Automotive Technology 5th Edition
Chapter 81 Fuel-Injection System Diagnosis & Service
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class provides complete coverage of the components, operation, design, and troubleshooting. It correlates material to task lists specified by ASE and NATEF and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Real World Fixes, Videos, Animations, and NATEF Task Sheet references.
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. Explain the procedure to diagnose the electronic fuel-injection system. 2. Describe how to diagnose a fuel injection system using a scan tool. 3. Describe the process to check fuel-injector resistance. 4. Describe how to service the fuel-injection 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 the 5th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 81: ATE5 Chapter Images

ICONS	Ch81 Fuel-Injection System Diagnosis & Service
	**1. SLIDE 1 CH81 FUEL-INJECTION SYSTEM DIAGNOSIS & SERVICE**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED**
	**Videos**
	**Quick Check Injector Pulse (View) (Download)** **Quick Check Injector Volts (View) (Download)** **Test Injector Resistance (View) (Download)**
	**2. SLIDE 2 EXPLAIN Figure 81-1** If the vacuum hose is removed from the fuel-pressure regulator when the engine is running, the fuel pressure should increase. If it does not increase, then the fuel pump is not capable of supplying adequate pressure or the fuel-pressure regulator is defective. If gasoline is visible in the vacuum hose, the regulator is leaking and should be replaced
	**DEMONSTRATION: Show the students location of fuel rail and pressure regulator on a vehicle. Point out vacuum connections at regulator and intake manifolds. Show them fuel inlet and return lines at fuel rail. FIGURE 81-1**
	**DISCUSSION: discuss port fuel-injected engines. Why is a fuel pressure regulator needed? Why must pressure differential between fuel rail and intake manifold remain constant?**
	**DISCUSSION: Have the students talk about positive crankcase ventilation systems. What problems or issues can be caused by a clogged PCV system? FIGURE 81-2 & 3**
	**3. SLIDE 3 EXPLAIN FIGURE 81-2** good pressure gauge should be used to check fuel pressure and then compared with factory specification found in service information. **4. SLIDE 4 EXPLAIN Figure 81-3** clogged PCV system caused engine oil fumes to be drawn into the air cleaner assembly. This is what the technician discovered during a visual inspection on this TBI system

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	**DEMONSTRATION: Show good & defective (oil contaminated, brittle, soft, or deteriorated) vacuum hoses. Show how to check for injector operation by listening for injector clicking with a stethoscope. Disconnect one injector to simulate a nonoperative condition. FIGURE 81-4**
	**DISCUSSION: Have the students talk about vacuum leaks. What effect will a ruptured or leaking pressure regulator have on engine operation? Explain that excess fuel can be drawn into the intake manifold, resulting in an extremely rich condition that can damage catalytic converter.**
	5. **SLIDE 5 EXPLAIN Figure 81-4** All fuel injectors should make the same sound with the engine running at idle speed. 6. **SLIDE 6 EXPLAIN Figure 81-5** Fuel should be heard returning to fuel tank at fuel return line if fuel-pump and fuel-pressure regulator are functioning correctly. 7. **SLIDE 7 EXPLAIN Figure 81-6** Using scan tool to check for IAC counts or percentage
	**DISCUSSION: Have the students discuss normal IAC counts. What does a very high or very low IAC count (_45 or _5) indicate? FIGURE 81-6**
	**HANDS-ON TASK: Have students use ON-LINE service INFORMATION to look up fuel pressure specifications for their own cars.**
	**ON-VEHICLE NATEF TASK Diagnose hot or cold no-starting, hard starting, poor driveability, incorrect idle speed, poor idle, flooding, hesitation, surging; determine necessary action Page 252**
	8. **SLIDE 8 EXPLAIN Figure 81-7** Checking the fuel pressure using a fuel-pressure gauge connected to the Schrader valve. 9. **SLIDE 9 EXPLAIN Figure 81-8** Shutoff valves must be used on vehicles equipped with plastic fuel lines to isolate the cause of a pressure drop in the fuel system
	**DEMONSTRATION: Demonstrate a fuel pressure test with a pressure gauge connected to fuel rail and a vacuum gauge connected to intake vacuum**

