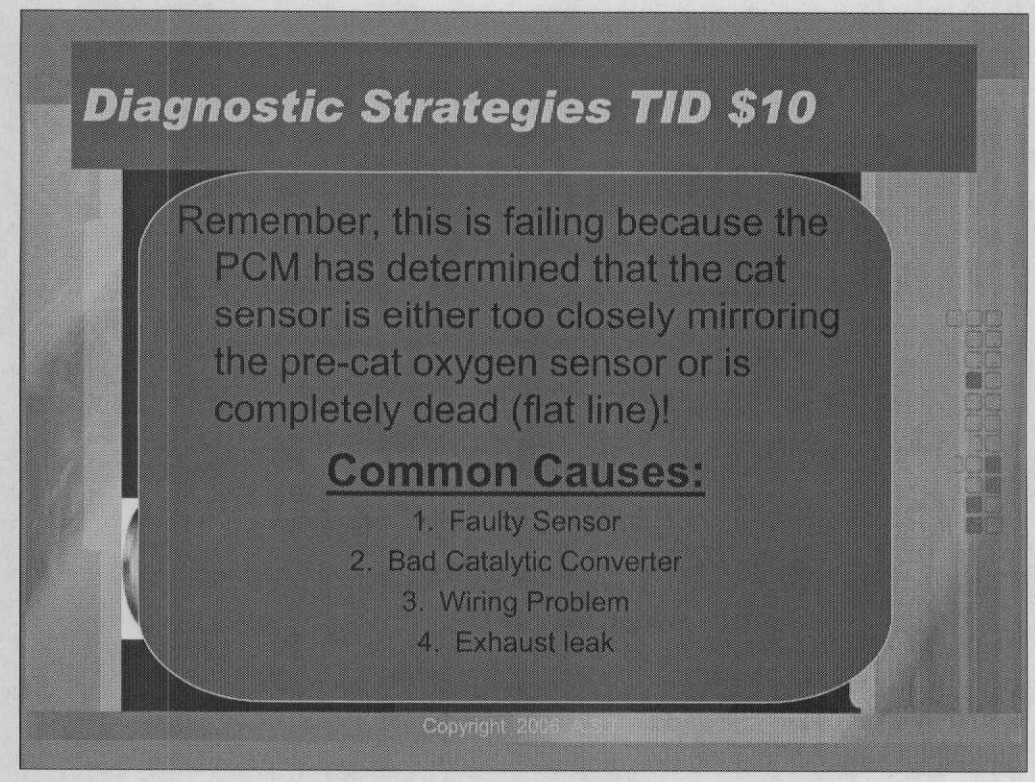


Typically, most OBD II vehicles will want to see that the amplitude (big slopes) and the frequency (half cycles) test of the catalyst sensor is 30% or less than the pre-cat sensor is displaying. If you have your scope leads attached properly to the pre and post sensors, you should be viewing a waveform similar to the one shown above.



We want to begin our diagnostics by printing a wiring diagram for the vehicle we are working on. We see that the color of the wires that we wish to back-probe to attach our scope leads to in this case both happen to be the black wires coming directly off the sensors themselves.

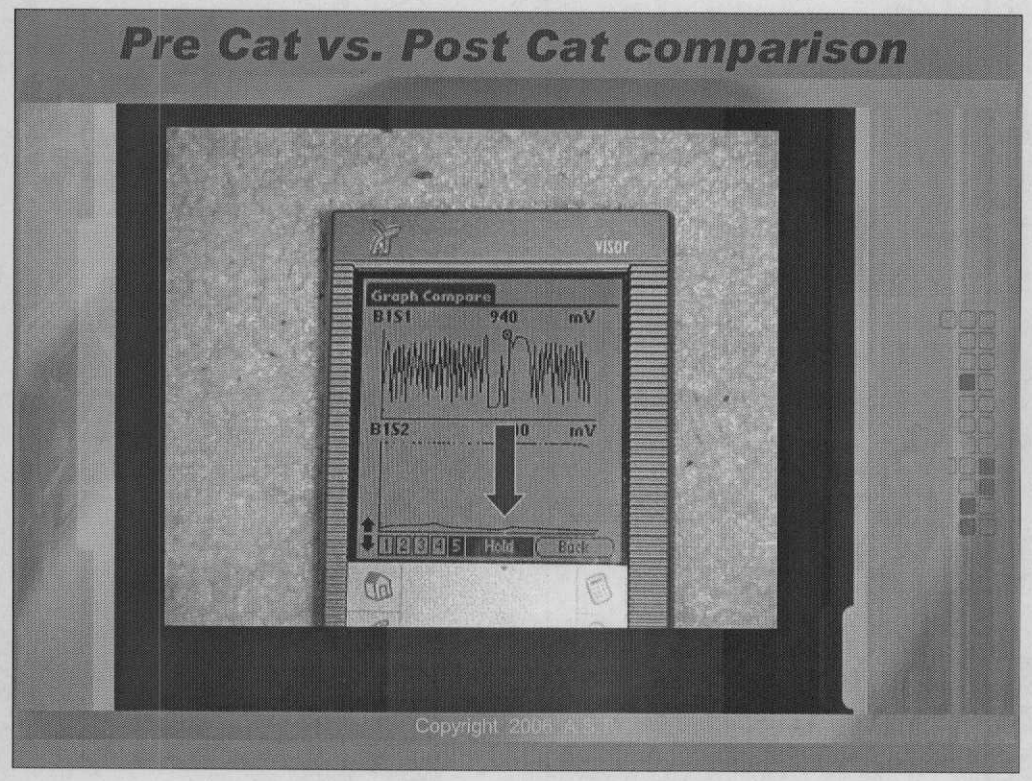




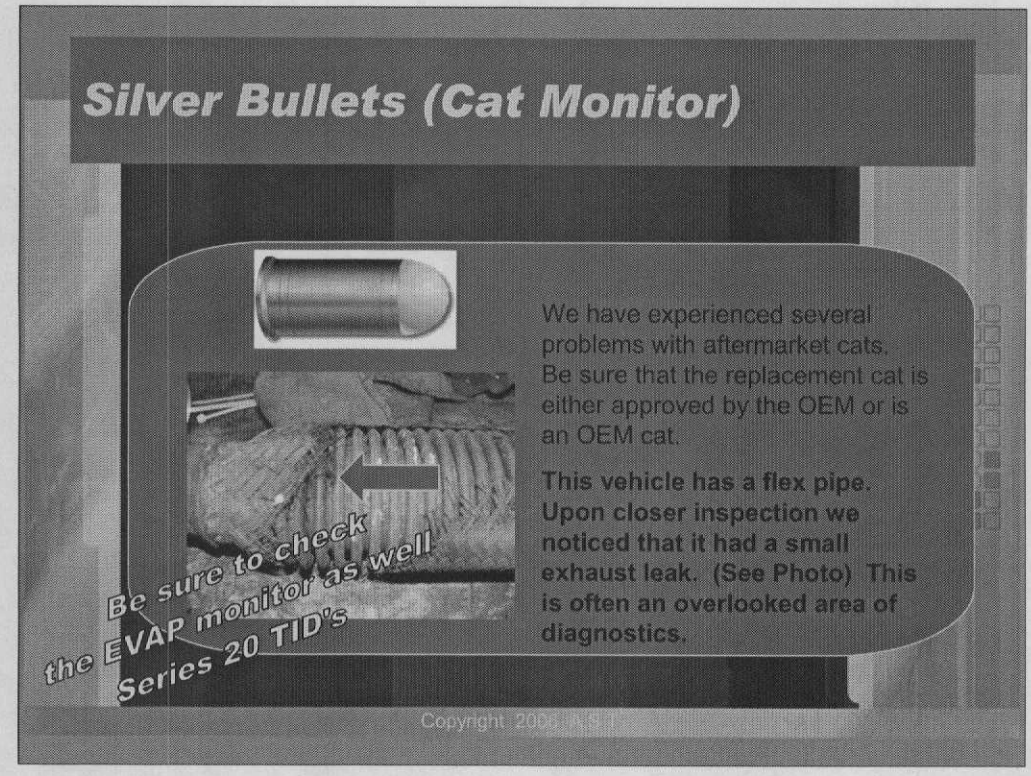
The most common causes for this condition are a faulty sensor, a bad converter, a wiring problem or an exhaust leak allowing pirate air into the exhaust stream thus influencing the sensor.

We feel pretty safe about ruling out a mixture related problem since we do not have any DTC stored pertaining to lean conditions. Our fuel trim values are also not indicating any problem due to a mixture problem.

It is for these reasons that we have decided to test the sensors first. Once we raised the vehicle on a lift to gain better access to the oxygen sensors we noticed some black and sooty residue emitting from the vehicle's flex pipe!



The above photo shows the actual pre and post catalytic sensor's waveforms. Remember that you can also use most scan tools to graph these signals as well. This is often a little easier to do since you only have to hook up to the ALDL.

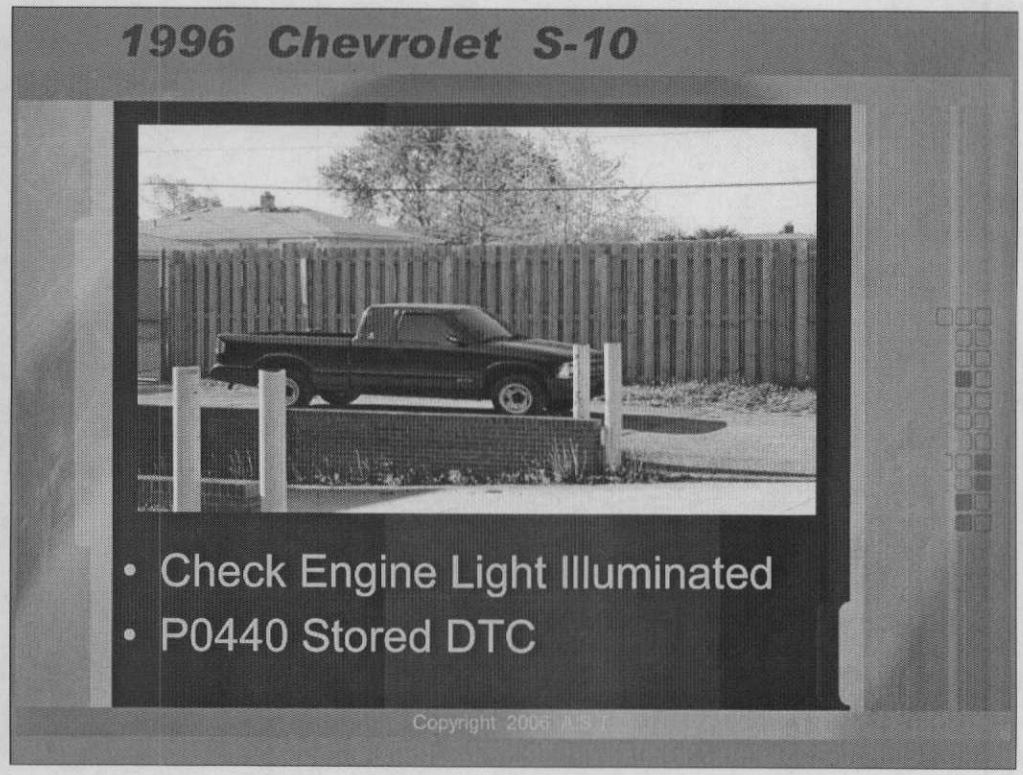


Special Note: We have experienced several problems with aftermarket cats. Be sure that the replacement cat is either approved by the OEM or is an OEM cat.

