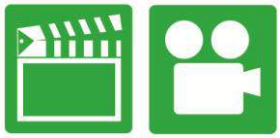
Advanced Engine Performance Diagnosis 6/E

Chapter 29 Emission Control Devices OP & SVC

Opening Your Class

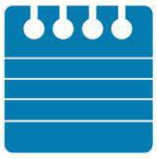
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **ADVANCED Automotive Engine Performance Diagnosis 6/E.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. 1. Prepare for the ASE Engine Performance (A8) certification test content area "D" (Emission Control Systems). 2. Describe the purpose and function of the exhaust gas recirculation (EGR) system. 3. Explain methods for diagnosing and testing for faults in the exhaust gas recirculation system. 4. Describe the purpose and function of the positive crankcase ventilation (PCV) and the secondary air-injection (SAI) reaction systems. 5. Explain methods for diagnosing and testing faults in the PCV and SAI systems. 6. Describe the purpose and function of the catalytic converter. 7. Explain the method for diagnosing and testing the catalytic converter. 8. Describe the purpose and function of the evaporative emission control system. 9. Discuss how the evaporative emission control system is tested under OBD-II regulations. 1 10. Explain methods for diagnosing and testing faults in the evaporative emission control system.
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on Advanced Engine Performance Diagnosis 6/E Chapter Images found on Jim's web site @ www.jameshalderman.com
LINK CHP 29: Chapter Images

ICONS	Ch29 Emission Control Devices OP & SVC
	**1. SLIDE 1 CH29 Emission Control Devices OP & SVC**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE REGULARLY UPDATED** **Engine Controls (284 Links)**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**
	
	**2. SLIDE 2 EXPLAIN FIGURE 29-1** Notice the haze caused by nitrogen oxides that is often over many major cities. **EXHAUST GAS RECIRULATION, EGR**
	**DISCUSSION: DISCUSS HOW EGR SYSTEMS ARE DESIGNED TO RECIRCULATE EXHAUST INTO THE COMBUSTION CHAMBER. WHAT CONDITIONS MUST BE PRESENT TO ALLOW PROPER ENGINE OPERATION WHILE EXHAUST IS RECIRCULATED? FIGURE 29-1**
	**3. SLIDE 3 EXPLAIN Figure 29-2** When the EGR valve opens, the exhaust gases flow through the valve and into passages in the intake manifold
	**DEMONSTRATION: WHILE APPLYING VACUUM USING A HAND-HELD PUMP, OPEN & CLOSE A STANDARD EGR VALVE SO STUDENTS CAN SEE DIAPHRAGM & VALVE OPERATION. FIGURE 29-2**

ICONS	Ch29 Emission Control Devices OP & SVC
	**DEMONSTRATION: PASS AROUND VARIOUS EGR VALVES TO THE STUDENTS. POINT OUT POSITIVE AND NEGATIVE FIGURE 29-2 BACKPRESSURE STYLES AND HOW THEY VARY.**
	4. **SLIDE 4 EXPLAIN Figure 29-3** Back pressure in the exhaust system is used to close the control valve, allowing engine vacuum to open the EGR valve.
	**EXPLAIN TECH-TIP**
	5. **SLIDE 5 EXPLAIN Figure 29-4** Typical vacuum-operated EGR valve. The operation of the valve is controlled by the PCM by pulsing the EGR control solenoid on and off.
	**EGR VALVES CAN BE TESTED FOR LEAKAGE BY INVERTING AND SPRAYING CARBURETOR CLEANER INTO THE PINTLE VALVE. IF THE CARBURETOR CLEANER LEAKS PAST PINTLE, VALVE IS DEFECTIVE.**
	6. **SLIDE 6 EXPLAIN Figure 29-5** EGR valve position sensor on top of an EGR valve
	**DEMONSTRATION: PASS AROUND BOTH DIGITAL & LINEAR EGR VALVES FOR THE STUDENTS TO SEE. FIGURES 29-3, 4, & 5**
	**DEMONSTRATION: PASS AROUND VARIOUS TYPES OF EGR VALVE POSITION SENSORS FOR THE STUDENTS TO SEE. FIG 29-3, 4, & 5**
	7. **SLIDE 7 EXPLAIN Figure 29-6** Digital EGR valve as used on some older General Motors engines. 8. **SLIDE 8 EXPLAIN Figure 29-7** GM linear EGR valve
	**HANDS-ON TASK: HAVE STUDENTS GRADUALLY OPEN EGR VALVE WITH A HAND OPERATED VACUUM PUMP. HAVE THEM USE AN OHMMETER TO CHECK VALVE POSITION SENSOR RESISTANCE AT VARIOUS VALVE OPENINGS.**
	**DISCUSSION: DISCUSS THE DIFFERENCE BETWEEN LINEAR AND DIGITAL EGR VALVES. WHAT IS THE DIFFERENCE? FIG 29-6, 7, & 8**

