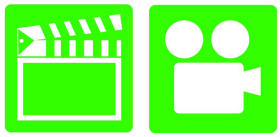
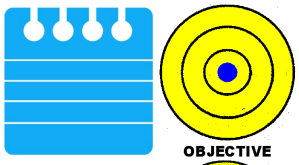
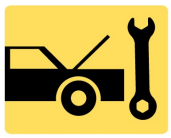
A8 Engine Performance 4th Edition

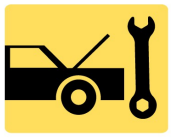
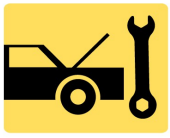
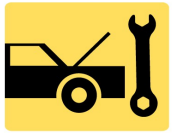
Chapter 30 Fuel-Injection Diagnosis and Service

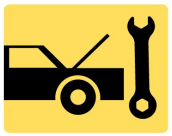
Opening Your Class

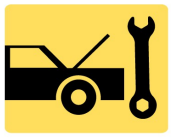
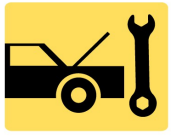
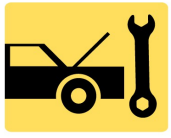
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Automotive Engine Performance.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, 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 the chapter learning objectives to the students. 1. Prepare for ASE Engine performance (A8) certification test content "C" (Fuel, air Induction, and exhaust System diagnosis and Repair. 2. Describe how to check an electric fuel pump for proper pressure and volume delivery. 3. Explain how to check a fuel-pressure regulator. 4. Describe how to test fuel injectors 5. Explain how to diagnose electronic fuel-injection problems. 6. 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.

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	1. SLIDE 1 CH30 Fuel-Injection Diagnosis and Service
	Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE REGULARLY UPDATED
	POWER POINTS DONE BY INDIVIDUAL LEARNING OBJECTIVES, SO THERE IS POWER POINT FILE FOR EACH LEARNING OBJECTIVE
	2. SLIDE 2 EXPLAIN OBJECTIVE CH30 AEP_LO1 3. SLIDES 3-6 EXPLAIN Port Fuel-Injection Pressure Regulator Diagnosis
	7. SLIDE 7 EXPLAIN Figure 30-1 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 30-1
	DISCUSSION: DISCUSS 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 30-2 & 3
	2. SLIDE 2 EXPLAIN OBJECTIVE CH30 AEP_LO2 3. SLIDES 3-5 EXPLAIN Port Fuel-Injection System Diagnosis

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	**DISCUSSION:** DISCUSS **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.
	**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.
	**DISCUSSION:** HAVE THE STUDENTS DISCUSS NORMAL **IAC COUNTS**. WHAT DOES A VERY HIGH OR VERY LOW IAC COUNT (_45 OR _5) INDICATE? **FIGURE 30-6**
	6. **SLIDE 6 EXPLAIN FIGURE 30–7** Checking the fuel pressure using a fuel-pressure gauge connected to the Schrader valve.
	7. **SLIDE 7 EXPLAIN FIGURE 30–8** 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 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 30-7 & 8**
	8. **SLIDES 8-9 EXPLAIN** Testing for an Injector Pulse 10. **SLIDE 10 EXPLAIN FIGURE 30-9 (a)** Noid lights are usually purchased as an assortment so that one is available for any type/size of injector wiring connector. **(b)** Connector is unplugged from injector and a Noid light is plugged into harness side of connector. Noid light should flash when engine is being cranked if power

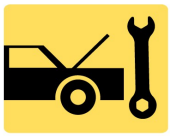
ICONS	Ch30 Fuel-Injection Diagnosis and Service
	circuit and the pulsing to ground by the computer are functioning normally.
DEMO	**DEMONSTRATION: INSTALL A NOID LIGHT IN INJECTOR HARNESS AND CRANK OR OPERATE ENGINE TO DEMONSTRATE LIGHT OPERATION FOR DIAGNOSIS. WHAT CAN CAUSE A NOID LIGHT NOT TO FLASH OR TO FLASH DIMLY: FIGURE 30-9**
	11. **SLIDE 11 EXPLAIN** Testing for an Injector Pulse 12. **SLIDE 12 EXPLAIN Figure 30-10** DMM set to read DC volts to check voltage drop of positive circuit to fuel injector. 0.5 volt or less is considered to be acceptable 13. **SLIDES 13-14 EXPLAIN** Checking Fuel-Injector Resistance 15. **SLIDE 15 EXPLAIN Figure 30-11** An ohmmeter is connected to the injector electrical terminals to read injector coil resistance.
	**DISCUSSION: DISCUSS FUEL-INJECTOR RESISTANCE. WHY IS INJECTOR RESISTANCE CRITICAL? ASK STUDENTS TO LOOK UP INJECTOR RESISTANCE SPECIFICATIONS FOR THEIR OWN CARS.**
DEMO 	**DEMONSTRATION: SHOW HOW TO CHECK INJECTOR RESISTANCE WITH OHMMETER. HEAT INJECTOR WITH A HEAT GUN & THEN RECHECK RESISTANCE TO DEMONSTRATE HEAT RELATED CHANGE. FIGURE 22-11 ALSO SHOW VOLTAGE DROP METHOD IN FIGURE 22-10**
	**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.**
	**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**