This vehicle has a flex pipe. Upon closer inspection we noticed that it had a small exhaust leak. (See Photo) This is often an overlooked area of diagnostics. The repair for this vehicle is simply to replace the flex pipe.

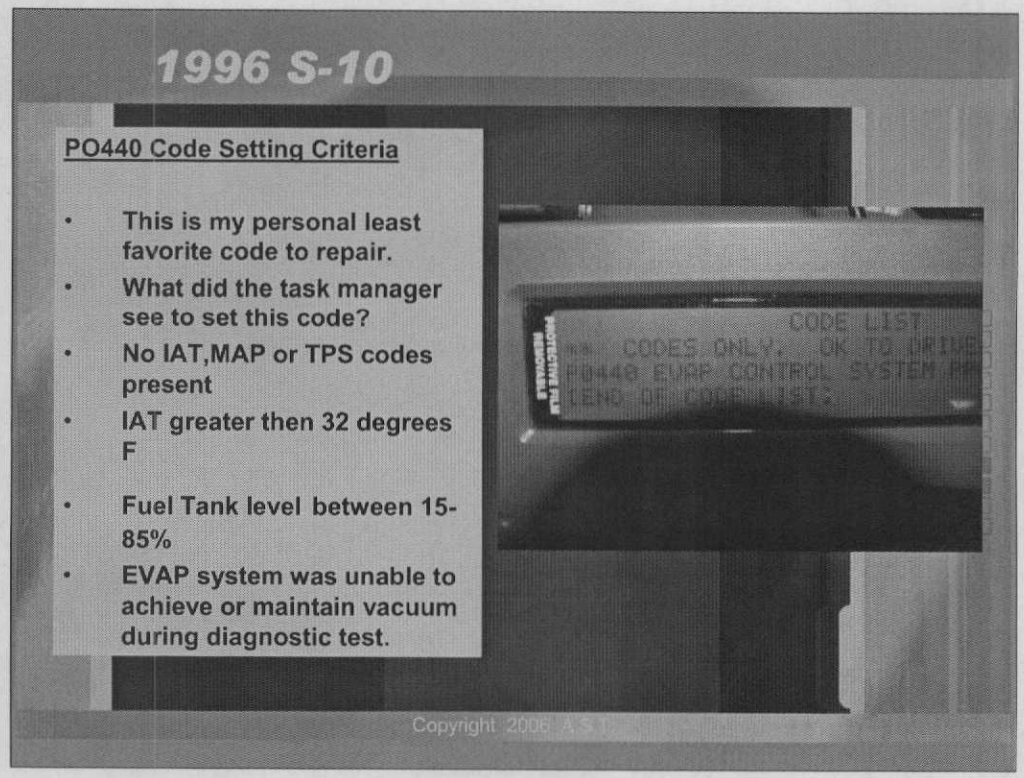
We were able to determine that the oxygen sensor would begin switching normally by momentarily spraying the hole in the pipe with some water from a spray bottle with the vehicle running and our scope leads attached to the pre and post sensors. Once we did this, our patterns returned to normal.

We should state that this vehicle did not run loudly so this was a very small leak! Remember to not only view this circuit in Mode $06 after the repair, but also to check the EVAP monitor (series 20 TID's) since the PCM had shut down running this test as a result of setting this DTC.! All you need to do is to make sure they all have a pass in the test result window.



This next vehicle has an interesting story behind it. It seems that one of the local high school automotive programs will perform light customer service work to help generate funds for their auto program. I can remember my days as an auto instructor and the potential head aches that could come from performing customer pay jobs. Several new components had already been replaced on this vehicle including a gas cap and now the customer was demanding that the vehicle be repaired!

This vehicle had its check engine light illuminated and a P0440 DTC stored in the computer's memory.



PO440 Code Setting Criteria

This is my personal least favorite code to repair!!!!!! I'll explain why later.

What did the Computer need to see to set this code?

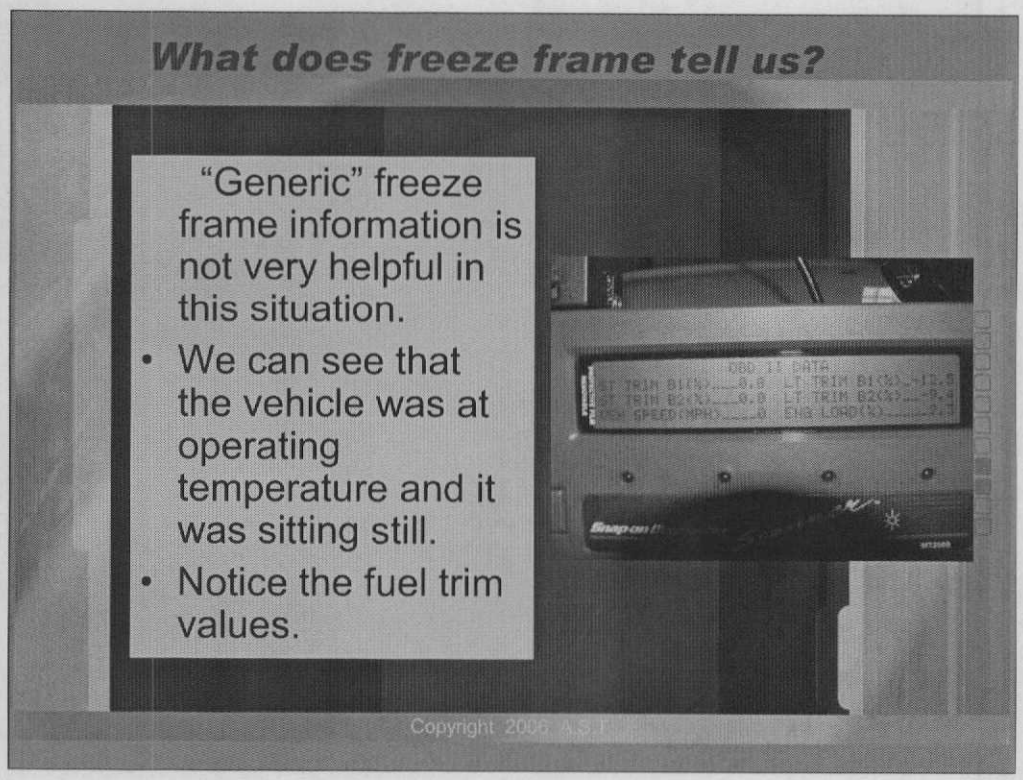
No IAT,MAP or TPS codes present

IAT greater then 32 degrees F

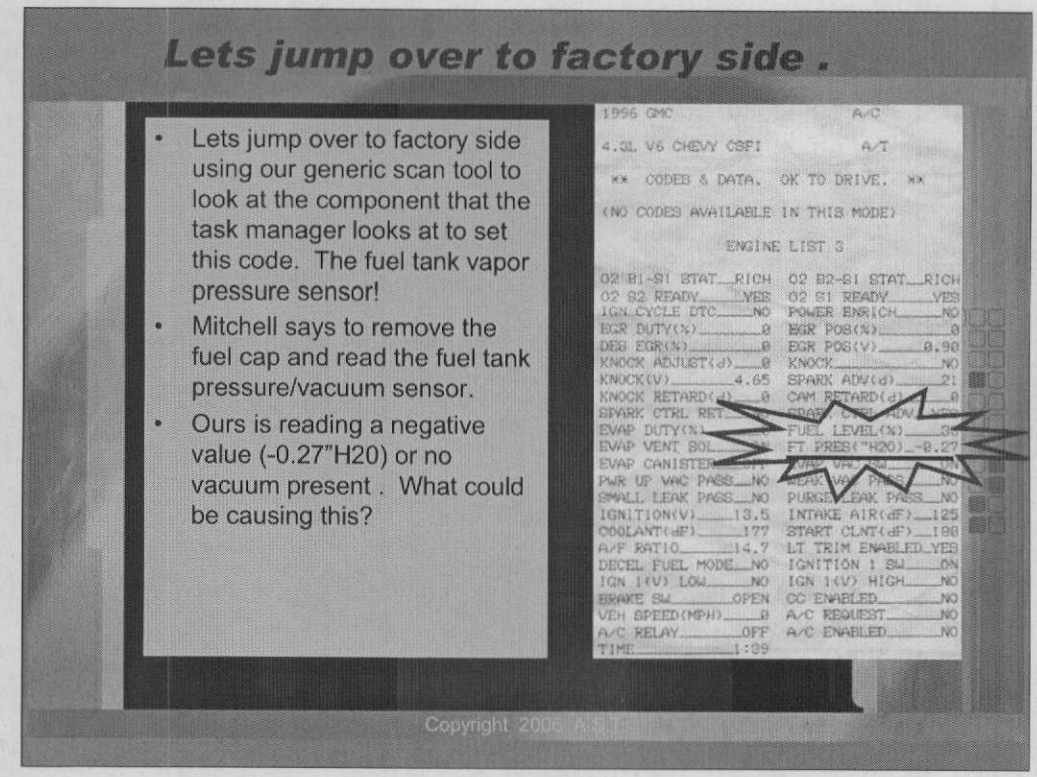
Fuel Tank level between 15-85%

EVAP system was unable to achieve or maintain vacuum during diagnostic test.

The computer will determine this by monitoring the Fuel Tank Pressure sensor's value over time.



Freeze frame information is not of too much value to us in this case. The reason I chose to display this information is because the PCM will often look for changes in Idle Air Counts and Fuel Trim values to help determine if the system is operating correctly. This is just one of several tests that GM uses to test the integrity of the EVAP monitor.