ICONS	Ch29 Emission Control Devices OP & SVC
	**DISCUSSION:** DISCUSS & LIST POSSIBLE SYMPTOMS OF A MALFUNCTIONING EGR SYSTEM. WHAT DRIVEABILITY ISSUES COULD BE CAUSED BY TOO MUCH, OR INCORRECT, EGR FLOW OR TIMING? WHAT PROBLEMS CAN BE CAUSED BY NO, TOO LITTLE, EGR FLOW?
	9. **SLIDE 9 EXPLAIN FIGURE 29-8** DPFE sensor and related components 10. **SLIDE 10 EXPLAIN FIGURE 29-9** An OBD-II active test. The PCM opens the EGR valve and then monitors the MAP sensor and/or engine speed (RPM) to meet acceptable values.
	**DISCUSSION:** DISCUSS MALFUNCTIONING EGR SYSTEMS. WHAT PROBLEMS CAN BE ASSOCIATED WITH CONTROL SIDE OF EGR SYSTEM? WHAT PROBLEMS CAN BE ASSOCIATED WITH FUNCTIONAL SIDE OF THE EGR SYSTEM?
	**DISCUSSION:** DISCUSS VARIOUS TYPES OF WARNING LIGHTS THAT OEMS USE & SIGNIFICANCE OF THE AMBER COLOR. WHAT IS MIL & WHAT IS ITS COLOR?
	**DISCUSSION:** DISCUSS OBD II EGR MONITORS, SEE FIGURES 29-9 & 10. HOW ARE THEY USED IN DIAGNOSIS?
	**HANDS-ON TASK:** HAVE STUDENTS DISCONNECT EGR VACUUM HOSE ON A CAR AND DRIVE IT UNTIL IT MEETS ENABLING CRITERIA FOR EGR MONITOR TO RUN. CONNECT A SCAN TOOL & RETRIEVE DTC. IF MONITOR RUNS ONLY ONCE, DTC WILL BE STORED AS A PENDING CODE. IF THE MONITOR RUNS TWICE AND FAILS, A MATURED DTC WILL SET, AND THE MIL WILL BE ILLUMINATED.
	EXPLAIN TECH-TIP
	**DISCUSS REAL-WORLD TIP**

ICONS	Ch29 Emission Control Devices OP & SVC
	EXPLAIN TECH-TIP 11. SLIDE 11 EXPLAIN FIGURE 29-10 Removing EGR passage plugs from the intake manifold on a Honda
	**DISCUSSION: HAVE THE STUDENTS DISCUSS DETONATION. WHAT IS DETONATION AND HOW IS IT CAUSED? WHAT ARE ITS EFFECTS? WHAT KIND OF MECHANICAL DAMAGE CAN DETONATION CAUSE TO THE ENGINE?**
	**HANDS-ON TASK: HAVE THE STUDENTS LOOK UP OEM PROCEDURES FOR TESTING EGR SYSTEM ON THEIR OWN VEHICLES.**
	**SPEED-DENSITY FUEL SYSTEM MEASURES INTAKE MAP (VACUUM) CAN BE FOOLED BY A STUCK OPEN EGR VALVE. OPEN EGR VALVE ADMITS EXHAUST PRESSURE INTO INTAKE MANIFOLD, WHICH PCM MISINTERPRETS AS AN INCREASE IN ENGINE LOAD, DRIVING FUEL SYSTEM VERY RICH. ADDITIONAL FUEL WILL KEEP ENGINE RUNNING, ALTHOUGH POORLY DUE TO EXCESS EXHAUST. BLACK EXHAUST SMOKE CAUSED BY THIS OVERLY RICH CONDITION CAN CAUSE TECHNICIAN TO MISTAKENLY LOOK FOR FUEL SYSTEM PROBLEM**
	**DEMONSTRATION: ON A RUNNING ENGINE, APPLY VACUUM INCREMENTALLY TO THE EGR VALVE USING A HAND-HELD VACUUM PUMP. SHOW EFFECT OF INCREASED VACUUM ON ENGINE OPERATION AS EGR VALVE OPENS UP. APPLY ENOUGH VACUUM TO STALL THE ENGINE.**
	**DEMONSTRATION: ON A VEHICLE WITH EITHER A DIGITAL OR LINEAR EGR VALVE, OPEN THE VALVE INCREMENTALLY WITH A BIDIRECTIONAL SCAN TOOL TO SHOW STUDENTS ITS EFFECTS**
	**ON-VEHICLE NATEF TASK: INSPECT, TEST, SERVICE AND REPLACE COMPONENTS OF EGR SYSTEM, EXHAUST PASSAGES, VACUUM/PRESSURE CONTROLS, FILTERS AND HOSES; PERFORM NECESSARY ACTION.**

