

# Automotive Fuel and Emissions Control Systems 4/E






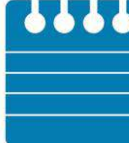






## Chapter 9 Turbocharging and Supercharging

### Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of <b>Automotive Fuel and Emissions Control Systems</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 airflow requirements and volumetric efficiency of engines.</li><li>2. Understand forced induction principles.</li><li>3. List the advantages and disadvantages of superchargers.</li><li>4. Explain the purpose and function of turbochargers.</li><li>5. Explain boost control and turbocharger failures.</li><li>6. Describe the purpose and function of a nitrous oxide system.</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 Fuel & Emission Control 4<sup>th</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)**

**LINK CHP 9: [Chapter Images](#)**

ICONS	Ch09 Turbocharging and Supercharging
         	<p><b>1. SLIDE 1 CH09 Turbocharging and Supercharging</b></p> <p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b> @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a> <b>WEB SITE REGULARLY UPDATED</b></p> <p><b>2. SLIDE 2 EXPLAIN FIGURE 9-1</b> supercharger on a Ford V-8 &amp; <b>EXPLAIN FIGURE 9-2</b> turbocharger on a Toyota engine.</p> <p><b><u>Videos</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><b><u><a href="#">Crossword Puzzle (Microsoft Word) (PDF)</a></u></b> <b><u><a href="#">Word Search Puzzle (Microsoft Word) (PDF)</a></u></b></p> <p><b>3. SLIDES 3 EXPLAIN</b> Forced Induction Principles &amp; <b>EXPLAIN FIGURE 9-3</b> more air and fuel that can be packed in a cylinder, the greater the density of the air-fuel charge.</p> <p><b>4. SLIDE 4 EXPLAIN</b> Forced Induction Principles &amp; <b>EXPLAIN FIGURE 9-4</b> Atmospheric pressure decreases with increases in altitude</p>
	<p><b><u>DEMONSTRATION: DEMONSTRATE AN ENGINE'S CHANGE IN VOLUMETRIC EFFICIENCY BY PERFORMING COMPRESSION TEST DURING CRANKING AND AT 2500 RPM. POINT OUT TO STUDENTS THAT THE HIGHER CYLINDER PRESSURE AT CRANKING SPEEDS IS DUE TO THE INCREASED TIME FOR AIR TO FLOW INTO CYLINDER. AT SLOWER SPEEDS THERE IS MORE TIME FOR AIR TO LEAK PAST RINGS</u></b></p>
	<p><b><u>DISCUSSION: ASK STUDENTS TO DISCUSS ADVANTAGES OF USING FORCED INDUCTION OVER INCREASED DISPLACEMENT</u></b></p>

## ICONS

## Ch09 Turbocharging and Supercharging



### ON-VEHICLE TASK: NATEF TASK: RESEARCH VEHICLE INFORMATION ON TURBOCHARGERS OR SUPERCHARGERS

6. **SLIDE 6 EXPLAIN FIGURE 9-5** roots-type supercharger uses two lobes to force the air around the outside of the housing and into the intake manifold.
7. **SLIDE 7 EXPLAIN FIGURE 9-6** bypass actuator opens the bypass valve to control boost pressure

#### **Supercharger Bypass (View) (Download)**

8. **SLIDE 8 EXPLAIN FIGURE 9-7** Ford supercharger cutaway display showing the roots-type blower and air charge cooler (intercooler). The air charge cooler is used to reduce the temperature of the compressed air before it enters the engine to increase the air charge density.

#### **EXPLAIN TECH TIP**

### **SUPERCHARGER OPTIONAL EQUIPMENT ON 1957 FORDS. SOME MUSCLE CARS USED RAM AIR SCOOPS TO ACHIEVE A SUPERCHARGING EFFECT BY CAPTURING HIGH PRESSURE OUTSIDE AIR.**

**DEMONSTRATION: SHOW A SUPERCHARGER TO STUDENTS, POINTING OUT THE DRIVE PULLEY, INLET, OUTLET, AND BYPASS PASSAGE. CARE SHOULD BE TAKEN AROUND THE SUPERCHARGER DRIVE TO PREVENT INJURY. CLOTHING OR BODY PARTS CAN GET CAUGHT IN BELT.**

**DISCUSSION: HAVE STUDENTS DISCUSS WHY A NORMAL MANIFOLD ABSOLUTE PRESSURE SENSOR CAN'T BE USED ON A FORCED INDUCTION MOTOR.**

**HANDS-ON TASK: HAVE YOUR STUDENTS CHECK A SUPERCHARGER'S OIL LEVEL.**

#### **Turbocharger Operation (View) (Download)**

## ICONS

## Ch09 Turbocharging and Supercharging



9. **SLIDE 9 EXPLAIN FIGURE 9-8** A turbocharger uses some of heat energy that would normally be wasted. &

10. **SLIDE 10 EXPLAIN FIGURE 9-9** turbine wheel is turned by the expanding exhaust gases.