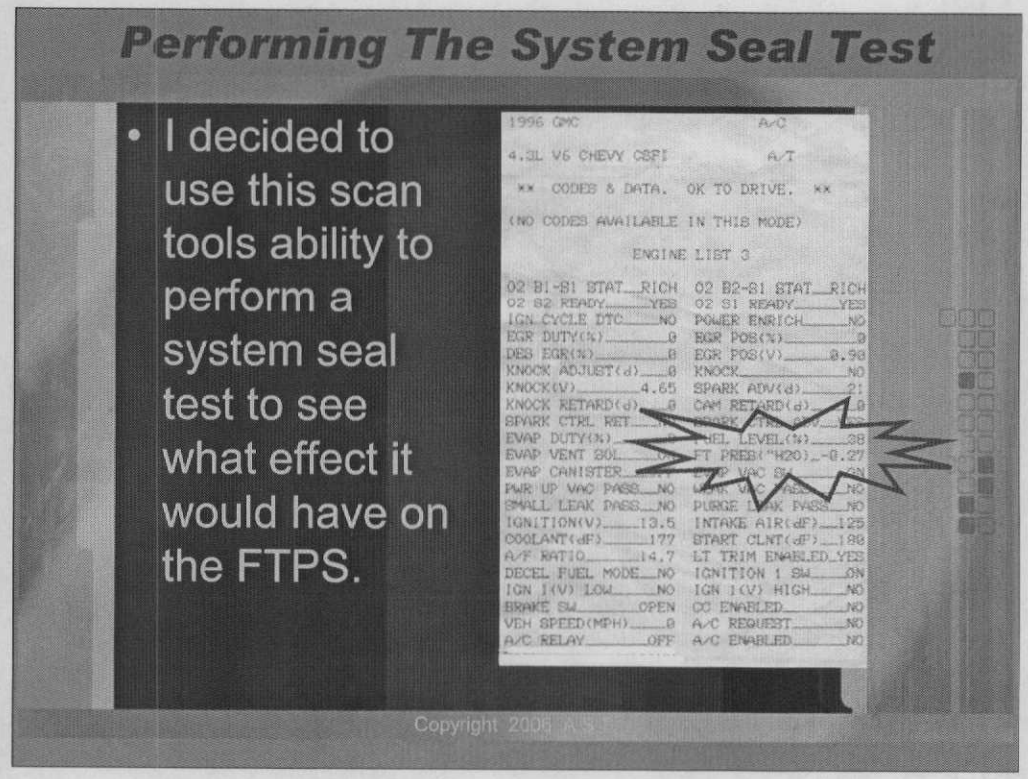


Lets jump over to factory side using our generic scan tool to look at the component that the PCM looks at to set this code. <u>The fuel tank vapor pressure sensor!</u>

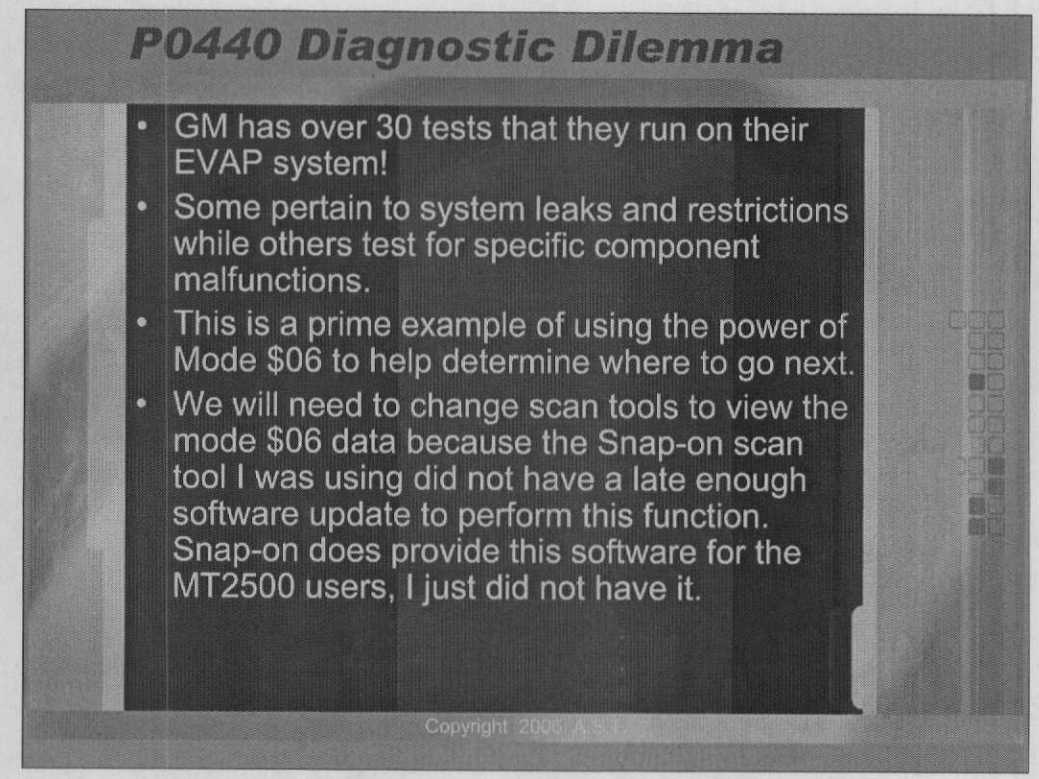
Mitchell says to remove the fuel cap and read the fuel tank pressure/vacuum sensor.

Ours is reading a negative value (-0.27"H20) or no vacuum present .

What could be causing this? At this point in our diagnostic procedure several things could cause our reading not to have a pressure value. A bad gas cap could be the cause but is very unlikely since it is new. Any other form of a severe leak in the system, a faulty PCM, Wiring or pressure sensor are all possibilities that we must rule out one at a time until there is only 1 possibility left!

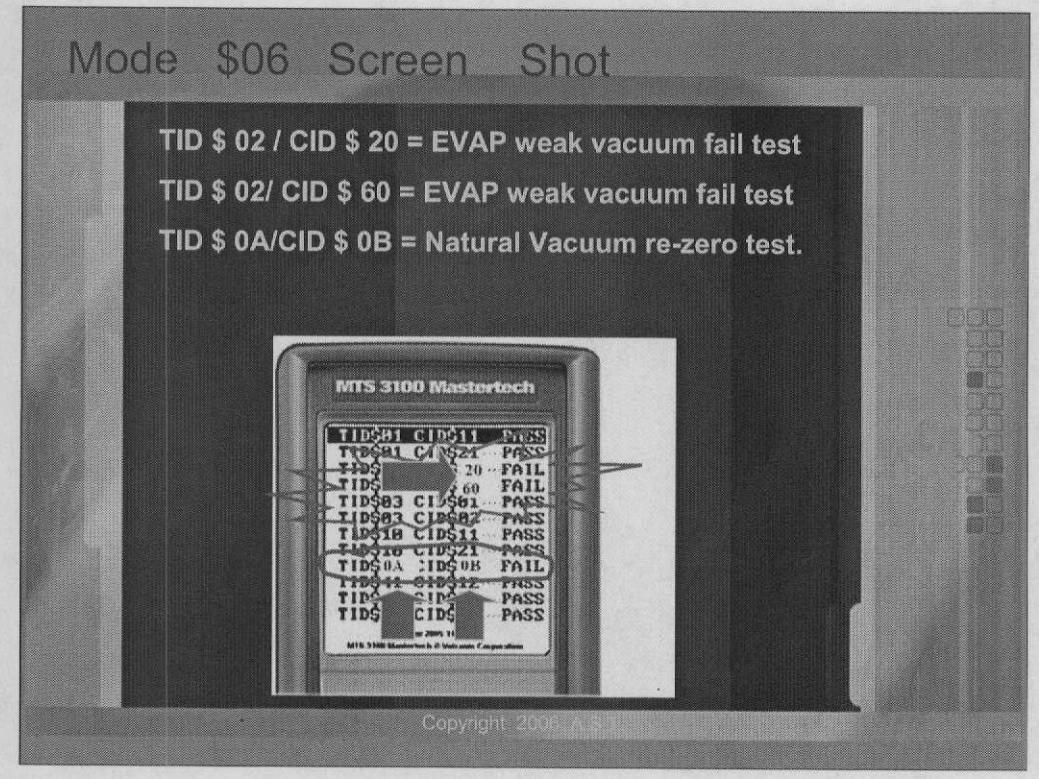


I figured the best place to start was to perform a system seal test using my scan tool and also monitoring the fuel tank pressure sensor for any changes over time. When I performed the system seal test I noticed that the value of the fuel tank pressure sensor did not change no matter what I did. Example: shake vehicle etc…



I started to tell you that the P0440 DTC is my personal least favorite of all trouble codes to diagnose. The reason I hate this code so much is because there are several things that can cause this code to set, not just a faulty gas cap!

GM has more than 30 different tests they will use to test the EVAP system's integrity. A great deal of these tests will pertain to vacuum or pressure problems, but some of them test the circuit and or components that make up the EVAP system. This is where Mode $06 really shines! We can view the data stored in Mode $06 to help determine where we should begin our diagnosis. We will need to change our scan tool however, since my MT2500 does not have new enough software to be able to read Mode $06 data. I never purchased it since I also currently own the Modis and Solus versions of their tools.



The Mode $06 information has proved to be a real asset! We have three different failures present, which pertain to the EVAP monitor.

TID $ 02 / CID $ 20 = EVAP weak vacuum fail test:

This is a test that will check for the system's ability to build vacuum over time.

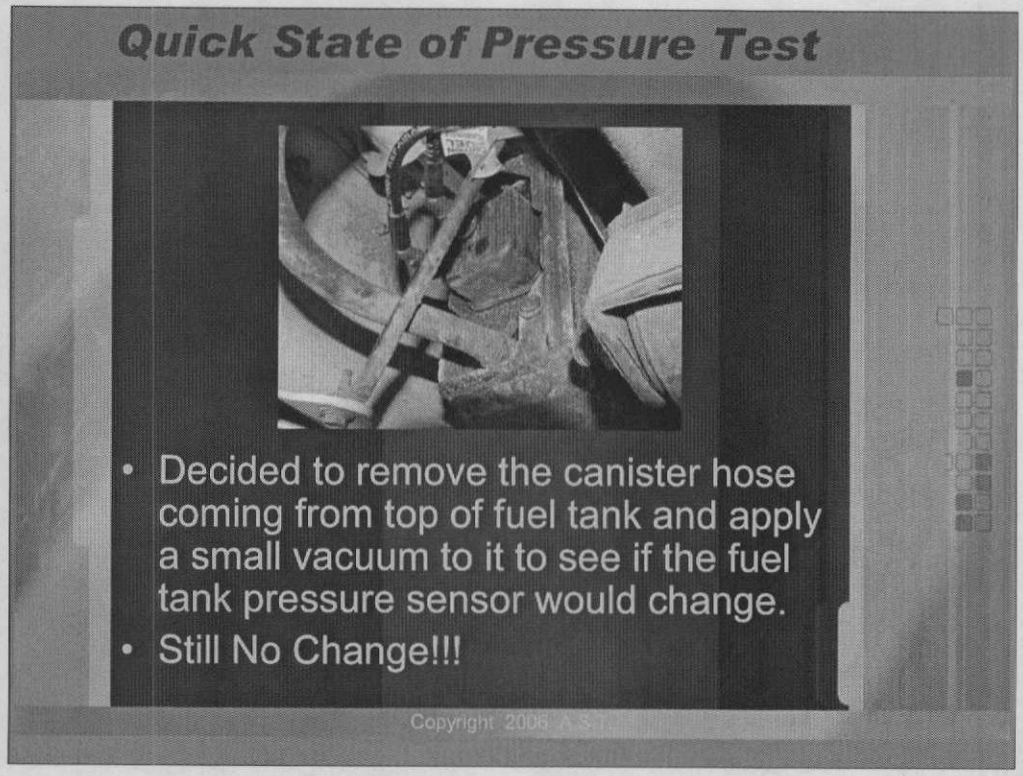
TID $ 02/ CID $ 60 = EVAP weak vacuum fail test :

This is a test that will check for the system's ability to build vacuum over time.

