In this industry, it seems the more things change, the more they stay the same. As technology accelerates, so does the need for technicians to stay updated with all facets of the systems and subsystems on today’s vehicles.

Here at ATRA, we constantly strive to provide you with the information you need to stay abreast of those changes. Our close relationship with the OEMs allows us to provide you with the information you need to repair today’s vehicles the first time they come into your shop. If you haven’t attended this year’s seminar, you don’t know what you don’t know.

One of the technology updates released for 2005 and covered in this year’s seminar is the GM DOD (Displacement On Demand) system. Like several other advances in technology, DOD is really nothing new. Those of you old enough may remember the Cadillac system of the late 70s and early 80s: the 8/6/4.

As in the 70s and 80s, fuel economy is becoming an ever more important feature for today’s cars and trucks. DOD is touted as being able to raise fuel economy by as much as 25%. In reality, the numbers are closer to 8-14%, but that’s still a significant gain in fuel economy.

DOD was introduced on the 5.3L V-8 (RPO LH6 VIN code M) used in the Chevrolet Trailblazer EXT, GMC Envoy XL and the XUV. The Buick Rainer has the hardware, but the DOD feature has been electronically disabled for 2005.

The LH6 5.3L engine is new for 2005 and contains these features:
• Electronic throttle control
• All aluminum construction, new block with relocated sensors (Cam and Knock sensors), and special oil passage castings
• High capacity oil pump
• 9.95:1 compression ratio
• Coil-near-plug ignition
• VLOM (Valve Lifter Oil Manifold)
• Special DOD lifters for cylinders 1, 4, 6 and 7
• E40 ECM and updated engine wiring harness
• DTCs added for DOD components
• Standalone TCM for transmission operation
• Return-less fuel system
• Firing order 1-8-7-2-6-5-4-3
• Brake booster vacuum sensor added

**DOD System Operation**

The ECM controls a series of solenoids mounted on the Valve Lifter Oil Manifold. The Valve Lifter Oil Manifold is an electrohydraulic actuator which houses the DOD solenoids and the hydraulic passages that control oil feed to the DOD lifters. The solenoids are either on or off, and are normally closed in design (figure 1). The Valve Lifter Oil Manifold is bolted to the top of the engine block and directs oil pressure into the special valve lifters on cylinders 1, 7, 6, and 4 (figure 2). The DOD lifters are used on both the intake and exhaust valves for the DOD cylinders.

When commanded on (DOD active), the ECM grounds every other cylinder solenoid in the firing order (figure 3); 1, 3, 7, 6, 4 (4-cylinder mode), starting with the exhaust valve for the next DOD cylinder in the firing order. With the solenoid driver circuits grounded, the pressurized engine oil flows through the Valve Lifter Oil Manifold into eight vertical passages in the lifter valley. This action allows oil pressure to force the lock pins within the lifter to move upward, unlatching the lifter.

With the lifter in the active position, the outer lifter body is allowed to move up and down while the inner lifter remains stationary. With the inner portion of the lifter stationary, the valve won’t open, although the lifter will...
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Displacement On Demand (DOD) maintain contact with the pushrod and camshaft.

By deactivating the exhaust valve first, the burned air/fuel charge is trapped in the cylinder. This action reduces noise, vibration levels, and oil consumption. Switching between V-4 and V-8 modes is accomplished in less than 250 milliseconds. In addition to closing the valves for the DOD cylinders, the fuel injectors are also disabled for the DOD cylinders. The ignition system is allowed to function even when DOD is active.

With DOD commanded off (DOD inactive), the oil pressure is removed through bleed passages in the Valve Lifter Oil Manifold. With pressure exhausted, the two lifter bodies become locked together, allowing the valves to open. With DOD disabled, the engine will return to the 8-cylinder mode. DOD is capable of deactivating within two revolutions of the crankshaft. DOD can remain active for up to 10 minutes of continuous operation. After operating for 10 minutes, DOD will be disabled for one minute before reactivating for another 10 minutes of continuous operation. There are no indicator lamps to tell the driver when the system is operating. If DOD is functioning correctly, system operation should be transparent to the driver.

