

# Advanced Engine Performance Diagnosis 6/E
















## Chapter 22 Fuel Pumps, Lines, & Filters










### Opening Your Class







| KEY ELEMENT   | EXAMPLES   |
|---|--|
| Introduce Content   | This course or class covers operation and service of <b>ADVANCED Automotive Engine Performance Diagnosis 6/E</b> . 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. <ol style="list-style-type: none"><li>1. Discuss the purpose and function of the fuel delivery system.</li><li>2. Explain the types of fuel lines.</li><li>3. Discuss the different types of electric fuel pumps.</li><li>4. Describe the purpose and function of fuel filters.</li><li>5. Describe how to test and replace fuel pumps.</li></ol> |
| Establish the Mood or Climate   | Provide a <i>WELCOME</i> , 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](http://www.jameshalderman.com)**











**LINK CHP 22: Chapter Images**

| ICONS   | Ch22 Fuel Pumps, Lines, & Filters   |
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| <br> <br><br> <br><br>  <p>QUESTION</p><br>  <p>QUESTION</p><br> <p>DEMO</p><br><br>  <p>QUESTION</p> | <p><b>1. SLIDE 1 CH22 Fuel Pumps, Lines, &amp; Filters</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b><br/> @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a><br/> <b>WEB SITE REGULARLY UPDATED</b></p> <p><b><u>Engine Controls (284 Links)</u></b></p> <p>At the beginning of this class, you can download the crossword puzzle &amp; Word Search from the links below to familiarize your class with the terms in this chapter &amp; then discuss them</p> <p><a href="#"><u>Crossword Puzzle (Microsoft Word) (PDF)</u></a><br/> <a href="#"><u>Word Search Puzzle (Microsoft Word) (PDF)</u></a></p> <p><b><u>DISCUSSION:</u> HAVE THE STUDENTS TALK ABOUT THE VARIOUS COMPONENTS USED IN FUEL DELIVERY SYSTEM.WHAT IS THE <u>PURPOSE OF FUEL DELIVERY SYSTEMS?</u></b></p> <p><b><u>DISCUSSION:</u> HAVE THE STUDENTS DISCUSS THE USE OF <u>BAFFLES IN FUEL TANKS.</u> ASK THEM IF THEY HAVE EVER HEARD FUEL SLOSHING IN A FUEL TANK</b></p> <p><b><u>DEMONSTRATION:</u> SHOW EXAMPLES OF <u>METAL &amp; PLASTIC FUEL TANKS.</u> DISCUSS WHETHER THERE ARE ADVANTAGES TO USING TANKS MADE FROM EITHER OF THESE MATERIALS</b></p> <p>2. SLIDE 2 EXPLAIN Figure 22-1 typical fuel tank installation.</p> <p>3. SLIDE 3 EXPLAIN Figure 22-2 A three-piece filler tube assembly. The main three parts include the upper neck, hose, and lower neck</p> <p><b><u>DISCUSSION:</u> HAVE THE STUDENTS DISCUSS THE MOUNTING POSITION OF FUEL TANKS. WHAT FACTORS ARE CONSIDERATIONS IN FUEL TANK LOCATION? <u>FIGURES 22-1 &amp; 2</u></b></p> |