ICONS	Ch29 Emission Control Devices OP & SVC
	**ON-VEHICLE NATEF TASK: INSPECT AND TEST ELECTRICAL/ELECTRONIC SENSORS, CONTROLS, AND WIRING OF EXHAUST GAS RECIRCULATION (EGR) SYSTEMS; PERFORM NECESSARY ACTION.**
	**DEMONSTRATION: SHOW STUDENTS BASIC EVAPORATIVE EMISSIONS SYSTEM COMPONENTS. MAKE SURE STUDENTS CAN IDENTIFY COMPONENTS & THEIR FUNCTIONS**
	**ANIMATION: POSITIVE CRANKCASE VENTILATION (PCV)**
	**DEMONSTRATION: PASS AROUND VARIOUS PCV VALVES FOR THE STUDENTS TO SEE. STUDENTS SHOULD UNDERSTAND WHERE THE PCV VALVE CAN BE LOCATED ON AN ENGINE**
	12. **SLIDE 12 EXPLAIN Figure 29-11** PCV valve in a cutaway valve cover, showing the baffles that prevent liquid oil from being drawn into the intake manifold. 13. **SLIDE 13 EXPLAIN Figure 29-12** Spring force, crankcase pressure, and intake manifold vacuum work together to regulate the flow rate through the PCV valve. 14. **SLIDE 14 EXPLAIN Figure 29-13 A**ir flows through the PCV valve during idle, cruising, and light-load conditions & 15. **SLIDE 15 EXPLAIN Figure 29-14** Air flows through the PCV valve during acceleration and when the engine is under a heavy load. 16. **SLIDE 16 EXPLAIN Figure 29-15** PCV valve operation in the event of a backfire
	**DISCUSS REAL-WORLD TIP**
	**DEMONSTRATION: SHOW THE STUDENTS HOW TO CHECK VALVE OPERATION BY SHAKING THE VALVE. FIGURES 29-11 TO 15**
	**HANDS-ON TASK: HAVE THE STUDENTS LOCATE PCV SYSTEM COMPONENTS ON THEIR OWN VEHICLES. ASK THEM TO EXPLAIN HOW AIR FLOWS THROUGH THE SYSTEM.**

ICONS	Ch29 Emission Control Devices OP & SVC
	EXPLAIN TECH-TIP
	**DISCUSSION:** DISCUSS WHAT CAN HAPPEN TO A PCV SYSTEM FROM A VEHICLE OWNER WHO **NEGLECTS OR EXTENDS NORMAL OIL AND FILTER REPLACEMENTS.** WHAT PROBLEMS CAN RESTRICTED AIRFLOW CAUSE?
	**DEMONSTRATION:** SHOW EXAMPLES OF **PLUGGED, DIRTY, OR STUCK PCV VALVES**.
	17. **SLIDE 17 EXPLAIN Figure 29-16** Using a gauge that measures vacuum in units of inches of water to test the vacuum at the dipstick tube, being sure that the PCV system is capable of drawing a vacuum on the crankcase (28 in. H_2O = 1 PSI, or about 2 in. Hg of vacuum)
	**DON'T OVERLOOK MALFUNCTIONING PCV SYSTEM WHEN DIAGNOSING EXCESSIVE OIL LEAKS. PLUGGED PCV SYSTEM CAN CREATE EXCESS PRESSURE IN CRANKCASE DUE TO ACCUMULATION OF COMBUSTION VAPORS. THIS EXCESS PRESSURE CAN FORCE OIL OUT OF CRANKCASE THROUGH ENGINE SEALS & GASKETS. FIGURE 29-6**
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**HANDS-ON TASK:** SHOW ORIFICE-CONTROLLED CRANKCASE VENTILATION SYSTEM. HAVE THEM **LOCATE & LABEL MAIN COMPONENTS** & EXPLAIN AIRFLOW THROUGH THE SYSTEM.
	**DEMONSTRATION:** SHOW HOW TO CHECK FOR A SLIGHT VACUUM ON A RUNNING ENGINE BY USING A **3 X 5 INDEX CARD**. **PINCH VACUUM LINE** BETWEEN INTAKE MANIFOLD AND PCV VALVE TO ILLUSTRATE PLUGGED OR OBSTRUCTED SYSTEM WITH NO VACUUM.
	18. **SLIDE 18 EXPLAIN Figure 29-17** Most PCV valves used on newer vehicles are secured with fasteners, making it more difficult to disconnect and thereby less likely to increase emissions

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	**HANDS-ON TASK:** PERFORM THE **SNAP-BACK TEST** ON A PCV VALVE ON A RUNNING ENGINE BY PLACING THEIR FINGER OVER VALVE INLET. STUDENTS SHOULD LISTEN & FEEL FOR CLICK WHEN THEY REMOVE THEIR FINGER INDICATING THE VALVE IS FUNCTIONING PROPERLY.
	**DISCUSSION:** DISCUSS WHY **OBD-II SYSTEM** CHECKS OR MONITORS **PCV** SYSTEM. HOW DO CRANKCASE EMISSIONS AFFECT ATMOSPHERE? WHAT DOES PCV SYSTEM DO TO PREVENT POLLUTION?
	**HANDS-ON TASK:** HAVE THE STUDENTS RESEARCH A **PCV SYSTEM FAILURE DTC**. STUDENTS SHOULD BE ABLE TO DETERMINE CONDITIONS THAT CAUSED DTC & OEM TROUBLESHOOTING PROCEDURE FOR DTC.
	**ON-VEHICLE NATEF TASK:** DIAGNOSE OIL LEAKS, EMISSIONS, AND DRIVEABILITY CONCERNS CAUSED BY THE POSITIVE CRANKCASE VENTILATION (**PCV**) SYSTEM; DETERMINE NECESSARY ACTION.
	**ON-VEHICLE NATEF TASK:** INSPECT, TEST AND **SERVICE POSITIVE CRANKCASE VENTILATION** (PCV) FILTER/BREATHER CAP, VALVE, TUBES, ORIFICES, AND HOSES; PERFORM NECESSARY ACTION.
	19. **SLIDE 19 EXPLAIN Figure 29-18** typical belt-driven AIR pump. Air enters through revolving fins behind the drive pulley. The fins act as an air filter because dirt is heavier than air, and therefore the dirt is deflected off of the fins at the same time air is being drawn into the pump
	**SECONDARY AIR INJECTION**
	**DEMONSTRATION:** SHOW THE STUDENTS VARIOUS TYPES OF **AIR INJECTION PUMPS**. MOST BELT-DRIVEN PUMPS CAN BE EASILY DISASSEMBLED TO SHOW THEIR INTERNAL COMPONENTS. **FIGURE 29-18**