The ECM is in charge of DOD operation. To activate DOD, these criteria must be met:
- Transmission in 3rd or 4th gear
- Engine oil pressure between 25-75 PSI
- Engine speed 900-3000 RPM
- Engine oil temp between 20º-150º C (68º-302º F)
- Engine load steady
- Battery voltage 11-18 volts

DOD will be disabled if:
- Engine vacuum is low
- Brake booster vacuum is low
- APP rate of increase is too high
- Ignition voltage is out of range
- Transmission shift is in process
- Decel fuel cut active
- Minimum heater temp is too low (HVAC)
- ECM operating in reduced power mode
- Brake torque management is active

- Piston protection mode is active (detonation)
- Catalytic converter over-temp mode is active
- Hot coolant mode is active
- Engine overspeed cut is active
- Transmission range is incorrect
- MAP, BBV, EOP, ECT, VSS, Misfire, CKP, or DOD trouble codes are set.

**Diagnosing the DOD System**

As with other systems on today's vehicles, scan data is available to make diagnosis a little easier. DTCs are used to isolate DOD circuit and solenoid electrical problems. Four DTCs are available:
- P3441 — cylinder #3 solenoid circuit
- P3442 — cylinder #2 solenoid circuit
- P3443 — cylinder #1 solenoid circuit
- P3449 — cylinder #4 solenoid circuit

Scan data can be used to monitor the operation of the DOD system. The scan data will include information such as:
- DOD commanded position
- DOD solenoid circuit feedback status
- Distance driven with DOD active and inactive
- Brake booster vacuum
- Valve Lifter Oil Manifold (VLOM) oil pressure

Like other systems on today's vehicles, diagnosis must start with the basics. Now the basics not only include the electrical system, but also the engine oiling and mechanical systems.

A special tool (Part # EN-46999) is available to allow you to interface with the DOD solenoids and Valve Lifter Oil Manifold. Using the tool and a digital multimeter, the resistance for each solenoid should measure between 11-18 ohms.

Oil pressure is tested by measuring the oil pressure available at the Valve Lifter Oil Manifold and oil pressure available at the filter. To check the Valve Lifter Oil Manifold pressure, install a gauge at the rear of the Valve Lifter Oil Manifold in place of the oil pressure sensor. Install another pressure gauge in place of the oil filter. Compare the two readings; they should be the same.

Doing a compression test is part of a functional test for the Valve Lifter Oil Manifold and the lifters. When the DOD is activated with a bidirectional scan tool, compression won't develop within the cylinder. As DOD is deactivated, compression should build within the cylinder. Typically the engine should be running when you activate and deactivate the DOD for the compression test (running compression test). If all cylinders build to a minimum of 50 PSI, and exhaust pressure is less than 25 PSI, the system is functioning correctly.

Another test that can be performed is a flow test of the Valve Lifter Oil Manifold. This can be accomplished by using the special tool (EN-46999) and shop air pressure. When you energize the solenoids, air will flow from the solenoid exhausts; de-energized the solenoids should prevent flow.

As you can see, the DOD system isn't really something to be intimidated by. With some basic understanding of system operation and diagnosis, you can tackle this system with confidence. Until next time, keep the shiny side up and the rubber side down.
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Panel of Speakers

Phillip S. Landis, Ph.D.
Employed by Mobil Research and Development Corporation for 37 years, Dr. Landis currently holds more than 60 patents and has published extensive works in major technical chemistry journals.

Ph.D. - 1958
Northwestern University and M.S. Organic Chemistry - 1947
University of Kentucky and B.S. Chemistry - 1943
Franklin and Marshall College

Sam Memmolo
Sam is an ASE Master Auto Technician certification with Advanced Drivability rating.

Sam Memmolo is best known for his television and radio productions including 'The Car Show', 'Sam's Garage Radio Show', 'Shadetree Mechanic', and 'Crank and Chrome'. Sam can also be seen on 'My Classic Car'.

Patrick Burrow

Burrow served as Lubrication Technologist at Perkin Elmer Automotive Research (formerly E.G. & G. Automotive Research) for over 23 years. Perkin Elmer was one of only two labs in the world approved by GM and Ford to conduct testing necessary for qualification as an approved ATF fluid for DEXRON® and MERCOR® specifications.

Burrow was certified to conduct "shift feel" evaluations for DEXRON ATF specification. He was also responsible for monitoring and conducting wear, friction and oxidation tests for G.M./Ford qualification for the DEXRON/MERCOR ATF specifications. Since 2003, Burrow has headed up Technical Department at International Lubricants in Seattle.

B.S. - 1979
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