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|    | <p>4. <b>SLIDE 4 EXPLAIN</b> Figure 22-3 view of a typical filler tube with the fuel tank removed. Notice the ground strap used to help prevent the buildup of static electricity as the fuel flows into the plastic tank. The check ball looks exactly like a ping-pong ball</p> |
|    | <p><b>DISCUSSION: HAVE THE STUDENTS TALK ABOUT ONBOARD FUELING VAPOR RECOVERY SYSTEMS. HOW IS THIS SYSTEM DIFFERENT FROM THE RECOVERY SYSTEM USED ON GASOLINE PUMPS? FIGURE 22-3</b></p>  |
|    | <p>5. <b>SLIDE 5 EXPLAIN</b> Figure 22-4 Vehicles equipped with onboard refueling vapor recovery usually have a reduced-size fill tube.</p>   |
|    | <p><b>DEMONSTRATION: SHOW FUEL TANK FILLER NECK FROM VEHICLE EQUIPPED WITH AN ONBOARD REFUELING VAPOR RECOVERY SYSTEM, POINTING OUT REDUCED NECK SIZE &amp; VENT. FIGURE 22-4</b></p>   |
|  | <p>6. <b>SLIDE 6 EXPLAIN</b> Figure 22-5 fuel pickup tube is part of the fuel sender and pump assembly</p>  |
|  | <p><b>DEMONSTRATION: SHOW FUEL PUMP/PICKUP TUBE ASSEMBLY. POINT OUT FILTER SOCK &amp; FUEL RETURN LINE. FIGURE 22-5</b></p>   |
|  | <p><b>DEMONSTRATION: SHOW THE STUDENTS CHARCOAL CANISTER STORAGE DEVICE FOR FUEL VAPORS</b></p>   |
|  | <p><b>DISCUSSION: HAVE THE STUDENTS DISCUSS THE COMPONENTS OF AN EVAPORATIVE EMISSION CONTROL SYSTEM. HOW ARE FUEL VAPORS VENTED?</b></p>   |
|  | <p><b>HANDS-ON TASK: HAVE STUDENTS LOCATE &amp; IDENTIFY FUEL SYSTEM COMPONENTS ON LAB VEHICLE. GRADE THEM ON ACCURACY IN IDENTIFYING COMPONENTS AND THEIR UNDERSTANDING OF THE FUEL SYSTEM.</b></p>  |

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|   | <p>7. SLIDE 7 EXPLAIN Figure 22-6 On some vehicles equipped with an airflow sensor, a switch is used to energize the fuel pump. In the event of a collision, the switch opens and the fuel flow stops.</p>   |
|   | <p>8. SLIDE 8 EXPLAIN Figure 22-7 Ford uses an inertia switch to turn off the electric fuel pump in an accident.</p>   |
| <p><b>DISCUSSION: HAVE THE STUDENTS DISCUSS DIFFERENT TYPES OF FUEL LINES. WHAT ARE ADVANTAGES &amp; DISADVANTAGES OF DIFFERENT MATERIALS?</b></p> | <p><b>DISCUSSION: HAVE THE STUDENTS DISCUSS DIFFERENT TYPES OF FUEL LINES. WHAT ARE ADVANTAGES &amp; DISADVANTAGES OF DIFFERENT MATERIALS?</b></p>   |
| <p><b>DEMO</b></p>   | <p><b>DEMONSTRATION: SHOW FORD INERTIA SWITCH USED TO TURN OFF FUEL PUMP IN EVENT OF AN ACCIDENT. IF FORD VEHICLE IS AVAILABLE, TRIP SWITCH BY TAPPING ON IT TO SHOW STUDENTS HOW IT WORKS</b></p>   |
|   | <p><b>FIGURE 22-7</b></p>  |
|   | <p>SOME FORD VEHICLES, MAINLY TRUCKS, HAVE FUEL PUMP INERTIA SWITCH LOCATED INSIDE CAB ON EITHER FIREWALL OR COWL SIDE PANEL.</p>  |
| <p><b>DEMO</b></p>   | <p>9. SLIDE 9 EXPLAIN Figure 22-8 Fuel lines are routed along the frame or body and secured with clips</p>   |
| <p><b>DEMO</b></p>   | <p><b>DEMONSTRATION: SHOW EXAMPLES OF RIGID &amp; FLEXIBLE FUEL LINES USED ON A VEHICLE. DISCUSS MATERIAL, ROUTING, &amp; RETENTION METHODS USED.</b></p>  |
|   | <p><b>FIGURE 22-8 SAFETY EXPLAIN THE DANGERS INVOLVED WHEN WORKING WITH FUEL SYSTEMS. SOME OF THESE SYSTEMS CAN OPERATE AT PRESSURES OF 80 TO 100 PSI. ANY TIME A FUEL LINE NEEDS TO BE DISCONNECTED, FUEL PRESSURE MUST BE RELEASED USING OEM RECOMMENDED METHOD.</b></p> |
|   | <p><b>DISCUSSION: HAVE THE STUDENTS DISCUSS NEWER FUEL SUPPLY SYSTEMS THAT DO NOT UTILIZE A RETURN LINE. WHAT COMPONENTS HAD TO BE MODIFIED OR CHANGED FOR THIS SYSTEM TO OPERATE PROPERLY?</b></p>  |