ICONS	Ch29 Emission Control Devices OP & SVC
	**HANDS-ON TASK: HAVE THE STUDENTS USE ELECTRONIC SERVICE INFORMATION COMPONENT LOCATOR TO LOCATE THE SECONDARY AIR-INJECTION COMPONENTS ON THEIR OWN CARS. STUDENTS SHOULD BE ABLE TO IDENTIFY COMPONENTS AND EXPLAIN THEIR OPERATION AND PURPOSES.**
	20. **SLIDE 20 EXPLAIN Figure 29-19** external air manifold and exhaust check valve on a restored muscle car engine. 21. **SLIDE 21 EXPLAIN Figure 29-20 (a)** When engine is cold and before the oxygen sensor is hot enough to achieve closed loop, the airflow from the air pump is directed to the exhaust manifold(s) through the one-way check valves, which keep the exhaust gases from entering the switching solenoids and the pump itself. 22. **SLIDE 22 EXPLAIN Figure 29-20 (b)** When engine achieves closed loop, air directed to catalytic converter.
	**DEMONSTRATION: SHOW VARIOUS AIR DISTRIBUTION MANIFOLDS & EXHAUST CHECK VALVES. DEMONSTRATE CHECK VALVE OPERATION BY ATTEMPTING TO BLOW AIR THROUGH EACH SIDE. IF VALVE IS GOOD, AIR SHOULD PASS THROUGH ONLY ONE SIDE. FIGURES 29-19 & 20**
	23. **SLIDE 23 EXPLAIN Figure 29-21** typical electric motor–driven SAI pump. This unit is on a Chevrolet Corvette and only works when the engine is cold
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE VARIOUS CONDITIONS THAT REQUIRE AIR INJECTION & AREAS THAT WILL RECEIVE AIR INJECTION. UNDER WHAT CONDITIONS DOES THE SAI SYSTEM OPERATE, AND WHERE DOES IT INJECT AIR?**
	**DEMONSTRATION: CREATE A SAI SYSTEM FAILURE ON OBD-II VEHICLE. THIS CAN BE DONE EASILY BY DISCONNECTING AN ELECTRIC PUMP OR AIR HOSE. OPERATE THE VEHICLE UNDER CONDITIONS NECESSARY TO SET DTC. FIGURE 29-21**

ICONS	Ch29 Emission Control Devices OP & SVC
	**HANDS-ON TASK:** HAVE STUDENTS RETRIEVE THE DTC AND LIST CONDITIONS NECESSARY FOR THE CODE TO SET DEMONSTRATED ABOVE FIGURE 29-21
	**EXPLAIN** Secondary Air-Injection System Diagnosis & **EXPLAIN CHART 29–1** Typical SAI system operation showing location of airflow from pump.
	**DISCUSSION:** HAVE STUDENTS DISCUSS ENABLING CRITERIA REQUIRED FOR OBD-II SYSTEM TO TEST AIR INJECTION SYSTEMS AND VARIOUS SAI SYSTEMS & RESULTING VARIATIONS IN CRITERIA. WHAT ENABLING CRITERIA ARE NECESSARY FOR THE OBD-II SYSTEM TO TEST THE SAI SYSTEM?
	**ON-VEHICLE NATEF TASK:** DIAGNOSE EMISSIONS AND DRIVEABILITY CONCERNS CAUSED BY THE SECONDARY AIR INJECTION AND CATALYTIC CONVERTER SYSTEMS.
	**ON-VEHICLE NATEF TASK:** INSPECT AND TEST MECHANICAL COMPONENTS OF SECONDARY AIR INJECTION SYSTEMS.
	**ON-VEHICLE NATEF TASK:** INSPECT AND TEST ELECTRICAL/ELECTRONICALLY-OPERATED COMPONENTS AND CIRCUITS OF AIR INJECTION SYSTEMS; PERFORM NECESSARY ACTION.
	**ANIMATION:** CATALYTIC CONVERTER OPERATION
	24. **SLIDE 24 EXPLAIN Figure 29-22** Most catalytic converters are located as close to the exhaust manifold as possible, as seen in this display of a Chevrolet Corvette
	25. **SLIDE 25 EXPLAIN Figure 29-23** typical catalytic converter with a monolithic substrate.
	**DEMONSTRATION:** WITH A VEHICLE ON LIFT, SHOW INSTALLED CATALYTIC CONVERTERS & THEIR LOCATIONS. POINT OUT THE REDUCTION CATALYST & OXIDIZING CATALYST.