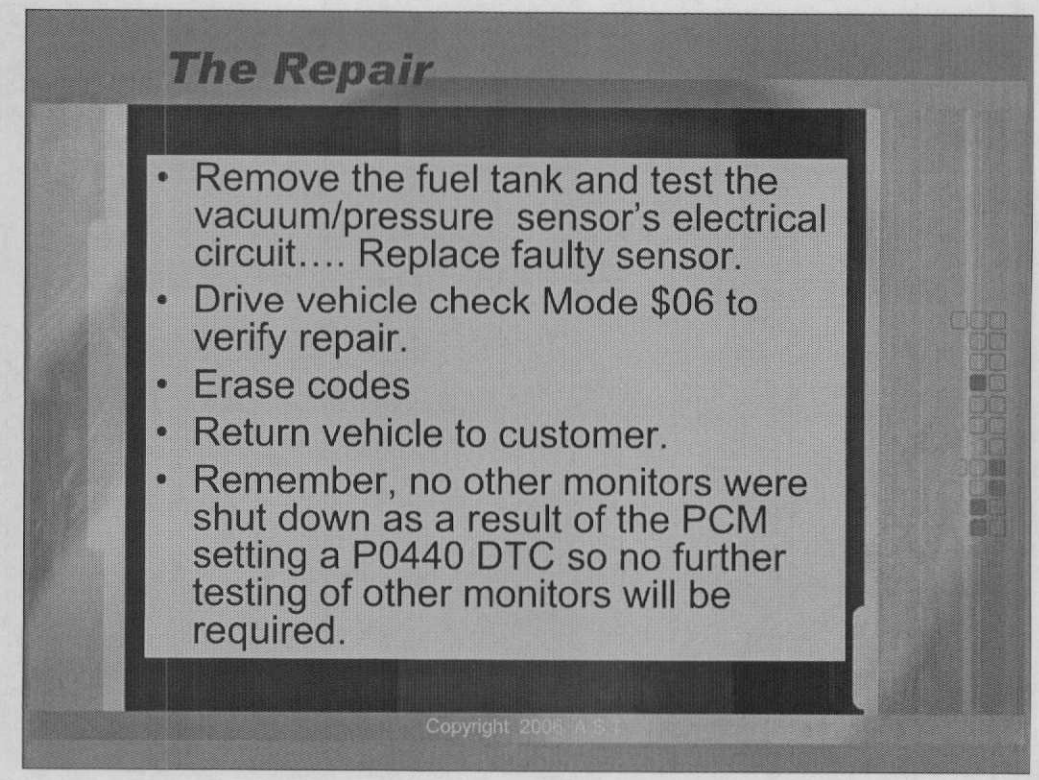
TID $ 0A/CID $ 0B = Natural Vacuum re-zero test:

This is a test that is used to by the PCM to make sure that system has the ability to set a zero level starting point.

After looking at the information above, I decided that we most likely were not dealing with a leak in the system. Instead we may be dealing with an out of calibration condition, thus instead of attaching a smoke machine and looking for a leak, I decided to pursue the reason for the system not being able to re-zero itself. This is information/guidance that I would only have obtained using Mode $06!

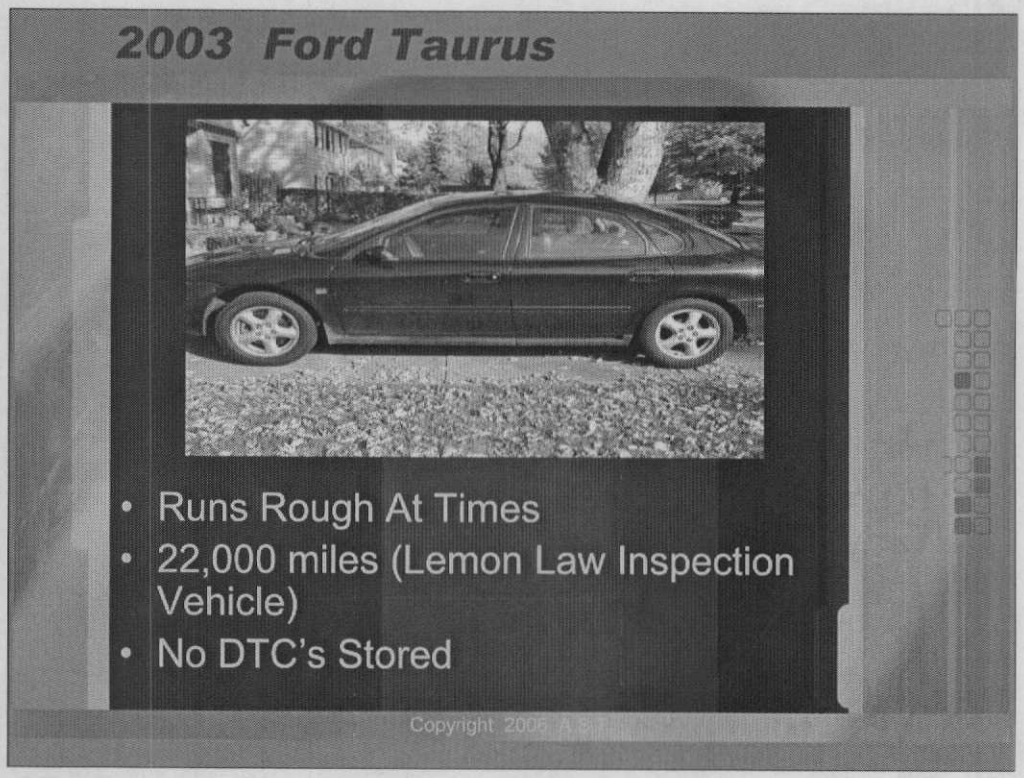


The quickest way to start gathering the information I was looking for was to raise the vehicle and remove the line that comes from the top of the fuel tank to the canister. I still had a scan tool displaying the pressure sensor reading and I tried to supply a small amount of vacuum to the line to see if I could get the reading on the scan tool to change. I still had no change from the fuel tank pressure sensor!



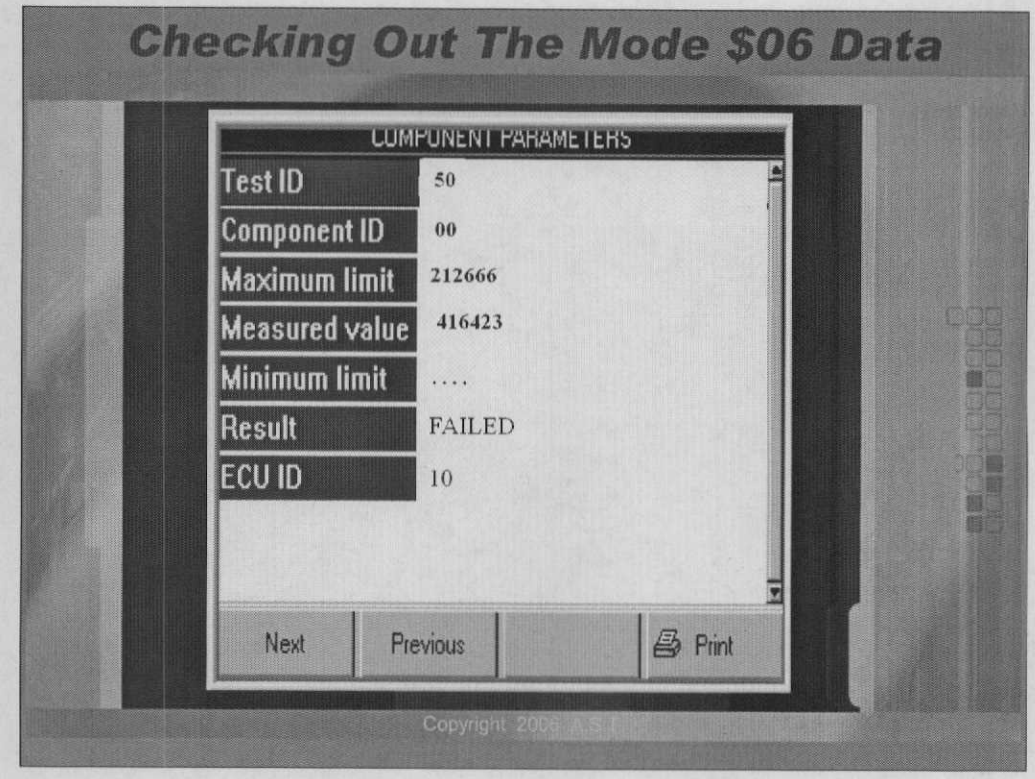
At this point I decided I needed to remove the tank and perform some circuit and component testing on the fuel tank pressure sensor itself. I was able to determine that the circuit was fine and that the sensor itself had failed. Replacing the sensor had successfully repaired this vehicle.

Without being able to view the Mode $06 data, I could have literally spent hours trying to diagnose a leak in this vehicle. No amount of smoke machine testing would have been able to diagnose this condition. Once we were able to see that the Mode $06 data was pointing us in the direction of a calibration problem, we were able to quickly narrow the possibilities to things such as a re-flash, Circuit problem or a faulty component. This is a great example of how to use Mode $06 to cut the amount of time it takes to diagnose vehicles.

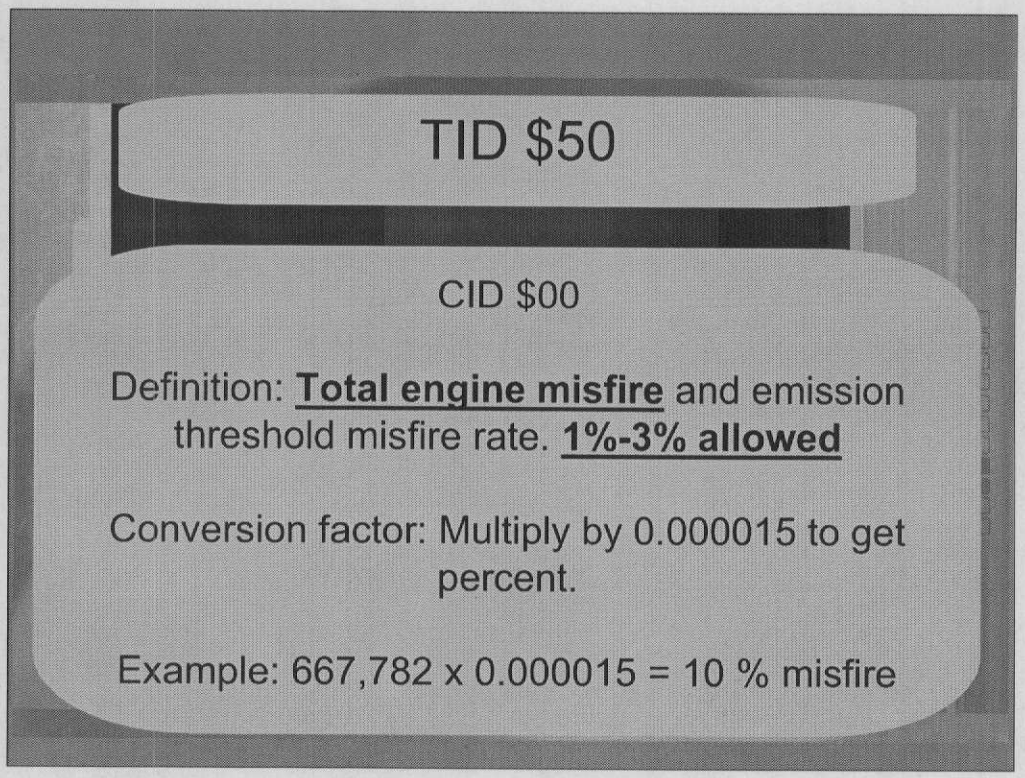


This next vehicle was a relatively new car that the customer was involved with a lemon law suit against the manufacturer. The customer had several complaints ranging from braking problems and suspension noise, to an intermittent rough running engine. The vehicle was taken back to the dealer several times to try to cure these conditions, but every time they got the vehicle back it would still run rough intermittently.