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|    | <p>10. SLIDE 10 EXPLAIN Figure 22-9 Some Ford metal line connections use spring locks and O-rings.</p>  |
| <p>11. SLIDE 11 EXPLAIN Figure 22-10 Ford spring-lock connectors require a special tool for disassembly.</p>  | <p>11. SLIDE 11 EXPLAIN Figure 22-10 Ford spring-lock connectors require a special tool for disassembly.</p>  |
| <p>12. SLIDE 12 EXPLAIN Figure 22-11 Typical quick-connect steps</p>  | <p>12. SLIDE 12 EXPLAIN Figure 22-11 Typical quick-connect steps</p>  |
|                       | <p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p>   |
|    | <p><b><u>DEMONSTRATION: SHOW EXAMPLES OF FUEL LINE SPRING-LOCK FITTINGS. SHOW SPECIAL TOOLS NEEDED TO DISCONNECT THESE FITTINGS. FIGURES 22-9 TO 11</u></b></p> |
|    | <p><b><u>HANDS-ON TASK: HAVE STUDENTS DISASSEMBLE AND REASSEMBLE FUEL LINE CONNECTIONS, INCLUDING SPRING-LOCK FITTINGS. FIGURES 22-9, 10, &amp; 11</u></b></p>  |
|   | <p><b><u>ANIMATION: FUEL PUMP CONTROL</u></b></p>   |
|    | <p>13. SLIDE 13 EXPLAIN Figure 22-12 A roller cell-type electric fuel pump</p>  |
|    | <p><b><u>DEMONSTRATION: SHOW EXAMPLES OF ROTARY FUEL PUMPS AND DISCUSS HOW THEY WORK. FIGURES 22-12 &amp; 13</u></b></p>  |
|    | <p>14. SLIDE 14 EXPLAIN Figure 22-13 The pumping action of an impeller or rotary vane pump</p>  |
|   <p>QUESTION</p> | <p><b><u>DISCUSSION: ASK STUDENTS TO DISCUSS ROTARY VANE FUEL PUMP SHOWN IN FIGURE 22-13. WILL PUMP BE ABLE TO PUMP MORE FUEL IF IT TURNS FASTER?</u></b></p>   |
|    | <p>15. SLIDE 15 EXPLAIN Figure 22-14 An exploded view of a gerotor electric fuel pump</p>   |