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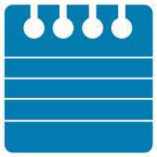	**BECAUSE PRICES OF PRECIOUS METALS USED IN CATALYTIC CONVERTERS HAVE RISEN STEEPLY IN THE PAST FEW YEARS, THESE COMPONENTS HAVE BECOME POPULAR AMONG THIEVES. OWNERS OF TRUCKS & 4WD VEHICLES HAVE RETURNED TO THEIR PARKED VEHICLES TO FIND THAT THIEVES HAVE STOLEN THEIR CATALYTIC CONVERTERS WITH BATTERY-POWERED RECIPROCATING SAW. REPLACEMENTS CAN RUN AS HIGH AS $2,500.**
	26. **SLIDE 26 EXPLAIN Figure 29.24** The three-way catalytic converter first separates the NOx into nitrogen and oxygen and then converts the HC and CO into harmless water (H2O) and carbon dioxide (CO2). 27. **SLIDE 27 EXPLAIN Figure 29-25** The OBD-II catalytic converter monitor compares the signals of upstream and downstream oxygen sensors to determine converter efficiency.
	**DISCUSSION: HAVE THE STUDENTS DISCUSS HOW OFTEN A PCM TESTS A CATALYTIC CONVERTER. HOW IS CATALYTIC CONVERTER MONITOR CLASSIFIED? WHEN WILL THE MONITOR CHECK THE EFFICIENCY OF CONVERTER? WHAT WILL HAPPEN IF THE TEST FAILS?**
	**DEMONSTRATION: TALK ABOUT DIAGNOSING CATALYTIC CONVERTERS. HOW ARE CATALYTIC CONVERTERS TESTED?**
	**DEMONSTRATION: CONNECT A DIGITAL STORAGE OSCILLOSCOPE (DSO) TO AN UPSTREAM OXYGEN SENSOR & OPERATE ENGINE AT NORMAL OPERATING TEMPERATURE. SHOW WAVEFORM OF AN UPSTREAM OXYGEN SENSOR IN OPERATION.**
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**DEMONSTRATION: AFTER SHOWING STUDENTS A WAVEFORM OF UPSTREAM OXYGEN SENSOR, CONNECT DSO TO DOWNSTREAM OXYGEN SENSOR TO SHOW STUDENTS DIFFERENCE**

ICONS	Ch29 Emission Control Devices OP & SVC
	**BETWEEN SENSORS. OBD-II USES DOWNSTREAM SENSOR TO CHECK THE EFFICIENCY OF THE CATALYTIC CONVERTER** **DEMONSTRATION: SIMULATE A PLUGGED OR MELTED CONVERTER BY INSTALLING AN EXPANDABLE PLUG INTO A VEHICLE EXHAUST PIPE. OPERATE VEHICLE ON DYNAMOMETER OR ON A TEST DRIVE WITH VACUUM GAUGE TAPED TO WINDSHIELD. SHOW STUDENTS HOW VACUUM DROPS AS EXHAUST BACK PRESSURE INCREASES, CAUSING A SUBSTANTIAL DROP IN ENGINE PERFORMANCE. REMOVE PLUG AND OPERATE VEHICLE NORMALLY TO SHOW PROPER VACUUM READINGS.**
	28. **SLIDE 28 EXPLAIN Figure 29-26** A back pressure tool can be made by using an oxygen sensor housing and epoxy or braze to hold the tube to the housing
	**DEMONSTRATION: INSTALL EXHAUST BACK PRESSURE GAUGE IN PLACE OF AN OXYGEN SENSOR FIGURE 29-26. LEAVE OXYGEN SENSOR CONNECTED WHILE IT IS REMOVED AND OPERATE ENGINE, SHOWING STUDENTS NORMAL BACK PRESSURE. INSTALL EXPANDABLE PLUG IN TAILPIPE TO SIMULATE A PLUGGED CONVERTER AND HAVE STUDENTS WATCH BACK PRESSURE INCREASE.**
	**ON-VEHICLE NATEF TASK: PERFORM EXHAUST SYSTEM BACK-PRESSURE TEST; DETERMINE NECESSARY ACTION.**
	29. **SLIDE 29 EXPLAIN Figure 29-27** temperature of the outlet should be at least 10% hotter than the temperature of the inlet. If a converter is not working, the inlet temperature will be hotter than the outlet temperature.
	**ANIMATION:** **CATALYTIC CONVERTER (2004+)**