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	**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 22-11, 12, & 13**
	16. **SLIDE 16 EXPLAIN Figure 30-12** 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. 17. **SLIDES 17-18 EXPLAIN** Measuring Resistance of Grouped Injectors
	**HANDS-ON TASK: HAVE THE STUDENTS CHECK INJECTOR RESISTANCE ON THEIR OWN CARS, STARTING WITH A COMPARISON MEASUREMENT TO SPECIFICATIONS. FIGURES 22-11, 12, & 13**
	**DISCUSSION: DISCUSS 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?**
	19. **SLIDE 19 EXPLAIN Figure 30-13 (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). **(b)** meter is connected to other group of 3 injectors and indicates that most, if not all 3, injectors are shorted. Replaced all 6 injectors and engine ran great.
	20. **SLIDE 20 EXPLAIN Figure 30-14** If an injector has specified resistance, this does not mean that it is okay. This injector had specified resistance yet it did not deliver correct amount of fuel because it was clogged

ICONS	Ch30 Fuel-Injection Diagnosis and Service
DEMO	**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 30-14**
	21. **SLIDES 21-22 EXPLAIN** Pressure-Drop Balance Test 23. **SLIDE 3 EXPLAIN Figure 30-15** After connecting a pressure gauge, unplug the electrical connector from an injector and attach test lead from the pulse unit to injector
DEMO 	**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 30-15**
	24. **SLIDE 24 EXPLAIN Figure 30-16** 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
DEMO 	**DEMONSTRATION: PERFORM VOLTAGE-DROP TEST ACROSS INJECTORS. FIG 30-16**
 QUESTION	**DISCUSSION: DISCUSS VOLTAGE-DROP TESTS. WHY IS THE VOLTAGE DROP ACROSS INJECTORS IMPORTANT? WHAT PROBLEMS OR SYMPTOMS WOULD BE PRESENT IF VOLTAGE DROP WAS HIGHER ACROSS ONE INJECTOR? FIGURE 30-16**
	25. **SLIDE 25 EXPLAIN Figure 30-17** digital storage oscilloscope can be easily connected to an injector by carefully back probing the electrical connector. 26. **SLIDE 26 EXPLAIN** Scope-Testing Fuel Injectors 27. **SLIDE 27 EXPLAIN Figure 30-18** injector on-time is called the pulse width
DEMO 	**DEMONSTRATION: DISPLAY INJECTOR DRIVE CIRCUIT WAVEFORM USING AN OSCILLOSCOPE. AFTER DISPLAYING WAVEFORM, MEASURE INJECTOR RESISTANCE. FIGURES 30-17 & 18**

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	28. **SLIDE 28 EXPLAIN Figure 30-19** A typical peak-and-hold fuel-injector waveform. Most fuel injectors that measure less than 6 ohms will usually display a similar waveform
DEMO	**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 22-19**
OBJECTIVE	2. **SLIDE 2 EXPLAIN OBJECTIVE CH30 AEP_LO3** 3. **SLIDES 3-5 EXPLAIN Diagnosing Electronic Fuel-Injection Problems Using Visual Inspection**
	4. **SLIDE 4 EXPLAIN FIGURE 30–3** clogged PCV system caused the engine oil fumes to be drawn into the air cleaner assembly. This is what the technician discovered during a visual inspection. 5. **SLIDE 5 EXPLAIN FIGURE 30–4** All fuel injectors should make the same sound with the engine running at idle speed. A lack of sound indicates a possible electrically open injector or a break in the wiring. A defective computer could also be the cause of a lack of clicking (pulsing) of the injectors.
DEMO	**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 NONOPERATIVE CONDITION FIG 30-4**
	6. **SLIDE 6 EXPLAIN FIGURE 30–5** Fuel should be heard returning to the fuel tank at the fuel return line if the fuel-pump and fuel-pressure regulator are functioning correctly.
We Support NATEF	**ON-VEHICLE NATEF TASK INSPECT AND TEST FUEL INJECTORS.**