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|    | <p><b>DISCUSSION: ASK THE STUDENTS TO DISCUSS THE GEROTOR-TYPE PUMP. WHAT PROCESS DOES THIS TYPE OF PUMP USE TO PRESSURIZE FUEL? FIGURES 22-14</b></p>   |
|    | <p><b>DEMONSTRATION: SHOW EXAMPLE OF A GEROTOR TYPE FUEL PUMP. EXPLAIN DIFFERENCE BETWEEN IT &amp; VANE-TYPE PUMP. THEN, SHOW STUDENTS EXAMPLE OF A TURBINE TYPE FUEL PUMP. FIGURES 22-14 &amp; 15</b></p> |
|    | <p>16. SLIDE 16 EXPLAIN Figure 22-15 A cutaway view of a typical two-stage turbine electric fuel pump.</p>   |
|    | <p><b>DISCUSS FREQUENTLY ASKED QUESTION</b></p>  |
|   | <p>17. SLIDE 17 EXPLAIN FIGURE 22-16 A typical fuel-pump module assembly, which includes the pickup strainer and fuel pump, as well as the fuel pressure sensor and fuel level sensing unit</p>            |
|  | <p><b>DEMONSTRATION: SHOW EXAMPLE OF A MODULAR FUEL SENDER ASSEMBLY USED IN MODERN VEHICLES. POINT OUT THE PUMP, CONVOLUTED TUBE, &amp; FLOAT ASSEMBLY. FIGURES 22-16</b></p>                              |
|  | <p><b>DISCUSSION: DISCUSS REASON FUEL PUMP MODULES ARE SPRING-LOADED. DOES FUEL TANK MATERIAL MAKE A DIFFERENCE?</b></p>   |
|  | <p><b>DISCUSSION: HAVE THE STUDENTS TALK ABOUT ELECTRIC FUEL PUMP CONTROL CIRCUITS. WHY ARE RELAYS CONTROLLED BY THE PCM?</b></p>  |
|  | <p>18. SLIDE 18 EXPLAIN Figure 22-17 schematic showing that an inertia switch is connected in series between the fuel-pump relay and the fuel pump.</p>  |
|  | <p><b>DISCUSSION: DISCUSS WIRING DIAGRAM SHOWN IN FIGURE 22-17. COULD INERTIA SWITCH BE PLACED ANYWHERE ELSE IN CIRCUIT AND STILL PROVIDE SAME RESULTS?</b></p>  |



## ICONS

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19. **SLIDE 19 EXPLAIN** Figure 22-18 A typical fuel pulsator used mostly with roller vane-type pumps to help even out the pulsation in pressure that can cause noise

**DISCUSSION:** HAVE THE STUDENTS DISCUSS THE **PULSATORS AND ACCUMULATORS** USED IN FUEL SUPPLY SYSTEM. WHY DO SOME EXPERTS ADVISE REMOVAL OF THE PULSATORS IN THE FUEL TANK? **FIGURE 22-18**

### **Fuel Filters**

20. **SLIDE 20 EXPLAIN** Figure 22-19 Inline fuel filters are usually attached to the fuel line with screw clamps or threaded connections. Fuel filter must be installed in the proper direction or a restricted fuel flow can result.

**EXPLAIN TECH-TIP**











**DEMONSTRATION:** SHOW **LOCATION OF FUEL FILTERS** ON VEHICLES. ARE ALL FILTERS LOCATED IN COMMON AREAS? **FIGURE 22-19**

**DEMONSTRATION:** SHOW EXAMPLES OF FUEL FILTERS. SHOW SOME FILTERS FROM CARBURETED ERA & HIGH PRESSURE FILTERS USED IN FUEL-INJECTED VEHICLES. POINT OUT THAT VEHICLE WITH RETURNLESS-TYPE FUEL SYSTEM WILL MOST LIKELY HAVE FUEL FILTER INSIDE FUEL TANK. **FIGURE 22-19**

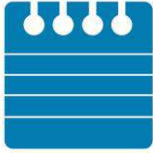

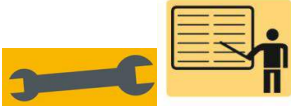





**DISCUSSION:** HAVE THE STUDENTS DISCUSS NEED TO FILTER FUEL BEFORE IT GOES THROUGH ANY FUEL METERING DEVICE, SUCH AS A CARBURETOR OR FUEL INJECTOR. WHAT DO FUEL FILTERS REMOVE? **FIGURE 22-19 & 20**

