Automotive Technology 6th Edition
Chapter 84 Vehicle Emission Standards & Testing
Opening Your Class

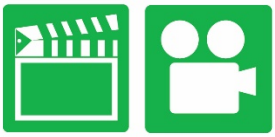
KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, Animations, and ASEEducation (NATEF) Task Sheets.
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, which translates into more money.
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 learning objectives to students as listed below: 1. Identify the reasons why excessive amounts of HC, CO, and NOx exhaust emissions are created. 2. Diagnose driveability and emissions problems resulting from Malfunctions of interrelated systems. 3. Discuss emissions standards. 4. Describe how to test for various emissions products. 5. This chapter will help prepare for ASE A8 certification test content area "D" (Emissions Control Systems Diagnosis and Repair) and ASE L1 certification test content area "F" (I/M Failure Diagnosis).
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: Lesson plan is based on 6th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 84 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

ICONS	Ch84 Vehicle Emission Standards & Testing
	1. **SLIDE 1 CH84 VEHICLE EMISSION STANDARDS & TESTING**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF**
	**Videos**
	
	2. **SLIDE 2 EXPLAIN FIGURE 84–1** air entering the engine consists of mostly nitrogen (78%) with about 21% oxygen and about 1% other gases**.**
	**DISCUSSION: Have the students talk about emissions. What are their impressions of emissions standards?**
	3. **SLIDE 3 EXPLAIN FIGURE 84–2** Hydrocarbons can include many combinations of hydrogen and carbon..
	**DISCUSSION: Have the students talk about federal emissions standards. Explain that Emission Control Systems (ECS) label is under the hood of every vehicle produced for sale in the US & includes information about emissions systems installed when it was manufactured. What does higher tier number mean?** **If a vehicle is damaged in a collision, the ECS label may not have been replaced during body repairs. If label is missing, the VIN must be used to determine year. A replacement ECS label can be obtained from dealer using the VIN.**
	

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	**DISCUSSION:** Have the students discuss 3 main pollutants for which vehicles are tested. How are the main pollutants produced? CHART 84-1 & 2
	**DISCUSSION:** discuss hydrocarbons, carbon monoxide, & oxides of Nitrogen. What are acceptable levels of each pollutant? What are units of measurement for properly tuned and running engine? What is meant by air pollution score (BIN)? CHARTS 84-1 & 2
	**DISCUSSION:** Briefly review and discuss the role of catalytic converters in oxidizing hydrogen and carbon while reducing oxides of nitrogen. Why would a vehicle with a catalytic converter that is not functioning fail an emissions test?
	4. **SLIDE 4 EXPLAIN FIGURE 84–3** Carbon dioxide has two oxygen atoms attached to one carbon atom and is a stable molecule..
	5. **SLIDE 5 EXPLAIN FIGURE 84–4** NO and NO2 shown together are referred to as NOx..
	**DISCUSSION:** Discuss differences between testing vehicle's emissions at different idle speeds vs. load test on dynamometer. How do emissions change as vehicle load increases? Discuss term loaded-mode testing. Students should understand that loaded mode testing requires vehicle to be ON dynamometer. How does dynamometer simulate real-world driving conditions in a testing environment?
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***Why is steam seen from the tailpipe when cold outside, but not always?*** **Steam is water vapor and is invisible. However, when an engine is cold, the water vapor created by combustion partially condenses into small droplets of water that are visible as "steam" from the tailpipe of vehicle. After exhaust system has been heated, the water vapor no longer condenses in the exhaust system, so it is not**