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	source. Hold throttle wide open to demonstrate low vacuum and its effect on fuel pressure. Remove vacuum hose connected to the pressure regulator to show increase in fuel pressure. **FIGURES 81-7 & 8**
	10. **SLIDE 10 EXPLAIN Figure 81-9 (a)** Noid lights are usually purchased as an assortment so that one is available for any type/size of injector wiring connector. 11. **SLIDE 11 EXPLAIN Figure 81-9 (b)** The connector is unplugged from the injector and a Noid light is plugged into the harness side of the connector. The Noid light should flash when the engine is being cranked if the power circuit and the pulsing to ground by the computer are functioning normally.
	**DEMONSTRATION: Install a Noid Light in injector harness and crank or operate engine to demonstrate light operation for diagnosis. What can cause a Noid light not to flash or to flash dimly: FIGURE 81-9**
	**DISCUSSION: Have the students discuss fuel-injector resistance. Why is injector resistance critical? Ask students to look up injector resistance specifications for their own cars.**
	12. **SLIDE 12 EXPLAIN Figure 81-10** Use DMM set to read DC volts to check the voltage drop of the positive circuit to the fuel injector. A reading of 0.5 volt or less is generally considered to be acceptable 13. **SLIDE 13 EXPLAIN Figure 81-11** An ohmmeter is connected to the injector electrical terminals to read injector coil resistance.
	**DEMONSTRATION: Show how to check injector resistance with ohmmeter. Heat injector with a heat gun & then recheck resistance to demonstrate heat related change. FIGURE 81-11 Also show VOLTAGE DROP method in FIGURE 81-10**
	**Some vehicles are designed to shut down injectors individually, or in groups that can cause a no-start condition, to protect PCM circuitry if current is too high.**

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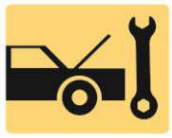
	**DISCUSSION: Discuss relationship between resistance and amperage (Ohm's law). How does a change in resistance affect injector operation? How can a decrease in resistance cause damage to injector drive circuitry?**
	**DEMONSTRATION: Show how to disconnect injectors & check for resistance. Remind students that resistance will change as injector temperature changes. An infrared thermometer can be used to check injector temperature and compare resistance specs FIGURES 81-11, 12, & 13**
	14. **SLIDE 14 EXPLAIN Figure 81-12** To measure fuel-injector resistance, a technician constructed a short wiring harness with a double banana plug that fits into the V and COM terminals of the meter and an injector connector at the other end. This setup makes checking resistance of fuel injectors quick and easy.
	**HANDS-ON TASK: Have the students check injector resistance on their own cars, starting with a comparison measurement to specifications. FIGURES 81-11, 12, & 13**
	**DISCUSSION: Have students talk about a pressure-drop balance test. What happens to fuel delivery if an injector is restricted? How will change in air/fuel mixture in 1 cylinder affect engine operation?**
	15. **SLIDE 15 EXPLAIN Figure 81-13 (a)** meter is connected to read one group of "3" 12-ohm injectors. Result should be 4 ohms & this reading is little low indicating that at least 1 injector is shorted (low resistance). 16. **SLIDE 16 EXPLAIN Figure 81-13 (b)** This meter is connected to the other group of three injectors and indicates that most, if not all three, injectors are shorted. Technician replaced all 6 injectors and engine ran great.
	17. **SLIDE 17 EXPLAIN Figure 81-14** If an injector has the specified resistance, this does not mean that it is okay. This injector had specified resistance yet it did not deliver the correct amount of fuel because it was clogged

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	**DEMONSTRATION: Show examples of good and bad injectors. Remind them that injector spray patterns cannot be determined by a visual inspection of injector alone. FIGURE 81-14**
	18. **SLIDE 18 EXPLAIN Figure 81-15** After connecting a pressure gauge, unplug the electrical connector from an injector and attach test lead from pulse unit to injector
	**DEMONSTRATION: Perform an injector pressure balance test. Insert a check ball from a carburetor or automatic transmission into an injector inlet prior to performing a balance test with a simulated plugged or restricted injector. FIGURE 81-15**
	19. **SLIDE 19 EXPLAIN Figure 81-16** injector tester being used to check the voltage drop through the injector while the tester is sending current through the injectors. This test is used to check the coil inside the injector. This same tester can be used to check for equal pressure drop of each injector by pulsing the injector on for 500 ms
	**DEMONSTRATION: Perform a voltage-drop test across injectors. FIGURE 81-16**
	**DISCUSSION: Have the students talk about voltage-drop tests. Why is the voltage drop across the injectors important? What problems or symptoms would be present if voltage drop was higher across one injector? FIGURE 81-16**
	20. **SLIDE 20 EXPLAIN Figure 81-17** A digital storage oscilloscope can be easily connected to an injector by carefully back probing the electrical connector. 21. **SLIDE 21 EXPLAIN Figure 81-18** injector on-time is called the pulse width
	**DEMONSTRATION: Display an injector drive circuit waveform using an oscilloscope. After displaying waveform, measure injector resistance. FIGURES 81-17 & 18**
	22. **SLIDE 22 EXPLAIN Figure 81-19** A typical peak-and-hold fuel-injector waveform. Most fuel injectors that measure less than 6 ohms will usually display a similar waveform.