The vehicle had no stored DTC's and obviously had relatively low mileage. When I first test drove the vehicle it ran fine and I honestly thought I may not find anything wrong with this vehicle. I decided to take a quick look at the data stream at items such as fuel trim in an effort to get some sort of clue as to what could be wrong. All PIDS appeared to be in order…



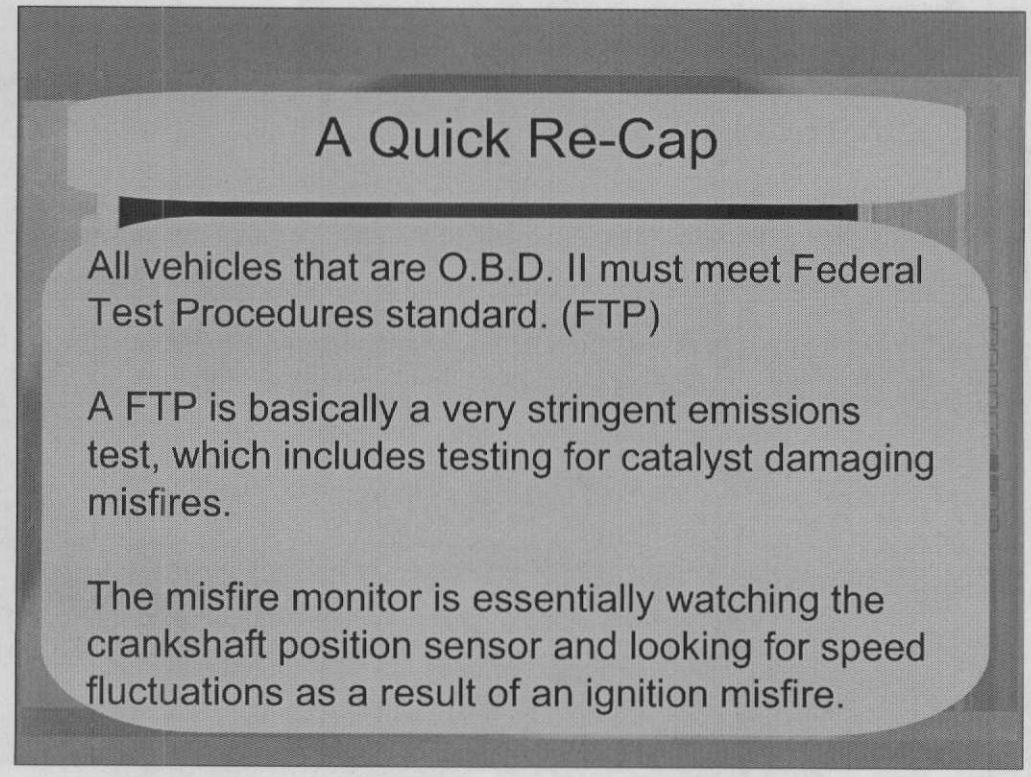
I decided to take a quick look at the Mode $06 data to try to obtain any sort of clues. Honestly, I did not feel that I would find anything. Just then I saw that the Test ID for the total engine misfire threshold had failed its test. I now started to feel confident that this vehicle would be repaired.



Test ID 50 is Ford's total engine misfire test found within Mode $06. This test is usually the first to fail when a misfire is present. Eventually, we would fail a specific cylinder misfire test and thus begin to set diagnostic trouble codes. Ford has a testing procedure which allows approx. 3% total misfire to accommodate things such as road terrain etc.

We must remember to use the conversion factor that Ford gives us to determine the total **percentage** of engine misfire. Our current reading was 416423 x 0.000015 = 6.2% misfire present. Since this is nearly doubling the maximum allowable threshold limit, the PCM has failed this test ID.

At this point we now know that the customer is not lying or trying to get out of their car payment. Now all we have to do is figure out what is causing this to happen.

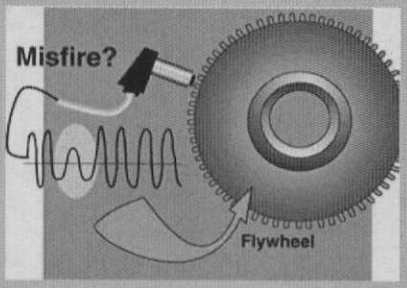


A quick re-cap of why we even need the misfire monitor is in order. All OBD II vehicles need to pass a Federal Test Procedure, which is basically a glorified emissions test whose main focus is to identify potentially damaging catalyst conditions.

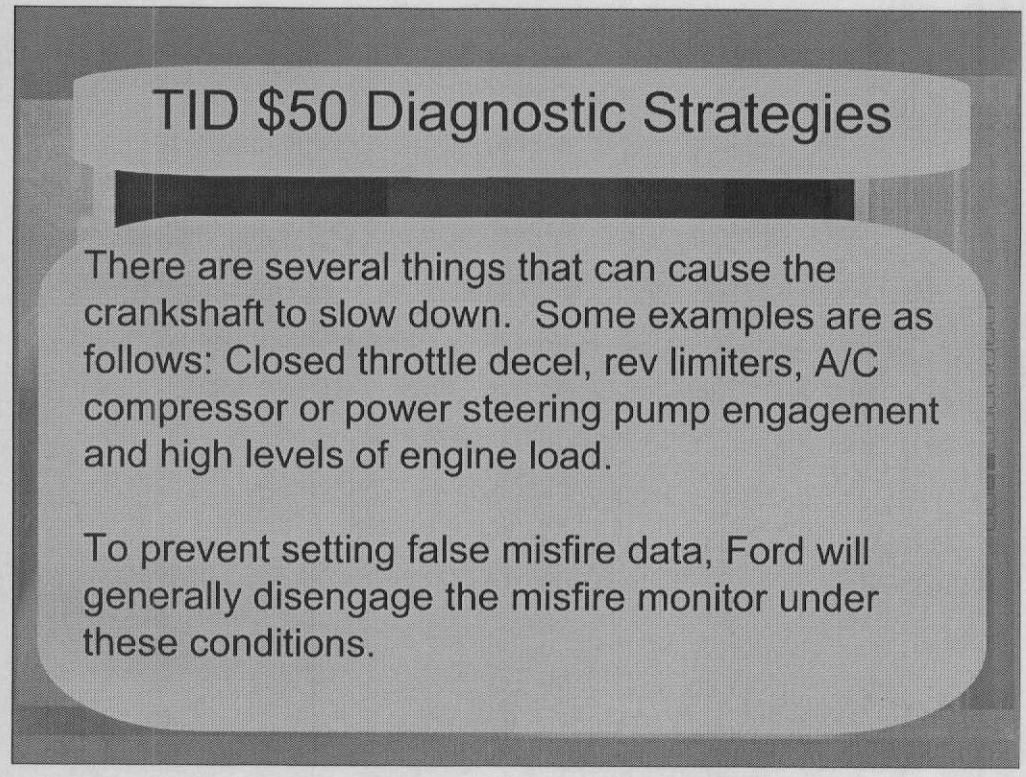
Misfires, above all else will damage the catalytic converter more so than any other condition! The misfire monitor will essentially detect cylinder misfires by monitoring the RPM of the crankshaft.

TID $50 Diagnostic Strategies

Anytime a misfire occurs, the crankshaft will slow down momentarily thus causing the CKP sensor's amplitude to drop. Refer to photo below.

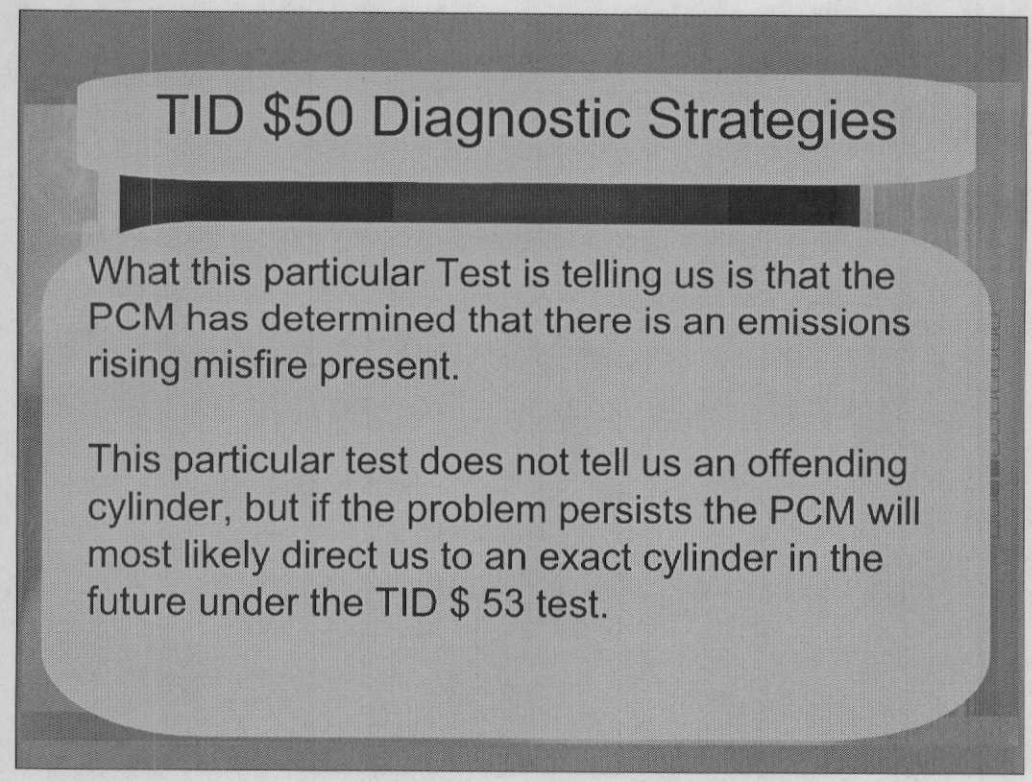


The PCM will monitor crankshaft speed by sampling the waveform emitted by the Crankshaft position sensor. Anytime a misfire occurs the crankshaft position sensor will produce a smaller amplitude signal. Since several things can cause the crankshaft to slow at times, the PCM will also generally look to the O2 sensor when it suspects a misfire is present. Remember, if a misfire did indeed occur, the exhaust will have a high level of oxygen since it did not get burned through the act of combustion.