**ON-VEHICLE NATEF TASK REPLACE FUEL FILTERS**

**DISCUSSION:** DISCUSS **FUEL PUMP TEST PROCEDURES**. WHAT DRIVABILITY PROBLEMS WOULD WARRANT A FUEL PUMP TEST?

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|    | <p><b><u>DEMONSTRATION: SHOW HOW TO JAR A STALLED FUEL PUMP INTO OPERATION BY STRIKING THE FUEL TANK. WHY SHOULD A RUBBER Mallet BE USED FOR THIS PROCEDURE? THEN, SHOW STUDENTS HOW TO LISTEN FOR FUEL PUMP OPERATION BY REMOVING FUEL CAP &amp; INSERTING A FUNNEL INTO FILLER NECK. FIGURE 22-21</u></b></p>  |
|    | <p>21. SLIDES 21 EXPLAIN FIGURE 22-20 The final filter, also called a filter basket, is the last filter in the fuel system</p>   |
|    | <p><b>EXPLAIN TECH-TIP</b></p> <p>22. SLIDE 22 EXPLAIN FIGURE 22-21 (a) A funnel helps in hearing if the electric fuel pump inside the gas tank is working.</p>  |
|    | <p>23. SLIDE 23 EXPLAIN FIGURE 22-21 (b) If the pump is not running, check the wiring and current flow before going through the process of dropping the fuel tank to remove the pump</p>   |
|    | <p>24. SLIDE 24 EXPLAIN Figure 22-22 The Schrader valve on this General Motors 3800 V-6 is located next to the fuel-pressure regulator</p>   |
|                   | <p><b>EXPLAIN TECH-TIP</b></p>   |
|   <p>QUESTION</p> | <p>25. SLIDE 25 EXPLAIN Figure 22-23 fuel system should hold pressure if the system is leak free</p> <p><b><u>DISCUSSION: DISCUSS PRESSURE-TESTING FUEL PUMP. IF PRESSURE IS CORRECT AT IDLE, WILL IT ALSO BE CORRECT UNDER LOAD? FIGURE 22-22 &amp; 23. DISCUSS REST PRESSURE TEST. WHAT COULD HAPPEN IF PRESSURE LEAKS DOWN RAPIDLY? DISCUSS DYNAMIC PRESSURE TEST. IF PRESSURE DOESN'T CHANGE WHEN THROTTLE IS CYCLED, WHAT PROBLEMS MIGHT EXIST?</u></b></p> |
|    | <p>26. SLIDE 26 EXPLAIN Figure 22-24 If vacuum hose is removed from fuel pressure regulator when the engine is running, fuel pressure should increase. If it does not increase, then fuel pump is not capable of supplying</p>   |



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|    | <p>adequate pressure or fuel-pressure regulator is defective. If gasoline is visible in the vacuum hose, the regulator is leaking and should be replaced</p> <p><b>PRESENCE OF FUEL IN VACUUM LINE TO REGULATOR CAN MEAN ONLY ONE THING—DIAPHRAGM IS LEAKING. THIS CAN CAUSE MULTIPLE DRIVABILITY PROBLEMS AND DTCS: <u>FIGURE 22–24 &amp; 25</u></b></p>                                     |
|    | <p><b><u>HANDS-ON TASK: GIVE STUDENTS LIST OF VEHICLES. HAVE THEM LOCATE FUEL PRESSURE SPECIFICATIONS &amp; TEST PROCEDURE FOR EACH VEHICLE.</u></b></p>  |
|    | <p><b>EXPLAIN TECH-TIP</b></p> <p>27. <b>SLIDE 27 EXPLAIN FIGURE 22–25</b> 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.</p> <p>28. <b>SLIDE 28 EXPLAIN Figure 22-26</b> A fuel-pressure reading does not confirm that there is enough fuel volume for the engine to operate correctly.</p> |
|  | <p><b><u>DISCUSSION: HAVE THE STUDENTS TALK ABOUT THE NEED FOR PROPER VOLUME OF FUEL FIGURE 22–26. WHAT ARE SOME INDICATORS OF A CLOGGED FUEL FILTER?</u></b></p>   |
|  | <p><b>EXPLAIN TECH-TIP</b></p> <p>29. <b>SLIDES 29 EXPLAIN FIGURE 22–27</b> Fuel should be heard returning to fuel tank at fuel return line if fuel pump &amp; fuel-pressure regulator are functioning correctly.</p>   |
|  | <p><b><u>DEMONSTRATION: DEMONSTRATE QUICK &amp; EASY FUEL PUMP VOLUME TEST. IS THIS TEST 100% ACCURATE? FIGURE 22–26 &amp; 27</u></b></p>   |
|  | <p>30. <b>SLIDE 30 EXPLAIN FIGURE 22–28</b> Hookup for testing fuel-pump current draw on any vehicle equipped with a fuel-pump relay</p>  |
|  | <p><b><u>DISCUSSION: HAVE STUDENTS DISCUSS WHETHER REMOVING BED FROM A PICK-UP TRUCK MIGHT MAKE IT EASIER TO REPLACE A FUEL PUMP. IF TANK WAS COMPLETELY FULL OF FUEL, WOULD</u></b></p>  |