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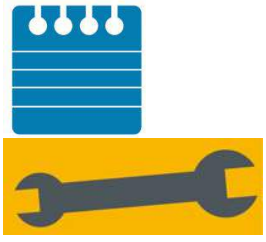
	**DISCUSSION:** HAVE THE STUDENTS TALK ABOUT **CATALYTIC CONVERTER EFFICIENCY TESTS**. HOW ARE RESULTS OF AN OXYGEN LEVEL TEST INTERPRETED?
	**HANDS-ON TASK:** HAVE STUDENTS OPERATE AN ENGINE AT 2,500 RPM UNTIL NORMAL OPERATING TEMPERATURE IS ACHIEVED, THEN **MEASURE INLET & OUTLET TEMPERATURES** OF CATALYTIC CONVERTER WITH AN INFRARED THERMOMETER. **FIGURE 29-27**
	**ON-VEHICLE NATEF TASK:** INSPECT AND TEST **CATALYTIC CONVERTER** EFFICIENCY.
	**DISCUSSION:** DISCUSS WITH THE STUDENTS THAT AN **OVERLY RICH MIXTURE OR ANY MALFUNCTION SUCH AS MISFIRE** CAN ALLOW UNBURNED HYDROCARBONS TO ENTER CATALYTIC CONVERTER. HOW DOES THIS AFFECT THE CATALYTIC CONVERTER? (POINT OUT THAT THIS CAN CAUSE THE CONVERTER TO MELT INTERNALLY AND CAN EVEN SET ON FIRE)
	**DEMONSTRATION:** WITH VEHICLE ON A LIFT, CREATE A MISFIRE; CLOSE ELECTRODES ON A SPARK PLUG. OPERATE AT 2,500 RPM UNTIL THE CONVERTER BEGINS TO OVERHEAT AND STUDENTS OBSERVE THE SMELL OF ROTTEN EGGS. CONTINUE OPERATING VEHICLE FOR A FEW MORE MINUTES, CHECK CONVERTER TEMPERATURE WITH INFRARED THERMOMETER TO SHOW STUDENTS EXTREME OVERHEAT CONDITION.
	HEAT IS CRITICAL FOR CONVERTER OPERATION, AND UNDERHOOD SPACE IS LIMITED, MANY OEMS LOCATE CATALYST IN EXHAUST MANIFOLD.
	EXPLAIN TECH-TIP 30. **SLIDE 30 EXPLAIN FIGURE 29–28** Whenever replacing a catalytic converter with a universal unit, first measure the distance between the rear brick and the center of the rear oxygen sensor. Be sure that the replacement unit is installed to the same dimension

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	EXPLAIN TECH-TIP
	**HANDS-ON TASK:** HAVE THE STUDENTS LOOK UP CATALYST EFFICIENCY DTCS FOR THEIR OWN VEHICLES. STUDENTS SHOULD BE ABLE TO FIND CONDITIONS THAT MUST BE MET FOR DTC TO SET AND FIND OEM TROUBLESHOOTING PROCEDURE TO DIAGNOSE DTC.
	**DEMONSTRATION:** DEMONSTRATE CATALYTIC CONVERTER OPERATION BY TESTING EXHAUST EMISSIONS WITH 5-GAS ANALYZER BEFORE AND AFTER CONVERTER RUNS. REMOVE THE UPSTREAM OXYGEN SENSOR AFTER THE ENGINE HAS WARMED UP, THEN OPERATE ENGINE WITH SENSOR CONNECTED AND INSERT ANALYZER PROBE INTO SENSOR BOSS WHILE SAMPLING.
	**DEMONSTRATION:** PERFORM A CONVERTER SNAP-THROTTLE TEST WHILE SAMPLING EXHAUST EMISSIONS. HAVE STUDENTS PAY ATTENTION TO O2 READINGS TO DETERMINE CONVERTER EFFICIENCY.
	**ON-VEHICLE NATEF TASK:** CATALYTIC CONVERTER RATTLE TEST
	**ON-VEHICLE NATEF TASK: CATALYTIC CONVERTER PERFORMANCE TEST**
	**DISCUSS FREQUENTLY ASKED QUESTION**
	**31. SLIDE 31 EXPLAIN Figure 29-29** Cap less system from a Ford Flex does not use a replaceable cap; instead, it is spring-loaded closed **32. SLIDE 32 EXPLAIN Figure 29-30** A charcoal canister can be located under the hood or underneath the vehicle. **33. SLIDE 33 EXPLAIN Figure 29-31** EVAP system includes all of the lines, hoses, and valves, plus the charcoal canister.