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	**ON-VEHICLE NATEF TASK FUEL INJECTOR BALANCE TEST**
	**ON-VEHICLE NATEF TASK INJECTOR VOLTAGE WAVEFORM TEST.**
	2. SLIDE 2 EXPLAIN OBJECTIVE CH30 AEP_LO4 3. SLIDES 3-4 EXPLAIN Idle Air Speed Control Diagnosis
	**DISCUSSION: HAVE THE STUDENTS TALK ABOUT IDLE AIR SPEED CONTROL. WHAT IS CONTROLLED BY INCREASING OR DECREASING AMOUNT OF AIR BYPASSING THROTTLE PLATE?**
	5. SLIDE 5 EXPLAIN Figure 30-21 IAC controls idle speed by controlling amount of air that passes around throttle plate. More airflow results in higher idle speed. 6. SLIDE 6 EXPLAIN Figure 30-22 typical IAC. 7. SLIDE 7 EXPLAIN Figure 30-23 Some IAC units are purchased with housing as shown. Carbon buildup in these passages 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 FIG 30-21, 22, & 23**
	2. SLIDE 2 EXPLAIN OBJECTIVE CH30 AEP_LO5 3. SLIDE 3 EXPLAIN FIGURE 30–24 (a) Nothing looks unusual when the hood is first opened. (b) When the cover is removed from the top of the engine, a mouse or some other animal nest is visible. The animal had already eaten through a couple of injector wires. At least the cause of the intermittent misfire was discovered
	4. SLIDES 4-5 EXPLAIN Fuel-Injection Service
	**DEMONSTRATION: CONNECT SCAN TOOL TO A VEHICLE & OPERATE IDLE AIR CONTROL VALVE TO DEMO ITS OPERATION. SHOW IDLE AIR COUNTS AS DISPLAYED ON SCAN TOOL.**

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	**HANDS-ON TASK: HAVE STUDENTS 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 & CLEANED PERIODICALLY TO ENSURE PROPER ENGINE IDLE SPEEDS.**
	
	5. **SLIDE 5 EXPLAIN Figure 30-25** Checking fuel-pump volume using a hose from the outlet of the fuel-pressure regulator into a calibrated container. 6. **SLIDE 6 EXPLAIN Figure 30-26** Testing fuel-pump volume using a fuel-pressure gauge with a bleed hose inserted into a suitable container. The engine is running during this test
	**DEMONSTRATION: DEMONSTRATE TESTING OF FUEL PUMP VOLUME WITH A PRESSURE GAUGE CONNECTED TO A RUNNING ENGINE. FIGURES 30-25 & 26**
	**SAFETY FUEL LEAKS FROM IMPROPERLY INSTALLED TEST EQUIPMENT CAN BE CATASTROPHIC. EMPHASIZE SAFETY BY DEMONSTRATING CHECKS FOR FUEL LEAKS WITH TESTER INSTALLED, KOEO. REMIND STUDENTS TO HAVE FIRE EXTINGUISHER AVAILABLE BEFORE STARTING A TEST.**
	**DISCUSSION: HAVE THE STUDENTS DISCUSS FUEL PUMP VOLUME DEMANDS. WHY IS CHECKING FUEL PUMP VOLUME IMPORTANT? FIGURES 30-25 & 26**
	**VIDEO: 3 MIN FUEL PUMP REPLACEMENT WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=FUEL%20PUMP%20REPLACEMENT&CLIP=PANDC/CHET/2012/AUTOMOTIVE/INSTALLING_EFI_SYSTEM/T12CD11.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/INSTALLING_EFI_SYSTEM/XML/T12CD11.XML
	7. **SLIDE 7 EXPLAIN Figure 30-27** 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,

ICONS	Ch30 Fuel-Injection Diagnosis and Service
	or Motor-Vac. 8. **SLIDE 8 EXPLAIN Figure 30-28** 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 30-27 & 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?**
	**DEMONSTRATION: CONNECT A 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.**