There are several things that can cause the crankshaft to slow down. Some examples are as follows: Closed throttle decel, rev limiters, A/C compressor or power steering pump engagement and high levels of engine load.

To prevent setting false misfire data, Ford will generally disengage the misfire monitor under these conditions so as not to set any false misfire DTC's.



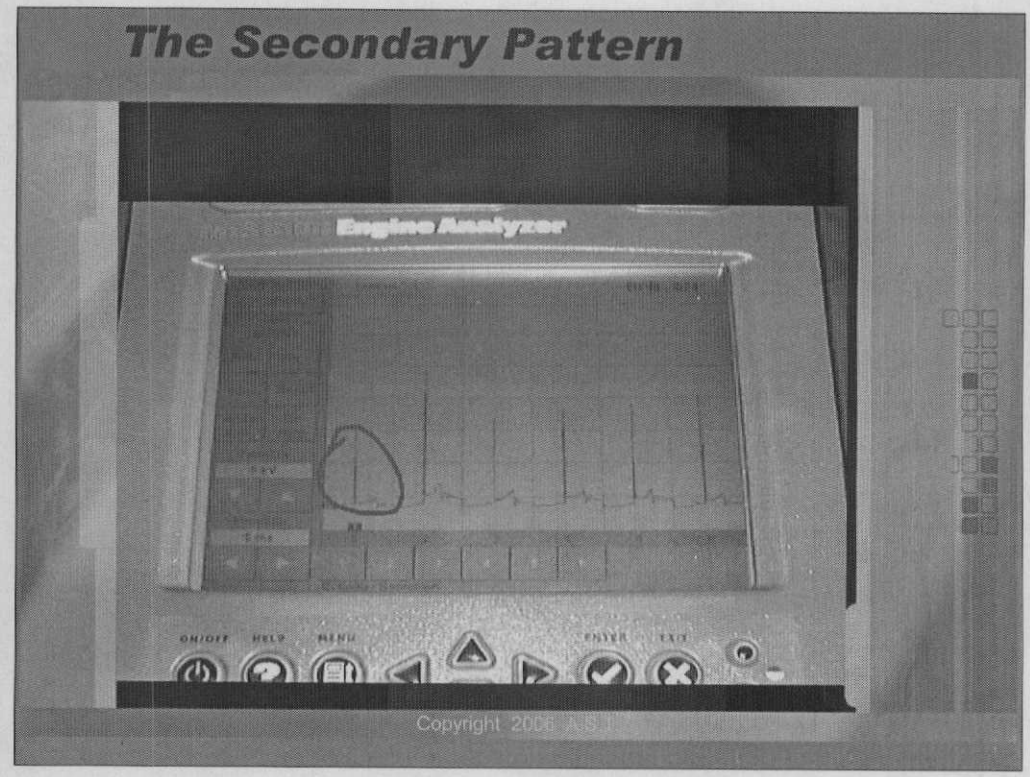
On Pre-C.A.N. vehicles the specific cylinder misfire test is either a TID 53 or a TID 51. Can vehicles will use letters in their TID. The specific cylinder will be identified by a CID 0-12 for the offending cylinder.

TID $50 Diagnostic Strategies

Possible causes:

1) Faulty spark plug
2) Faulty plug wire
3) Faulty coil/s
4) Cam/Crank re-learn out of synch. (use scan tool to re-set)
5) Mixture problems
6) Etc.. (diagnose this like any other misfire you have had in the past)

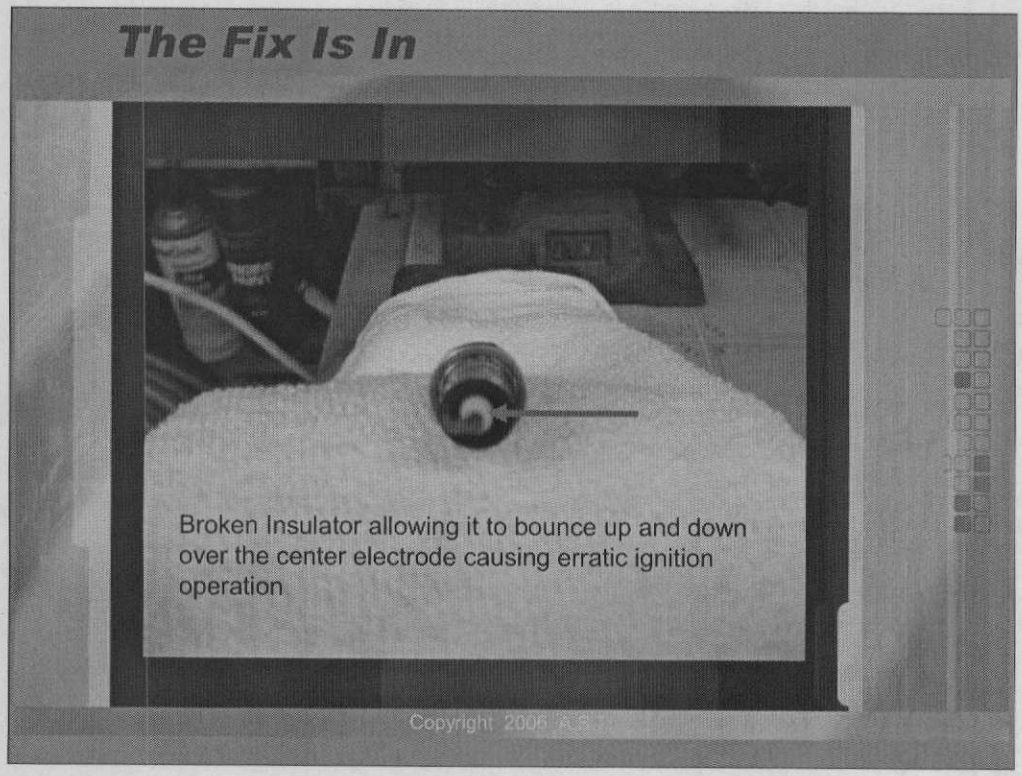
Diagnosing ignition misfires is really nothing new. All of the items listed above are examples of things that could cause a misfire to occur. Remember I stated earlier that I was not able to see any indication of a fuel system problem so I then decided I would warrant taking the necessary steps of hooking up an ignition scope to see if the ignition pattern could shed any light on the problem. I first however wanted to check for any possible TSB related fixes or re-flashes that might pertain to this condition. I was unable to find any bulletins relating to this type of complaint.



Once I had the ignition scope attached I initially saw nothing wrong with the waveform. I needed to drive the vehicle under several types of load conditions before I could get the miss to occur. Once the miss was present, it would come and go sporadically even at idle.

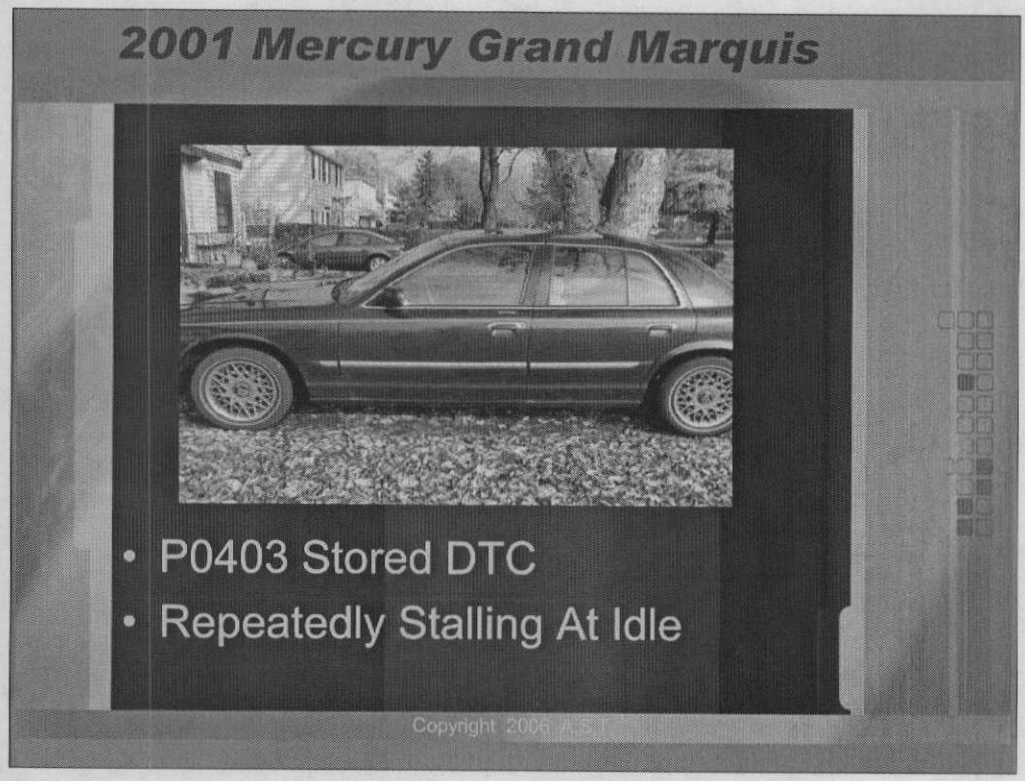
I was able to capture the misfire on the scope just as it was beginning to go away. What I saw was that cylinder #1's firing line would get less than 5 thousand volts and the spark line would show signs of a fouling plug at times. The other cylinder's would typically have about 12-15 KV firing lines and fairly normal looking spark lines.

I could not believe that I would find a fouling spark plug on this cylinder because when the problem was not present, the pattern looked normal. I also did not see any other mixture related signs of how the plug would have gotten fouled in the first place. No matter what, I needed to remove the spark plug for closer inspection.