## ICONS








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### THIS PROCEDURE HELP? FIGURE 22–28

**SAFETY EXTREME CAUTION ADVISED WHEN WORKING AROUND ANY COMPONENT OF THE FUEL SYSTEM, ESPECIALLY WHEN THE ENGINE IS HOT.**

### **ON-VEHICLE NATEF TASK INSPECT AND TEST FUEL PUMPS & PUMP CONTROL SYSTEMS FOR PRESSURE, REGULATION, AND VOLUME; PERFORM NECESSARY ACTION.**

31. **SLIDE 31 EXPLAIN** Figure 22-29 Hookup for testing fuel-pump current draw on any vehicle equipped with a fuel-pump relay
32. **SLIDE 32 EXPLAIN** FIGURE 22–30 A typical electric fuel pump motor that uses triangular commutator segments and horizontal brushes
33. **SLIDE 33 EXPLAIN** FIGURE 22–31 As the fuel pump motor rotates, it produces a current waveform (as shown) as the brushes pass over the commutator segments. Each vertical line represents 1 ampere therefore the waveform shows that the pump is requiring a little over 4.5 amperes.
34. **SLIDE 34 EXPLAIN** FIGURE 22–32 The speed of the fuel pump motor can be determined by the time it takes the motor to make one revolution, as determined by looking for unique commutator segment patterns.
35. **SLIDE 35 EXPLAIN** FIGURE 22–33 The RPM of a pump is determined by first locating unique humps in the voltage waveform. Counting the number of divisions between unique humps and then multiplying it by the time per division determines the time for one revolution.
36. **SLIDE 36 EXPLAIN** FIGURE 22–34 This fuel pump voltage waveform shows good pump speed (4,724 RPM) and current draw. Each vertical line represents 1 ampere therefore the waveform shows that the pump is requiring a little over 4.5 amperes.
37. **SLIDE 37 EXPLAIN** FIGURE 22–35 Although the voltage waveform of this pump looks good, a calculation of the pump motor speed indicates that it is rotating far below the 3,000 RPM minimum acceptable speed

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| <br> <br>  | <p><b><u>DEMONSTRATION: EXPLAIN HOW A CURRENT DRAW TEST CAN INDICATE A WORN FUEL PUMP. USE FUEL PUMP CURRENT DRAW TABLE TO SHOW THAT PUMP CAN DRAW MORE OR LESS CURRENT THAN SPECIFICATIONS. SHOW HOW TO PERFORM FUEL PUMP CURRENT DRAW TEST.</u></b></p> <p><b><u>ON-VEHICLE NATEF TASK FUEL PUMP CURRENT DRAW TEST</u></b></p><br><p><b><u>ON-VEHICLE NATEF TASK PERFORM ACTIVE TESTS OF ACTUATORS USING A SCAN TOOL; DETERMINE NECESSARY ACTION</u></b></p> |