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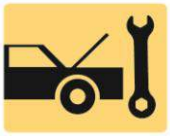
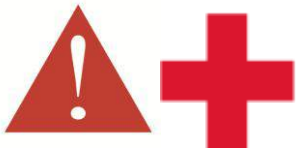
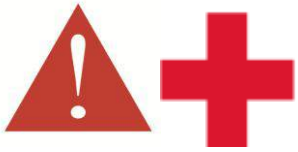
	**DISCUSSION: HAVE THE STUDENTS LIST AND DESCRIBE MAIN FUNCTIONS OF THE EVAPORATIVE SYSTEM & POTENTIAL PROBLEMS. WHAT IS THE SYSTEM DESIGNED TO DO WITH FUEL VAPORS (HYDROCARBONS)? WHAT ARE POTENTIAL PROBLEMS WITH THE SYSTEM?**
	**34. SLIDE 34 EXPLAIN Figure 29-32** typical EVAP system. Note that when the computer turns on the canister purge solenoid valve, manifold vacuum draws any stored vapors from the canister into the engine. Manifold vacuum also is applied to the pressure control valve. When this valve opens, fumes from the fuel tank are drawn into the charcoal canister and eventually into the engine. When the solenoid valve is turned off (or the engine stops and there is no manifold vacuum), pressure control valve is spring-loaded shut to keep vapors inside the fuel tank from escaping to atmosphere.
	**DEMONSTRATION: PASS AROUND EXAMPLES OF EVAPORATIVE PURGE & VENT SOLENOIDS. SHOW HOW TO LOCATE PURGE AND VENT SOLENOIDS ON A VEHICLE USING ELECTRICAL COMPONENT LOCATOR.**
	**EXPLAIN** Evaporative Emission Control System & **EXPLAIN CHART 29–2** Pressure conversions. *NOTE: 1 PSI = 28 in. H_2O, 0.25 PSI = 7 in. H_2O*
	**EXPLAIN TECH-TIP**
	**HANDS-ON TASK: STUDENTS CUT OPEN A USED EVAPORATIVE CANISTER TO SHOW THE STUDENTS WHAT ACTIVATED CHARCOAL GRANULES LOOK LIKE.**
	**SAFETY REMIND THE STUDENTS OF EXTREME FIRE HAZARD OF WORKING AROUND & SERVICING EVAPORATIVE EMISSION SYSTEM ON A VEHICLE. FUEL VAPORS ARE EXTREMELY EXPLOSIVE.**
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT FUEL EVAPORATION RATES. WHAT FACTORS (E.G., ALCOHOL CONTENT, TEMPERATURE, ATMOSPHERIC PRESSURE, ETC.) INFLUENCE FUEL**

ICONS	Ch29 Emission Control Devices OP & SVC
	**EVAPORATION RATES?** **DEMONSTRATION: SHOW HOW TO USE AN ALCOHOL TEST KIT TO OBTAIN A SAMPLE OF FUEL FROM A VEHICLE & TEST FOR ALCOHOL CONTENT.**
	35. **SLIDE 35 EXPLAIN FIGURE 29-33** leak detection pump (LDP) used on some Chrysler vehicles to pressurize (slightly) the fuel system to check for leaks
	**DEMONSTRATION: SHOW THE STUDENTS HOW TO USE A VEHICLE UNDERHOOD ECS LABEL & WIRING DIAGRAM AND/OR VACUUM DIAGRAM TO DETERMINE WHETHER THE VEHICLE HAS AN ENHANCED OR NON-ENHANCED SYSTEM**
	**HANDS-ON TASK: ASK THE STUDENTS TO IDENTIFY AND LOCATE PURGE SOLENOID & EVAPORATIVE CANISTERS ON THEIR OWN CARS USING OEM SERVICE INFORMATION.**
	**STUDENTS CAN EASILY REMEMBER REST POSITION OF BOTH PURGE & VENT SOLENOIDS (NORMALLY CLOSED & NORMALLY OPEN, RESPECTIVELY) BY USING ANALOGY OF A HOME'S FRONT & BACK DOORS. FRONT DOOR IS USUALLY CLOSED, WHEREAS BACK DOOR IS FREQUENTLY LEFT OPEN.**
	**EXPLAIN HOW VENT SOLENOIDS CAN BE TESTED USING JUMPER WIRES AND A 12 V SOURCE TO ALLOW SYSTEM TESTING. REMEMBER, THE VENT SOLENOID IS NORMALLY OPEN AND SHOULD BE ENERGIZED FOR ONLY SHORT PERIODS (5 MINUTES OR LESS) TO PREVENT DAMAGE.**
	**DEMONSTRATION: PASS AROUND VARIOUS LEAK DETECTION PUMPS. SHOW LOCATION OF THE PUMP ON VEHICLE.**
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT LEAK DETECTION PUMP SYSTEMS. WHAT OTHER POSSIBLE METHODS MIGHT MANUFACTURERS USE TO LEAK TEST AN EVAPORATIVE SYSTEM WITHOUT USING A PUMP?**