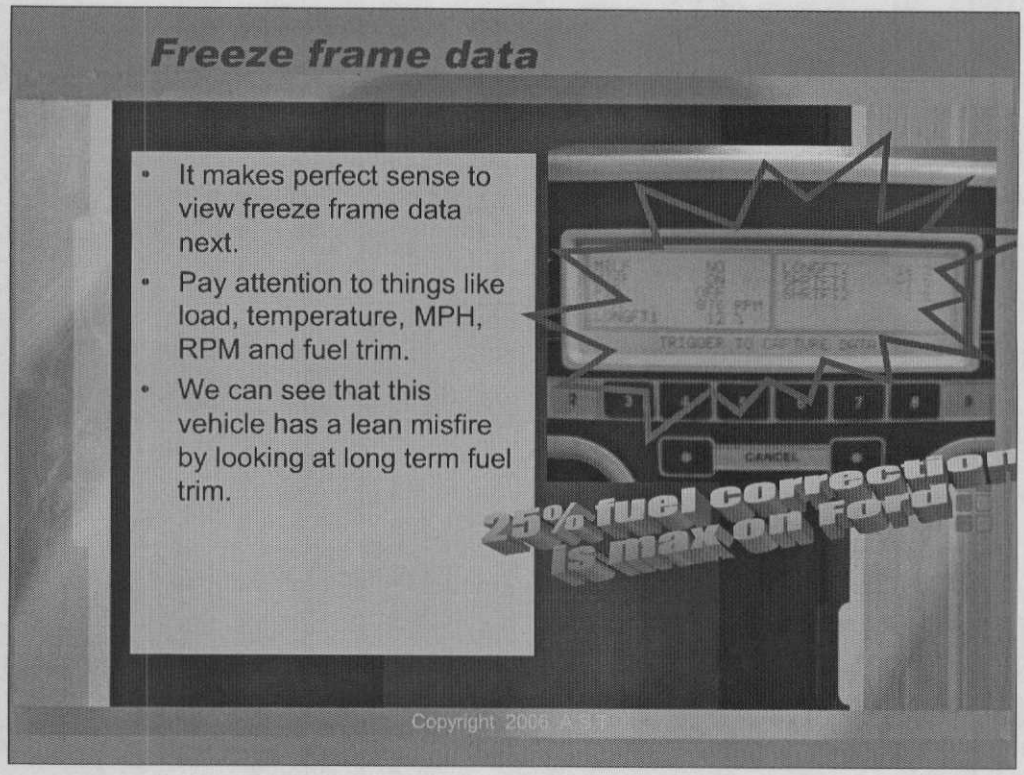
Shown above is the #1 cylinder's spark plug. It is a little difficult to see from the picture but what is actually wrong is the spark plug has a broken insulator allowing it to bounce up and down over the center electrode causing the erratic ignition operation. I have been working on cars for 25 years and in this amount of time I have seen this occur about 5 times. These can be real hair-pullers to find because unless you are conditioned to turn the plug upside down and slightly tap it, you may not see the electrode get covered up.

I think I can honestly say that if it weren't for Mode $06, I probably would not have taken the amount of time I did to locate the problem with this vehicle. I probably would have just chalked it up to a customer wanting to get out of their high car payment. This proved to me again, the value of using every form of diagnostics I have available to me, and especially Mode $06!

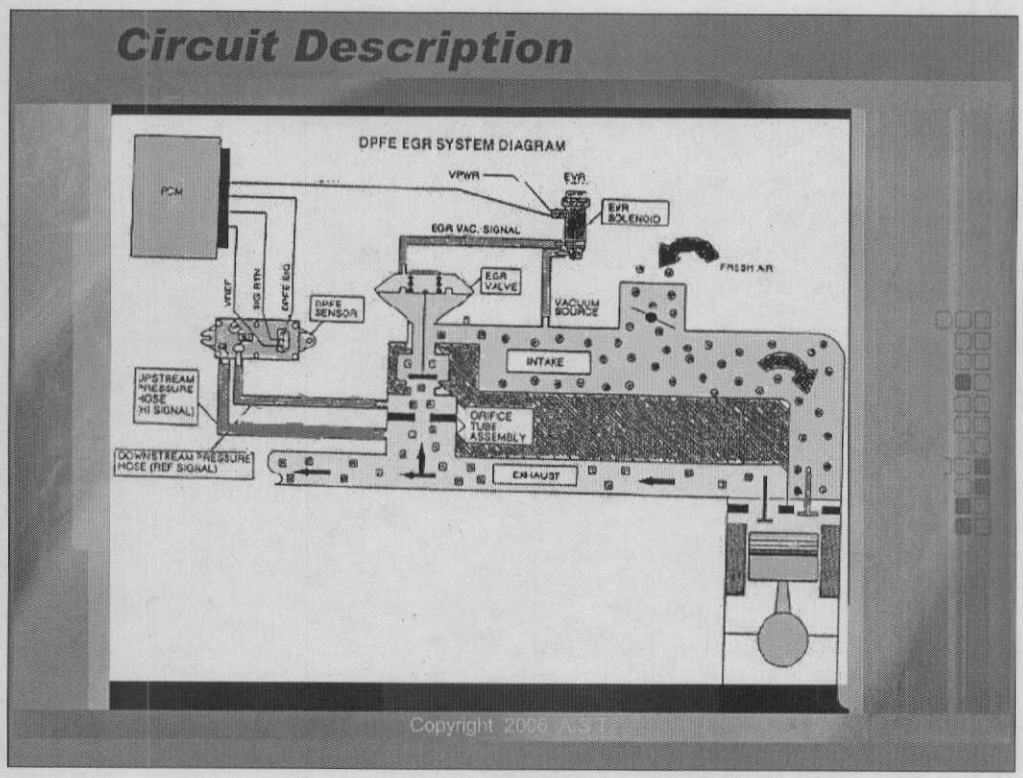


This next vehicle was an 01" Mercury that would not idle. We had a P0403 trouble code stored in the PCM's memory. This code represents a malfunction in the EGR's solenoid circuit. This code sets when the system is not in the correct state when the PCM is trying to run the EGR test. This can be caused by many things but with the complaint at hand, we would probably suspect a hanging open EGR valve due to carbon build-up or other debris.

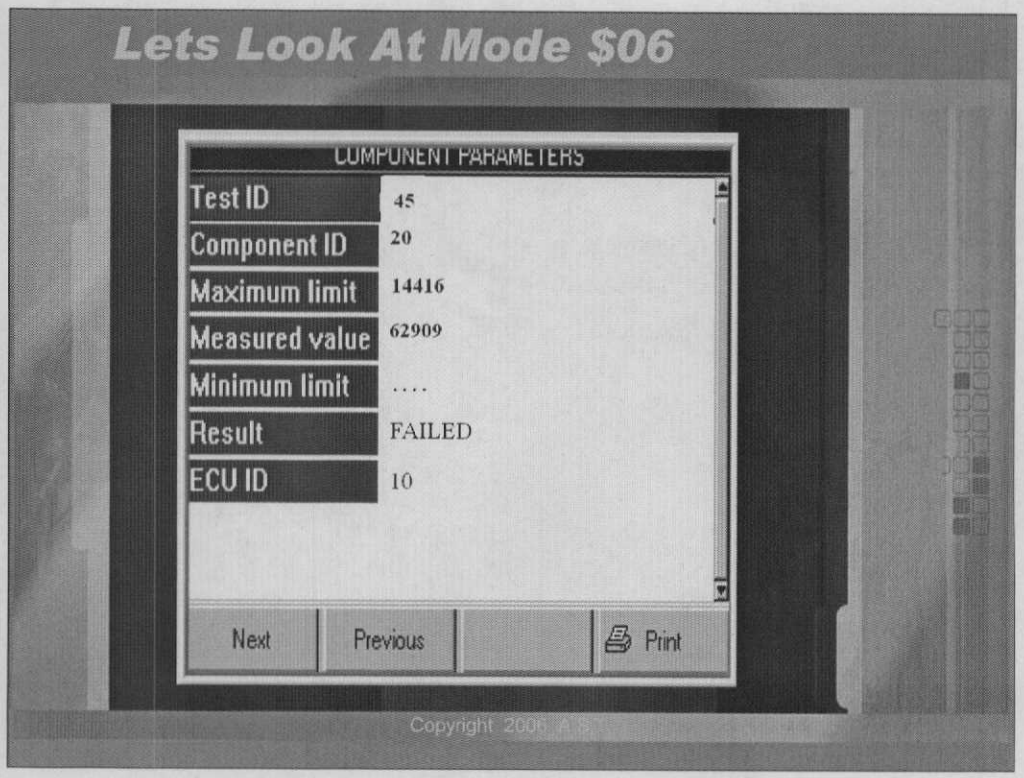
Once this code sets in the computer's memory, the PCM will typically abort running the EVAP monitor so be sure to use Mode $06 to check the EVAP circuits once we have completed repairing this vehicle. Ford's EVAP monitor's test ID for this vintage vehicle is any of the 20" series TID's.



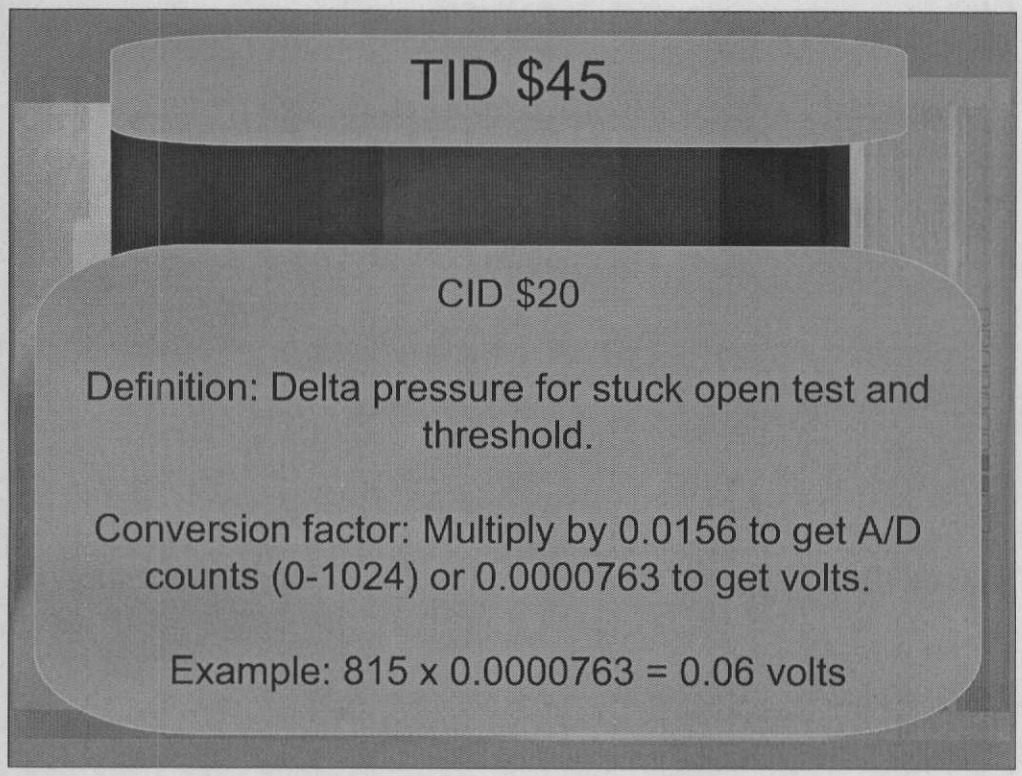
If we are right in our assumption that the EGR is stuck open, we should see our fuel trim counts subtracting fuel due to the rich exhaust since the combustion chambers are full of exhaust gasses and very little oxygen. When we look at the freeze frame information, we can clearly see that the fuel trim values are as high as – 16 %! Remember when we are viewing data stream on the factory side of Ford vehicles, our fuel trim scale goes from 0-25% not the 0-100% that we are used to when viewing Generic OBD II.