11. **SLIDE 11 EXPLAIN FIGURE 9-10** exhaust drives turbine wheel on left which is connected to impeller wheel on right through a shaft. Bushings that support shaft are lubricated with engine oil under pressure.

12. **SLIDE 12 EXPLAIN FIGURE 9-11** Engine oil is fed to the center of the turbocharger to lubricate the bushings and returns to the oil pan through a return line

### **TURBOCHARGED ENGINE CAN HAVE HORSEPOWER OF A LARGER ENGINE BUT WITH BETTER GAS MILEAGE**

**DEMONSTRATION: SHOW TURBOCHARGER AND POINT OUT THE TURBINE, COMPRESSOR, WASTEGATE, AND LUBRICATION PASSAGES.**

**DISCUSSION: ASK YOUR STUDENTS TO COMPARE POWER CURVE OF TURBOCHARGERS TO THAT OF SUPERCHARGERS DISCUSS HOW THIS AFFECTS VEHICLE PERFORMANCE.**

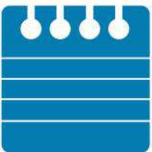
**HANDS-ON TASK: GIVE STUDENTS AN EXPLODED VIEW DIAGRAM OF A TURBOCHARGER AND HAVE THEM USE SERVICE INFORMATION TO LABEL ALL COMPONENTS.**




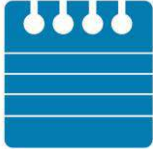









13. **SLIDE 13 EXPLAIN FIGURE 9-12** unit on top of this Subaru that looks like a radiator is the intercooler, which cools the air after it has been compressed by the turbocharger.

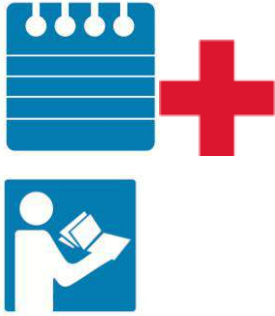
14. **SLIDE 14 EXPLAIN FIGURE 9-13** wastegate is used on many turbocharged engines to control maximum boost pressure. The wastegate is controlled by a computer-controlled valve.

**HANDS-ON TASK: HAVE STUDENTS MEASURE BOOST AT VARIOUS RPM RANGES USING A PRESSURE GAUGE OR A SCAN TOOL**

15. **SLIDE 15 EXPLAIN FIGURE 9-14** A blow-off valve is used in some turbocharged systems to relieve boost pressure during deceleration



ICONS	Ch09 Turbocharging and Supercharging
            	<p><b>EXPLAIN TECH TIP</b></p> <p><b><u>Turbocharger Blow-Off Valve (View) (Download)</u></b></p> <p><b><u>Turbocharger Wastegate (View) (Download)</u></b></p> <p>16. SLIDE 16 EXPLAIN FIGURE 9-15 dual turbocharger system installed on a small block Chevrolet V-8 engine.</p> <p><b>RELIEF VALVES ALSO PREVENT COMPRESSOR SURGING THAT CAN HURT PERFORMANCE AND DAMAGE TURBOCHARGER.</b></p> <p><b><u>DISCUSSION:</u> ASK YOUR STUDENTS TO DISCUSS WHY THEY MIGHT USE A BOV WHEN A CBV IS MUCH LESS OBTRUSIVE</b></p> <p><b><u>ON-VEHICLE TASK: NATEF TASK: TEST OPERATION OF TURBOCHARGER &amp; SUPERCHARGER SYSTEMS; DETERMINE NECESSARY ACTION</u></b></p> <p><b><u>HANDS-ON TASK: HAVE STUDENTS FIND TURBOCHARGER ENDPLAY SPECIFICATIONS IN ON-LINE SERVICE INFORMATION.</u></b></p> <p>17. SLIDE 17 EXPLAIN FIGURE 9-16 Nitrous bottles have to be mounted at an angle to ensure that the pickup tube is in the liquid N<sub>2</sub>O</p> <p><b>EXPLAIN TECH TIP</b></p> <p>18. SLIDE 18 EXPLAIN TECH TIP FIGURE 9-17 An electrical heating mat is installed on the bottle of nitrous oxide to increase the pressure of the gas inside</p> <p><b><u>DISCUSSION:</u> ASK YOUR STUDENTS TO DISCUSS THE ADVANTAGES AND DISADVANTAGES OF USING NITROUS OXIDE INSTEAD OF SUPERCHARGER OR TURBOCHARGER</b></p>

**ICONS****Ch09 Turbocharging and Supercharging**

**SAFETY NOTE: DELIBERATE INHALATION OF NITROUS OXIDE CAN HAVE SERIOUS HEALTH CONSEQUENCES BY DEPRIVING BRAIN OF OXYGEN.**

**SEARCH INTERNET: HAVE STUDENTS RESEARCH INTERNET TO FIND THE EFFECT OF ELEVATION ON VOLUMETRIC EFFICIENCY. ASK STUDENTS TO REPORT THEIR FINDINGS TO THE CLASS.**