ICONS	Ch29 Emission Control Devices OP & SVC
	**DEMONSTRATION: USING SMALL DRILL BITS FOR AUTOMATIC TRANSMISSION SERVICE, DRILL TWO .020" & 0.040" HOLES IN A SMALL ALUMINUM PLATE. HAVE STUDENTS OBSERVE DRILLED PLATE SO THEY CAN VISUALIZE SIZE OF LEAK THAT AN ENHANCED SYSTEM MUST DETECT.**
	**36. SLIDE 36 EXPLAIN Figure 29-34** restricted fuel fill pipe shown on vehicle with the interior removed
	37. SLIDE 37 EXPLAIN FIGURE 29-35 Some vehicles will display a message if an evaporative control system leak is detected that could be result of a loose gas cap.
	38. SLIDE 38 EXPLAIN Figure 29-36 To test for a leak, this tester was set to the 0.020-inch hole and turned on. The ball rose in the scale on the left, and the red arrow was moved to that location. If when testing the system for leaks the ball rises higher than the arrow, then the leak is larger than 0.02 inch. If the ball does not rise to the level of the arrow, the leak is smaller than 0.020 inch
	39. SLIDE 39 EXPLAIN Figure 29-37 unit is applying smoke to the fuel tank through an adapter, and the leak was easily found to be the gas cap seal
	**DEMONSTRATION: SHOW HOW TO LEAK-CHECK AN EVAPORATIVE SYSTEM USING A SMOKE MACHINE. CREATE A SMALL LEAK BY DISCONNECTING A VACUUM OR VAPOR HOSE TO SHOW SMOKE DIAGNOSIS.**
	**40. SLIDE 40 EXPLAIN Figure 29-38** emission tester that uses nitrogen to pressurize the fuel system.
	**SAFETY REMIND STUDENTS THAT IT IS IMPERATIVE TO USE AN INERT GAS SUCH AS NITROGEN TO PREVENT POSSIBLE EXPLOSIONS WHEN PRESSURE-CHECKING EVAPORATIVE EMISSION SYSTEM FOR LEAKS. USING COMPRESSED AIR COULD PRODUCE A FLAMMABLE MIXTURE OF FUEL VAPORS AND OXYGEN.**

ICONS	Ch29 Emission Control Devices OP & SVC
	**ON-VEHICLE NATEF TASK** DIAGNOSE EMISSIONS AND DRIVEABILITY CONCERNS CAUSED BY THE EVAPORATIVE EMISSIONS CONTROL SYSTEM; DETERMINE ACTION
	**ON-VEHICLE NATEF TASK:** INSPECT AND TEST COMPONENTS AND HOSES OF **EVAPORATIVE** EMISSIONS CONTROL SYSTEM
	**ON-VEHICLE NATEF TASK:** INTERPRET DIAGNOSTIC TROUBLE CODES (DTCS) AND SCAN TOOL DATA RELATED TO THE **EMISSIONS CONTROL SYSTEMS**; DETERMINE ACTION
	**ON-VEHICLE NATEF TASK:** DIAGNOSE EMISSIONS AND DRIVEABILITY CONCERNS CAUSED BY THE EXHAUST GAS RECIRCULATION (**EGR**) SYSTEM; DETERMINE NECESSARY ACTION.
	41. **SLIDE 41 EXPLAIN Figure 29-39** fuel tank pressure sensor (black unit with three wires) looks like a MAP sensor and is usually located on top of fuel pump module (white unit)
	**EXPLAIN TECH-TIP** 42. **SLIDE 42 EXPLAIN FIGURE 29-40** This Toyota cap has a warning—the check engine light will come on if not tightened until one click.
	**DISCUSSION:** HAVE THE STUDENTS DISCUSS THE ROLE THAT FUEL STABILITY AS WELL AS ENGINE-OPERATING CONDITIONS PLAY BEFORE **OBD II EVAPORATIVE MONITOR** WILL RUN. ASK STUDENTS TO LIST OR EXPLAIN ENABLING CRITERIA FOR THE EVAPORATIVE MONITOR TO RUN.
	**DEMONSTRATION:** SHOW STUDENTS FUEL TANK UNITS WITH **FUEL TANK PRESSURE (FTP) SENSORS:** POINT OUT THAT THESE SENSORS, ABLE TO SENSE VERY SMALL PRESSURE CHANGES, ARE MUCH MORE SENSITIVE THAN TRADITIONAL PRESSURE SENSORS.
	**HANDS-ON TASK:** HAVE THE STUDENTS LOOK UP AN **EVAP DTC** FOR A PARTICULAR VEHICLE USING **ELECTRONIC SERVICE**

ICONS	Ch29 Emission Control Devices OP & SVC
     QUESTION	**INFORMATION.** WHAT CONDITIONS MUST BE MET TO CAUSE PCM TO SET DTC? HAVE STUDENTS DESCRIBE OEM TROUBLESHOOTING PROCESS FOR DIAGNOSING DTC. EXPLAIN TECH-TIP 43. SLIDE 43 EXPLAIN FIGURE 29-41 The fuel level must be above 15% and below 85% before the EVAP monitor will run on most vehicles PCM ON A VEHICLE THAT USES ENGINE-OFF NATURAL VACUUM FOR EVAPORATIVE SYSTEM TESTING MUST STAY "ON," OPERATING LONG AFTER VEHICLE OWNER HAS SHUT OFF IGNITION, IN ORDER TO SATISFACTORILY TEST EVAPORATIVE SYSTEM INTEGRITY. DON'T OVERLOOK THIS CAPABILITY WHEN DIAGNOSING A PARASITIC BATTERY DRAIN. **DISCUSSION:** HAVE THE STUDENTS DISCUSS HOW A HYBRID VEHICLE'S EVAPORATIVE EMISSION SYSTEM SHOULD DIFFER FROM THAT OF A TRADITIONAL VEHICLE. WILL HYBRID VEHICLE OPERATE LONGER WITH FUEL IN TANK? WHAT MUST THE HYBRID'S SYSTEM BE CAPABLE OF DOING FOR LONGER PERIODS OF TIME?