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	**DEMONSTRATION:** With a scope connected to an injector drive circuit, show how PCM controls fuel mixture by changing injector on-time with the coolant temperature sensor signal wire open and grounded. This process allows PCM to think the engine is operating at temperature extremes, so it changes fuel mixture accordingly. **FIGURE 81-19**
	**ON-VEHICLE NATEF TASK** Inspect and test fuel injectors. **Page 253**
	**ON-VEHICLE NATEF TASK** Fuel Injector Balance Test. **Page 254**
	**ON-VEHICLE NATEF TASK** Injector Voltage Waveform Test. **Page 255**
	**DISCUSSION:** Have the students talk about **idle air speed control.** What is controlled by increasing or decreasing amount of air bypassing throttle plate?
	23. **SLIDE 23 EXPLAIN Figure 81-20** IAC controls idle speed by controlling amount of air that passes around throttle plate. More airflow results in higher idle speed. 24. **SLIDE 24 EXPLAIN Figure 81-21** set of six reconditioned injectors. Sixth injector is barely visible at the far right 25. **SLIDE 25 EXPLAIN FIGURE 81-22** IAC controls idle speed by controlling amount of air that passes around throttle plate. More airflow results in higher idle speed. 26. **SLIDE 26 EXPLAIN Figure 81-23** typical IAC. 27. **SLIDE 27 EXPLAIN Figure 81-24** Some IAC units are purchased with the housing as shown. Carbon buildup can cause a rough or unstable idling or stalling.
	**DEMONSTRATION:** Show examples of **idle air control valves.** Connect idle air control valve to 12 VOLT source to demonstrate operation. **FIGURES 81-21, 22, & 23**

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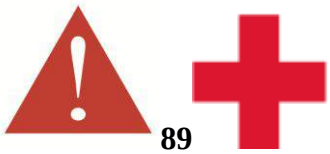
	**DEMONSTRATION: Connect scan tool to a vehicle & operate idle air control valve to demonstrate its operation.**
	**HANDS-ON TASK: remove throttle body from their own cars and inspect the idle air control valve passages for deposits, cleaning as necessary.**
	**Throttle bodies should be removed and cleaned periodically for good operation**
	28. **SLIDE 28 EXPLAIN Figure 81-25A** Nothing looks unusual when the hood is first opened 29. **SLIDE 29 EXPLAIN Figure 81-25B** When the cover is removed from the top of the engine, a mouse or some other animal nest is visible 30. **SLIDE 30 EXPLAIN Figure 81-26** Checking fuel-pump volume using a hose from the outlet of the fuel-pressure regulator into a calibrated container. 31. **SLIDE 31 EXPLAIN Figure 81-27** Testing fuel-pump volume using a fuel-pressure gauge with a bleed hose inserted into a suitable container. Engine running
	**DEMONSTRATION: Demonstrate testing of fuel pump volume with a pressure gauge connected to a running engine. FIGURES 81-25 & 26**
	**SAFETY Fuel leaks from improperly installed test equipment can be catastrophic. Emphasize safety by demonstrating checks for fuel leaks with a tester installed, the key on, & engine off. have fire extinguisher available before starting a test.**
	**DISCUSSION: Discuss fuel pump volume demands. Why is checking fuel pump volume important? FIGURES 81-25 & 26**
	32. **SLIDE 32 EXPLAIN Figure 81-28** A typical two-line cleaning machine hookup, showing an extension hose that can be used to squirt a cleaning solution into the throttle body while the engine is running on the cleaning solution and gasoline mixture. Typical two-line cleaning machines include Carbon Clean, Auto Care, Injector Test, DeCarbon, or Motor-Vac.

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	**33. SLIDE 33 EXPLAIN Figure 81-28** To thoroughly clean a throttle body, it is sometimes best to remove it from the vehicle
	**DEMONSTRATION: Remove throttle body to inspect it for carbon deposits. Clean and reinstall it without relearning computer idle air control counts to demonstrate improper idle speed. Perform computer relearn according to specifications.**
	FIGURES 81-27 & 28
	**DISCUSSION: Discuss fuel trim values. What happens to long term fuel trim when short-term fuel trim reaches its reduction limit? What happens when short-term fuel trim reaches enrichment limit? What happens when long-term fuel trim reaches its correction limits?**
	**34. SLIDES 34-63 OPTIONAL EXPLAIN FUEL INJECTOR CLEANING**
	**DEMONSTRATION: Connect scan tool to a running engine so students can view long & short-term fuel trim values. Create rich & lean conditions by using propane enrichment & creating vacuum or air leaks. Show students fuel trim corrections as the mixture changes.**
	**DEMONSTRATION: Show the students how to find the fuel pump relay using a component locator.**
	**When OEM does not provide identification information on cover of relay box, relays must be located and identified using an electrical component locator.**
	**Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF)**