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	visible after the engine is warm. • SEE FIGURE 84–5.
	6. SLIDE 6 EXPLAIN FIGURE 84–5 chart showing that about 13% of the exhaust emissions is water (H2O) in the form of steam.
	DISCUSSION: discuss abbreviations HC, CO, and NO_x and what these compounds are. How are HC, CO & NOx formed in the combustion chamber?
	DEMONSTRATION: Using 5-GAS exhaust analyzer, measure HC, CO, and NOx emissions on a vehicle simulating a two-speed idle test. Use the same vehicle and measure again, performing an ASM test to show students difference in emissions.
	DISCUSSION: Have the students discuss how and why emissions such as NO_x increase during ASM test compared to TSI tests. Why does NO_x increase as a result of a loaded engine?
	7. SLIDE 7 EXPLAIN FIGURE 84–6 Exhaust emissions are very complex. When air–fuel mixture becomes richer, some exhaust emissions are reduced, while others increase.
	DEMONSTRATION: While performing an emissions test, disconnect spark plug wire for short time. Show the students the increase emissions caused by misfiring cylinder.
	DEMONSTRATION: Disconnect fuel pressure regulator vacuum hose or ECT sensor to show how carbon monoxide (CO) readings can be increased during an emissions test.
	DEMONSTRATION: Demonstrate USING an INFRARED THERMOMETER what happens to the temperature of catalytic converter when a misfire or rich mixture is created.
	DEMONSTRATION: Before- and after converter Emission readings can be obtained by removing oxygen sensor and inserting 5-GAS analyzer probe into the sensor boss. Leave sensor connected while operating the engine and quickly record readings. Remove analyzer and insert it into the tailpipe after converter to illustrate operation of catalytic converter.

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    	**DISCUSSION: Discuss the differences between rich & lean exhaust. What indicates that engine is operating correctly?** 8. **SLIDE 8 EXPLAIN FIGURE 84–7** image on left shows exhaust gases existing in an engine without a catalytic converter with rich exhaust being toward left of the vertical line and lean exhaust to the right of the line. The image on right shows the exhaust after it has been treated by the catalytic converter. **EXPLAIN TECH TIP: How to Find a Leak in the Exhaust System: A hole in the exhaust system can dilute the exhaust gases with additional O2. • SEE FIGURE 84–8. This additional O2 in exhaust can lead service technician to believe that air–fuel mixture is too lean. To help identify an exhaust leak, perform an exhaust analysis at idle and at 2,500 RPM (fast idle) and compare with following:** • **If O2 is high at idle and at 2,500 RPM, the mixture is lean at both idle and at 2,500 RPM.** • **If O2 is low at idle and high at 2,500 RPM, this usually means that vehicle is equipped with a working AIR pump.** • **If O2 is high at idle, but okay at 2,500 RPM, a hole in exhaust or a small vacuum leak that is "covered up" at higher speed is indicated.** 9. **SLIDE 9 EXPLAIN FIGURE 84–8** A hole in the exhaust system can cause outside air (containing O2) to be drawn into the exhaust system. This extra O2 can be confusing to a service technician because the extra O2 in exhaust stream could be misinterpreted as a too-lean air–fuel mixture. **DISCUSS CASE STUDY: *O2S Shows Rich, But Pulse Width Is Low*** **A service technician is attempting to solve a driveability problem. PCM does not indicate any DTCS. A check of oxygen sensor voltage indicates a higher-than-normal reading almost all time. The pulse width to the port injectors is lower than normal. The lower-than- normal pulse width indicates that PCM is attempting**

to reduce fuel flow into engine by decreasing the amount of on-time for all injectors. What could cause a rich mixture if the injectors are being commanded to deliver a lean mixture? Finally, technician shuts off the engine and takes careful look at the entire fuel-injection system. When vacuum hose is removed from the fuel-pressure regulator, fuel is found dripping from the vacuum hose. The problem is a defective fuel-pressure regulator that is allowing an uncontrolled amount of fuel to be drawn by intake manifold vacuum into cylinders. While PCM is trying to reduce fuel by reducing the pulse-width signal to injectors, extra fuel is being drawn directly from fuel rail and is causing engine to operate with too rich an air–fuel mixture.

Summary:

- **Complaint—Customer stated that the engine did not perform correctly.**
- **Cause—No stored DTCs were found, but the oxygen sensor reading was higher than normal, indicating that exhaust air-fuel mixture was too rich.**
- **Correction—fuel pressure regulator was found to be leaking, causing fuel to be drawn into the intake and causing the richer-than-normal air-fuel mixture. Replacing the fuel pressure regulator solved the driveability complaint.**

DISCUSS CASE STUDY: *Case of the Retarded Exhaust Camshaft* **A Toyota equipped with a double overhead camshaft (DOHC) six-cylinder engine failed the state-mandated enhanced exhaust emissions test for NOx. The engine ran perfectly without spark knocking (ping), which**

is usually a major reason for excessive NOx emissions. The technician checked following:

- Cylinders, which were decarbonized using top engine cleaner
- EGR valve, which was inspected and the EGR passages cleaned

After all the items were completed, vehicle was returned to the inspection station where the vehicle again failed for excessive NOx emissions (better, but still over maximum allowable limit). After additional hours of troubleshooting, the technician decided to go back to basics and start over again. Check of the vehicle history with the owner indicated that the only previous work performed on the engine was a replacement timing belt over a year before. The technician discovered that the exhaust cam timing was retarded two teeth, resulting in late closing of the exhaust valve. The proper exhaust valve timing resulted in a slight amount of exhaust being retained in the cylinder. This extra exhaust helped reduce NOx emissions. After repositioning the timing belt, the vehicle passed emissions test well within the limits.

Summary:

- Complaint—Customer stated that the vehicle failed an emission test due to excessive NOx exhaust emissions.
- Cause—exhaust cam was discovered to be retarded by two teeth because of the timing belt being incorrectly installed during a previous repair.
- Correction—timing belt was properly aligned, and the vehicle passed the emission test.

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	**EXPLAIN TECH TIP: Your Nose Knows** **Using nose, a technician can often identify a major problem without having to connect the vehicle to an exhaust analyzer. For example:** • **Strong smell of exhaust is due to excessive unburned HC emissions. Look for an ignition system fault that could prevent the proper burning of the fuel.** • **If your eyes start to burn or water, suspect excessive NOx emissions. NOx combine with the moisture in the eyes to form a mild solution of nitric acid. The acid formation causes the eyes to burn and water. Excessive NOx exhaust emissions can be caused by a lack of proper amount of exhaust gas recirculation (EGR) or a variable valve timing issue (This is usually noticed above idle on most vehicles.)** • **Dizzy feeling or headache. This is commonly caused by excessive CO exhaust emissions. Get into fresh air as soon as possible. A probable cause of high levels of CO is an excessively rich air–fuel mixture.**
	10. **SLIDE 10 EXPLAIN FIGURE 84–9** A vehicle emission control information (VECI) sticker for a vehicle showing that meets Tier 3, Bin 1 (T2B3) EPA rating and California ULEV125 standard. 11. **SLIDE 11 EXPLAIN FIGURE 84–10** This label on a Toyota Camry hybrid shows relative smog-producing emissions, but this does not include CO2, which may increase global warming. 12. **SLIDE 12 EXPLAIN FIGURE 84–11** A partial stream sampling exhaust probe being used to measure exhaust gases in parts per million (PPM) or percent (%).
	**HANDS-ON TASK: Prepare a vehicle to fail emissions test. Close electrodes on a spark plug. Students operate vehicle for an ASM emissions test. Ask students to explain failure and list causes for the high emissions. Grade them on their ability to identify ignition problems as cause of high HC**

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	**DEMONSTRATION:** Simulate a lean condition while analyzing a vehicle's emissions by disconnecting one or two injectors. Show drop in carbon monoxide and increase in oxygen.
	**DISCUSSION:** Have the students talk about the emission readings of the vehicle in previous DEMO. Why is increase in oxygen & corresponding decrease in carbon monoxide a result of lean condition?
	**DISCUSSION:** Have the students discuss how an **exhaust leak** can cause a false lean condition. How are low pressure pulses in exhaust system caused by the 4-stroke cycle drawing outside air past the oxygen sensor?
 	**ON-VEHICLE ASEEDUCATION TASK:** Prepare **4 or 5 Gas Analyzer**; inspect and prepare vehicle for test, and obtain exhaust readings; interpret readings, and determine necessary action.
	**DEMONSTRATION:** Advance ignition timing and/or disconnect EGR system on a vehicle prior to conducting an ASM emissions test. **Show students increase in NOx.**
	**DISCUSSION:** Have the students talk about the **increase in NOx in previous DEMONSTRATION**. What are the potential causes?
	**HANDS-ON TASK:** Have Students **correct the condition** that caused increase in NO_x in vehicle used in **demonstration** & retest vehicle to see changes.