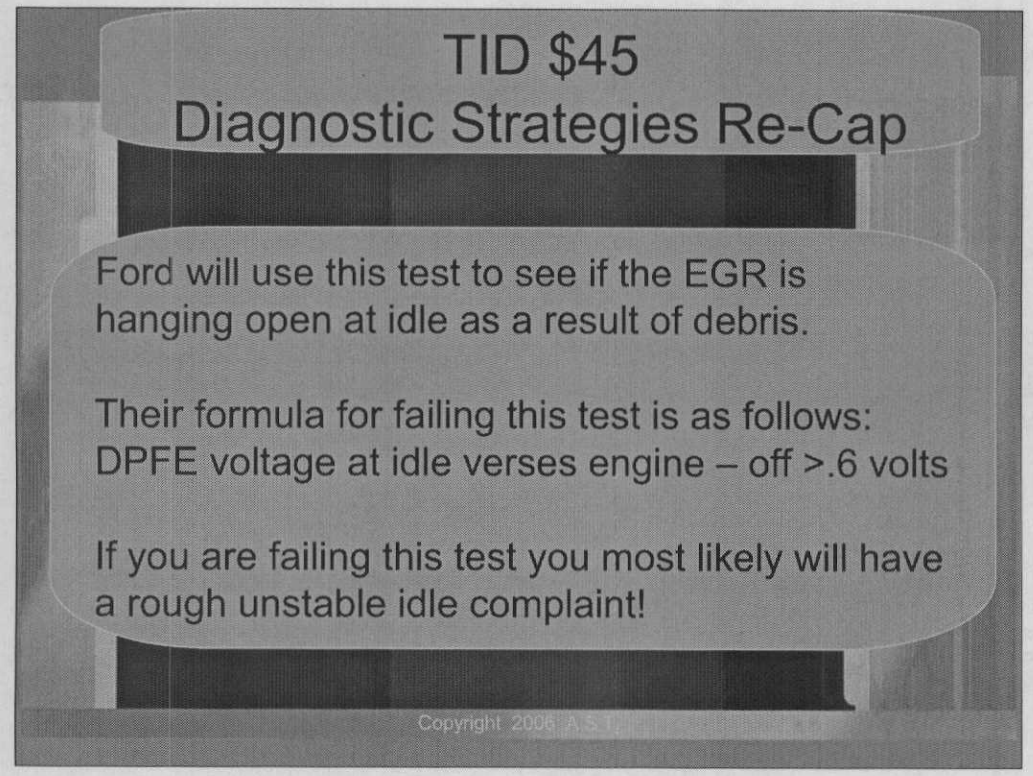
Lets take a break for a quick explanation of the Ford EGR circuit. This circuit will supply a full time vacuum source to an electronic vacuum regulator. This vacuum is normally bled to the atmosphere except when the PCM commands it to be sent to the EGR. When the EGR opens, if the passages are free from restriction the back pressure in the exhaust should drop. The PCM will measure the back pressure with a delta pressure feedback EGR sensor that is attached directly to the exhaust. It will sense the amount of backpressure and send its value back to the PCM to be used to determine if the EGR is open/closed and if the circuit is flowing enough EGR when it is opened. This is a very thorough test and it really works well.



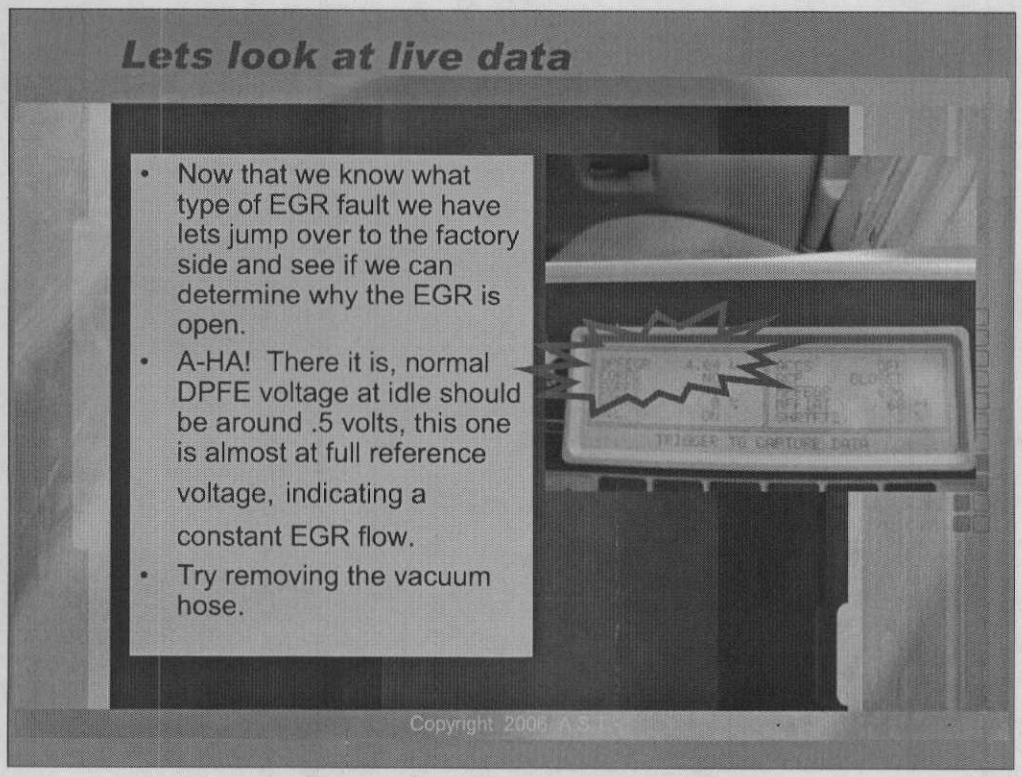
Looking at the Mode $06 information on our scan tool, we see that the PCM has flagged the Test ID 45 as failed. TID 45 and CID 20 is the computer's test for a stuck open EGR valve. The test expects to see a voltage of less than .6 volts from the last reading it seen with the key on and engine off. If the voltage is higher, than it can safely assume there is a stuck open EGR valve present causing the voltage difference.



In order to convert the reading we had on our Mode $06 screen to something more user friendly (volts), we need to perform the conversion as listed above. Our reading was 62909 x 0.0000763 = 4.8 volts! Wow, I can see that this EGR is nearly stuck open 100%. Either there is a great deal of carbon in this engine or we have another cause for the EGR hanging open.


TID $45
Diagnostic Strategies Re-Cap
Ford will use this test to see if the EGR is hanging open at idle as a result of debris.
Their formula for failing this test is as follows:
DPFE voltage at idle verses engine – off >.6 volts
If you are failing this test you most likely will have a rough unstable idle complaint!
Copyright 2006 A.S.T.

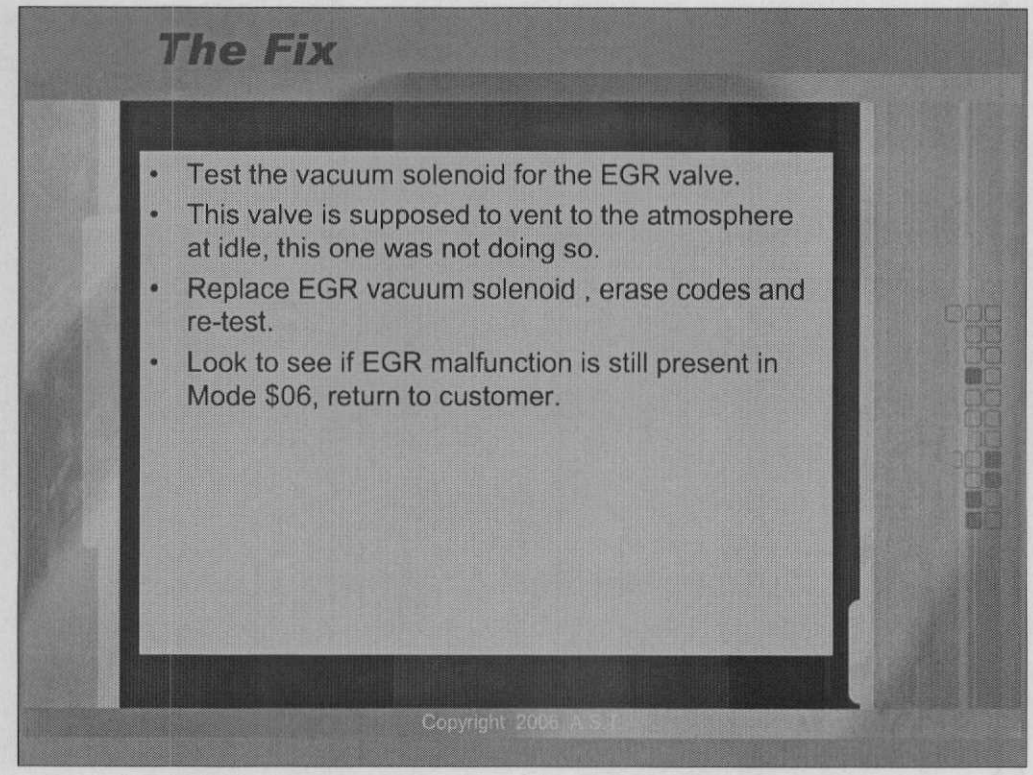
Notes



Now that we know what type of EGR fault we have lets jump over to the factory side and see if we can determine why the EGR is open.

A-HA! There it is, normal DPFE voltage at idle should be around .5 volts, this one is almost at full reference voltage, indicating a constant EGR flow.

At this point it is fairly easy to remove the vacuum hose from the EGR valve to see if this allows the valve to close. We could also lightly tap on the EGR valve itself to see if it closes. If it closes when we tap on it, then that is a good indication of carbon/debris. If it closes when the hose is removed, that is telling us the problem is with the EVR solenoid or PCM / Wiring. It could also be an indication of misrouted vacuum hoses.



We then compared the vacuum hose routing to the vacuum schematic located under the hood, they matched to a tee!

We then manually unplugged the electrical 2-wire connector at the EVR solenoid and the EGR was still stuck open. This should rule out the possibility of a bad PCM or a wiring problem.

Remember we said that this component is supposed to vent to atmosphere at idle. This one was not doing so. We could not find anything restricting the component's vent or filter, it just decided it was done venting.

The cure for this vehicle was to replace the EVR solenoid. Remember to use Mode $06 to verify this repair as well as to verify no problems in the EVAP monitor which was shut down as a result of setting this code.

We purposely chose a relatively easy complaint for the last case study just to show you that Mode $06 can be used to not only diagnose troublesome vehicles, but to also allow you to use it to verify your thoughts as you proceed through your diagnostic process!